MEETING PROGRAM & ABSTRACTS

SVP
SOCIETY OF
VERTEBRATE
PALEONTOLOGY

November 5 – 8, 2014 • Estrel Berlin • Berlin, Germany

SOCIETY OF VERTEBRATE PALEONTOLOGY
NOVEMBER 2014
ABSTRACTS OF PAPERS
74th ANNUAL MEETING

Estrel Berlin
Berlin, Germany
November 5 – 8, 2014

GESAMTÜBERSICHT
GENERAL PLAN

Estrel Convention Center

- Convention Hall
- Festival Center
- 1. Etage / First Floor
- 2. Etage / Second Floor

(42) Foyer 1
(43) Galerie (1-4) / Gallery (1-4)
(44) VIP-Galerie / VIP Gallery
(45) Künstlergarderobe (mehrstöckig) / Artist Dressing Room (multistorey)
(46) Innenhof (1+2) / Inner Courtyard (1+2)
(47) Foyer 3
(48) ECC - Raum 4 (2. Etage) / Room 4 (2nd Floor)
(49) ECC - Raum 5 (2. Etage) / Room 5 (2nd Floor)
(50) Zufahrt / Entrance Convention Center
(51) Zulieferzone / Delivery Zone Convention Center
(52) Zugang Rotunde / Entrance Rotunda
(53) Nebeneingang Räume 1-3 / Side entrances rooms 1-3

Estrel Hotel

- Flügel 1 / Wing 1
- Flügel 2 / Wing 2
- Flügel 3 / Wing 3
- Flügel 4 / Wing 4
- Restaurants / Gastronomie / Gastronomy
- Conference
- Lift
- Toiletten / Toilets
- Raucherbereich / Smoking Area

(1) Konferenzraum Antibes / Conference Room Antibes
(2) Business Center / Business Center
(3) Estrel Stube
(4) Gepäckraum / Luggage Room
(5) Rezeption / Reception
(6) Concierge / Ticketcounter
Konferenz-Service / Conference Service
(7) Geldautomat / Cash Machine
Telefon / Telephone
(8) Konferenzraum Straßburg / Conference Room Straßburg
(9) Minimarkt / Hotel Shop
(10) Kleine Galerie / Small Gallery
(11) Konferenzraum Lyon / Conference Room Lyon
(12) Große Galerie / Large Gallery
(13) Konferenzraum Paris / Conference Room Paris
(14) Estrel Saal A, B, C / Estrel Hall A, B, C
(15) Foyer Estrel Saal / Foyer Estrel Hall
(16) Passage Estrel Saal / Passage Estrel Hall
(17) Sun-Thai - Asiatisches Restaurant / Asian Restaurant
(18) Portofino - Italienisches Restaurant / Italian Restaurant
(19) La Patisserie
(20) Sanssouci - Internationale Spezialitäten / International Specialities
(21) Pianobar
(22) Atriumbar
(23) Orangerie (1. Etage / 1st Floor)
(24) Terrasse / Terrace
(25) Konferenzraum Saint Tropez / Conference Saint Tropez
(26) Konferenzraum Nizza / Conference Room Nizza
(27) Konferenzraum Cannes / Conference Room Cannes

(28) Zufahrt Hotel-Tiefgarage / Entrance Underground Garage Hotel
(29) Taxistand / Taxi Rank
(30) Sommergarten / Summer Garden
(31) Bootsanleger / Landing Pier
(32) Bahnhof / Train Station
(33) Atrium
(34) Rotunde / Rotunda
(Übergang zum Festival- und Convention Center / Passage to Festival and Convention Center)

Weiterhin finden Sie in / In addition you find on:

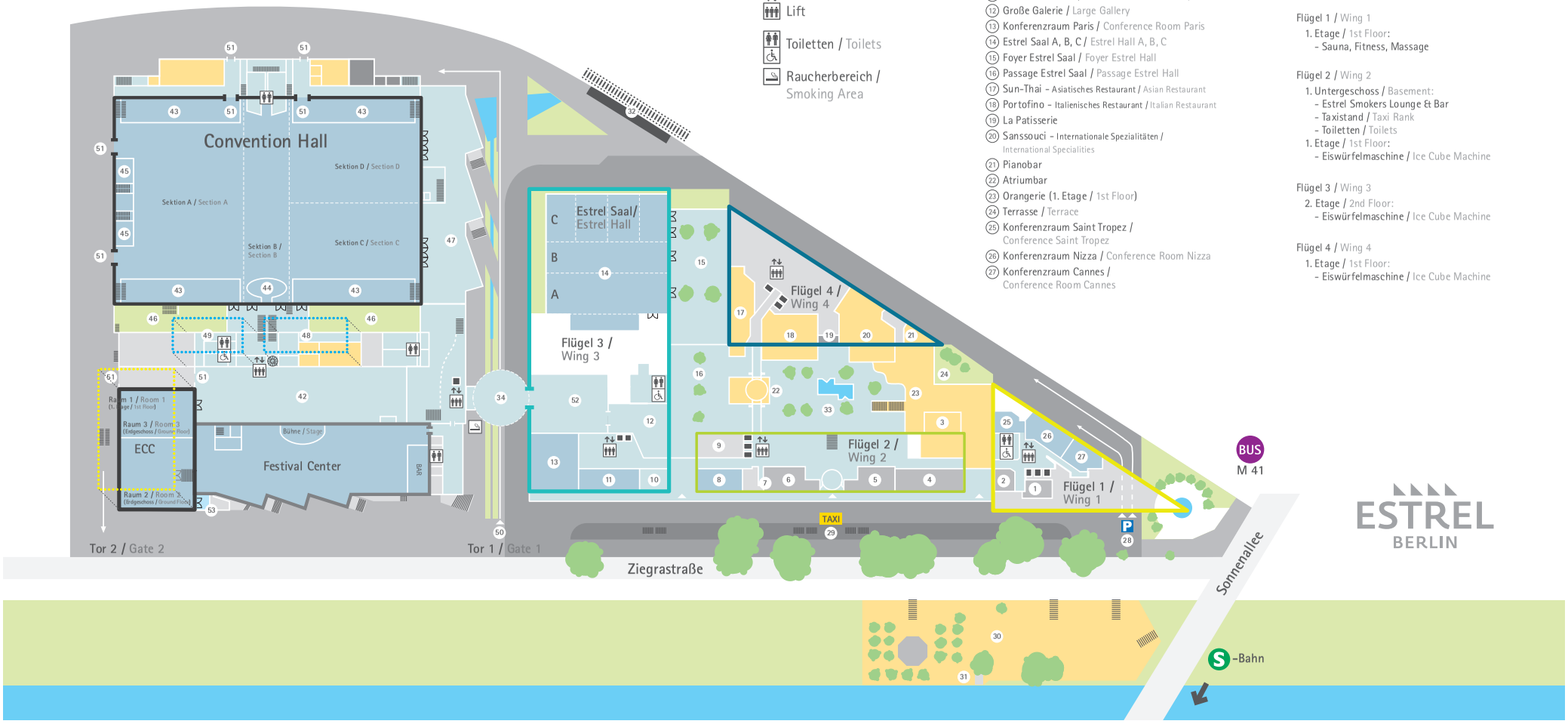
Flügel 1 / Wing 1
1. Etage / 1st Floor:
- Sauna, Fitness, Massage

Flügel 2 / Wing 2
1. Untergeschoss / Basement:
- Estrel Smokers Lounge & Bar
- Taxistand / Taxi Rank
- Toiletten / Toilets

1. Etage / 1st Floor:
- Eiswürfelmaschine / Ice Cube Machine

Flügel 3 / Wing 3
2. Etage / 2nd Floor:
- Eiswürfelmaschine / Ice Cube Machine

Flügel 4 / Wing 4
1. Etage / 1st Floor:
- Eiswürfelmaschine / Ice Cube Machine



WELCOME TO BERLIN

It is a great honor and pleasure for the Host Committee to welcome you to the 74th Annual Meeting of the Society of Vertebrate Paleontology in Berlin, Germany. The meeting will take place at the Estrel Convention Center conveniently situated in the southern part of the city, in immediate proximity to Berlin's excellently developed public transit system and the city highway, allowing you get to around quickly.

This is only the second time that the meeting takes place outside North America, and the first time it is held in continental Europe. Hosted by the Museum für Naturkunde Berlin, our Committee consists entirely of staff members from this institution. Since the German reunification and especially in the last decade, the museum underwent some dramatic changes. The main parts of the exhibition were completely redone, and by now our classic dinosaur hall not only displays the largest mounted dinosaur in the world, *Brachiosaurus brancai*, but also, for the first time since its acquisition in 1880, the famous Berlin specimen of *Archaeopteryx lithographica*. In addition, the museum's East wing, which had been left as a ruin since the allied bombings from 1945, was entirely rebuilt to house the zoological wet collections, and in 2011 was awarded the renowned *Prize for Architecture in Germany*. We are very happy and proud to have the opportunity to showcase the museum's extensive renovations at our Welcome Reception.

Like probably no other city in the world, Berlin illustrates and reflects the history of the past century. Be it the flair of the 1920's, the horrors of Nazi dictatorship and World War II, or the Cold War and the Wall – they all left an imprint in both the city's structure and atmosphere that can still be witnessed today. Berlin is also famous for its arts scene and culture. Just to name but a few possibilities, there is Museum Island, a UNESCO World Heritage Site showing the cultural history of mankind from its early beginnings to the verge of modern times. The Jewish Museum and the New National Gallery are further excellent opportunities, and for those interested in classical music Berlin's three opera houses and the world famous Berlin Philharmonic offer just another wide range of options. Berlin is also one of the greenest capitals in the world with many large parks and recreation areas. And not to forget the very international culinary landscape with diverse restaurants, bars, clubbing and nightlife!

Germany has a long research tradition in paleontology, and some of the most famous fossil sites can be found here. It is our pleasure to offer you field trips for every kind of taste, ranging from the Paleozoic to (almost) the Present and covering important localities such as the Permian Bromacker quarry, the Jurassic Solnhofen limestones, and the Eocene Messel Pit World Heritage Site. We also have a variety of workshops covering a wide range of topics that we are sure will gain your interest.

The 74th meeting of the Society of Vertebrate Paleontology represents a great opportunity for researchers from all around the world to exchange ideas and further advance our discipline. We are convinced that you will enjoy the meeting, its fieldtrips and its workshops, and that Berlin's historical flavor and vibrant cultural life will make your stay a memorable experience. Welcome to the city where the East meets the West!

74th Annual Meeting Host Committee

PRESENTATION POLICIES

SVP Abstracts are reviewed by the Program Committee and occasionally by outside reviewers. Authors are responsible for the technical content of their articles.

Unless specified otherwise, coverage of abstracts presented orally at the Annual Meeting is strictly prohibited until the start time of the presentation, and coverage of poster presentations is prohibited until the relevant poster session opens for viewing. As defined here, "coverage" includes all types of electronic and print media; this includes blogging, tweeting, advanced online publication and other intent to communicate or disseminate results or discussion presented at the SVP Annual Meeting.

Still photography, video and/or audio taping or any other electronic recording at the SVP Annual Meeting is strictly prohibited. (The SVP reserves the right to engage professional photographers or audo/videotape professionals to archive sections of the Meeting for the Society's use.)

Editorial policies of Science and Nature magazine: If you are planning to submit, or have submitted, your publication to Science or Nature, be sure you are familiar with their embargo policies.

Please address any questions about program practices to the Program Committee or to the Executive Committee.

Citing an Abstract in the 2014 SVP Program and Abstracts Book
This Program and Abstracts Book is an official supplement to the online version of the *Journal of Vertebrate Paleontology.* The citation format for an abstract printed in this book is: *Journal of Vertebrate Paleontology*, Program and Abstracts, 2014, <insert page number here>.

2014 SVP Schedule of Events (subject to change)

All events are held at the Estrel Berlin unless otherwise noted with an **

Event/Function	TUE, November 4	WED, November 5	THUR, November 6	FRI, November 7	SAT, November 8
Registration Desk	2:00pm – 7:00 pm **ROTUNDA**	7:00 am – 5:00 pm **ROTUNDA**	7:00 am – 5:00 pm **ROTUNDA**	7:30 am – 4:00 pm **ROTUNDA**	7:30 am – 4:00pm **ROTUNDA**
Symposium		8:00 am – 12:15 pm *Archaeopteryx* – The Iconic Fossil in Modern View **HALL A**	1:45 pm – 4:15 pm The Influence of R. McNeill Alexander on Paleobiological Inferences **HALL A**	8:00 am – 12:15 pm Putting Fossils in Trees: New Methods for Combining Morphology, Time, and Molecules to Estimate Phylogenetic Position and Divergence Times of Living and Fossil Taxa **HALL A** 8:00 am – 12:15 pm The Lives of Temnospondyls: Investigations into their Biology **HALL C**	1:45 pm – 4:15 pm Ecometrics: Quantitative Trait-Based Approaches to Biotic Change **HALL A**
Romer Prize Session			8:00 am – 12:15 pm **HALL A**		
Preparators' Symposium					1:45 pm – 4:15 pm **HALL D**
Technical Sessions		8:00 am – 12:15 pm Technical Session I Cetrtiodactyla and Marine Mammals **HALL C**	8:00 am – 12:15 pm Technical Session VI Euarchontoglires **HALL C**	8:00 am – 12:15 pm Technical Session X Neogene Mammalia **HALL D**	8:00 am – 12:15 pm Technical Session XIV Mesozoic Reptiles **HALL A**
		8:00 am – 12:15 pm Technical Session II Mesozoic Vertebrates, primarily Mammali **HALL D**	8:00 am – 12:15 pm Technical Session VII Archosaurs **HALL D**	1:45 pm – 4:15 pm Technical Session XI Mammalian Dietary Ecology **HALL A**	8:00 am – 12:15 pm Technical Session XV General Methods and Macroevolutionary Patterns **HALL C**
		1:45 pm – 4:15 pm Technical Session III Theropod Dinosaurs **HALL A**	1:45 pm – 4:15 pm Technical Session VIII Paleogene Mammals **HALL C**	1:45 pm – 4:15 pm Technical Session XII Amniotes and Early Reptiles **HALL D**	8:00 am – 12:15 pm Technical Session XVI Fishes and Early Tetrapods **HALL D**
		1:45 pm – 4:15 pm Technical Session IV Cenozoic Mammals **HALL C**	1:45 pm – 4:15 pm Technical Session IX Squamates **HALL D**	1:45 pm – 4:15 pm Technical Session XIII Paleozoic Fishes **PARIS**	1:45 pm – 4:15 pm Technical Session XVII Permo-Triassic Tetropods **HALL C**
		1:45 pm – 4:15 pm Technical Session V Amphibians **HALL D**			

Event/Function	TUE, November 4	WED, November 5	THUR, November 6	FRI, November 7	SAT, November 8
Poster Sessions Set-up: 7:30 am – 9:30 am		Poster Session I: 9:30 am – 6:15 pm Reception: 4:15 pm – 6:15 pm **ROOMS 2 and 3**	Poster Session II: 9:30 am – 6:15 pm Reception: 4:15 pm – 6:15 pm **ROOMS 2 and 3**	Poster Session III: 9:30 am – 6:15 pm Reception: 4:15 pm – 6:15 pm **ROOMS 2 and 3**	Poster Session IV: 9:30 am – 6:15 pm Reception: 4:15 pm – 6:15 pm **ROOMS 2 and 3**
Exhibit Viewing		9:30 am – 6:15 pm **ROOMS 2 and 3**	9:30 am – 6:15 pm **ROOMS 2 and 3**	9:30 am – 6:15 pm **ROOMS 2 and 3**	9:30 am – 6:15 pm **ROOMS 2 and 3**
SVP Business Meeting and Open Forum			12:30pm – 1:30pm **HALL A**		
Preparators' Meeting			2:00pm – 3:30pm **ROOM 4**		
Social Events	7:30pm – 8:30pm Special Presentation by Professor Hans W. Fricke ****MUSEUM FUR NATURKUNDE, LECTURE HALL 7**	7:30pm – 10:30pm Welcome Reception ****MUSEUM FUR NATURKUNDE**	7:30pm – 11:30pm Student Roundtable Forum and Reprint Exchange **HALL C**	6:30pm – 12:00 am Auction **HALL C**	7:00pm – 10:00pm Awards Ceremony **HALL A** 10:00pm – 1:00 am After Hours Party **HALL C/D**

***Please note: There is no Speaker Ready Room this year. Please take your presentation to the session room at least 30 minutes in advance of your presentation.**

2014 SVP Workshop Offerings

For Pre-registered Attendees

Day					
MON, November 3	9:00 am – 5:00pm Phylogeny, Evolution, and Biochronology of the Arvicolidae **Museum für Naturkunde, Paleontological Seminar Room**				
TUE, November 4	8:30 am – 5:30pm Paleopathology – Establishing Criteria for Recognizing Bone Pathologies **Museum für Naturkunde, Paleontological Seminar Room**	10:00 am – 4:00pm Tip-Dating: Estimating Dated Phylogenies Using Fossils as Terminal Taxa **The Leibniz Headquarters**	1:00pm – 4:00pm Inferring Diet and Dental Function from Dental Microwear Textures **Museum für Naturkunde, Lecture Hall 8**		

2014 SVP Field Trip Offerings

For Pre-registered Attendees

Day	
THUR, October 30 – TUE, November 4	Famous Vertebrate Fossillagerstätten in Souther and Central Germany **Time:** Field Trip will depart from the Frankfurt Airport at 12:00 noon on October 30, and arrive at 6:00pm on November 4 at the Estrel Berlin (headquarters hotel) **Pick up Location:** Frankfurt Airport **Drop off Location:** Estrel Berlin
SUN, November 2 – TUE, November 4	Tetrapods and Fishes from the Pennsylvanian and Permian of Saxonia and Thuringia **Time:** Field Trip will depart at 8:00 am and arrive at 6:00pm **Pick up/Drop off Location:** Estrel Berlin
MON, November 3 – TUE, November 4	Messel, Geiseltal and Rome: Highlights from the Cenozoic **Time:** Field Trip will depart at 8:30 am on November 3 and arrive in the early evening on November 4 **Pick up Location:** Hotel Corona in downtown Frankfurt am Main **Drop off Location:** Estrel Berlin
SUN, November 9	Field Trip to Rüdersdorf and Niederlehme **Ends:** 8:30 am - 4:30pm **Pick up/Drop off Location:** Museum für Naturkunde

PROGRAM AT A GLANCE

	Hall A	Hall C	Hall D	Hall A	Hall C	Hall D
	Symposium 1: *Archaeopteryx* – The Iconic Fossil in Modern View	**Technical Session I**	**Technical Session II**	**Romer Prize Session**	**Technical Session VI**	**Technical Session VII**
	WED	**WED**	**WED**	**THUR**	**THUR**	**THUR**
8:00 am	O'Connor	Mihlbachler	Niedzwiedzki	Yi	Schmerge	Peecook
8:15 am	Dyke	Roessner	Prasad	Vietti	Kraatz	Ezcurra
8:30 am	Rauhut	Heckeberg	Meyer	Schmitt	Tomiya	Stocker
8:45 am	Kundrat	Maier	Marzola	Rabi	Flynn	Sobral
9:00 am	Erickson	Bibi	Jacobs	Pimiento	Smiley	Dzikiewicz
9:15 am	Balanoff	Faith	Bell	Kolb	Bertrand	Foffa
9:30 am	Longrich	Costeur	Martin	Jones	Morse	Müller
9:45 am	Habib	Boisserie	Crompton	Grass	Silcox	Gignac
10:00 am	COFFEE					
10:15 am	Carney	Lihoreau	Hoffmann	Dunn	Beard	Mannion
10:30 am	Schwarz-Wings	Gingerich	Zhang	Cuff	Kemp	Wilberg
10:45 am	Lefevre	Bebej	Bolortsetseg	Clarke	Asher	Baier
11:00 am	Moyer	Loch	Corfe	Button	Cote	Cerio
11:15 am	Bhullar	Corrie	Bamforth	Burch	Casanovas Vilar	Vinther
11:30 am	Benton	Park	Williamson	Brown	Almécija	Padian
11:45 am	Mitchell	Buchholtz	Grossnickle	Brocklehurst	Scott	Unwin
12:00 pm	Smith	Crerar	Halliday	Bales	Wroe	Dean
12:15 pm	**BREAK**					
1:30 pm						
	Hall A	**Hall C**	**Hall D**	**Hall A**	**Hall C**	**Hall D**
	Technical Session III	**Technical Session IV**	**Technical Session V**	**Symposium 2: The Influence of R. McNeill Alexander on Paleobiological Inferences**	**Technical Session VIII**	**Technical Session IX**
1:45 pm	Langer	Macphee	Gao	Palmer	Theodor	Gearty
2:00 pm	Stiegler	Sánchez-Villagra	Vanburen	Christian	Secord	Polcyn
2:15 pm	Foth	Finarelli	Chen	Rayfield	Rose	Campbell
2:30 pm	Ibrahim	Weisbecker	Baez	Snively	Franzen	Simoes
2:45 pm	Gold	Morris	Vasilyan	Preuschoft	Gheerbrant	Conrad
3:00 pm	Hendricks	Couzens	Zhang	Janis	Sanders	Caldwell
3:15 pm	Lauters	Cook	Stein	Hutchinson	Smith	Hsiang
3:30 pm	Funston	Beck	Maddin	Otero	Borths	Werning
3:45 pm	Tanaka	Attard	Kawano	Sellers	Habersetzer	Mahlow
4:00 pm	Varricchio	Sharp	Boehmer	Falkingham	Emerson	Kemp
4:15 pm	*Poster Session I*			*Poster Session II*		
6:15 pm						

	Hall A	Hall D	Hall C	Hall A	Hall C	Hall D
	Symposium 3: Putting Fossils in Trees	**Technical Session X**	**Symposium 4: The Lives of Temnospondyls: Investigations into their Biology**	**Technical Session XIV**	**Technical Session XV**	**Technical Session XVI**
	FRI	**FRI**	**FRI**	**SAT**	**SAT**	**SAT**
8:00 am	Matzke	Hooker	Marjanovi	Morhardt	Alroy	Coates
8:15 am	Irmis	Sansalone	Ruta	Bourke	Fraser	Richards
8:30 am	Wagner	Thompson	Marsicano	Maidment	Madden	Fischer
8:45 am	Guillerme	Su	Beightol	Hill	Mychajliw	Criswell
9:00 am	Pol	Rincon	Sengupta	Campione	Van Der Geer	Underwood
9:15 am	Clarke	Rabinovich	Sanchez	Romilio	Kilbourne	Sferco
9:30 am	Puttick	Samonds	Konietzko-Meier	Barrett	Macleod	Davesne
9:45 am	Warnock	Lewis	Mukherjee	Prieto-Marquez	Watanabe	Close
10:00 am	COFFEE					
10:15 am	Ksepka	Saila	Danto	Kay	Clavel	Cloutier
10:30 am	O'Reilly	Goswami	Fortuny	Zheng	Mabee	Qu
10:45 am	Friedman	Tseng	Reisz	Nair	Pian	Lemberg
11:00 am	Turner	Balisi	Steyer	Upchurch	Biller	Clement
11:15 am	Wright	Shaw	Witzmann	Fronimos	Castanhinha	Richter
11:30 am	Brochu	Wang	Pérez Ben	Moon	Koyabu	Clack
11:45 am	Gorscak	Miller	Milner	Maxwell	Chatterjee	Mondéjar-Fernández
12:00 pm	Lloyd	Barnosky	Scheyer	Schumacher	Ferreira Cardoso	Porro
12:15 pm	**BREAK**					
1:30 pm						
	Hall A	**Hall D**	**Paris**	**Hall A**	**Hall C**	**Hall D**
	Technical Session XI	**Technical Session XII**	**Technical Session XIII**	**Symposia 5: Ecometrics**	**Technical Session XVII**	**Preparators' Symposium**
1:45 pm	Clementz	Turner	Keating	Badgley	Olroyd	Behlke
2:00 pm	Haveles	Richards	Scott	Bernor	Sidor	Brown
2:15 pm	Bocherens	Leblanc	Miyashita	Damuth	Sues	Jabo
2:30 pm	Patterson	Sumida	Trinajstic	Stegner	Shelton	Capobianco
2:45 pm	Ungar	Verriére	Rücklin	Schnitzler	Huttenlocker	Knötschke
3:00 pm	Karme	Nicholson	Sallan	Stenseth	Fröbisch	Van Beek
3:15 pm	DeSantis	Bever	Giles	Werdelin	Jansen	Fitzgerald
3:30 pm	Rivals	Lyson	López-Arbarello	Fritz	Laaß	Fox
3:45 pm	Reed	Pritchard	Chevrinais	Meachen	Walther	Davidson
4:00 pm	Davis	Buchwitz	Brazeau	Head	O'Meara	Eklund
4:15 pm	*Poster Session III*			*Poster Session IV*		
6:15 pm						

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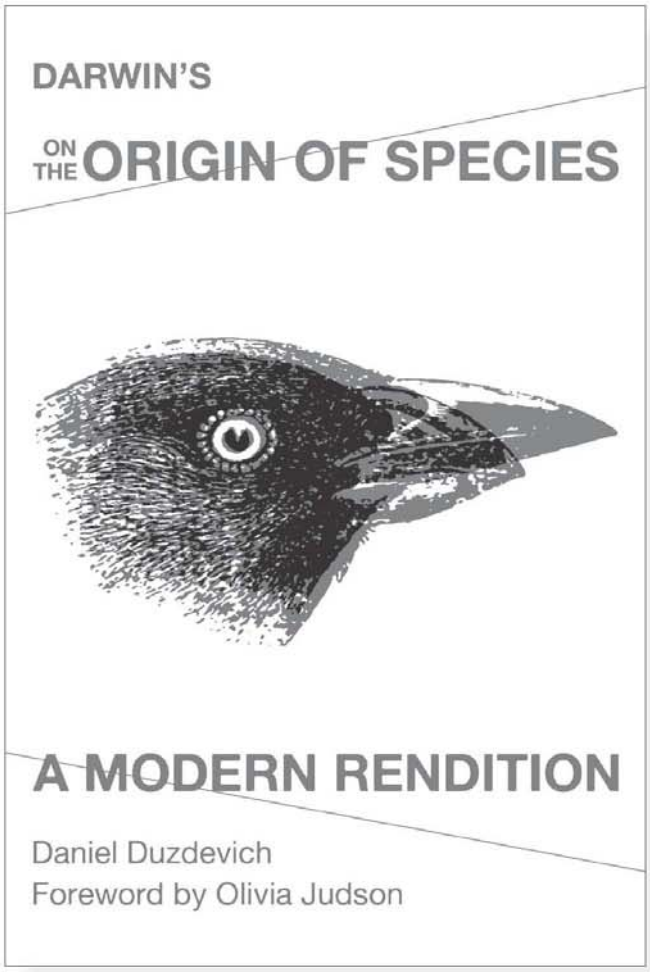

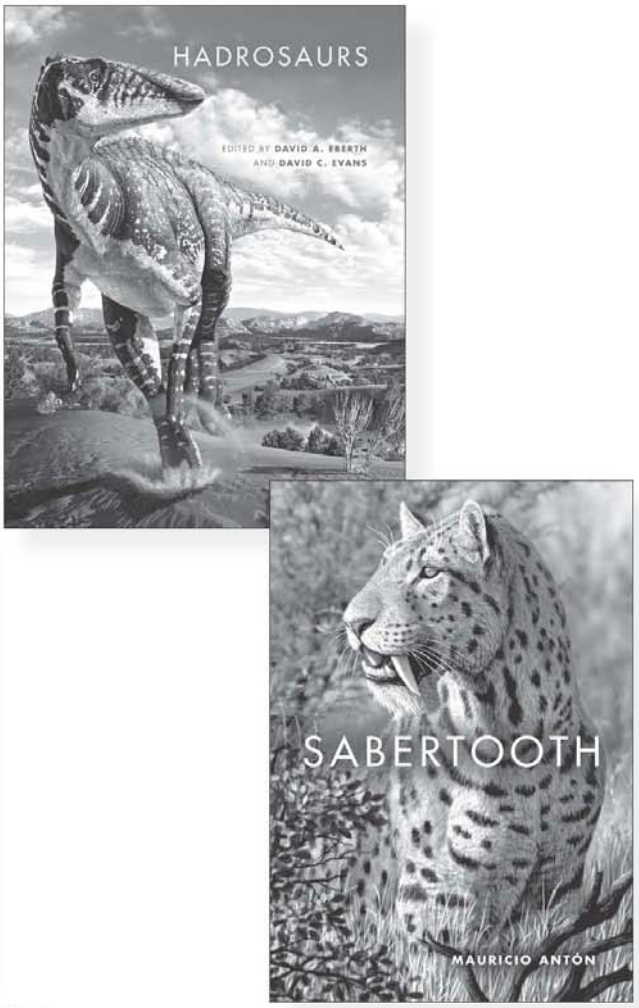

Darwin's On the Origin of Species: A Modern Rendition

Daniel Duzdevich

"Daniel Duzdevich's modern rendition of the 1859 text is a most useful addition to the general understanding of this major revision in biology. He has presented a full account of Darwin's ideas in the original and in a form that makes them far more understandable to the reader who is not a specialist in evolutionary theory."

—Walter Bock, Columbia University

At the Top of the Grand Staircase: The Late Cretaceous of Southern Utah

Edited by Alan L. Titus and Mark A. Loewen

"What was once a terra incognito has now become one of the most exciting areas for paleontological research in the world..."

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Cambrian Ocean World: Ancient Sea Life of North America

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Hadrosaurs

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Sabertooth

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"The best paleomammal artist working today [and] his knowledge of sabertooths and their evolution is second to none."

- Lars Werdelin, Swedish Museum of Natural History

Dinosaurs and Other Reptiles from the Mesozoic of Mexico

Edited by Héctor E. Rivera-Sylva, Kenneth Carpenter, and Eberhard Frey

Fossils of the Carpathian Region

István Fozy and István Szente

"A rich source of otherwise not published background knowledge on the paleontology and geology of the region."

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RECOGNITION OF MAJOR DONORS

The following people have made substantial donations to SVP funding initiatives from November 1, 2013, through June 5, 2014. SVP thanks them for their generous support.

Many of our members sponsored student memberships in 2013. Whether you gave a partial membership or donated several memberships, the Society is truly grateful for your generosity and your support of our students.

Information regarding all SVP funds and how to donate to those funds can be found on our website at www.vertpaleo.org. Anyone wishing to make a donation to the Society should contact the SVP business office at: svp@vertpaleo.org or +1-301-634-7814.

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Andre Wyss

SVP Congratulates the 2014 Award Winners

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Hans-Peter Schultze

Gregory Service Award
Catherine Badgley

Morris Skinner Prize
Richard Smith

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Julius Csotonyi

Lanzendorf PaleoArt Prize Scientific Illustration
Robert Laws

Lanzendorf PaleoArt Prize Sculpture
A. and A. Kennis

Lanzendorf PaleoArt Prize Modeling/Animation
Chris Sloan

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Honorary Member Award
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Sanaa El-Sayed

Student Awards

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Eugenia Gold

Estes Graduate Research Grant
Tetsuto Miyashita

Patterson Student Fieldwork Grant
Mohamed Abdel Gawad

Wood Student Research Award
Katharine Criswell

Taylor & Francis Award for Best Student Article in JVP - First Place
Anthony Romillio

Taylor & Francis Award for Best Student Article in JVP - Second Place
Hillary Maddin

JSG Student Travel Awards

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Mairin Balisi
Matthew Borths
Robert Burroughs
Katharine Criswell
Stephanie Crofts
Thomas Cullen
Susan Drymala
Sara ElShafie
Lauren English
Elizabeth Ferrer
Daniel Field
Georgio Georgalis
Ryan Haupt
Sergi Lopez-Torres
Zachary Morris
Alexis Mychajliw
Jay Nair
Nirina Ratsimbaholison
Alana Sharp
Adriana Strapasson de Souza
Caitlin Syme
April Wright
Roberto Yury

WEDNESDAY MORNING, NOVEMBER 5, 2014

SYMPOSIUM 1: *ARCHAEOPTERYX* - THE ICONIC FOSSIL IN MODERN VIEW

ESTREL BERLIN, HALL A

MODERATORS: Daniela Schwarz-Wings and Martin Kundrat

8:00 **O'Connor, J., Zhou, Z.** EARLIEST STAGES IN THE EVOLUTION OF THE MODERN AVIAN SKELETON: *ARCHAEOPTERYX* AND THE JEHOL AVIFAUNA COMPARED

8:15 **Dyke, G., Cau, A., Naish, D., Brougham, T., Godefroit, P.** *ARCHAEOPTERYX* AND PARAVIAN PHYLOGENY: THE ENIGMA OF *BALAUR*

8:30 **Rauhut, O., Foth, C.** NEW INFORMATION ON THE THEROPOD DINOSAURS FROM THE LATE JURASSIC LITHOGRAPHIC LIMESTONES OF SOUTHERN GERMANY

8:45 **Kundrat, M., Albersdoerfer, R., Nudds, J., Ahlberg, P.** THE DAITING SPECIMEN OF *ARCHAEOPTERYX*

9:00 **Erickson, G., Rauhut, O. W., Röper, M., Lochner, E., Norell, M.** LONG BONE HISTOLOGY, GROWTH, AND THE 'BLOOD' OF *ARCHAEOPTERYX*

9:15 **Balanoff, A.** *ARCHAEOPTERYX* AND THE EVOLUTION OF THE PARAVIAN BRAIN

9:30 **Longrich, N.** PRIMITIVE FEATHER ARRANGEMENT IN *ARCHAEOPTERYX LITHOGRAPHICA* SHEDS LIGHT ON THE ORIGIN AND EVOLUTION OF BIRDS

9:45 **Habib, M.** RECONSTRUCTING LOCOMOTOR PERFORMANCE IN *ARCHAEOPTERYX*

10:00 BREAK

10:15 **Carney, R., Molnar, J., Updike, E., Brown, W., Jackson, J., Shawkey, M., Lindgren, J., Sjövall, P., Falkingham, P., Gauthier, J.** *ARCHAEOPTERYX* IN 4D

10:30 **Schwarz-Wings, D., Kundrat, M.** POSTCRANIAL SKELETAL PNEUMATICITY IN *ARCHAEOPTERYX*

10:45 **Lefevre, U., Cau, A., Hu, D., Wu, W., Escuillié, F., Godefroit, P.** NEW BASAL AVIALAE FROM THE JURASSIC OF CHINA

11:00 **Moyer, A., Zheng, W., Schweitzer, M.** USING DEGRADATION EXPERIMENTS OF EXTANT FEATHERS TO ADDRESS THE PRESENCE OF MICROBODIES IN FOSSIL FEATHERS

11:15 **Bhullar, B., Abzhanov, A., Gauthier, J.** A SIMPLE MOLECULAR MECHANISM FOR THE ORIGIN OF THE AVIAN ROSTRAL AND PALATAL SKELETON

11:30 **Benton, M., Puttick, M., Prieto Marquez, A., Hone, D.** KEY CHARACTERS AND EVOLUTIONARY RATES IN THE ORIGIN OF BIRDS

11:45 **Mitchell, J.** ECOLOGICAL EVOLUTION IN AVES: TESTING EVOLUTIONARY MODELS AGAINST FOSSIL DATA

12:00 **Smith, N., Heins, L.** PHYLOGENETICALLY INFORMED SKELETAL MORPHOMETRIC PREDICTORS OF BODY MASS IN THE DIVERSE 'WATERBIRD' CLADE (TETRAPODA, AVES)

WEDNESDAY MORNING, NOVEMBER 5, 2014

TECHNICAL SESSION I

ESTREL BERLIN, HALL C

MODERATORS: Matthew Mihbachlar and Jean-Renaud Boisserie

8:00 **Mihlbachler, M., Lau, T., Kapner, D., Shockey, B.** COEVOLUTION OF THE SHOULDER AND KNEE IN UNGULATES: IMPLICATIONS FOR THE EVOLUTION OF LOCOMOTION AND STANDING

8:15 **Roessner, G., Jost, J., Azanza, B., Costeur, L.** NEW EVIDENCE OF EARLY CERVIDS AND PHYLOGENETIC IMPLICATIONS

8:30 **Heckeberg, N., Asher, R.** ARTIFICIAL EXTINCTION AND THE IMPACT OF MISSING DATA ON THE PHYLOGENY OF CERVIDAE (MAMMALIA, RUMINANTIA)

8:45 **Maier, W., Ruf, I.** DIRECT CONNECTION BETWEEN CAVUM TYMPANI AND CAVUM CRANII: A NEW APOMORPHY OF RUMINANTS (CETARTIODACTYLA, MAMMALIA)

9:00 **Bibi, F., Bärmann, E.** PHYLOGENY OF FOSSIL AND LIVING RUMINANTS BASED ON A LARGE MATRIX OF OSTEOLOGICAL CHARACTERS

9:15 **Faith, J., O'Brien, H., Tryon, C., Jenkins, K., Peppe, D.** EXTREME NASAL DOMING IN NEW MATERIAL OF THE PLEISTOCENE ALCELAPHINE *RUSINGORYX ATOPOCRANION* (ARTIODACTYLA, BOVIDAE) FROM RUSINGA ISLAND, KENYA: RE-DESCRIPTION AND FUNCTIONAL ANALYSIS

9:30 **Costeur, L., Mennecart, B., Métais, G.** LARGE SCALE MICRO-CT BASED RECONSTRUCTIONS OF THE INNER EARS OF LIVING AND FOSSIL RUMINANTS GIVE NEW INSIGHTS INTO PECORA PHYLOGENY

9:45 **Boisserie, J.** THE HIPPOPOTAMINE EVENT

10:00 BREAK

10:15 **Lihoreau, F., Boisserie, J., M'Bua, E., Ducrocq, S.** A NEW ANTHRACOTHERE FROM THE OLIGOCENE OF KENYA EVENTUALLY ROOTS THE HIPPOPOTAMIDAE DEEP INTO THE PALEOGENE

10:30 **Gingerich, P., Antar, M., Zalmout, I.** SKELETON OF A NEW PROTOCETID (CETACEA, ARCHAEOCETI) FROM THE LOWER GEHANNAM FORMATION OF WADI AL HITAN IN EGYPT: SURVIVAL OF A PROTOCETID INTO THE PRIABONIAN LATE EOCENE

10:45 **Bebej, R., Braun, M., Valk, J.** ANATOMY AND FUNCTION OF THE TAIL IN THE PROTOCETID ARCHAEOCETE *MAIACETUS INUUS* (MAMMALIA, CETACEA): INSIGHTS INTO THE EVOLUTION OF TAIL-POWERED SWIMMING IN EARLY CETACEANS

11:00 **Loch, C., Kieser, J., Fordyce, R.** THE ENAMEL ULTRASTRUCTURE OF FOSSIL CETACEANS (CETACEA, ARCHAEOCETI AND ODONTOCETI)

11:15 **Corrie, J., Fordyce, R. E.** THE ECOMORPHOLOGY OF NEW ZEALAND KEKENODONTIDS AND IMPLICATIONS FOR NICHE PARTITIONING WITH EARLY NEOCETI

11:30 **Park, T., Evans, A., Fitzgerald, E., McHenry, C.** TOOTHED MYSTICETE COCHLEAR MORPHOLOGY PROVIDES EVIDENCE FOR A GRADUAL SPECIALISATION TOWARD LOW FREQUENCY HEARING AND INABILITY TO ECHOLOCATE

11:45 **Buchholtz, E., Wayrynen, K., Lin, I.** GLOBAL REPATTERNING OF THE AXIAL SKELETON IN *TRICHECHUS* (SIRENIA, MAMMALIA)

12:00 **Crerar, L., Crerar, A., Domning, D., Parsons, E.** REWRITING THE HISTORY OF AN EXTINCTION: WAS A SECOND ISOLATED POPULATION OF STELLER'S SEA COWS (*HYDRODAMALIS GIGAS*) DRIVEN TO EXTINCTION FIRST?

WEDNESDAY MORNING, NOVEMBER 5, 2014

TECHNICAL SESSION II

ESTREL BERLIN, HALL D

MODERATORS: Christian Meyer and Louis Jacobs

8:00 **Niedzwiedzki, G., Pienkowski, G.** TETRAPOD TRACK RECORDS ACROSS THE TRIASSIC-JURASSIC BOUNDARY IN POLAND

8:15 **Prasad, G., Parmar, V., Kumar, D.** RECENT VERTEBRATE FOSSIL DISCOVERIES FROM THE JURASSIC KOTA FORMATION OF INDIA

8:30 **Meyer, C., Marty, D.** THE RECURRENT RECORD OF TERRESTRIAL ENVIRONMENTS IN THE LATE JURASSIC OF THE SWISS JURA MOUNTAINS: IMPLICATIONS FOR PALEOGEOGRAPHIC RECONSTRUCTIONS

8:45 **Marzola, M., Mateus, O., Schulp, A., Jacobs, L., Polcyn, M., Pervov, V.** EARLY CRETACEOUS TRACKS OF A LARGE MAMMALIAMORPH, A CROCODYLOMORPH, AND DINOSAURS FROM AN ANGOLAN DIAMOND MINE

9:00 **Jacobs, L., Polcyn, M., Mateus, O., Scott, M., Graf, J., Kappelman, J., Jacobs, B., Schulp, A., Morais, M., Goncalves, O.** CENOZOIC VERTEBRATES OF COASTAL ANGOLA

9:15 **Bell, M., Upchurch, P., Mannion, P., Benson, R., Goswami, A.** EXTRATROPICAL PEAKS IN CRETACEOUS TERRESTRIAL VERTEBRATE DIVERSITY: THE INFLUENCE OF PRIMARY PRODUCERS ON VERTEBRATE SPECIES DISTRIBUTION

9:30 **Martin, T., Averianov, A., Lopatin, A., Schultz, J.** MAMMALS FROM THE MIDDLE JURASSIC OF WESTERN SIBERIA

9:45 **Crompton, A., Bhullar, B., Musinsky, C.** ORIGIN OF MAMMALIAN PHARYNGEAL MUSCULATURE

10:00 BREAK

10:15 **Hoffmann, S., Krause, D., Wible, J., Seiffert, E.** NEW INSIGHTS FROM THE FIRST CRANIAL REMAINS OF A GONDWANATHERIAN AND IMPLICATIONS FOR MAMMALIAFORM PHYLOGENY

10:30 **Zhang, Y., Hunter, J.** PHYLOGENETIC ANALYSIS OF NEOPLAGIAULACIDAE (MAMMALIA, MULTITUBERCULATA) AND ITS IMPLICATIONS

10:45 **Bolortsetseg, M.** A TOTAL EVIDENCE PHYLOGENY OF MULTITUBERCULATA

11:00 **Corfe, I., Wilson, G. P., Evans, A., Jernvall, J.** TESTING DEVELOPMENTAL BIOLOGY PREDICTIONS WITH FOSSILS: DENTAL COMPLEXITY AND EVOLUTIONARY RATES OF THE MULTITUBERCULATA

11:15 **Bamforth, E., Larsson, H.** TERRESTRIAL BIODIVERSITY IMMEDIATELY PRIOR TO THE END-CRETACEOUS MASS EXTINCTION IN CENTRAL CANADA: PATTERNS AND PROCESSES

11:30 **Williamson, T., Peppe, D., Heizler, M., Brusatte, S., Secord, R.** CHRONOSTRATIGRAPHY OF THE CRETACEOUS-PALEOGENE TRANSITION IN THE SAN JUAN BASIN, NORTHWESTERN NEW MEXICO

11:45 **Grossnickle, D., Luo, Z.** MORPHOLOGICAL DISPARITY PATTERNS OF CRETACEOUS AND EARLY PALEOCENE THERIANS

12:00 **Halliday, T., Upchurch, P., Goswami, A.** PALAEOCENE TAXA SUPPORT A CRETACEOUS ORIGIN AND CENOZOIC DIVERSIFICATION OF PLACENTAL MAMMALS

WEDNESDAY AFTERNOON, NOVEMBER 5, 2014

TECHNICAL SESSION III

ESTREL BERLIN, HALL A

MODERATORS: Max Langer and David Varricchio

1:45 **Langer, M., Rincón, A., Ramezani, J., Solorzano, A., Rauhut, O. W.** NEW THEROPOD MATERIAL FROM THE TRIASSIC-JURASSIC BOUNDARY OF THE VENEZUELAN ANDES

2:00 **Stiegler, J., Wang, S., Xu, X., Clark, J.** NEW ANATOMICAL DETAILS OF THE BASAL CERATOSAUR *LIMUSAURUS* AND IMPLICATIONS FOR THE JURASSIC RADIATION OF THEROPODA

2:15 **Foth, C., Haug, C., Haug, J., Tischlinger, H., Rauhut, O.** NEW DETAILS ON THE INTEGUMENTAL STRUCTURES IN THE JUVENILE MEGALOSAUROID *SCIURUMIMUS ALBERSDOERFERI* FROM THE LATE JURASSIC OF GERMANY USING DIFFERENT AUTO-FLUORESCENCE IMAGING TECHNIQUE

2:30 **Ibrahim, N., Maganuco, S., Sereno, P., Dal Sasso, C., Keillor, T., Martill, D., Zouhri, S., Fabbri, M., Auditore, M.** ASSOCIATED REMAINS OF *SPINOSAURUS AEGYPTIACUS*, AN ENORMOUS PREDATORY DINOSAUR WITH SUBAQUATIC ADAPTATIONS

2:45 **Gold, M., Balanoff, A., Watanabe, A., Norell, M.** ENDOCAST SHAPE DIFFERENCES IN COELUROSAURIA (DINOSAURIA: THEROPODA) REFLECT PHYLOGENY AND LOCOMOTOR MODE ACROSS THE EVOLUTION OF FLIGHT

3:00 **Hendricks, S., Erickson, G.** A BIOMECHANICAL EXPLANATION FOR THE AMPULLAE OF TYRANNOSAURID TEETH BASED UPON FRACTURE MECHANICS

3:15 **Lauters, P., Lee, Y., Barsbold, R., Currie, P., Kobayashi, Y., Escuillié, F., Godefroit, P.** THE BRAIN OF *DEINOCHEIRUS MIRIFICUS*, A GIGANTIC ORNITHOMIMOSAURIAN DINOSAUR FROM THE CRETACEOUS OF MONGOLIA

3:30 **Funston, G., Currie, P.** NEW *ELMISAURUS* (DINOSAURIA: OVIRAPTOROSAURIA) MATERIAL FROM MONGOLIA AND ALBERTA, CANADA, AND ITS BEARING ON NORTH AMERICAN CAENAGNATHID TAXONOMY.

3:45 **Tanaka, K., Zelenitsky, D., Lü, J., Yi, L., Pu, H., Chang, H., Xu, L., Li, H.** NEST TYPE AND INCUBATION BEHAVIOR IN OVIRAPTOROSAURS IN RELATION TO BODY SIZE

4:00 **Varricchio, D., Jackson, F., Jin, X.** LAY-BROOD-REPEAT: NESTING SITE FIDELITY IN ECOLOGIC TIME FOR TWO CRETACEOUS TROODONTID DINOSAURS

WEDNESDAY AFTERNOON, NOVEMBER 5, 2014

TECHNICAL SESSION IV

ESTREL BERLIN, HALL C

MODERATOR: Vera Weisbecker

1:45 **MacPhee, R., Welker, F., Thomas, J., Brace, S., Cappellini, E., Turvey, S., Barnes, I., Reguero, M., Gelfo, J., Kramarz, A.** BARCODING THE DEAD: ANCIENT PROTEIN SEQUENCING RESOLVES LITOPTERN AND NOTOUNGULATE SUPERORDINAL AFFINITIES

2:00 **Sánchez-Villagra, M., Carrillo, J., Carlini, A., Jaramillo, C.** NEW FOSSIL MAMMALS FROM THE NORTHERN NEOTROPICS (URUMACO, VENEZUELA; CASTILLETES, COLOMBIA) AND THEIR SIGNIFICANCE FOR THE LATITUDINAL GRADIENT IN DIVERSITY AND THE GREAT AMERICAN BIOTIC INTERCHANGE

2:15 **Finarelli, J., Raj Pant, S., Goswami, A.** UNEXPECTED COMPLEXITY IN THE BODY SIZE EVOLUTION OF SLOTHS (XENARTHRA, PILOSA)

WEDNESDAY AFTERNOON, NOVEMBER 5, 2014
TECHNICAL SESSION IV (CONTINUED)

2:30 **Weisbecker, V., Ramirez-Chaves, H., Selwood, L., Leigh, C., Kardjilov, N., Hinds, L., Wroe, S.** MAMMALIAN MIDDLE EAR EVO-DEVO: HOW MUCH DOES ONTOGENY RECAPITULATE ONTOGENY?

2:45 **Morris, Z.** VARIATION AND VARIABILITY IN THE DEVELOPMENT OF THE SKELETON OF *MONODELPHIS DOMESTICA*: IMPLICATIONS FOR ASSESSING MATURITY IN EXTINCT AND EXTANT ORGANISMS

3:00 **Couzens, A., Skinner, M., Evans, A., Prideaux, G.** EXAMINING THE DEVELOPMENTAL ORIGINS OF EVOLUTIONARY REVERSAL IN THE MOLAR TEETH OF MACROPODOIDS (DIPROTODONTIA: MARSUPIALIA)

3:15 **Cook, J., Attard, M., Krall, P., Wroe, S.** COULD THE GIANT KANGAROO HOP?

3:30 **Beck, R., Louys, J., Brewer, P.** THE SKULL AND SKELETON OF A LARGE-BODIED DIPROTODONTIAN MARSUPIAL FROM THE LATE OLIGOCENE OF CENTRAL AUSTRALIA AND THE ORIGIN OF WOMBATS

3:45 **Attard, M., Parr, W., Wilson, L., Archer, M., Hand, S., Rogers, T., Wroe, S.** TALES OF A TINY KILLER: JAWS OF THE TASMANIAN TIGER'S COUSIN WERE SUITED TO CATCH LARGE PREY

4:00 **Sharp, A.** COMPARATIVE FEEDING BIOMECHANICS OF *DIPROTODON OPTATUM* AND FUNCTIONAL INTERPRETATION OF THE EXTENSIVE ENDOCRANIAL SINUSES

WEDNESDAY AFTERNOON, NOVEMBER 5, 2014
TECHNICAL SESSION V
ESTREL BERLIN, HALL D
MODERATORS: Koen Stein and Ana Baez

1:45 **Gao, K.** AMPHIBIANS OF THE JURASSIC DAOHUGOU BIOTA, INNER MONGOLIA AND WESTERN LIAONING, CHINA

2:00 **Vanburen, C., Mannion, P., Norman, D., Barrett, P.** THE EFFECTS OF SAMPLING AND RESEARCH EFFORT BIAS ON THE 'POOR' LISSAMPHIBIAN FOSSIL RECORD OF THE LAST 80 MILLION YEARS

2:15 **Chen, J., Gao, K.** AN EARLY CRETACEOUS FROG FROM NORTHERN CHINA AND THE EARLY EVOLUTION OF ANURANS

2:30 **Baez, A., Gomez, R.** IS HYPEROSSIFICATION CONCEALING THE PHYLOGENETIC SIGNAL OF OSTEOLOGICAL TRAITS IN ANURANS? A TEST-CASE FROM THE UPPER CRETACEOUS OF BRAZIL

2:45 **Vasilyan, D., Böhme, M., Joyce, W.** RECENT AND FOSSIL EURASIAN CENOZOIC GIANT SALAMANDERS (PANCRYPTOBRANCHA, LISSAMPHIBIA): SYSTEMATICS, PHYLOGENY, BIOLOGY AND PALEOCLIMATIC SIGNIFICANCE

3:00 **Zhang, Z., Hadly, E.** LIFE HISTORY DYNAMICS OF THE TIGER SALAMANDER, *AMBYSTOMA TIGRINUM*, IN RESPONSE TO LATE PLEISTOCENE CLIMATE

3:15 **Stein, K., Skutchas, P., Schoch, R., Struble, M., Organ, C., Fröbisch, N.** GENOME SIZE AND OSTEOCYTE LACUNA SIZE IN RECENT AND FOSSIL SALAMANDERS

3:30 **Maddin, H., Piekarski, N., Hanken, J.** EXPERIMENTALLY INDUCED HOMEOTIC SHIFTS IN ANTERIOR AXIAL PATTERNING MIMIC EVENTS IN THE EVOLUTION OF THE TETRAPOD SKULL

WEDNESDAY AFTERNOON, NOVEMBER 5, 2014
TECHNICAL SESSION V (CONTINUED)

3:45 **Kawano, S., Blob, R.** BIOMECHANICAL COMPARISONS OF MODERN ANALOGS FOR UNDERSTANDING THE FUNCTIONAL EVOLUTION OF TERRESTRIAL LOCOMOTION IN EARLY STEM TETRAPODS

4:00 **Boehmer, C., Hirasawa, T., Kuratani, S., Fröbisch, N.** DEVELOPMENT OF THE VERTEBRAL COLUMN IN AMPHIBIANS REVEALS MECHANISMS FOR THE EVOLUTIONARY TRANSITION FROM WATER TO LAND

WEDNESDAY, NOVEMBER 5, THROUGH SATURDAY, NOVEMBER 8
SVP 2014 EDWIN H. AND MARGARET M. COLBERT PRIZE COMPETITION POSTER
ESTREL BERLIN, ROOMS 2 AND 3

Authors Will Be Present at Their Posters: Thursday, November 6 from 4:15 – 6:15 pm
Posters must be removed by 6:30 pm, Saturday, November 8

1 **Chapelle, K., Choiniere, J.** THE FIRST DETAILED CRANIAL DESCRIPTION OF *MASSOSPONDYLUS CARINATUS* USING A COMPUTED TOMOGRAPHY (CT) SCAN AND 3D DIGITAL REPRESENTATION

2 **Georgalis, G., Kear, B., Campione, N., Delfino, M.** REDISCOVERY OF *LAOPHIS CROTALOIDES* - THE WORLD'S LARGEST VIPER?

3 **Holwerda, F., Rauhut, O., Pol, D.** OSTEOLOGICAL REVISION OF THE HOLOTYPE OF *PATAGOSAURUS FARIASI*, A BASAL EUSAUROPOD FROM ARGENTINA

4 **Läbe, S.** INTERPRETATION OF FOSSIL VERTEBRATE TRACKS WITH A SOIL MECHANICAL APPROACH FOR BODY MASS ESTIMATION

5 **Skiba, M., Schulz, E., Kaiser, T.** CHARACTERIZATION OF FUNCTIONAL TRAITS IN THE CARNASSIALS OF THE WOLF (*CANIS LUPUS*) USING 3D SURFACE TEXTURE ANALYSIS

6 **Stubbs, T., Foffa, D., Benton, M.** EVOLUTIONARY BOTTLENECK OF MARINE REPTILES DURING THE TRIASSIC-JURASSIC TRANSITION

7 **Tsai, H., Middleton, K., Holliday, C.** MORE THAN ONE WAY TO BE A GIANT: CONVERGENCE AND DISPARITY IN SAURISCHIAN DINOSAUR HIP JOINTS DURING BODY SIZE EVOLUTION

8 **Waskow, K.** RECONSTRUCTING JUVENILE MORPHOLOGY: A NON DESTRUCTIVE METHOD TO DETECT HISTOLOGICAL STRUCTURES IN COMPUTED TOMOGRAPHY (CT) AND ITS POTENTIAL FOR FUTURE RESEARCH, USING THE EXAMPLE OF SAUROPOD RIBS

9 **Williams, M., McNamara, K.** QUANTITATIVE INVESTIGATION OF THE STERNAL MORPHOLOGY OF STATIC AND DYNAMIC SOARING BIRDS

10 **Winkler, D., Kaiser, T.** CAN TOOTH POSITION-SPECIFIC ENAMEL CONTENT PREDICT JAW BIOMECHANICS IN UNGULATES?

WEDNESDAY, NOVEMBER 5, THROUGH SATURDAY, NOVEMBER 8
SVP 2014 EDUCATION AND OUTREACH POSTER SESSION
ESTREL BERLIN, ROOMS 2 AND 3

Authors Will Be Present at Their Posters: Wednesday, November 5 from 4:15 – 6:15 pm
Posters must be removed by 6:30 pm, Saturday, November 8

11 **Semprebon, G., Gusky, S., Jack, T.** A CALL TO ACTION: A REPORT ON THE NEW NATIONAL INITIATIVE FOR GALVANIZING CHANGE IN UNDERGRADUATE LIFE SCIENCE EDUCATIONAL PRACTICES IN THE UNITED STATES

12 **Burnes, J.** HAVE BONES WILL TRAVEL: BRINGING THE MUSEUM TO THE CLASSROOM

13 **Arbour, V., Vavrek, M., Koppelhus, E., Currie, P.** DINO 101: A MASSIVE OPEN ONLINE COURSE ABOUT DINOSAUR PALEOBIOLOGY

14 **Burns, M., Arbour, V., Coy, C., Koppelhus, E., Currie, P.** UNDERGRADUATE RESEARCH AND CITIZEN SCIENCE AT THE DANEK *EDMONTOSAURUS* BONEBED, AN URBAN DINOSAUR LOCALITY

15 **Harper-Judd, J., Holliday, C., Knocke, M., Butaric, L., George, I., Middleton, K., Moffett, E., Swartz, S., Tsai, H., Warren, A.** DINOSAURS & CAVEMEN SCIENCE EXPO: SCIENCE OUTREACH USING INTERACTIVE AND EXPERIENTIAL ANATOMICAL LEARNING

16 **White, L. D.** UNDERSTANDING GLOBAL CHANGE: A NEW UNIVERSITY OF CALIFORNIA MUSEUM OF PALEONTOLOGY WEB RESOURCE

17 **Castanhinha, R., Araujo, R., Costa Júnior, L., Martins, R., Angielczyk, K., Martins, G. G., Nhamutole, N., Murrula, S., Vasconcelos, L.** THE PALNIASSA PROJECT: SCIENCE, EDUCATION, AND OUTREACH FROM MOZAMBIQUE

18 **Bradley, G., Campbell, M., Burns, M.** BRINGING FOSSILS TO LIFE: INTERACTIVE OUTREACH IN THE CLASSROOMS OF ALBERTA

19 **Farke, A., Gay, R., Lepore, T.** DIGITAL SPECIMENS IN THE HIGH SCHOOL CLASSROOM

20 **Maruyama, S., Mizuguchi, D., Kondo, S., Kusumoto, M., Miyoshi, S., Yoshida, Y.** HOW DOES TAKING A CLASS WITH SKELETAL SPECIMENS MAKE STUDENT INTEREST CHANGE? SOME REPORTS OF PRACTICE COURSES WITH HANDS-ON SPECIMENS TO A HIGH SCHOOL AND COLLEGES IN JAPAN

21 **Kaya, A., Kaya, F.** CENSORSHIP OF HUMAN EVOLUTION EDUCATION IN TURKEY

22 **Gay, R.** A PUBLIC HIGH SCHOOL PALEONTOLOGY PROGRAM; CREATING EMBEDDED LEARNING OPPORTUNITIES FOR STUDENTS BY FLIPPING OUTREACH ON ITS HEAD

23 **Heath, T., Lacey, E., Ickert-Bond, S., Edwards, S., Bell, K., Cook, J.** AIM-UP! MUSEUM-BASED APPROACHES TO INCREASING CORE COMPETENCIES IN UNDERGRADUATE EDUCATION

24 **Mall, M., Rawlings, S., Williams, S., Parks, H.** VIRTUAL FIELD TRIPS: USING REAL-TIME VIDEO CONFERENCING SOFTWARE IN RESPONSE TO THE DECLINE IN ON-SITE FIELD TRIPS.

25 **George, C.** A MULTI-FACETED APPROACH TO ENGAGE UNDERGRADUATE STUDENTS IN SCIENTIFIC INQUIRY USING KEY FOSSIL VERTEBRATE TAXA

26 **Nestler, J., Borths, M. R., Pritchard, A.** APPLYING FLIPPED CLASSROOM TECHNIQUES IN THE DIGITAL AGE: HOW PODCASTS AND VIDEO CONFERENCING CAN CONNECT STUDENTS WITH SCIENTISTS

27 **Besselink, M., Rijsdijk, K., De Louw, P., Claessens, L., Meijer, H., The Dodo Research Programme** THE ROLE OF MUSEUMS IN (RE)TELLING THE TALE OF THE DODO

28 **Williams, S., Parks, H., Tremaine, K., Rawlings, S.** PALEOFEST: 15 YEARS OF SCIENCE EDUCATION SUCCESS

WEDNESDAY AFTERNOON, NOVEMBER 5, 2014

POSTER SESSION I

ESTREL BERLIN, ROOMS 2 AND 3

Authors must be present from 4:15 - 6:15 pm

Posters must be removed by 6:30 pm

Posters Associated with Symposia 1: *Archaeopteryx* - The Iconic Fossil in Modern View

29 **Egerton, V., Manning, P., Wogelius, R., Sellers, W., Schwarz-Wings, D., Sokaras, D., Mori, R., Edwards, N., Larson, P., Bergmann, U.** CURATIONAL CHEMICAL SECRETS OF *ARCHAEOPTERYX*

30 **Wings, O.** THE DIGITAL *ARCHAEOPTERYX* - A HIGH-RESOLUTION PHOTOGRAMMETRIC 3D MODEL BENEFITING FUTURE RESEARCH

31 **Godefroit, P., Sinitsa, S., Dhouailly, D., Mc Namarra, M., Cincotta, A.** FEATHER-LIKE STRUCTURES IN ORNITHISCHIAN DINOSAURS

32 **Manning, P., Wogelius, R., Sellers, W., Schwarz-Wings, D., Sokaras, D., Mori, R., Edwards, N., Egerton, V., Larson, P., Bergmann, U.** TRACE-METAL JACKET: THE ROLE OF MELANIN PIGMENT IN THE PRESERVATION OF *ARCHAEOPTERYX* FEATHERS

33 **Schwandt, H., Fritsch, G., Jastram, B., Weinhold, J., Schwarz-Wings, D., Hildebrandt, T.** CT SCAN OF THE BERLIN SPECIMEN OF *ARCHAEOPTERYX* AND POTENTIAL USES OF THE ACQUIRED DATA

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34 **Wang, X., Clarke, J. A.** A GEOMETRIC MORPHOMETRIC INVESTIGATION OF WING SHAPE ACROSS AVES REVEALS STRONG PHYLOGENETIC SIGNAL AND A PREVIOUSLY UNRECOGNIZED IMPORTANCE FOR COVERT FEATHERS

35 **Marty, D., Belvedere, M., Díaz Martínez, I., Mallison, H., Menkveld, U.** STORK NEOICHNOLOGY FOR A BETTER UNDERSTANDING OF LARGE CENOZOIC ANISODACTYL BIRD TRACKS

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158 **Santaella, B., Figueirido, B., Cascales-Miñana, B., Janis, C., Palmqvist, P.** THE EFFECT OF SAMPLING EFFORT ON MAMMALIAN PALEODIVERSITY: THE FOSSIL RECORD OF LARGE AND SMALL MAMMALS COMPARED

159 **Pineda-Munoz, S., Evans, A., Alroy, J.** THE RELATIONSHIP BETWEEN DIET AND BODY MASS IN MAMMALS

160 **Evans, A.** THE INHIBITORY CASCADE AS A GENERAL MECHANISM FOR INTEGRATION IN THE MAMMALIAN PRIMARY DENTITION

161 **Prothero, D.** GARBAGE IN, GARBAGE OUT, THE EFFECT OF IMMATURE AND OUTDATED TAXONOMY ON DATABASE COMPILATIONS OF NORTH AMERICAN MIOCENE LAND MAMMALS

162 **Ladevèze, S.** SOLVING THE MICROBIOTHERE MARSUPIALS RELATIONSHIPS WITHIN AUSTRALIDELPHIA THROUGH THE REAPPRAISAL OF BASICRANIAL CHARACTERS

163 **Laing, A., Dodson, P.** NUTRIENT FORAMINA AS A POTENTIAL PROXY FOR VERTEBRATE POSTURE

164 **Cantalapiedra, J., Madern, A., Casanovas Vilar, I., Eronen, J., Fortelius, M.** A PALEOBIOGEOGRAPHIC APPROACH TO THE VALLESIAN MAMMAL TURNOVER AT A CONTINENTAL SCALE

165 **Madern, A., Van De Put, J., Casanovas Vilar, I., Van Den Hoek Ostende, L.** AT CLOSE RANGE: MICROMAMMAL BIOGEOGRAPHY OF THE MIDDLE/LATE MIOCENE WITHIN THE IBERIAN PENSINSULA

166 **Hager, S., Mihlbachler, M., Beatty, B.** INDENTATION HARDNESS OF TOOTH ENAMEL OF MULTIPLE MAMMALIAN SPECIES AND THE ROLE OF ENAMEL MICROSTRUCTURE ON DENTAL WEAR MECHANICS

167 **Domingo, L., Domingo, M., Koch, P.** CHARACTERIZATION OF PREDATOR-PREY INTERACTIONS IN THE CONTEXT OF A LATE MIOCENE ENVIRONMENTAL PERTURBATION

168 **Louys, J., Price, G., Herries, A.** NEW INVESTIGATIONS INTO THE PLIOCENE-AGED VERTEBRATE BEARING BEDS OF THE CHINCHILLA SAND FORMATION, NORTHEASTERN AUSTRALIA

169 **Tejada-Lara, J., MacFadden, B., Salas-Gismondi, R., Baby, P., Antoine, P.** ISOTOPE ECOLOGY OF A NEW MAMMALIAN FAUNA FROM THE LATE MIDDLE MIOCENE OF TROPICAL SOUTH AMERICA (PERUVIAN AMAZONIA)

170 **Lehmann, T., Peppe, D., Driese, S., Jenkins, K., Sanders, W., McNulty, K.** NEW FIELDWORK AT KARUNGU (EARLY MIOCENE; LAKE VICTORIA, KENYA): PRELIMINARY PALEONTOLOGICAL AND GEOLOGICAL RESULTS

171 **Smith, M., Polly, P.** REGIONAL FAUNAL DYNAMICS IN RESPONSE TO CLIMATE CYCLING THROUGH PHYSIOGRAPHIC REGIONS

172 **Memesh, A., Zalmout, I., Al-Mufarreh, Y., Alagaili, A.** REVISITING THE PLEISTOCENE VERTEBRATE FAUNA OF AN NAFUD DESERT, NORTHWESTERN SAUDI ARABIA

173 **Orcutt, J.** PALEOECOLOGY, PRESERVATIONAL ENVIRONMENT, AND PLEISTOCENE OCCURRENCE PATTERNS

WEDNESDAY AFTERNOON, NOVEMBER 5, 2014
POSTER SESSION I (CONTINUED)

174 **Dantas, M., Cherkinsky, A., Bocherens, H., Drefahl, M., França, L., Bernardes, C., Avilla, L.** ISOTOPIC SIGNATURE ($\Delta^{13}C$, $\Delta^{18}O$) OF THE PALEOECOLOGY AND NICHE PARTITIONING OF THE PLEISTOCENE MEGAFAUNA FROM BRAZILIAN INTERTROPICAL REGION, NORTHEASTERN BRAZIL

175 **Price, G., Louys, J., Cramb, J., Feng, Y., Nguyen, A.** TRACKING AUSTRALIAN PLEISTOCENE MEGAFAUNAL EXTINCTIONS THROUGH THE TROPICS

176 **Jass, C., Beaudoin, A., Brink, J.** POST-GLACIAL MAMMAL REMAINS FROM COLD LAKE, ALBERTA, CANADA

177 **Wallace, S., Schubert, B., Mead, J., Short, R., Doby, J., Swift, S.** RECENT FINDS FROM THE LATEST MIOCENE/EARLY PLIOCENE GRAY FOSSIL SITE LAGERSTÄTTEN OF EASTERN TENNESSEE, SOUTHERN APPALACHIANS, USA

178 **Njau, J., Pante, M., De La Torre, I., McHenry, L.** PALEOENVIRONMENTS OF BED II, OLDUVAI GORGE, TANZANIA

179 **Buckley, M., Carlini, A., Manning, P., Rybczynski, N.** RECONSTRUCTING MOLECULAR PHYLOGENIES OF EXTINCT VERTEBRATES USING COLLAGEN SEQUENCES

180 **Colleary, C., Vinther, J., Dolocan, A., Gardner, J.** A STATISTICAL AND MASS SPECTROMETRIC CHARACTERIZATION OF THE MOLECULAR PRESERVATION OF MELANIN

THURSDAY MORNING, NOVEMBER 6, 2014
ROMER PRIZE SESSION
ESTREL BERLIN, HALL A
MODERATOR: David Fox

8:00 **Yi, H.** RESOLVING THE LOCOMOTORY ECOLOGY OF THE ANCESTRAL SNAKE: LISTENING TO WHAT THE EAR TELLS US

8:15 **Vietti, L.** INSIGHTS INTO THE MICROBIOME ASSOCIATED WITH BONE DECAY DURING EARLY DIAGENESIS FROM RRNA GENE SEQUENCING OF BIOFILMS FROM ACTUALISTIC EXPERIMENTS

8:30 **Schmitt, A.** ACCELERATING OUR UNDERSTANDING OF THE INNER EAR OF SAUROPODOMORPHA: FIRST GLOBAL, STATISTICAL ANALYSIS OF SEMICIRCULAR CANALS OF DIPLODOCID AND MACRONARIAN DINOSAURS AND ITS IMPLICATION FOR NECK-POSTURE

8:45 **Rabi, M.** ORIGIN AND EARLY EVOLUTION OF SEA TURTLES

9:00 **Pimiento, C.** EXTINCTION AND BODY SIZE PATTERNS OF THE GIANT SHARK *CARCHAROCLES MEGALODON*

9:15 **Kolb, C.** BONE AND TOOTH GROWTH IN FOSSIL AND RECENT DEER AND IMPLICATIONS FOR BODY SIZE AND LIFE HISTORY EVOLUTION

9:30 **Jones, K.** THE AXIAL SKELETON: A MISSING PUZZLE PIECE IN THE EVOLUTION OF CURSORIAL LOCOMOTION IN HORSES

9:45 **Grass, A.** SLOTH ONTOGENETIC TRAJECTORIES AND IMPLICATIONS FOR CONVERGENCE IN *BRADYPUS* AND *CHOLOEPUS*

10:00 BREAK

THURSDAY MORNING, NOVEMBER 6, 2014
ROMER PRIZE SESSION (CONTINUED)

10:15 **Dunn, R.** HOW OPEN IS 'OPEN HABITAT'? QUANTIFYING AND RECONSTRUCTING THE ENVIRONMENTAL CONTEXT FOR VERTEBRATE EVOLUTION DURING THE CENOZOIC USING THE LEAF AREA INDEX

10:30 **Cuff, A.** THE FUNCTIONAL MECHANICS OF ORNITHOMIMOSAUR AND THEROPOD CRANIA

10:45 **Clarke, J.** ELEVATED RATES OF MORPHOLOGICAL EVOLUTION AND GREATER MORPHOLOGICAL INNOVATION IN FOSSIL TELEOSTS WITH DUPLICATE GENOMES

11:00 **Button, D.** BIOMECHANICAL INSIGHTS INTO THE CRANIODENTAL EVOLUTION OF SAUROPODOMORPH DINOSAURS

11:15 **Burch, S.** OSTEOLOGICAL, MYOLOGICAL, AND PHYLOGENETIC TRENDS OF FORELIMB REDUCTION IN NONAVIAN THEROPOD DINOSAURS

11:30 **Brown, C.** QUANTITATIVELY TESTING EVOLUTIONARY MODES IN CENTROSAURINE CERATOPSIDS (ORNITHISCHIA, DINOSAURIA) FROM THE DINOSAUR PARK FORMATION (LATE CRETACEOUS) OF ALBERTA, INCORPORATING ANALYSES OF MISSING DATA IN MORPHOMETRICS, AND STRATIGRAPHIC UNCERTAINTY

11:45 **Brocklehurst, N.** INNOVATION, EXTINCTION AND RATES OF CLADOGENESIS IN EARLY AMNIOTES

12:00 **Bales, A.** THE PHYLOGENETIC POSITION OF *PROCONSUL* AND THE IMPORTANCE OF MOSAIC EVOLUTION IN THE ORIGINATION OF CROWN CATARRHINE LINEAGES

THURSDAY MORNING, NOVEMBER 6, 2014
TECHNICAL SESSION VI
ESTREL BERLIN, HALL C
MODERATORS: Paul Morse and Susanne Cote

8:00 **Schmerge, J., Burnham, D.** INTERPRETATION OF BURROWING BEHAVIOR FROM INCISOR MORPHOLOGY OF FOSSORIAL RODENTS

8:15 **Kraatz, B., Sherratt, E.** EVOLUTION, ECOLOGY, AND MODULARITY OF THE LAGOMORPH SKULL

8:30 **Tomiya, S., Miller, L.** EVOLUTION OF MAXIMUM BODY SIZE IN NORTH AMERICAN LAGOMORPHS

8:45 **Flynn, L.** THE MIDDLE MIOCENE DORMOUSE DATUM IN THE SIWALIKS OF SOUTH ASIA

9:00 **Smiley, T., Badgley, C., Hyland, E., Cotton, J., Reynolds, R.** COUPLING ENVIRONMENTAL CHANGE AND ECOLOGICAL RESPONSE: THE MIOCENE OF THE MOJAVE DESERT, CALIFORNIA

9:15 **Bertrand, O., Amador-Mughal, F., Silcox, M.** VIRTUAL ENDOCAST OF *PARAMYS DELICATUS* (RODENTIA, ISCHYROMYIDAE) AND BRAIN EVOLUTION IN EARLY RODENTS

9:30 **Morse, P., Strait, S., Bloch, J., Boyer, D., Dunn, R. H.** PRIMATE BODY SIZE ACROSS THE PALEOCENE—EOCENE THERMAL MAXIMUM IN NORTH AMERICA

9:45 **Silcox, M., Rose, K., Chew, A.** EARLY EOCENE MICROSYOPINE MICROSYOPIDS (MAMMLIA, PRIMATES) FROM THE SOUTHERN BIGHORN BASIN, WYOMING: EVIDENCE FOR CLADOGENETIC SPECIATION AND EVOLUTIONARY RESPONSE TO CLIMATE CHANGE

10:00 BREAK

THURSDAY MORNING, NOVEMBER 6, 2014
TECHNICAL SESSION VI (CONTINUED)

10:15 **Beard, K., Coster, P., Marivaux, L., Salem, M., Chaimanee, Y., Jaeger, J.** NONRANDOM BUT UNPARSIMONIOUS PATTERNS OF MAMMALIAN DISPERSAL BETWEEN ASIA AND AFRICA DURING THE LATER PALEOGENE

10:30 **Kemp, A., Barr, W.** RATES OF HOMOPLASY IN THE MAMMALIAN SKELETON AND APPLICATION TO THE PRIMATE FOSSIL RECORD

10:45 **Asher, R., Pattinson, D., Thompson, R.** PHYLOGENY, PALEONTOLOGY, AND PRIMATES: DO INCOMPLETE FOSSILS BIAS THE TREE OF LIFE?

11:00 **Cote, S., McNulty, K., Nengo, I.** *LIMNOPITHECUS EVANSI* IS NOT *LOMORUPITHECUS HARRISONI*: IMPLICATIONS FOR ENDEMISM IN THE FOSSIL CATARRHINE COMMUNITIES OF EAST AFRICA

11:15 **Casanovas Vilar, I., Kimura, Y., Flynn, L., Alba, D., Pilbeam, D., Moyà-Solà, S.** THE END OF THE MIOCENE HOMINOID RADIATION IN EURASIA: NEW INSIGHTS PROVIDED BY STABLE ISOTOPE ANALYSIS OF TOOTH ENAMEL IN MUROID RODENTS

11:30 **Almécija, S., Tocheri, M., Patel, B., Orr, C., Jungers, W.** ON THE EVOLUTION OF HUMAN AND APE HAND PROPORTIONS

11:45 **Scott, N., Strauss, A., Neubauer, S., Hublin, J., Gunz, P.** DEVELOPMENTAL AND EVOLUTIONARY CRANIAL INTEGRATION IN EXTANT GREAT APES

12:00 **Wroe, S., D'Anastasio, R., Tuniz, C., Mancini, L., Cesana, D., Dreossi, D., Ravichandiran, M., Attard, M., Parr, W., Agur, A.** MICRO-BIOMECHANICS OF THE KEBARA 2 HYOID AND ITS IMPLICATIONS FOR SPEECH IN NEANDERTHALS

THURSDAY MORNING, NOVEMBER 6, 2014
TECHNICAL SESSION VII
ESTREL BERLIN, HALL D
MODERATORS: Martin Ezcurra and Kevin Padian

8:00 **Peecook, B., Sidor, C. A., Smith, R., Huttenlocker, A.** A NOVEL ARCHOSAUROMORPH FROM ANTARCTICA INCREASES SAURIAN DIVERSITY IN THE IMMEDIATE WAKE OF THE END-PERMIAN MASS EXTINCTION

8:15 **Ezcurra, M., Butler, R.** TAXONOMY AND ONTOGENY OF PROTEROSUCHIDAE (DIAPSIDA: ARCHOSAUROMORPHA): IMPLICATIONS FOR THE TEMPO AND MODE OF EARLY ARCHOSAURIFORM EVOLUTION

8:30 **Stocker, M., Nesbitt, S., Criswell, K., Parker, W., Brown, M., Rowe, T.** EARLY ARCHOSAUROMORPH DISPARITY IS REPEATED BY DINOSAURS: CONVERGENCE OF PACHYCEPHALOSAURID CRANIAL MORPHOLOGY BY A NEW DOME-HEADED ARCHOSAURIFORM FROM THE UPPER TRIASSIC OF TEXAS

8:45 **Sobral, G., Müller, J.** EVOLUTIONARY ORIGINS OF IMPEDANCE-MATCHING HEARING IN ARCHOSAURIA

9:00 **Dzikiewicz, K., Drymala, S., Schneider, V., Zanno, L.** ONTOGENY AND GROWTH IN BASAL CROCODYLOMORPHS AND THEIR CLOSE RELATIVES

9:15 **Foffa, D., Young, M., Brusatte, S.** THE CRANIAL ANATOMY AND FEEDING ECOLOGY OF *TYRANNONEUSTES LYTHRODECTIKOS* (CROCODYLOMORPHA: METRIORHYNCHIDAE) FROM THE MIDDLE JURASSIC OF EUROPE

THURSDAY MORNING, NOVEMBER 6, 2014

TECHNICAL SESSION VII (CONTINUED)

9:30 **Müller, J., Bussert, R., Klein, N., Nafi, M., Salih, K., Evans, D.** A NEW DUROPHAGOUS CROCODILE FROM THE LATE CRETACEOUS OF SUDAN

9:45 **Gignac, P.** INSIGHTS INTO THE FUNCTIONAL EVOLUTION OF THE CROCODYLOMORPH TROPHIC APPARATUS GLEANED FROM THE ONTOGENY OF EXTANT CROCODYLIAN FEEDING BIOMECHANICS

10:00 BREAK

10:15 **Mannion, P., Judd, J., Butler, R., Benson, R., Carrano, M., Tennant, J., Upchurch, P., Pol, D.** CLIMATE DRIVES SPATIOTEMPORAL PATTERNS IN CROCODYLOMORPH DIVERSITY

10:30 **Wilberg, E.** PATTERNS OF CROCODYLIFORM CRANIAL DISPARITY THROUGH THE MESOZOIC AND CENOZOIC USING A NOVEL METHOD OF PHYLOGENETIC CORRECTION FOR DISPARITY ANALYSIS OF CONTINUOUS DATA

10:45 **Baier, D., Moritz, S., Carney, R., Garrity, B.** ALLIGATOR (*ALLIGATOR MISSISSIPPIENSIS*) SHOULDER GIRDLE MOBILITY DURING HIGH WALKS

11:00 **Cerio, D. G., Ridgely, R., Witmer, L.** PEERING INTO THE PAST: SOFT-TISSUE RECONSTRUCTION, 3D MODELING, AND THE VISUAL APPARATUS OF THE EXTANT RELATIVES OF DINOSAURS

11:15 **Vinther, J.** PALEO-COLOR: TOWARDS A COMPLEMENTARY TOOL KIT

11:30 **Padian, K., Horner, J.** EMPIRICAL TESTS OF WHETHER SPECIES RECOGNITION OR SEXUAL SELECTION IS A BETTER EXPLANATION OF 'BIZARRE STRUCTURES' IN DINOSAURS AND PTEROSAURS

11:45 **Unwin, D., Lü, J., Pu, H., Jin, X.** PTEROSAUR TAILS TELL TALES OF MODULARITY AND HETEROCHRONY IN THE EVOLUTION OF THE PTERODACTYLOID BAUPLAN

12:00 **Dean, C., Mannion, P., Butler, R.** THE COMPLETENESS OF THE FOSSIL RECORD OF PTEROSAURS: IMPLICATIONS FOR THEIR DIVERSITY AND EVOLUTION THROUGH THE MESOZOIC

THURSDAY AFTERNOON, NOVEMBER 6, 2014

SYMPOSIUM 2: THE INFLUENCE OF R. MCNEILL ALEXANDER ON PALAEOBIOLOGICAL INFERENCES

ESTREL BERLIN, HALL A

MODERATORS: John R. Hutchinson and Eric Snively

1:45 **Palmer, C., Habib, M.** ALL TIME GIANTS OF THE AIR: NEW APPROACHES TO CALCULATING THE LIMITS TO THE SIZE OF PTEROSAURS

2:00 **Christian, A., Sander, M.** SAUROPOD NECKS: MECHANICS AND BENEFITS OF AN EXTREME STRUCTURE.

2:15 **Rayfield, E., Conium, R., Benson, R., Anderson, P.** ECOMORPHOLOGICAL AND FUNCTIONAL VARIATION IN THE THEROPOD DINOSAUR MANDIBLE

2:30 **Snively, E., Ridgely, R., Witmer, L.** ENERGETICS INFERENCES OF NECK MUSCLE SIZE AND HEAD ACCELERATIONS OF LARGE THEROPOD DINOSAURS

2:45 **Preuschoft, H.** BIOMECHANICAL REASONS FOR DEVELOPING THE CHARACTERISTIC SHAPES OF RIBS AND RIBCAGES IN CURSORIAL MAMMALS

THURSDAY AFTERNOON, NOVEMBER 6, 2014
SYMPOSIUM 2: THE INFLUENCE OF R. MCNEILL ALEXANDER ON PALAEOBIOLOGICAL INFERENCES (CONTINUED)

3:00 **Janis, C., Janis, C., Kuchenbecker, K., Figueirido, B.** LOCOMOTION IN EXTINCT GIANT KANGAROOS: WERE STHENURINES HOP-LESS MONSTERS?

3:15 **Hutchinson, J., Allen, V., Regnault, S.** THE FORGOTTEN LEVER: MECHANICS AND EVOLUTION OF THE PATELLAR SESAMOID IN BIRDS

3:30 **Otero, A., Hutchinson, J. R., Pol, D.** FORELIMB BIOMECHANICS OF *MUSSAURUS PATAGONICUS* (DINOSAURIA, SAUROPODOMORPHA): INSIGHTS FROM THREE DIMENSIONAL COMPUTER MODELING

3:45 **Sellers, W., Manning, P.** THE APPLICATIONS OF EVOLUTIONARY ROBOTICS TO RECONSTRUCTING LOCOMOTION IN EXTINCT ANIMALS

4:00 **Falkingham, P., Gatesy, S.** THE BIRTH OF A DINOSAUR TRACK: SUB-SURFACE 3-D MOTION RECONSTRUCTION AND DISCRETE ELEMENT SIMULATION REVEAL FOOTPRINT 'ONTOGENY'

THURSDAY AFTERNOON, NOVEMBER 6, 2014
TECHNICAL SESSION VIII
ESTREL BERLIN, HALL C
MODERATORS: Ross Secord and Matthew Borths

1:45 **Theodor, J., Rankin, B., Fox, J., Barron-Ortiz, C. R., Chew, A., Holroyd, P., Ludtke, J., Yang, X.** USING THE EXTENDED PRICE EQUATION TO QUANTIFY SPECIES SELECTION IN LATEST PALEOCENE AND EARLIEST EOCENE MAMMALS

2:00 **Secord, R., Williamson, T., Peppe, D., Brusatte, S.** TESTING THE LINK BETWEEN CLIMATE CHANGE AND MAMMALIAN FAUNAL TURNOVER DURING THE EARLY PALEOCENE WITH A NEW STABLE ISOTOPE RECORD FROM THE SAN JUAN BASIN, NEW MEXICO

2:15 **Rose, K., Holbrook, L., Rana, R., Kumar, K., Jones, K., Ahrens, H. E., Missiaen, P., Sahni, A., Smith, T.** EARLY EOCENE CAMBAYTHERES FROM INDO-PAKISTAN ARE THE SISTER GROUP OF PERISSODACTYLS

2:30 **Franzen, J., Aurich, C., Habersetzer, J.** A PREGNANT MARE WITH FETUS OF *EUROHIPPUS MESSELENSIS* (MAMMALIA, PERISSODACTLYA, EQUIDAE) FROM THE EARLY MIDDLE EOCENE OF MESSEL PIT (GERMANY)

2:45 **Gheerbrant, E., Amaghzaz, M., Bouya, B., Goussard, F., Letenneur, C.** DISCOVERY OF THE SKULL OF *OCEPEIA* (MIDDLE PALEOCENE OF MOROCCO): FIRST CLUE ON THE BASAL RADIATION OF AFROTHERIA AND PAENUNGULATA (PLACENTALIA)

3:00 **Sanders, W., Seiffert, E.** PROBOSCIDEANS FROM THE LATE EOCENE BIRKET QARUN FORMATION OF NORTHERN EGYPT, AND THEIR BIOCHRONOLOGICAL IMPLICATIONS

3:15 **Smith, T., Rana, R., Kumar, K., Zack, S., Solé, F., Rose, K., Missiaen, P., Singh, L., Sahni, A.** NEW SPECIMENS OF *INDOHYAENODON RAOI* FROM THE EARLY EOCENE OF VASTAN MINE, INDIA AND THEIR IMPLICATIONS FOR PHYLOGENY AND BIOGEOGRAPHY OF HYAENODONTID MAMMALS

3:30 **Borths, M.** THE PHYLOGENETIC RELATIONSHIPS AND BIOGEOGRAPHY OF AFRICAN HYAENODONTIDAE

3:45 **Habersetzer, J., Engels, S., Gunnell, G., Simmons, N.** ECOLOGY AND TAXONOMY OF MESSEL BATS

THURSDAY AFTERNOON, NOVEMBER 6, 2014
TECHNICAL SESSION VIII (CONTINUED)

4:00 **Emerson, C., Anemone, R.** A MULTI-SCALE, GEOSPATIAL MODEL FOR IDENTIFYING PRODUCTIVE FOSSIL LOCALITIES IN THE GREAT DIVIDE BASIN, WYOMING

THURSDAY AFTERNOON, NOVEMBER 6, 2014
TECHNICAL SESSION IX
ESTREL BERLIN, HALL D
MODERATORS: Sarah Werning and Michael Caldwell

1:45 **Gearty, W., Gauthier, J.** RESOLVING THE RELATIONSHIPS OF THE SQUAMATE TREE OF LIFE: AN ASSESSMENT OF NEW APPROACHES AND PROBLEMS

2:00 **Polcyn, M., Jacobs, L., Strganac, C., Mateus, O., Myers, S., May, S., Araujo, R., Schulp, A., Morais, M.** GEOLOGY AND PALEOECOLOGY OF A MARINE VERTEBRATE BONEBED FROM THE LOWER MAASTRICHTIAN OF ANGOLA

2:15 **Campbell, M., Caldwell, M.** EVIDENCE OF CONVERGENCE IN THE MIDDLE EAR ANATOMY OF LATE CRETACEOUS MOSASAUROIDS (SQUAMATA)

2:30 **Simoes, T., Caldwell, M., Nydam, R.** REASSESSMENT OF *POLYGLYPHANODON* (SQUAMATA: BORIOTEIIOIDEA) AND THE EVOLUTION OF THE LOWER TEMPORAL BAR IN SQUAMATES

2:45 **Conrad, J.** THE LIZARD (SQUAMATA) IN *COMPSOGNATHUS* (THEROPODA) IS A NEW SPECIES, NOT *BAVARISAURUS*

3:00 **Caldwell, M., Nydam, R., Palci, A., Apesteguía, S.** THE OLDEST KNOWN FOSSIL SNAKES: A TEMPORAL RANGE EXTENSION OF 70 MILLION YEARS

3:15 **Hsiang, A., Field, D., Behlke, A., Davis, M., Racicot, R., Webster, T., Gauthier, J.** SYNTHESIS OF FOSSIL AND MODERN DATA SHEDS LIGHT ON EARLY SNAKE ECOLOGY, BEHAVIOR, AND EVOLUTIONARY HISTORY

3:30 **Werning, S., Head, J., Bloch, J.** BONE HISTOLOGY AND GROWTH IN THE LARGEST KNOWN SNAKE, *TITANOBOA CERREJONENSIS*

3:45 **Mahlow, K., Head, J., Müller, J.** THE FIRST ARTICULATED SKULL OF A MIOCENE NATRICINE SNAKE AS REVEALED BY X-RAY COMPUTED TOMOGRAPHY

4:00 **Kemp, M., Hadly, E.** SELECTIVITY AND HETEROGENEITY OF EXTINCTION IN CARIBBEAN LIZARD COMMUNITIES

THURSDAY, NOVEMBER 6, 2014
POSTER SESSION II
ESTREL BERLIN, ROOMS 2 AND 3
Authors must be present from 4:15 - 6:15 pm
Posters must be removed by 6:30 pm

Posters Associated with Symposia 2: The Influence of R. McNeill Alexander on Paleobiological Inferences

29 **Milan, J., Gravesen, O., Loope, D.** DINOSAUR TECTONICS-;WHEN BIOMECHANICS MEET STRUCTURAL GEOLOGY

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30 **Razzolini, N., Vila, B., Falkingham, P., Galobart, A.** SUBSTRATE PROPERTIES AND FOOT ANATOMY: TWO OF THE VARIABLES CONTROLLING DINOSAUR TRACK MORPHOLOGY

31 **Bäker, M., Hage, J., Falkingham, P.** COMPLEX SUBSTRATES REDUCE THE SPECIFICITY OF THE GOLDILOCKS EFFECT IN TRACK FORMATION

32 **Barta, D., Varricchio, D. J., Jackson, F., Norell, M., Jin, X.** THE EVOLUTION OF DINOSAUR EGGS: EVIDENCE FROM A PHYLOGENETIC ANALYSIS UTILIZING TOPOLOGIC CONSTRAINTS

33 **MacLaren, J., Anderson, P., Barrett, P., Rayfield, E.** HERBIVOROUS DINOSAUR DISPARITY AND ITS RELATIONSHIP TO EXTRINSIC EVOLUTIONARY AND ECOLOGICAL DRIVERS

34 **Benson, R., Campione, N. E., Evans, D.** DINOSAUR BODY SIZE MAXIMA DRIVEN BY GLOBAL TEMPERATURE

35 **Kubo, T.** A NEW METHOD FOR CHRONOBIOGEOGRAPHY USING PATRISTIC DISTANCES

36 **Matthews, N., Pond, S., Breithaupt, B.** A MULTI-DIMENSIONAL LOOK AT MORPHOLOGICAL VARIATION IN ICHNOFAUNA: TRACKING CHANGES WITHIN AND BETWEEN ICHNOTAXA

37 **May, K., Druckenmiller, P., McCarthy, P., Hurum, J., Rousseau, J., Anderson, K.** TRACKING DINOSAURS ALONG THE YUKON RIVER: A NEW DINOSAUR-DOMINATED ICHNOFOSSIL ASSEMBLAGE FROM THE MID-CRETACEOUS ARCTIC OF ALASKA

38 **Vila, B., Garcia-Sellés, A., Blanco, A., Moreno-Azanza, M.** PALEOENVIRONMENTAL DISTRIBUTION OF THE LATEST CRETACEOUS DINOSAURS IN SOUTHWESTERN EUROPE

39 **Sellés, A., Vila, B., Moreno-Azanza, M.** NESTING SITE PREFERENCE IN THE LATEST CRETACEOUS DINOSAURS FROM SOUTHWESTERN EUROPE

40 **Salisbury, S., Romilio, A., Herne, M., Tucker, R., Nair, J.** THE EARLY CRETACEOUS DINOSAURIAN ICHNOFAUNA OF THE BROOME SANDSTONE FROM THE WALMADANY AREA (JAMES PRICE POINT) OF THE DAMPIER PENINSULA, WESTERN AUSTRALIA

41 **Makovicky, P., Shinya, A., Zanno, L.** NEW ADDITIONS TO THE DIVERSITY OF THE MUSSENTUCHIT MEMBER, CEDAR MOUNTAIN FORMATION DINOSAUR FAUNA

42 **Jirak, D., Janacek, J., Currie, P., Kundrat, M.** APPROXIMATE BRAIN PROPORTIONS DERIVED FROM THE ENDOCAST OF A JUVENILE HADROSAUR DINOSAUR

43 **Pond, S., Lockley, M., Breithaupt, B., Matthews, N., Lockwood, J.** TRACKING DINOSAURS ON THE ISLE OF WIGHT

44 **Britt, B., Eberth, D., Clark, J., Peng, G., Shan, J., Xu, X., Fukui, K., Christiansen, E., Scheetz, R.** DETRITAL ZIRCONS PROVIDE MAXIMUM DEPOSITIONAL AGE BRACKET FOR THE XIASHAXIMIAO FORMATION, SICHUAN, CHINA

45 **Hoffman, E., Dodson, P.** EXAMINING TAPHONOMIC BIAS IN THE MORRISON FORMATION (LATE JURASSIC: KIMMERIDGIAN) OF THE WESTERN UNITED STATES

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165 **Hielscher, R., Schultz, J., Martin, T.** COMPARISON OF DENTAL WEAR STAGES AND RECONSTRUCTION OF THE MASTICATORY MOVEMENT IN TWO BAT SPECIES (MAMMALIA, CHIROPTERA)

166 **De Smet, J., Czaplewski, N.** MAMMALIAN CAVE FAUNA FROM THE LATE PLEISTOCENE OF THE WESTERN OZARK PLATEAU, OKLAHOMA

167 **Gunnell, G., Butler, P., Greenwood, M., Simmons, N.** PLEISTOCENE BATS FROM OLDUVAI GORGE, TANZANIA

168 **Chester, S., Sargis, E., Cohron, C., Hunter, J., Lyson, T.** NEW SPECIES OF *MIMATUTA* ("CONDYLARTHRA," PERIPTYCHIDAE) FROM THE EARLIEST PALEOCENE OF MONTANA

169 **Shelley, S., Williamson, T., Brusatte, S.** PERIPTYCHIDAE; A PALEOCENE RADIATION OF UNGULATE-LIKE PLACENTAL MAMMALS

170 **Eberle, J., McComas, K.** PHYLOGENY OF A NEW EARLIEST PALEOCENE (PUERCAN) ARCTOCYONID 'CONDYLARTH' FROM THE GREAT DIVIDE BASIN, WYOMING, AND IMPLICATIONS FOR UNDERSTANDING RELATIONSHIPS AMONG THE EARLIEST 'CONDYLARTHS'

171 **Egi, N., Tsubamoto, T., Takai, M., Tsogtbaatar, K., Saneyoshi, M.** TAXONOMIC DIVERSITY AND GEOGRAPHICAL DISTRIBUTION PATTERN IN HYAENODONTIDS (MAMMALIA) FROM THE PALEOGENE OF ASIA

172 **Bastl, K., Nagel, D., Semprebon, G., Morlo, M.** MORPHOLOGICAL AND ECOLOGICAL DIVERSITY WITHIN THE HYAENODONTIDAN GENUS *HYAENODON* WITH REMARKS AS TO ITS ORIGIN

173 **Solé, F., Tabuce, R., Gheerbrant, E.** NEW DATA AND A REVIEW OF THE HYAENODONTANS FROM THE PALEOGENE OF AFRICA

174 **Ahrens, H.** LOCOMOTOR ECOMORPHOLOGY OF NORTH AMERICAN OXYAENIDAE AND HYAENODONTIDAE (MAMMALIA: CREODONTA)

175 **Zack, S.** SABER-TOOTH ORIGINS: A NEW SKELETAL ASSOCIATION AND THE AFFINITIES OF MACHAEROIDINAE (MAMMALIA, CREODONTA)

FRIDAY MORNING, NOVEMBER 7, 2014
SYMPOSIUM 3: PUTTING FOSSILS IN TREES: NEW METHODS FOR COMBINING MORPHOLOGY, TIME, AND MOLECULES TO ESTIMATE PHYLOGENETIC AND DIVERGENCE TIMES OF LIVING AND FOSSIL TAXA
ESTREL BERLIN, HALL A
MODERATORS: Nicholas J. Matzke and April Wright

8:00 **Matzke, N., Wright, A., Bapst, D.** INCORPORATION OF ABSOLUTE AND RELATIVE FOSSIL DATING INFORMATION IN BAYESIAN TIP-DATING ANALYSES USING THE R PACKAGE BEASTMASTERR: EXAMPLES FROM ASSASSIN SPIDERS, SALMONIDS, AND HOMINIDS

8:15 **Irmis, R., Parham, J., Ksepka, D.** UNDERSTANDING AND INCORPORATING GEOLOGIC INFORMATION IN DIVERGENCE DATING ANALYSES

FRIDAY MORNING, NOVEMBER 7, 2014

SYMPOSIUM 3: PUTTING FOSSILS IN TREES: NEW METHODS FOR COMBINING MORPHOLOGY, TIME, AND MOLECULES TO ESTIMATE PHYLOGENETIC AND DIVERGENCE TIMES OF LIVING AND FOSSIL TAXA (CONTINUED)

8:30 **Wagner, P., Marcot, J.** MACROEVOLUTIONARY MODELS AND TIP-DATING: TURNING PUTATIVE ASSUMPTIONS INTO TESTABLE HYPOTHESES

8:45 **Guillerme, T., Cooper, N.** COMBINING LIVING AND FOSSIL TAXA INTO PHYLOGENIES: THE MISSING DATA ISSUE

9:00 **Pol, D., Xu, X.** EFFECTS OF NON-RANDOMLY DISTRIBUTED MISSING DATA IN PARSIMONY AND BAYESIAN ANALYSES

9:15 **Clarke, J., Boyd, C.** METHODS FOR THE QUANTITATIVE COMPARISON OF MOLECULAR ESTIMATES OF CLADE AGE AND THE FOSSIL RECORD

9:30 **Puttick, M., Benton, M., Thomas, G.** ORIGIN OF MAMMALS: MOLECULAR VERSUS MORPHOLOGICAL CLOCKS

9:45 **Warnock, R., Donoghue, P.** TESTING THE MOLECULAR CLOCK USING SIMULATED TREES, FOSSILS, AND SEQUENCES

10:00 BREAK

10:15 **Ksepka, D., Phillips, M.** PUTTING FOSSIL BIRDS IN TREES: EMPIRICAL EVIDENCE FOR BIASES IN DATING THE AVIAN TREE OF LIFE

10:30 **O'Reilly, J., Donoghue, P., Dos Reis, M., Yang, Z.** EVALUATING THE PERFORMANCE OF NODE VERSUS TIP BASED FOSSIL CALIBRATION OF THE MOLECULAR CLOCK

10:45 **Friedman, M., Dornburg, A., Near, T.** MORPHOLOGICAL CLOCKS CLOSE THE GAP BETWEEN AGES OF TELEOST FISHES ESTIMATED FROM MOLECULAR CLOCKS AND THE FOSSIL RECORD

11:00 **Turner, A., Pritchard, A., Matzke, N. J.** 'TIP-DATING' WHEN ALL YOU HAVE ARE FOSSILS: COMPARING TRADITIONAL AND BAYESIAN APPROACHES TO FOSSIL DIVERGENCE TIMES

11:15 **Wright, A., Lloyd, G., Matzke, N.** FOSSILS--ONLY TIP-DATING OF DEINONYCHOSAURIAN THEROPODS: A COMPARISON OF METHODS AND MODELS

11:30 **Brochu, C.** GHARIAL BIOGEOGRAPHY, CONFLICTING SIGNALS, AND PHYLOGENETIC ENTMOOTS

11:45 **Gorscak, E., O'Connor, P.** RE-EVALUATION OF CRETACEOUS PALEOBIOGEOGRAPHICAL PATTERNS USING MORPHOLOGICAL CLOCK AND MODEL-BASED APPROACHES: A CASE STUDY UTILIZING TITANOSAURIAN SAUROPODS WITH EVIDENCE FOR A MORE CENTRALIZED ROLE FOR CONTINENTAL AFRICA

12:00 **Lloyd, G., Bapst, D., Davis, K., Friedman, M.** A PROBABILISTICALLY TIME-SCALED 1000-TAXON PHYLOGENETIC HYPOTHESIS FOR MESOZOIC DINOSAURS AND THE ORIGINS OF FLIGHT AND CROWN-BIRDS

FRIDAY MORNING, NOVEMBER 7, 2014

TECHNICAL SESSION X

ESTREL BERLIN, HALL D

MODERATORS: Karen Samonds and Zhijie Jack Tseng

8:00 **Hooker, J.** THE FIRST CRANIAL AND POSTCRANIAL REMAINS OF THE OLDEST MOLE *EOTALPA* FROM THE UK LATE EOCENE: IMPLICATIONS FOR RELATIONSHIPS AND LIFESTYLE

8:15 **Sansalone, G., Kotsakis, T., Colangelo, P., Loy, A., Piras, P.** DIFFERENTIAL RATES OF EVOLUTION WITHIN HIGHLY FOSSORIAL MOLES (TALPINAE) CONSTRAIN TRAJECTORIES AND EVOLUTIONARY ALLOMETRIES OF HUMERAL MORPHOLOGY

8:30 **Thompson, R., Schwermann, A. H., Asher, R.** PHYLOGENY OF THE LIVING AND FOSSIL LIPOTYPHLA (MAMMALIA) AND THE EVOLUTION OF TALPID FOSSORIALITY

8:45 **Su, D., Flynn, L. J., Kelley, J., Ji, X., Deng, C., Jablonski, N.** SHUITANGBA: A TERMINAL MIOCENE FOSSIL VERTEBRATE SITE IN YUNNAN, CHINA

9:00 **Rincon, A., Hulbert, R., O'Sullivan, J., Bloch, J., MacFadden, B., Wood, A. R.** A NEW EARLY MIOCENE PARAHIPPINE (MAMMALIA, EQUIDAE) FROM THE PANAMA CANAL AREA, CENTRAL AMERICA

9:15 **Rabinovich, R., Grossman, A., Ginat, H., Avni, Y., Calvo, R.** NEWLY DISCOVERED MIOCENE PROBOSCIDEANS IN THE SOUTHERN LEVANT

9:30 **Samonds, K., Gunnell, G., Simmons, N.** FILLING THE CENOZOIC GAP: MIOCENE BATS FROM NOSY MAKAMBY, MADAGASCAR

9:45 **Lewis, M.** CARNIVOROUS MAMMALS IN THE KENYAN MIOCENE: POSTCRANIAL EVIDENCE

10:00 BREAK

10:15 **Saila, L., Oikarinen, E., Corfe, I., Werdelin, L., Fortelius, M.** BLOOD IS THICKER THAN WATER: REPLACEMENT PATTERNS IN EURASIAN FELIFORM CARNIVORES

10:30 **Goswami, A., Binder, W., Meachen, J., O'Keefe, F.** DEVELOPMENTAL INTEGRATION CHANNELED MORPHOLOGICAL RESPONSE TO ENVIRONMENTAL STRESS IN LATE PLEISTOCENE CARNIVORANS

10:45 **Tseng, Z., Flynn, J.** NEW APPROACHES TO CHARACTERIZING FEEDING SPECIALIZATION AND RECONSTRUCTING ITS EVOLUTIONARY PATHWAYS BASED ON COMPARATIVE BIOMECHANICS OF LIVING AND FOSSIL CARNIVOROUS MAMMALS

11:00 **Balisi, M., Van Valkenburgh, B.** CHARACTER DISPLACEMENT IN BODY SIZE AND CRANIODENTAL ADAPTATIONS AMONG NORTH AMERICAN FOSSIL CANIDS

11:15 **Shaw, C., Croxen III, F., Sussman, D.** PALEOECOLOGICAL AND CLIMATOLOGICAL RECONSTRUCTION USING CERTAIN TAXA RECOVERED FROM THE IRVINGTONIAN BIOTA AT EL GOLFO DE SANTA CLARA, NORTHWESTERN SONORA, MEXICO

11:30 **Wang, X., Li, Q., Tseng, Z., Takeuchi, G., Deng, T.** THE PLIOCENE TIBETAN PLATEAU AS A TRAINING GROUND FOR COLD ENVIRONMENT ADAPTATION AND ORIGIN OF HOLARCTIC MEGAFAUNA

11:45 **Miller, J., Crowley, B.** THE LAST MARCH OF THE PROBOSCIDEANS: CHANGES IN LANDSCAPE USE AND MOBILITY PRECEDING THE PLEISTOCENE MEGAFAUNAL EXTINCTION

12:00 **Barnosky, A., Lindsey, E., Villavicencio, N., Marshall, C.** FOSSIL EVIDENCE FOR LASTING ECOLOGICAL TRANSFORMATION AS A RESULT OF DEFAUNATION

FRIDAY MORNING, NOVEMBER 7, 2014

SYMPOSIUM 4: THE LIVES OF TEMNOSPONDYLS: INVESTIGATIONS INTO THEIR BIOLOGY

ESTREL BERLIN, HALL C

MODERATORS: Andrew R. Milner and Jean-Sebastien Steyer

8:00 **Marjanović, D.** TEMNOSPONDYL ORIGINS IN A PHYLOGENETIC CONTEXT: AQUATIC, AMPHIBIOUS, OR TERRESTRIAL?

8:15 **Ruta, M., Milner, A.** THE DVINOSAUR *KOURERPETON*, AND A NEW ANALYSIS OF RELATIONSHIPS AND EVOLUTIONARY RATES IN PALAEOZOIC TEMNOSPONDYLS

8:30 **Marsicano, C., Angielczyk, K., Cisneros, J., Smith, R., Fröbisch, J., Kammerer, C., Richter, M., Sadleir, R.** A SPECTACULARLY PRESERVED EARLY PERMIAN DVINOSAUR (TEMNOSPONDYLI) FROM THE PARNAÍBA BASIN (BRAZIL) ILLUMINATES THE ANATOMY, FUNCTIONAL MORPHOLOGY, AND EVOLUTION OF AQUATIC LOCOMOTION IN THE CLADE

8:45 **Beightol V, C., Sidor, C. A., Peecook, B.** ARE TEMNOSPONDYLS MORE ENDEMIC THAN AMNIOTES IN GONDWANA DURING THE PERMIAN AND TRIASSIC?

9:00 **Sengupta, D.** PATTERN OF TEMNOSPONDYL DISTRIBUTION DURING TRIASSIC AND THE PROBLEM OF USING THEM FOR GLOBAL CORRELATION

9:15 **Sanchez, S., Schoch, R., Steyer, J.** TEMNOSPONDYL LIMB-BONE PALEOHISTOLOGY REVEALS A GREAT RANGE OF EVOLUTIONARY ADAPTIONS TO VARIOUS ENVIRONMENTS

9:30 **Konietzko-Meier, D.** INTERPRETING PALEOHISTOLOGY AND MODE OF LIFE AMONG TEMNOSPONDYLS

9:45 **Mukherjee, D., Sengupta, D. P.** LIMB BONE MICROANATOMY OF THE MIDDLE TRIASSIC CAPITOSAURS FROM INDIA AND ITS PALEOBIOLOGICAL IMPLICATIONS

10:00 BREAK

10:15 **Danto, M., Witzmann, F., Fröbisch, N.** THE DEVELOPMENT OF THE MULTIPARTITE AND MONOSPONDYLOUS VERTEBRAL CENTRA OF BASAL TETRAPODS BASED ON PALEOHISTOLOGICAL DATA

10:30 **Fortuny, J., Marcé-Nogué, J.** 3D COMPUTATIONAL MODELLING IN STEREOSPONDYLS (TEMNOSPONDYLI): SKULL MECHANICS AND ECOMORPHOLOGICAL IMPLICATIONS

10:45 **Reisz, R., Campione, N. E.** DIVERSITY AND DISPARITY OF DISSOROPHOID TEMNOSPONDYLS AT THE LOWER PERMIAN DOLESE QUARRY NEAR RICHARDS SPUR, OKLAHOMA

11:00 **Steyer, J.** THE SALT OF LIFE: EURYHALINITY AND HALOTOLERANCE IN TEMNOSPONDYLS

11:15 **Witzmann, F., Ruta, M., Fröbisch, N.** EVOLUTION OF BODY SIZE IN PALEOZOIC TEMNOSPONDYLS: A TEST FOR COPE'S RULE

11:30 **Pérez Ben, C., Schoch, R., Baez, A.** MINIATURIZATION, MORPHOLOGICAL CHANGE, AND ONTOGENY: A STUDY IN TEMNOSPONDYL AMPHIBIANS

11:45 **Milner, A.** SIMPLE METAMORPHOSIS IN THE TREMATOSAUROIDS

12:00 **Scheyer, T., Romano, C., Jenks, J., Bucher, H.** THE EARLY TRIASSIC MARINE BIOTIC RECOVERY FROM A PREDATOR'S PERSPECTIVE

FRIDAY AFTERNOON, NOVEMBER 7, 2014

TECHNICAL SESSION XI

ESTREL BERLIN, HALL A

MODERATORS: Mark Clementz and Herve Bocherens

1:45 **Clementz, M., Peek, S., Scott, S., Sims, K.** CALCIUM ISOTOPES AND TROPHIC DIVERSITY OF CETACEANS IN MODERN AND ANCIENT MARINE FOOD WEBS

2:00 **Haveles, A., Fox, D., Fox-Dobbs, K.** CHARACTERIZING ISOTOPIC VARIABILITY OF RODENTS ON LOCAL AND REGIONAL SCALES IN CENTRAL NORTH AMERICA: IMPLICATIONS FOR RECONSTRUCTING PALEODIETS AND HABITATS

2:15 **Bocherens, H., Arppe, L., Drucker, D., Karhu, J., Vartanyan, S.** HABITAT TRACKERS, NICHE ENGINEERS OR FLEXIBLE ALL-DOERS? ISOTOPIC INSIGHT (C, N) ON THE PALAEOECOLOGY OF THE LATEST PLEISTOCENE AND HOLOCENE WOOLLY MAMMOTHS *MAMMUTHUS PRIMIGENIUS*

2:30 **Patterson, D., Schroer, K., Bobe, R., Wood, B.** STABLE ISOTOPIC AND MORPHOLOGICAL EVIDENCE FOR DIETARY EVOLUTION IN THE MAMMALIAN COMMUNITY OF EAST TURKANA, NORTHERN KENYA, BETWEEN 2 AND 1.4 MILLION YEARS AGO WITH PARTICULAR EMPHASIS ON THREE LARGE-BODIED PRIMATES

2:45 **Ungar, P., Ragni, A., Desantis, L.** COMPARABILITY OF DENTAL MICROWEAR TEXTURE DATA BETWEEN STUDIES.

3:00 **Karme, A., Rannikko, J., Bertin, T., Clauss, M., Fortelius, M.** CHEWING MACHINE AND TOOTH WEAR: HOW PLANT MATERIALS AND GRIT AFFECT TEETH

3:15 **Desantis, L.** DRAMATIC DIETARY MODIFICATIONS OF CARNIVOROUS MARSUPIALS IN AUSTRALIA AS REVEALED BY DENTAL MICROWEAR TEXTURE ANALYSIS: POTENTIAL CONSEQUENCES OF INCREASED COMPETITION WITH NOVEL PREDATORS DURING THE HOLOCENE

3:30 **Rivals, F.** EVOLUTION OF TOOTH WEAR AND DIET OF RHINOCEROTIDAE DURING THE QUATERNARY IN WESTERN EUROPE

3:45 **Reed, K., Rector, A.** COMMUNITY RESOURCE PARTITIONING IN AFRICAN BOVIDAE (MAMMALIA, ARTIODACTYLA): NICHE OVERLAP AND RESOURCE DIVERSIFICATION THROUGH TIME

4:00 **Davis, M., Pineda-Munoz, S.** THE TEMPORAL SCALE OF DIET AND DIETARY PROXIES

FRIDAY AFTERNOON, NOVEMBER 7, 2014

TECHNICAL SESSSION XII

ESTREL BERLIN, HALL D

MODERATORS: G. S. Bever and Tyler Lyson

1:45 **Turner, M., Tsuji, L., Sidor, C. A.** THE APPENDICULAR SKELETON OF *BUNOSTEGOS AKOKANENSIS* (PARAREPTILIA: PAREIASAURIA): EVIDENCE FOR THE EARLIEST EVOLUTION OF A FULLY PARASAGITTAL QUADRUPED

2:00 **Richards, E., Leblanc, A., Reisz, R.** INFERRING THE PHYSIOLOGY OF *CAPTORHINUS AGUTI* (REPTILIA: CAPTORHINIDAE) FROM HISTOLOGICAL DATA OF LONG BONES AND TEETH

2:15 **Leblanc, A., Brink, K., Cullen, T., Reisz, R.** TOOTH SOCKETS AND INTERDENTAL PLATES: THE DEVELOPMENT AND HISTOLOGY OF THECODONTY IN AMNIOTES

FRIDAY AFTERNOON, NOVEMBER 7, 2014
TECHNICAL SESSSION XII (CONTINUED)

2:30 **Sumida, S., Jefcoat, B., Berman, D., Devlin, K., Henrici, A. C., Martens, T.** DIGITAL MODELING OF THE HIND LIMBS OF *EUDIBAMUS CURSORIS*: IMPLICATIONS FOR POSTURE AND LOCOMOTOR CAPABILITIES OF THE OLDEST KNOWN FACULTATIVE BIPED

2:45 **Verrière, A., Brocklehurst, N., Fröbisch, J.** ASSESSING THE COMPLETENESS OF THE FOSSIL RECORD: COMPARISON OF DIFFERENT METHODS APPLIED TO THE PARAREPTILES

3:00 **Nicholson, D., Holroyd, P., Carrano, M., Benson, R., Barrett, P.** TURTLE DIVERSITY IN THE MESOZOIC

3:15 **Bever, G., Lyson, T., Bhullar, B.** FOSSIL EVIDENCE FOR A DIAPSID ORIGIN OF THE ANAPSID TURTLE SKULL

3:30 **Lyson, T., Schachner, E., Botha-Brink, J., Scheyer, T., Lambertz, M., Bever, G., Rubidge, B., De Queiroz, K.** ORIGIN OF THE UNIQUE VENTILATORY APPARATUS OF TURTLES

3:45 **Pritchard, A., Nesbitt, S.** THE CRANIAL MORPHOLOGY OF DREPANOSAURS AND THE PERMO-TRIASSIC DIVERSIFICATION OF DIAPSID REPTILES

4:00 **Buchwitz, M., Ezcurra, M.** A SMALL ARCHOSAUROMORPH WITH ARCHOSAUR-LIKE FEATURES FROM THE MIDDLE-LATE TRIASSIC OF KYRGYZSTAN (CENTRAL ASIA)

FRIDAY AFTERNOON, NOVEMBER 7, 2014
TECHNICAL SESSION XIII
ESTREL BERLIN, PARIS
MODERATORS: Kate Trinajstic and Tetsuto Miyashita

1:45 **Keating, J., Donoghue, P., Johanson, Z.** ASPIDIN: A BONE OF CONTENTION

2:00 **Scott, B., Wilson, M.** AN EARLY DEVONIAN ATELEASPIDID OSTEOSTRACAN (JAWLESS VERTEBRATE) FROM THE NORTHWEST TERRITORIES, CANADA, HAD POLYODONTODE, DENTICULATED SCALES RESEMBLING THOSE OF SOME PALEOZOIC GNATHOSTOMES

2:15 **Miyashita, T.** CYCLOSTOME- AND CROWN GNATHOSTOME-LIKE CHARACTERS AMONG STEM GNATHOSTOMES AND CRITICAL TESTS OF COMPETING HYPOTHESES ABOUT JAW ORIGINS

2:30 **Trinajstic, K., Johanson, Z., Mark-Kurik, E., Zhu, M., Lee, M., Young, G., Boisvert, C., Long, J.** THE DIVERSITY OF COPULATORY STRUCTURES AND REPRODUCTIVE STRATEGIES IN STEM GNATHOSTOMES

2:45 **Rücklin, M., Donoghue, P., Trinajstic, K., Cunningham, J.** DENTAL EVOLUTION READ IN TOOTH AND JAW

3:00 **Sallan, L., Galimberti, A.** ECOLOGICALLY DRIVEN 'COPE'S RULE' SIZE INCREASES IN DEVONIAN FISHES REVERSED BY END-DEVONIAN MASS EXTINCTION

3:15 **Giles, S., Darras, L., Clément, G., Friedman, M.** A REMARKABLY PRESERVED DEVONIAN ACTINOPTERYGIAN SKULL PROVIDES A NEW MODEL FOR EARLY RAY-FINNED FISH ENDOCRANIAL ANATOMY

3:30 **López-Arbarello, A.** MODULARITY IN THE AXIAL SKELETON OF ACTINOPTERYGIANS

3:45 **Chevrinais, M., Cloutier, R., Sire, J.** HOW DID DEVONIAN ACANTHODIANS GROW? THE DEVELOPMENTAL HISTORY OF THE SKELETON OF *TRIAZEUGACANTHUS AFFINIS* FROM THE MIGUASHA-FOSSIL-FISH LAGERSTÄTTE

FRIDAY AFTERNOON, NOVEMBER 7, 2014
TECHNICAL SESSSION XIII (CONTINUED)

4:00 **Brazeau, M., De Winter, V.** THE HYOID ARCH AND BRAINCASE OF *ACANTHODES* AND THE CHONDRICHTHYAN AFFINITIES OF ACANTHODIANS

FRIDAY, NOVEMBER 7, 2014
POSTER SESSION III
ESTREL BERLIN, ROOMS 2 AND 3
Authors must be present from 4:15 - 6:15 pm
Posters must be removed by 6:30 pm

Posters Associated with Symposia 3: Putting Fossils in Trees: New Methods for Combining Morphology, Time, and Molecules to Estimate Phylogenetic Position and Divergence Times of Living and Fossil Taxa

29 **Holder, M., Heath, T. A.** THE EFFECTS OF USING FILTERED DATA FOR BRANCH LENGTH AND DIVERGENCE TIME ESTIMATION

Posters Associated with Symposia 4: Lives of Temnospondyls: Investigations into their Biology

30 **Gruntmejer, K., Konietzko-Meier, D.** CRANIAL BONE HISTOLOGY OF *METOPOSAURUS DIAGNOSTICUS* (AMPHIBIA, TEMNOSPONDYLI) FROM THE LATE TRIASSIC OF POLAND

31 **Maganuco, S., Pasini, G.** A REVISION OF THE SHORT-SNOUTED STEREOSPONDYLS *MAHAVISAURUS DENTATUS* AND *LYROSAURUS AUSTRALIS* FROM THE LOWER TRIASSIC OF MADAGASCAR: CRANIAL ANATOMY, PHYLOGENY, ONTOGENETIC REMARKS, PALEOECOLOGY, AND THE PHYLOGENY OF THE RHYTHIDOSTEIDS

32 **McHugh, J.** LACK OF A PHYLOGENETIC SIGNAL IN THE OSTEOHISTOLOGY OF TEMNOSPONDYL PROPODIAL ELEMENTS

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33 **Strapasson De Souza, A., Lima Pinheiro, F. L., Bento Soares, M.** A NEW STEREOSPONDYLOMORPHA TEMNOSPONDYL FROM THE MIDDLE/LATE PERMIAN OF SOUTH BRAZIL

34 **Eltink, E., Langer, M.** REVISION OF CRANIAL ANATOMY AND PHYLOGENETIC RELATIONSHIPS OF *AUSTRALERPETON COSGRIFFI* (TETRAPODA: TEMNOSPONDYLI)

35 **Mikudíková, M., Klembara, J.** NEW BEST PRESERVED SPECIMENS OF *DISCOSAURISCUS PULCHERRIMUS* (SEYMOURIAMORPHA, DISCOSAURISCIDAE) FROM THE LOWER PERMIAN SEDIMENTS OF BOSKOVICE BASIN (CZECH REPUBLIC)

36 **Mercier, G., Demar, D., Wilson, G. P.** FROGS AND TOADS (LISSAMPHIBIA, ANURA) DURING THE END-CRETACEOUS MASS EXTINCTION: EVIDENCE FROM THE FOSSIL RECORD OF NORTHEASTERN MONTANA

37 **Romo De Vivar, P., Montellano, M., Garcia, D.** PRESENCE OF ALBANERPETONTIDAE (LISSAMPHIBIA) FROM THE 'EL GALLO FORMATION' (LATE CAMPANIAN), BAJA CALIFORNIA, MEXICO

38 **Jacisin, J., Hopkins, S.** *TARICHA* OR *PALAEOTARICHA*? THE EVOLUTIONARY ENIGMA OF NORTH AMERICAN NEWTS

39 **Folie, A., Smith, T.** A NEW PALAEOBATRACHID FROG FROM THE EARLY PALEOCENE OF BELGIUM

40 **Blackburn, D., Roberts, E., Stevens, N. J.** THE EARLIEST RECORD OF THE ENDEMIC AFRICAN FROG FAMILY PTYCHADENIDAE FROM THE OLIGOCENE NSUNGWE FORMATION OF TANZANIA

41 **Henrici, A.** THE EVOLUTIONARY HISTORY OF BURROWING IN NORTH AMERICAN ANURA

42 **Darcy, H., Mead, J., Morgan, G.** OVERVIEW AND NEW FINDS OF *AMBYSTOMA* (AMPHIBIA; CAUDATA) FROM THE PLIO-PLEISTOCENE OF ARIZONA AND NEW MEXICO, USA

43 **Miller-Camp, J., Brochu, C.** A BIOGEOGRAPHIC ASSESSMENT OF INTERCONTINENTAL DISPERSALS IN ALLIGATORINAE

44 **Furui, S., Iijima, M., Kobayashi, Y., Taruno, H.** PHYLOGENETIC STATUS OF A NEW TOMISTOMINE FROM JAPAN AND CROCODYLIAN RESPONSE TO PLEISTOCENE CLIMATE CHANGE

45 **Figueiredo, R., Souza, R. G., Cidade, G., Rincon, A.** SYSTEMATIC AND MORPHOLOGICAL REVISION OF FOSSIL AND EXTANT *MELANOSUCHUS* (CROCODYLIA: CAIMANINAE) FROM THE AMAZON

46 **Salas-Gismondi, R., Antoine, P., Baby, P., Tejada-Lara, J., Urbina, M.** EVIDENCE FROM THE CLOUD FOREST: MATTHIESSEN SPECIMEN OF *PURUSSAURUS* FROM THE LATE MIDDLE MIOCENE OF PERUVIAN AMAZONIA

47 **Guest, R., Brochu, C.** THE FIRST PHYLOGENETIC ANALYSIS OF A CAIMANINE CROCODYLIAN FROM THE EOCENE OF LAREDO, TEXAS

48 **Godoy, P., Montefeltro, F., Cidade, G., Langer, M., Norell, M.** NEW INSIGHTS ON THE MORPHOLOGY OF *EOCAIMAN CAVERNENSIS* (CROCODYLIA, CAIMANINAE)

49 **Ortega, F., Arcucci, A., Narváez, I., Escaso, F.** ANALYSIS OF A PECULIAR STRUCTURE OF THE PALATO-FACIAL ANATOMY OF THE EUROPEAN ZIPHODONT MESOEUCROCODILE *IBEROSUCHUS* (EOCENE, IBERIAN PENINSULA)

50 **Arcucci, A., Ortega, F.** *IBEROSUCHUS* (CROCODYLIFORMES) POSTCRANIAL MATERIAL FROM THE DUERO BASIN (EOCENE OF THE IBERIAN PENINSULA) AND ITS SEBECOSUCHIAN AFFINITIES

51 **Hastings, A., Wirkner, C., Hellmund, M.** FUNCTIONAL MORPHOLOGY OF HOOF-LIKE DISTAL PHALANGES OF *BOVERISUCHUS* (CROCODYLIFORMES) FROM THE MIDDLE EOCENE OF GEISELTAL, GERMANY, USING 3D GEOMETRIC MORPHOMETRICS

52 **Delfino, M., Martin, J., Tschopp, E., Steel, L.** REAPPRAISAL OF THE MORPHOLOGY AND PHYLOGENETIC RELATIONSHIPS OF THE ALLIGATOROID CROCODILIAN *DIPLOCYNODON HANTONIENSIS* FROM THE EOCENE OF HORDWELL, UNITED KINGDOM

53 **Puértolas Pascual, E., Moreno-Azanza, M., Canudo, J.** THE LAST RECORD OF GONIOPHOLIDIDAE: BIODIVERSITY AND PHYLOGENY OF THE ALBIAN CROCODYLOMORPHS OF TERUEL (SPAIN)

54 **Martin, E., Palmer, C.** BONE MASS AND AIR SPACE PROPORTION OF PTEROSAURS

55 **Bennett, S.** NEW SMALLEST SPECIMEN OF THE PTEROSAUR *PTERANODON* AND MULTI-NICHE ONTOGENY IN PTEROSAURS

56 **Pinheiro, F., Liparini, A., Schultz, C.** WAS *TAPEJARA WELLNHOFERI* (PTEROSAURIA, PTERODACTYLOIDEA) REALLY FRUGIVOROUS?

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150 **McNulty, K., MacLatchy, L., Peppe, D., Nengo, I., Manthi, F., Miller, E., Stevens, N. J., Cote, S., Kingston, J., Lehmann, T.** A REGIONAL APPROACH TO EAST AFRICAN EARLY MIOCENE PALEOBIOLOGY

151 **Hori, T.** EVOLUTIONARY TENDENCY OF MOLAR TEETH IN *NEOSAIMIRI* AND *SAIMIRI*

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159 **Beatty, B.** FEEDING ECOLOGY OF DESMOSTYLIA AS INFERRED FROM SPECIALIZATIONS FOR INGESTION, DENTAL MORPHOLOGY, AND DENTAL WEAR

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163 **Maxime, D., Gheerbrant, E., Allain, R.** ORIGIN AND EARLY EVOLUTION OF MAMMAL ACROSS THE TRIASSIC—JURASSIC TRANSITION: NEW LIGHT FROM MORGANUCODONTS

164 **Plogschties, T., Martin, T.** REVEALING THE UNSEEN: COMPUTED MICRO TOMOGRAPHY SCANNING AND 3D RECONSTRUCTION OF A LOWER CRETACEOUS (BARREMIAN) SYMMETRODONT SKULL

165 **Wilson, G., Varricchio, D. J.** EXCEPTIONALLY WELL-PRESERVED MAMMAL FOSSILS FROM THE UPPER CRETACEOUS (CAMPANIAN) EGG MOUNTAIN LOCALITY (TWO MEDICINE FORMATION)

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168 **Schwermann, A., Schultz, J., Kullmer, O., Martin, T.** MOLAR FORM AND FUNCTION OF THE LATE JURASSIC STEM-ZATHERIAN *NANOLESTES* (MAMMALIA)

169 **Newham, E., Corfe, I., Gill, P.** CEMENTUM HISTOLOGY OFFERS A NEW PERSPECTIVE ON THE LIFE HISTORIES OF EARLY MAMMALS

170 **Latimer, A. E., Rowe, T.** JUVENILE PLATYPUS (*ORNITHORHYNCHUS ANATINUS*) TEETH ARE DIVERSE: MORPHOLOGICAL FEATURES AND EVOLUTIONARY IMPLICATIONS OF A REDUCED DENTITION

SATURDAY MORNING, NOVEMBER 8, 2014

TECHNICAL SESSION XIV

ESTREL BERLIN, HALL A

MODERATORS: Erin Maxwell and Nicolás Campione

8:00 **Morhardt, A., Hurlburt, G., Ridgely, R., Witmer, L.** EQ IN THE 21ST CENTURY: A REASSESSMENT OF NON-AVIAN DINOSAUR ENCEPHALIZATION QUOTIENT CALCULATIONS AND IMPLICATIONS FOR MODERN PALEONEUROLOGY

8:15 **Bourke, J., Porter, W., Ridgely, R., Witmer, L.** AIRFLOW RECONSTRUCTION AND HEAT-TRANSFER POTENTIAL IN THE ELONGATE NASAL PASSAGES OF THE ANKYLOSAURS *PANOPLOSAURUS MIRUS* AND *EUOPLOCEPHALUS TUTUS*

8:30 **Maidment, S., Bertazzo, S.** NANO-ANALYTICAL TECHNIQUES REVEAL BLOOD CELLS, BANDED COLLAGEN FIBERS AND AMINO ACIDS PRESERVED IN 75 MILLION YEAR OLD DINOSAUR SPECIMENS

8:45 **Hill, R., D'Emic, M., Bever, G., Norell, M.** THE MOST COMPLETE, OSSIFIED HYOBRANCHIAL APPARATUS OF A FOSSIL DINOSAUR: IMPLICATIONS FOR ONTOGENY AND FUNCTIONAL ANATOMY

9:00 **Campione, N., Evans, D.** QUANTIFYING BODY SIZE EVOLUTION IN ORNITHOPOD DINOSAURS

9:15 **Romilio, A., Salisbury, S., Nair, J. P.** ICHNOLOGICAL EVIDENCE FOR DIVERSE PEDAL POSTURES IN ORNITHOPODAN DINOSAURS

9:30 **Barrett, P., Milner, A., Hooker, J.** A NEW ORNITHOPOD DINOSAUR FROM THE LATEST CRETACEOUS OF THE ANTARCTIC PENINSULA

9:45 **Prieto-Marquez, A., Erickson, G., Ebersole, J.** A NEW HADROSAURID FROM APPALACHIA AND THE EVOLUTION OF THE FACIAL SKELETON IN DUCK-BILLED DINOSAURS

10:00 BREAK

10:15 **Kay, D., Erickson, G. M., Norell, M., Krick, B.** EVOLUTION OF COMPLEX DENTAL ARCHITECTURE AND SLICING DENTITIONS IN CERATOPSIDS

10:30 **Zheng, W., Jin, X., Xu, X.** A NEW BASAL NEOCERATOPSIAN (ORNITHISCHIA, CERATOPSIA) FROM THE LATE CRETACEOUS OF CENTRAL CHINA

10:45 **Nair, J., Yates, A.** OSTEOLOGY OF THE TYPE MATERIAL OF *MELANOROSAURUS READI*, A 'NEAR SAUROPOD' (DINOSAURIA: SAUROPODOMORPHA) FROM THE UPPER TRIASSIC LOWER ELLIOT FORMATION OF SOUTH AFRICA, AND THE STATUS OF REFERRED SPECIMENS

11:00 **Upchurch, P., Mannion, P.** A NEW CHARACTER SET FOR THE ANALYSIS OF SAUROPOD PHYLOGENY, AND ITS IMPLICATIONS FOR THE EVOLUTIONARY HISTORY OF EUSAUROPODA

11:15 **Fronimos, J., Wilson, J.** CONCAVO-CONVEX INTERVERTEBRAL JOINTS IN SAUROPODS AND CROCODYLIANS: DO THEY INCREASE FLEXIBILITY OR STABILITY?

11:30 **Moon, B.** A NEW SPECIES-LEVEL PHYLOGENY OF THE ICHTHYOPTERYGIA AND ANALYSIS OF MACROEVOLUTIONARY TRENDS

11:45 **Maxwell, E., Fernandez, M., Larsson, H., Schoch, R.** A NEW ICHTHYOSAUR FROM THE MIDDLE JURASSIC OF GERMANY PROVIDES INSIGHTS INTO THE ASSOCIATION BETWEEN LIMB FORM AND FUNCTION

SATURDAY MORNING, NOVEMBER 8, 2014
TECHNICAL SESSION XIV (CONTINUED)

12:00 **Schumacher, B.** PHYLOGENY AND POSITED DIMORPHISM OF POLYCOTYLID PLESIOSAURS, NEW INFORMATION FROM A NEARLY COMPLETE SKELETON OF *POLYCOTYLUS LATIPINNIS* FROM THE NIOBRARA FORMATION (EARLY CAMPANIAN) OF SOUTH DAKOTA, UNITED STATES

SATURDAY MORNING, NOVEMBER 8, 2014
TECHNICAL SESSION XV
ESTREL BERLIN, HALL C
MODERATORS: Akinobu Watanabe and Rebecca Pian

8:00 **Alroy, J.** A NEW TWIST ON A VERY OLD FAUNAL SIMILARITY INDEX

8:15 **Fraser, D., Gorelick, R., Rybczynski, N.** PHYLOGENETIC OVER-DISPERSION OF LATE CENOZOIC NORTH AMERICAN UNGULATE COMMUNITIES

8:30 **Madden, R.** EARTH SURFACE PROCESSES IN THE EVOLUTION OF MAMMALIAN TOOTH SHAPE

8:45 **Mychajliw, A., Hadly, E.** ISLANDS ARE NOT CONTINENTS: PHYLOGENY AND BODY SIZE DRIVE UNIQUE EXTINCTION DYNAMICS OF CARIBBEAN MAMMALS

9:00 **Van Der Geer, A., Lyras, G., Lomolino, M., Palombo, M., Sax, D.** BODY SIZE EVOLUTION ON PALAEO-ISLANDS: ANTIQUITY OF THE ISLAND RULE AND TEMPORAL FLUCTUATIONS

9:15 **Kilbourne, B.** ENERGETIC BENEFITS AND ADAPTATIONS IN MAMMALIAN DESIGN: SCALE EFFECTS AND SELECTIVE PRESSURES

9:30 **MacLeod, N., Steart, D., Pearce, L., Bartleet-Cross, C., Nedza, C., Frost, A., Rose, K.** NEW MORPHOLOGIES FOR OLD: APPLICATION OF THREE DIMENSIONAL SURFACE ANALYSIS & COMPUTER VISION/MACHINE LEARNING TECHNIQUES TO COMPARATIVE ANATOMY WITH SPECIAL EMPHASIS ON VERTEBRATE PALEONTOLOGY

9:45 **Watanabe, A.** R2D3 AND C3PO: A COMPANION TOOL FOR TESTING THE FIDELITY OF TWO-DIMENSIONAL GEOMETRIC MORPHOMETRIC DATA IN A THREE-DIMENSIONAL WORLD OF VERTEBRATE CRANIA.

10:00 BREAK

10:15 **Clavel, J., Merceron, G., Escarguel, G.** MISSING DATA ESTIMATION IN MORPHOMETRICS: HOW MUCH IS TOO MUCH?

10:30 **Mabee, P., Dececchi, A., Blackburn, D.** MATRIX VS. MONOGRAPHS: COMPARISON OF PHENOTYPIC RICHNESS ACROSS DATA SOURCES.

10:45 **Pian, R.** ASSESSING THE RELATIVE IMPORTANCE OF DIFFERENT CHARACTER PARTITIONS IN PHYLOGENETIC ANALYSES OF MAMMALS

11:00 **Billet, G.** THE MORPHOLOGICAL VARIATION OF SOME SELECTED CHARACTERS OF THE BONY LABYRINTH IN PLACENTALS AND THEIR PERTINENCE FOR PHYLOGENETIC ANALYSES

11:15 **Castanhinha, R., Sucena, É., Rodríguez-León, J.** THE FRONTAL BONE: PROBLEMS AND SOLUTIONS IN AMNIOTE SKULL HOMOLOGY

11:30 **Koyabu, D., Werneburg, I., Sánchez-Villagra, M.** MACROEVOLUTIONARY PATTERNS IN MAMMALIAN CRANIOGENESIS REVEALS MODULAR EVOLUTION AND A LINK BETWEEN CRANIAL DEVELOPMENT AND BRAIN SIZE

SATURDAY MORNING, NOVEMBER 8, 2014
TECHNICAL SESSION XV (CONTINUED)

11:45 **Chatterjee, S., Chatterjee, S.** GENE DUPLICATIONS, CO-OPTION, AND THE EVOLUTION OF VERTEBRATE BRAINS

12:00 **Ferreira-Cardoso, S., Araujo, R., Castanhinha, R., Walsh, S., Martins, R., Martins, G.** THE FLOCCULAR COMPLEX: NEUROANATOMY AS A TOOL TO UNVEIL PALEOECOLOGY

SATURDAY MORNING, NOVEMBER 8, 2014
TECHNICAL SESSION XVI
ESTREL BERLIN, HALL D
MODERATORS: Martha Richter and Charlie Underwood

8:00 **Coates, M., Criswell, K., Hardy, A., Sansom, I., Finarelli, J.** *GLADBACHUS*: UNCONVENTIONAL CONDITIONS IN AN EARLY CHONDRICHTHYAN

8:15 **Richards, K., Clack, J.** A NEW CARBONIFEROUS CHONDRICHTHYAN FROM THE DERBYSHIRE LIMESTONE, UK.

8:30 **Fischer, J., Schneider, J., Rößler, R., Spindler, F., Hoffmann, U.** AN EARLY CARBONIFEROUS MASS OCCURRENCE OF SHARK EGG CAPSULES FROM FRESHWATER DEPOSITS -; THE OLDEST CHONDRICHTHYAN MULTI-TAXON NURSERY

8:45 **Criswell, K., Coates, M.** CONVERGENCE AND COMPLEXITY IN CHONDRICHTHYAN VERTEBRAL COLUMNS

9:00 **Underwood, C., Welten, M., Johanson, Z., Smith, M., Fraser, G.** TEETH INSIDE AND OUTSIDE THE MOUTH: A MICRO-CT ANALYSIS OF TOPOGRAPHIC RELATIONSHIPS IN SAWFISH AND SAWSHARK DENTITIONS (ELASMOBRANCHII; CHONDRICHTHYES)

9:15 **Sferco, E., López-Arbarello, A., Baez, A.** SYSTEMATIC POSITION OF THE CONTINENTAL LATE JURASSIC TELEOST *LUISIELLA FERUGLIOI* FROM PATAGONIA (ARGENTINA) AND THE OCCURRENCE OF A NEW GONDWANAN CLADE OF BASAL TELEOSTS

9:30 **Davesne, D., Gallut, C., Barriel, V., Lecointre, G., Janvier, P., Otero, O.** THE EARLY RADIATION OF ACANTHOMORPH TELEOSTS: WHEN FOSSILS HELP TO RESOLVE DEEP PHYLOGENETIC RELATIONSHIPS IN A MAJOR EXTANT CLADE

9:45 **Close, R., Johanson, Z., Tyler, J., Friedman, M.** A REMARKABLE NEW BEAKED TETRAODONTIFORM FISH FROM THE EARLY EOCENE LONDON CLAY FORMATION

10:00 BREAK

10:15 **Cloutier, R., Béchard, I.** STEP BY STEP TOWARDS A TETRAPOD SKULL: A HEAD-START FOR *ELPISTOSTEGE*

10:30 **Qu, Q., Zhu, M., Ahlberg, P.** HISTOLOGY OF A PRIMITIVE OSTEICHTHYAN (*PSAROLEPIS ROMERI*) SHEDS LIGHT ON THE ORIGIN OF MONOTYPIC ENAMEL ON VERTEBRATE TEETH

10:45 **Lemberg, J., Ross, C., Shubin, N., Daeschler, E.** FUNCTIONAL IMPLICATIONS OF PLATYROSTRAL SKULLS FOR FEEDING IN WATER WITH INSIGHTS INTO THE CRANIAL MORPHOLOGY OF *TIKTAALIK ROSEAE*

11:00 **Clement, A., Ahlberg, P.** BUCCAL-PUMP AIR GULPING IN DEVONIAN LUNGFISHES (SARCOPTERYGII; DIPNOI): INSIGHTS FROM TOMOGRAPHIC DATA

SATURDAY MORNING, NOVEMBER 8, 2014

TECHNICAL SESSION XVI (CONTINUED)

11:15 **Richter, M., Cisneros, J., Angielczyk, K., Marsicano, C., Kammerer, C., Fröbisch, J., Sadleir, R., Smith, R.** FIRST ARTICULATED COELACANTH FISH (SARCOPTERYGII: ACTINISTIA) FROM THE PALAEOZOIC OF SOUTH AMERICA (BRAZIL)

11:30 **Clack, J., Smithson, T. R., Anderson, J.** EVOLUTION OF THE TETRAPOD APPENDICULAR SKELETON: NEW EVIDENCE FROM ROMER'S GAP

11:45 **Mondéjar-Fernández, J.** THE SCALES OF A DEVONIAN TETRAPOD REVEALED BY SYNCHROTRON MICROTOMOGRAPHY: HISTOLOGICAL IMPLICATIONS FOR THE FISH—TETRAPOD TRANSITION

12:00 **Porro, L., Rayfield, E., Clack, J., Herrel, A., Adriaens, D.** MANDIBULAR MECHANICS AND FEEDING ACROSS THE WATER-LAND TRANSITION: FINITE ELEMENT ANALYSIS OF THE EARLY TETRAPOD LOWER JAW

SATURDAY AFTERNOON, NOVEMBER 8, 2014

SYMPOSIUM 5: ECOMETRICS: QUANTITATIVE TRAIT-BASED APPROACHES TO BIOTIC CHANGE

ESTREL BERLIN, HALL A

MODERATORS: Jussi T. Eronen and P. David Polly

1:45 **Badgley, C., Damuth, J.** ECOMORPHOLOGICAL STRUCTURE OF MAMMALIAN FAUNAS IN RELATION TO CLIMATE AND PHYSIOGRAPHY AT THE CONTINENTAL SCALE

2:00 **Bernor, R., Kaya, F., Fortelius, M.** DIACHRONOUS EVOLUTION OF MOLAR CROWN HEIGHT IN OLD WORLD *HIPPARION* LINEAGES UNDER CLIMATE CHANGE

2:15 **Damuth, J., Janis, C., Travouillon, K., Figueirido, B., Archer, M., Hand, S.** ECOMETRICS DOWN UNDER: CORRELATION OF MORPHOLOGY WITH PALEOHABITAT IN KANGAROOS

2:30 **Stegner, M.** TRACKING VARIATION IN SMALL MAMMAL FUNCTIONAL GROUP ABUNDANCE: IMPACTS OF QUATERNARY CLIMATE AND LAND USE ON THE COLORADO PLATEAU

2:45 **Schnitzler, J., Fritz, S., Eronen, J., Graham, C., Böhning-Gaese, K., Polly, P.** FROM TEETH TO GENES: INTEGRATING FOSSIL AND MOLECULAR DATA TO UNDERSTAND MODES AND RATES OF TRAIT EVOLUTION

3:00 **Stenseth, N.** RED QUEEN AND COURT JESTER: BIOTIC AND ABIOTIC INTERACTIONS IN ECOLOGY AND EVOLUTION

3:15 **Werdelin, L.** TOWARDS AN ECOMETRIC ANALYSIS OF CARNIVORES

3:30 **Fritz, S., Eronen, J., Janis, C.** WHICH TRAITS CAN PROMOTE EXTINCTION IN LARGE MAMMALS? RELATING PERSPECTIVES FROM LIVING AND EXTINCT SPECIES

3:45 **Meachen, J., Janowicz, A.** NATURAL TRAP CAVE: A MORPHOLOGICAL ASSESSMENT OF THE PLEISTOCENE TO HOLOCENE TRANSITION

4:00 **Head, J., Lawing, A., Polly, P.** HERPETOMETRICS: TESTING SIZE-BASED METABOLIC THERMOMETRY OF RECENT AND FOSSIL COLUBROID SNAKES ACROSS NORTH AMERICA

SATURDAY AFTERNOON, NOVEMBER 8, 2014

TECHNICAL SESSION XVII

ESTREL BERLIN, HALL C

MODERATORS: Hans-Dieter Sues and Christian Sidor

1:45 **Olroyd, S., Angielczyk, K.** EXPLORING THE ROBUSTNESS OF PERMO—CARBONIFEROUS TERRESTRIAL COMMUNITIES: THE IMPORTANCE OF INSECT AND TETRAPOD HERBIVORES

2:00 **Sidor, C., Angielczyk, K., Beightol, C., Nesbitt, S., Peecook, B., Smith, R., Steyer, J., Tabor, N., Tolan, S.** FILLING OLSON'S GAP: A NEW PERMIAN TETRAPOD ASSEMBLAGE FROM THE MID-ZAMBEZI BASIN OF SOUTHERN ZAMBIA

2:15 **Sues, H., Olsen, P.** NEW DATA ON THE TRIASSIC-;JURASSIC TETRAPOD ASSEMBLAGES IN THE FUNDY GROUP OF THE CANADIAN MARITIMES

2:30 **Shelton, C., Sander, P.** CELLULOSE HERBIVORY OF BASAL SYNAPSIDA IS NOT LINKED TO ENDOTHERMY OR HIGH GROWTH RATES

2:45 **Huttenlocker, A., Sidor, C. A., Angielczyk, K.** THEROCEPHALIANS (THERAPSIDA, EUTHERIODONTIA) FROM THE UPPER PERMIAN MADUMABISA MUDSTONE OF ZAMBIA AND THEIR BIOGEOGRAPHIC IMPLICATIONS

3:00 **Fröbisch, J., Kammerer, C.** DIVERSITY OF SMALL-BODIED DICYNODONTS (THERAPSIDA, ANOMODONTIA) FROM THE LATE PERMIAN OF SOUTH AFRICA

3:15 **Jansen, M., Kammerer, C., Fröbisch, J.** THERAPSID CRANIAL ONTOGENY BASED ON 2- AND 3-DIMENSIONAL MORPHOMETRIC ANALYSIS

3:30 **Laaß, M., Schillinger, B.** WHAT DO INNER AND MIDDLE EAR ANATOMY TELL US ABOUT HEARING CAPABILITIES, BEHAVIOR, AND LIFESTYLE OF NON-MAMMALIAN SYNAPSIDS?

3:45 **Walther, M., Kammerer, C., Brocklehurst, N., Fröbisch, J.** NON-MAMMALIAN CYNODONT (SYNAPSIDA, THERAPSIDA) DIVERSITY PATTERNS AND THE QUALITY OF THEIR FOSSIL RECORD

4:00 **O'Meara, R., Dirks, W.** UNDERSTANDING DENTAL GROWTH PATTERNS ACROSS THE CYNODONT TO MAMMALIAFORM TRANSITION

SATURDAY AFTERNOON, NOVEMBER 8, 2014

PREPARATORS' SYMPOSIUM

ESTREL BERLIN, HALL D

MODERATORS: William Simpson and Steve Jabo

1:45 **Behlke, A.** TEACHING FOSSIL PREPARATION WITHOUT FOSSILS

2:00 **Brown, M.** A BETTER MODEL FOR TEACHING PALEONTOLOGICAL LABORATORY METHODS IN NORTH AMERICA

2:15 **Jabo, S., Kroehler, P., Pinsdorf, M.** THE RENOVATION OF THE VERTEBRATE PREPARATION LAB AT THE NATIONAL MUSEUM OF NATURAL HISTORY, SMITHSONIAN INSTITUTION

2:30 **Capobianco, C., Redman, C.** IMPROVING EFFICIENCY AND OUTPUT OF INDOOR SCREEN WASHING FACILITIES

2:45 **Knötschke, N., Mastroianni, M., Wings, O.** A SONG OF BLASTING AND FIRE: *EUROPASAURUS HOLGERI*

3:00 **Van Beek, C.** TRANSFER PREP OF AN EOCENE BIRD FROM THE GREEN RIVER FORMATION, WY.

SATURDAY AFTERNOON, NOVEMBER 8, 2014
PREPARATORS' SYMPOSIUM (CONTINUED)

3:15 **Fitzgerald, E., Sereno, P.** EXCAVATION AND PREPARATION OF FOSSILS PRESERVED IN LOOSE SAND

3:30 **Fox, M., Zdinak, A., Yarborough, V.** *BAROSAURUS* ON THE HALF SHELL: A TWO PIECE STORAGE JACKET DESIGN FOR LARGE OR FRAGILE SPECIMENS

3:45 **Davidson, A.** BREAKS, REPAIRS, AND ESSENTIAL COMPETENCIES FOR VERTEBRATE FOSSIL PREPARATORS

4:00 **Eklund, M., Brown, M.** SIMPLE FORENSIC METHODS FOR PALEONTOLOGICAL DIAGNOSIS

SATURDAY, NOVEMBER 8, 2014
POSTER SESSION IV
ESTREL BERLIN, ROOMS 2 AND 3
Authors must be present from 4:15 - 6:15 pm
Posters must be removed by 6:30 pm

Posters Associated with the Prepartors' Symposium

29 **Beardmore, S., Trythall, J.** THE DEVELOPMENT OF THE ELGIN MUSEUM AS A PUBLIC AND SCIENTIFIC RESOURCE

30 **Stache, M., Hastings, A., Hellmund, M.** 3-D SCANNING AND PRODUCTION OF ACCURATE FORM-FITTING SUPPORT CRADLES FOR FOSSILS USING CNC MILLING TECHNOLOGY (COMPUTERIZED NUMERICAL CONTROL TECHNIQUE): A PROJECT WITH THE GEISELTAL COLLECTION

31 **Pinsdorf, M., Jabo, S., Telfer, A., Kroehler, P., Hollis, K., Millhouse, A., Miller, M.** REPURPOSING THE PURPOSEFUL: RE-TRAINING FOSSIL PREPARATORS IN VERTEBRATE MOUNT DISMANTLING AND CONSERVATION

32 **Goldberg, S., Davidson, A.** ADHESIVES USED IN 2014 BY THE VERTEBRATE PALEONTOLOGY PREPARATION LABORATORY, AMERICAN MUSEUM OF NATURAL HISTORY: AN ILLUSTRATED WALL CHART

33 **Gishlick, A., Fox, M.** HOW TO PACK FOSSILS FOR LOANS

34 **Carrió, V., Da Rocha, S., Fraser, N.** SCOTTISH MAMMOTH TUSKS AT NATIONAL MUSEUMS SCOTLAND

35 **Sørensen, T.** MULTIPLE ISSUES WHEN PREPARING AND PRESERVING LATE MIOCENE BEAKED WHALE (GRAM FM) FOR RESEARCH AND EXHIBITION: THE DIFFICULT TASK OF DOING AS LITTLE AS POSSIBLE

36 **Marcos-Fernandez, F., Mocho, P., Elvira, A., Páramo, A., Escaso, F., Ortega, F.** THE SAUROPOD THAT STOPPED THE TRAIN

37 **English, L., Brown, M.** RESOLUTION AND ACCURACY OF 3-DIMENSIONAL MODELS OF SPECIMENS USING PHOTOGRAMMETRY AND IMAGE STACKING SOFTWARE

38 **Manucci, F., Maganuco, S., Panzarin, L., Bonadonna, D.** IMPROVING COLLABORATION BETWEEN PALEONTOLOGISTS AND PALEOARTISTS: A CASE STUDY, FOCUSED ON THE CERATOPSID DINOSAUR *STYRACOSAURUS*

39 **Murphey, P., Knauss, G., Fisk, L., Demere, T., Sullivan, R., Trujillo, K., Strauss, J.** A FOUNDATION FOR BEST PRACTICES IN MITIGATION PALEONTOLOGY

Posters Associated with Symposia 5: Ecometrics: Quantitative Trait-Based Approaches to Biotic Change

40 **Eronen, J., Janis, C., Chamberlain, C., Mulch, A.** PALEOGENE SURFACE UPLIFT AND ITS IMPACT ON TERRESTRIAL PALEOENVIRONMENTS AND MAMMALIAN COMMUNITIES IN WESTERN NORTH AMERICA

41 **Polly, P., Bormet, A. K., Lawing, A.** SELECTION OR GEOGRAPHIC SORTING IN THE ESTABLISHMENT OF ECOMETRIC PATTERNS: INTRASPECIFIC VARIATION AND ENVIRONMENT IN CARNIVORAN ANKLE MORPHOLOGY

42 **Fox, D., Keller, J., McNulty, K.** RODENT TOOTH SHAPES AS ECOMETRIC TRAITS: PREDICTING TROPHIC CATEGORIES OF RODENTS FROM 3D TOOTH MORPHOLOGY

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43 **Ode, S., Nakaya, H., Suwa, G., Asfaw, B.** PALEODIET RECONSTRUCTION OF EARLY PLEISTOCENE EQUIDAE FROM KONSO, RIFT VALLEY, SOUTH ETHOPIA

44 **Zazula, G., Hall, E., Scott, E., Jensen, B., Froese, D.** PRELIMINARY REPORT ON A NEW MIDDLE PLEISTOCENE (> 700 KA) HORSE (*EQUUS* SP.) SPECIMEN FROM YUKON, CANADA.

45 **Scott, E., McHorse, B., Jass, C., Zazula, G. D.** A MORPHOMETRIC ASSESSMENT OF PLEISTOCENE HORSE METAPODIALS ACROSS WESTERN NORTH AMERICA

46 **Bales, G.** RHINO FACE SPACE

47 **Coombs, M.** THE SIGNIFICANCE OF THE OLIGOCENE—MIOCENE TRANSITION IN THE DIVERSIFICATION AND SPREAD OF THE CHALICOTHERIIDAE (MAMMALIA, PERISSODACTYLA)

48 **Pandolfi, L., Kotsakis, T., Maiorino, L., Petronio, C., Piras, P.** SYSTEMATICS AND PHYLOGENY OF RHINOCEROTINI (MAMMALIA, RHINOCEROTIDAE)

49 **Schellhorn, R.** HEAD POSTURE IN THE WOOLLY RHINOCEROS

50 **Sanisidro, O., Domingo, L., Alberdi, M., Morales, J.** TWO GOOD NEIGHBORS: NICHE PARTITIONING IN MIOCENE RHINOS (RHINOCEROTIDAE, PERRISODACTLYA) FROM THE IBERIAN PENINSULA

51 **Arroyo-Cabrales, J., Perez-Crespo, V., Carranza-Castañeda, O., Morales-Puente, P., Cienfuegos-Alvarado, E.** DIET AND HABITAT FOR *DINOHIPPUS MEXICANUS* AND *NEOHIPPARION EURYSTILE* (PERISSODACTYLA, EQUIDAE) FROM TWO MEXICAN LOCALITIES.

52 **Biasatti, D., Bernor, R., Cooper, L.** PALEOECOLOGY OF LATE MIOCENE HORSES FROM MARAGHEH LAGERSTATTE, EASTERN AZERBAIJAN PROVINCE, NORTHWEST IRAN: A STABLE ISOTOPE PERSPECTIVE

53 **Wood, A., Ridgwell, N., Bourque, J., Rincon, A., Bloch, J., MacFadden, B.** PALEOBIOGEOGRAPHY OF NON-EQUID PERISSODACTYLS FROM THE EARLY MIOCENE OF PANAMA

54 **Wolf, D., Bernor, R., Coillot, T.** WHAT JUVENILE HIPPARIONINE SKULLS REVEAL ABOUT TAXONOMY AND PHYLOGENETIC RELATIONSHIPS: AN EXAMPLE FROM OLDUVAI, TANZANIA

55 **Watabe, M., Ataabadi, M.** HIPPARIONINE HORSES (MAMMALIA, PERISSODACTYLA, EQUIDAE) FROM MARAGHEH, NORTHWEST IRAN REVISITED

56 **Martinez-Maza, C., Alberdi, M., Prado, J.** A PRELIMINARY HISTOLOGICAL ANALYSIS OF THE GENUS *ANCHITHERIUM* FROM SPAIN: DESCRIPTION OF THE BONE MICROSTRUCTURE AND BIOLOGICAL INFERENCES

57 **Holbrook, L.** THE HOMOLOGY OF THE POSTPROTOCRISTA AND ITS IMPLICATIONS FOR THE EVOLUTION OF LOPHODONTY AND MOLARIZATION OF THE UPPER PREMOLARS IN PERISSODACTYLA (MAMMALIA)

58 **Miyata, K.** EVALUATION OF A PRIMITIVE TAPIROMORPH PERISSODACTYL FROM THE AKASAKI FORMATION, EARLY / MIDDLE EOCENE BOUNDARY, JAPAN

59 **Tütken, T.** ISOTOPE COMPOSITIONS (C, O, SR) OF VERTEBRATE FOSSILS FROM THE MIDDLE EOCENE OIL SHALE OF MESSEL, GERMANY: IMPLICATIONS FOR THEIR TAPHONOMY AND PALAEOENVIRONMENT

60 **Martin, J.** A NEW BALAENOPTERID (CETACEA, MYSTICETI) FROM THE UPPER MIOCENE EASTOVER FORMATION, VIRGINIA

61 **Tartarelli, G., Bisconti, M.** VIRTUAL BRAIN ENDOCAST RECONSTRUCTION OF A PLIOCENE DOLPHIN FROM NORTHERN ITALY (MAMMALIA, CETACEA, ODONTOCETI)

62 **Aguirre-Fernandez, G., Jaramillo, C., Sanchez, R., Carrillo-Briceño, J., Sanchez-Villagra, M.** NEW FOSSIL ODONTOCETES (CETACEA, ODONTOCETI) FROM THE MIOCENE OF VENEZUELA AND COLUMBIA

63 **Murakami, M.** CONVERGENT EVOLUTION OF SECONDARY CRANIAL SYMMETRY IN ODONTOCETI (MAMMALIA, CETACEA): HOW AND WHY?

64 **Ramassamy, B.** DISCOVERY OF A NEW GENUS OF A LONG-SNOUTED BEAKED WHALE FROM THE LATE MIOCENE GRAM FORMATION IN DENMARK

65 **Bisconti, M., Bosselaers, M.** A LARGE BALAENOPTERID SKELETON FROM THE EARLY PLIOCENE OF THE NORTH SEA SHEDS LIGHT ON THE AFFINITIES OF *'BALAENOPTERA' SIBBALDINA* (MAMMALIA, CETACEA, MYSTICETI)

66 **Ando, T., Tsai, C.** LARGE AETIOCETID IMPLIES A WIDE RANGES OF NICHE IN EARLY MYSTICETI

67 **Abu El Kheir, G., Van Vliet, H., Gibbs, S., El Anbaawy, M.** A NEW SKELETON OF THE BASILOSAURID *MASRACETUS MARKGRAFI* FROM NORTH OF LAKE QARUN, FAYUM DEPRESSION, EGYPT

68 **Van Vliet, H., Lambert, O., Bosselaers, M., Schulp, A., Jagt, J.** A NEW RECORD OF A PALEOGENE CETACEAN (BASILOSAURIDAE, AFF. *BASILOTRITUS*) FROM THE ST. PIETERSBERG, MAASTRICHT, SOUTHEAST NETHERLANDS

69 **Fordyce, R., Hiller, N.** ANAASSOCIATED SKELETON OF JUVENILE LATE EOCENE BASILOSAURID ARCHAEOCETE (CETACEA: ARCHAEOCETI) FROM NEW ZEALAND

70 **Uhen, M., Godfrey, S.** A NEW SPECIMEN OF *AGOROPHIUS PYGMAEUS* (CETACEA, ODONTOCETI, AGOROPHIIDAE) FROM THE EARLY OLIGOCENE ASHLEY FORMATION OF SOUTH CAROLINA, U.S.A.

71 **Zouhri, S., Gingerich, P. D., Rahali, M., Elboudali, N., Sebti, S.** NEW CETACEAN AND SIRENIAN FAUNAS AND SEA LEVEL CHANGE IN THE SAMLAT FORMATION, UPPER EOCENE, NEAR AD-DAKHLA IN SOUTHWESTERN MOROCCO

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Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

REPTILIAN FAUNA FROM THE EARLY MIOCENE OF WADI MOGHRA, WESTERN DESERT, EGYPT

ABDELGAWAD, Mohamed, Cairo Univ, Giza, Egypt; SERTICH, Joseph, Denver Museum of Nature & Science, Denver, CO, United States of America; SALLAM, hesham, Mansour university, mansour, Egypt; MILLER, Ellen, Wake Forest Univ, Winston Salem, NC, United States of America; EL- BARKOOKY, Ahmed, cairo University, Giza, Egypt; HAMDAN, mohamed, cairo University, Giza, Egypt; GUNNELL, Gregg, Duke University Lemur Center, Durham, NC, United States of America

The Moghra Formation, in the Qattara Depression of northern Egypt, remains one of the best windows into the Early Miocene of Africa. Comparisons of other African Miocene vertebrate faunas suggest that Moghra may be older than Gebel Zelten, Libya, but similar in age to deposits at Rusinga, Kenya and Napak, Uganda. Deposited in a tide-dominated estuarine environment, mammalian remains are among the best known and diverse components of the fauna and include 16 families representing aquatic and salt-water taxa, semiaquatic and freshwater groups (e.g., Sirenia, Anthracotheriidae), and terrestrial forms. Reptilian remains from Moghra, represented by crocodylians, turtles, lizards, and snakes, are relatively abundant but have received only sporadic attention over the past century. These include the types of several enigmatic forms such as the brevirostrine osteolamine crocodylian *Rimasuchus lloydi*. New specimens of *Rimasuchus*, together with at least three other crocodylians (*Crocodylus* sp., *Tomistoma dawsoni, Euthecodon* sp.), indicate a relatively high morphological diversity within the group. Further, the Early Miocene Moghra crocodylians hint at North African overlap between sub-Saharan taxa (*Euthecodon arambourgi, Rimasuchus lloydi*) and taxa known primarily from the Mediterranean basin and Asia (*Tomistoma*). Turtle fossils include at least two distinct taxa, *Podocnemis* sp. and *Trionyx* sp. The reptilian fauna supports the interpretation of a tropical, warm, Miocene climate in northern Africa and likely represents an intersection between circum-Mediterranean and African faunas during this interval.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A NEW SKELETON OF THE BASILOSAURID *MASRACETUS MARKGRAFI* FROM NORTH OF LAKE QARUN, FAYUM DEPRESSION, EGYPT

ABU EL KHEIR, Gebely, Egyptian Environmental Affairs Agency, Cairo, Egypt; VAN VLIET, Hendrik Jan, no, Utrecht, Netherlands; GIBBS, Susan, Australian Museum, Sidney, Australia; EL ANBAAWY, Mohammed I., Cairo University, Cairo, Egypt

A report is given of a newly found skeleton of *Masracetus markgrafi*, collected north of Lake Qarun in the Fayum Depression of Egypt. In the last 100 years, an exceptionally large amount of basilosaurid remains has been found in the middle to late Eocene strata of the Fayum Depression and recently to the west in Tibaghbagh, in Egypt.

The holotype of *Masracetus markgrafi*, a vertebral column and a cranium reconstructed with plaster, has been known for more a century but named only some years ago. It is far less common than *Basilosaurus isis* and *Dorudon atrox*. Isolated elements and a few partial skeletons of *Masracetus markgrafi* are known thus far. All remains have been found in the Priabonian Gehannam and Birket Qarun Formations of the southwestern parts of Wadi El Hitan to the northeast of Lake Qarun in the Fayum Depression, and also in Tibaghbagh. Centra of the lumbar vertebrae of *Masracetus* and *Basilosaurus* have more or less the same diameter but these *of Masracetus* are less than half its length in contrast to the very elongated vertebrae of *Basilosaurus*.

This new skeleton permits a full description of *Masracetus* for the first time. It is is represented by the cranium (missing the ventral parts), periotics and bullae, left and right semi complete mandibulae, seven cervical vertebrae, fourteen thoracic vertebrae (missing Th2–3), nineteen lumbar vertebrae, four sacral vertebrae, eight caudal vertebrae, ribs (some fragmented), three sternum elements, one right scapula, and ulna.

It is semi articulated; the bones are slightly abraded. 11 thoracic vertebrae, lacking neural arches and transverse processes, were scattered close to the skull. Most caudal vertebrae are missing or dislocated to the front of the skeleton. The posterior part is affected by recent erosion. The anterior part was at its finding covered with sedimensts and embedded in calcareous sandstone with abundant molluscs and fish remains. Bivalves and barnacles encrust the surface of the bones that shows also bite marks and traces of organisms suggestive that the carcass was lying for some time on the sea floor before burying. The occurence of shark teeth is indicative of scavenging, possibly responsible for the dispersal of vertebrae and other skeleton elements.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

TESTING THE CRETACEOUS DIVERSITY OF ICHTHYOSAURS AND THEIR EXTINCTION HYPOTHESES USING A QUANTITATIVE APPROACH

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Ichthyosaurs, as other Mesozoic marine amniotes, have been unfairly overshadowed by dinosaurs in both popular culture and the field of vertebrate paleontology. Yet by the effort of dedicated researchers, work on these secondarily-aquatic, fish-like marine reptiles had never died out, and in fact a second wave of interest emerged in the late 20th century. Since then, research on ichthyosaurs has focused on the discovery of new taxa, assessments of their paleobiology, and quantitative analyses of their diversity. Despite ever-growing interest, patterns and mechanisms leading up to their extinction in the Cenomanian were insufficiently evaluated. In other words, hypotheses focusing on abrupt extinction linked to a crash in prey diversity, notably belemnites, over a catastrophic event at the end-Cenomanian remain poorly tested. Our project thus aims to test: 1) whether the Cretaceous diversity of ichthyosaurs reflects biological signals, and 2) correlation of their diversity with the diversity of belemnites. In this regard, a species-level dataset of Cretaceous belemnites including belemnite-bearing formations was built to be employed together with the occurrence-based ichthyosaur and ammonite datasets in the same taxic level. Raw taxic counts, as observed diversities of the clades, were quantified in two different temporal scales, and compared with two sampling proxies: taxa-bearing, referring respective formations of each clade, as the first, and Cretaceous fossiliferous marine formations as the second for the amount of fossil-bearing rock outcrop. The model-based method was then applied to correct all taxic counts based on two proxies in both time bins to acquire expected diversities of all the clades. Comparisons resulted in strong correlations between the clades' observed diversities and proxies exposing biased curves under the influence of sampling intensity. Both observed and expected diversities show no evidence of a causal relationship between the predator and prey groups, suggesting that the diversity of the latter seems not being a parameter for that of the former. This is therefore unsupportive for a prey-driven demise of the predator. Furthermore, the expected trend of ichthyosaurs indicates low Albian diversity gradually declining towards their extinction in the Cenomanian, which appears to be contrasting with recent studies.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A LATE UINTAN CARETTOCHELYID TURTLE *PSEUDANOSTEIRA PULCHRA* FROM THE UINTA FORMATION, UINTA BASIN, UTAH, U.S.A.

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Carettochelyidae, or pig-nosed turtles, first appear in North America in the early middle Eocene as apparent immigrants from Asia and persisted to the Chadronian. Although carettochelyids are readily identifiable in the fossil record due to their distinctly patterned shell sculpture, they are typically rare in North American assemblages and their distribution is poorly documented. Three genera are known (*Anosteira*, *Pseudanosteira*, and *Allaeochelys*), primarily from early 20th century taxonomic literature and late 20th century faunal lists. Here we report on new records of *Pseudanosteira* from the middle Eocene Uinta Formation of northeastern Utah. The Uinta Formation contains diverse assemblages of turtles from the Uintan North American Land Mammal Age, and the site of Myton Pocket is the type area of *Pseudanosteira*. In addition to the type area, this genus is now known from multiple sites tied into the local stratigraphic framework. While turtles are abundantly preserved in the Uinta Formation, *Pseudanosteira* is currently only known from the Uinta C Member and from fewer than ten percent of localities where turtles have been systematically collected. This work highlights the need for systematic collecting to recover rare taxa and adequately document their geographic and stratigraphic distributions.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

NEW OSTEOSTRACANS (AGNATHA, VERTEBRATA) FROM THE LOWER DEVONIAN OF SEVERNAYA ZEMLYA ARCHIPELAGO, RUSSIA AND THE MODE OF DEVELOPMENT OF THEIR EXOSKELETON

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New osteostracans, *Reticulaspis menneri* and *Nucleaspis unica*, were described from the Lower Devonian deposits of the Severnaya Zemlya Archipelago, Russia. The remains come from the upper part of the Severnaya Zemlya Formation of October Revolution Island. The perfect preservation of the exoskeleton structure of *Reticulaspis menneri* allows the mode of formation of the skeleton of the cephalothoracic shield to be characterized. It has been determined that a three-dimensional reticular structure of the exoskeletal surface presents the second generation of dentine covering the first dentine generation of numerous tubercles. New information on the processes of ontogenetic development of the osteostracan under study was analyzed and compared with previous data. The bipolar vertical growth has been described for a small exoskeleton fragment (separate tessera) of *Paraungulaspis arctoa* from the same deposits; however, *Reticulaspis menneri* shows for the first time an opportunity of bipolar vertical growth throughout the exoskeletal surface of cephalothoracic shield and the mode of formation of consolidated shield by the development of a continuous reticular dentine structure connecting individual tesserae. *Nucleaspis unica* is represented by a juvenile stage, which is extremely scarce in this group of vertebrates. The structures displayed by scanning electron microscopy (SEM) on the *Nucleaspis* shield surface (traces of regular small tubercles and, probably, network fragments) are the initial exoskeleton elements. It seems highly probable that superpositional growth of the exoskeleton was much more widespread among osteostracans than was previously thought.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

NEW FOSSIL ODONTOCETES (CETACEA, ODONTOCETI) FROM THE MIOCENE OF VENEZUELA AND COLUMBIA

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There is an increasing interest on the deep-time patterns of the latitudinal biodiversity gradient and what they can predict on present biodiversity and the effects of future climate change. The known fossil record of cetaceans (whales and dolphins) in the Americas is patchy and mostly based on exploration and research effort outside the tropics. The best known localities are in the USA, Mexico, Peru, Chile and Argentina. Here, we summarize recent cetacean findings from prospected sequences in Venezuela and Colombia. The findings include five specimens in four localities: (1) the fused mandibles (symphyseal region) of an odontocete (eurhinodelphinid?) from the Urumaco Formation (middle to late Miocene, western Venezuela); (2) the rostrum of a possible eurhinodelphinid from the Codore Formation (late Miocene to early Pliocene, western Venezuela); (3) the partial skull (rostrum and eroded cranium) of a possible squalodelphinid from the Querales Formation (early to middle Miocene, western Venezuela); and (4) a cranium and tympanic bulla of a small odontocete (?Kentriodontidae), and the mandibles of a large odontocete (?Squalodontidae) from the Castilletes Formation (early Miocene, northern Colombia). Previously reported cetaceans

from Venezuela include several squalodelphinids (Cantaure and Castillo Formations, both early Miocene), some iniids (Socorro Fm, middle Miocene; Urumaco Fm, middle to late Miocene), and an indeterminate mysticete (Punta Gavilan Fm, early Pliocene). Besides the geographical importance of these new fossils, the early Miocene is one on the least known time intervals in cetacean evolution. Ongoing preparation and study of this material offers a unique opportunity to close the gap between northern and southern cetacean assemblages and underlines the need to prospect northern Neotropical localities.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

PLEISTOCENE SMALL MAMMAL BIOSTRATIGRAPHY OF THE GUADIX-BAZA BASIN (SOUTHEAST SPAIN)

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In this communication, a biozonation of the Pleistocene continental record of the Guadix-Baza Basin is proposed. This biozonation is based on the small mammal succession, which ranges from the earliest Pleistocene (ca. 2.6 Ma) to the middle Pleistocene (ca. 0.3 Ma). A total of 9 biozones have been recognized, all of them based on the range or concurrent-range of arvicolid species. Therefore, seven biozones have been defined for the early Pleistocene: the *Kislangia gusii* Zone, *Mimomys* cf. *reidi* Zone, *Tcharinomys oswaldoreigi* Zone, *Allophaiomys ruffoi* Zone, *Allophaiomys* aff. *lavocati* Zone, *Iberomys huescarensis* Zone, and *Terricola arvalidens* Zone. In the middle Pleistocene of the basin, two biozones have been recognized: the *Iberomys brecciensis-Arvicola mosbachensis* Zone and *Iberomys brecciensis-Arvicola* aff. *sapidus* Zone. According to different dating methods, the duration of each early Pleistocene biozone ranges between 0.4 and 0.1 Ma, with increasing resolution from the earliest Pleistocene to the late early Pleistocene. The small mammal succession reveals a high degree of endemism and a persistent Eastern Mediterranean influence, as opposed to Central and Eastern Europe. However, correlation with other Iberian and European sites has been possible on the basis of each biozone associated fauna.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

LOCOMOTOR ECOMORPHOLOGY OF NORTH AMERICAN OXYAENIDAE AND HYAENODONTIDAE (MAMMALIA: CREODONTA)

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Oxyaenidae and Hyaenodontidae (Mammalia: Creodonta) were important and diverse members of the Paleogene carnivore guild in North America. However, relatively few quantitative analyses of creodont locomotor variation and postcranial adaptations exist compared to those examining dental variation and the evolution of carnivory in Paleogene carnivores. Here, I investigate the ecological role of creodonts by determining the locomotor behavior utilized by North American oxyaenids and hyaenodontids. To quantify locomotor behavior, functional characters were derived from the postcranial skeleton and include 14 log-transformed ratios calculated from 24 linear measurements. A comparative sample is comprised of 21 species of ecologically analogous, extant Carnivora assigned to six locomotor categories. Principal coordinates analysis (PCO) was used to visualize locomotor variation, and a multivariate analysis of variance (MANOVA) on the principal coordinates scores was used to test the relationship between morphology and locomotor behavior in the comparative sample. In addition, several well-preserved creodont species were classified to locomotor categories using a discriminant function analysis (DFA) based on a subset of informative functional characters. The MANOVA indicates that locomotor behavior, taxonomic family, and the interaction between the two factors are significantly associated with morphological variation (p-value < 0.0001). More variance is explained by locomotor mode ($\eta^2 = 0.637$) than by family ($\eta^2 = 0.577$) based on effect size. The PCO shows that the majority of oxyaenids and hyaenodontids fall outside the range of living carnivores with similar hypothesized locomotor behaviors; however, several creodont species were classified into locomotor categories with the DFA. Species are assigned to both expected locomotor groups, such as *Hyaenodon horridus* (cursorial), *Thinocyon medius* (terrestrial), and *Tritemnodon agilis* (scansorial), as well as unexpected locomotor groups, such as *Palaeonictis* sp. (semiaquatic). This is one of the first studies to quantitatively determine the locomotor behavior in a broad sample of North American creodont species, and further analysis will provide a more thorough understanding of the ecology and diversification patterns of this early radiation of eutherian carnivores.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

***MICROMERYX FLOURENSIANUS*—REVIEW OF A MIOCENE EUROPEAN MOSCHID 'SURVIVING' FOR 5 MILLION YEARS**

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The species *Micromeryx flourensianus* is a quite common faunal element in the Miocene of Western and Central Europe and is recorded for at least five million years from the early middle to the late Miocene (MN5-9; (11)?). It differs from small early to middle Miocene Pecora like *Lagomeryx* or *Hispanomeryx* by having a closed or nearly closed anterior valley in the triangular p4, lower molars with only an anterior cingulid, a bicuspid third lobe with a high entoconulid in the m3, and a non-shortened lower premolar row. *M. flourensianus* differs from other species of the genus, *M. styriacus*, *M. mirus*, *M. azanzae*, and *M. soriae*, in the overall morphology of the p4, presence and morphology of the external postprotocristid in the lower molars, relative tooth crown height, and tooth dimensions. Although the species represents the type species of the genus, exhaustive descriptions of the type material and of specimens from other rich localities are still missing. Therefore, estimations of intraspecific variability or gradual character change from early to late representatives of the species are limited so far. Recent comparisons of specimens from different localities and ages showed a gradual change from stratigraphically older to younger specimens: increase in some tooth dimensions, increase in relative tooth crown height, and reduction of the external postprotocristid. The so far missing scientific descriptions of the material from the type locality Sansan (France) and from other rich localities presented a challenge to the assignment of late middle Miocene and early late Miocene *Micromeryx* findings from Central and Western Europe to the species *M. flourensianus*. We present here morphological and dimensional changes that occur from early to late records inside the species. We thus provide a first step for more exhaustive work on the evaluation of the species and its phylogenetic relationship among the Miocene moschids.

This research received support from the Synthesys Project (FR-TAF-1892) which is financed by the European Community Research Infrastructure Action under the FP7 'Capacities' Program.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

NEW MATERIAL OF THE THEROPOD *ICHTHYOVENATOR* FROM BAN KALUM TYPE LOCALITY (LAOS): IMPLICATIONS FOR THE SYNONYMY OF *SPINOSAURUS* AND *SIGILMASSASAURUS* AND THE PHYLOGENY OF SPINOSAURIDAE

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New excavations conducted in January 2012 at Ban Kalum, in the Savannakhet Basin, have recovered additional remains of the spinosaurid theropod *Ichthyovenator laosensis*. The newly discovered material includes the complete cervical skeleton and the first dorsal vertebra, as well as the left pubis, seven additional caudal vertebrae and three teeth. Thanks to this discovery, we are also able to referred isolated theropod teeth and vertebrae, previously collected in various localities of the Savannakhet basin, to *Ichthyovenator*. This suggests the contemporaneity of all these localities. *Ichthyovenator* was an important component of the late Early Cretaceous Laotian dinosaur fauna.

The first dorsal vertebra of *Ichthyovenator* is nearly identical to the holotypic vertebra of the enigmatic theropod *Sigilmassasaurus brevicollis* from the Cenomanian 'Kem Kem beds' of southeastern Morocco. *Sigilmassasaurus* has been recognized either as a subjective junior synonym of *Carcharodontosaurus saharicus* by some authors or as a valid basal tetanuran taxon by others. The two diagnostic characters used to define *Sigilmassasaurus* (i.e., articular surface of the "cervical" centra much wider than high, with a width/height ratio of approximately 1.5; interzygapophyseal laminae absent so that the short neural spine contacts the dorsal margin of the neural canal anteriorly and posteriorly) are present on the first dorsal vertebra of *Ichthyovenator*, as well as on the last two cervical vertebrae. These characters are no longer autapomorphic of *Sigilmassasaurus*. The latter is here regarded as a nomen dubium, but we refer its holotypic and referred material to Spinosauridae, based on a phylogenetic analysis. The fossiliferous beds which have yielded *Sigilmassasaurus* material in Morocco, Egypt, and Niger have also yielded remains of *Spinosaurus*. It is thus very likely that *Sigilmassasaurus* is a subjective junior synonym of *Spinosaurus*.

Ichthyovenator was originally placed as the sister group to the remaining baryonychines *Suchomimus* and *Baryonyx*. In addition to the peculiar morphology of posterior cervical and anterior dorsal vertebrae, the straight unserrated crowns of the teeth of *Ichthyovenator* suggest it is more closely related to Spinosaurinae than previously thought.

Technical Session VI (Thursday, November 6, 2014, 11:30 AM)

ON THE EVOLUTION OF HUMAN AND APE HAND PROPORTIONS

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Human hand morphology is highly distinctive, yet debates remain on the evolutionary origins of modern human hand proportions (which facilitate increased manual dexterity) despite a growing fossil record of manual remains. Nonhuman primates use their hands on a regular basis for both manipulation and locomotion, and their hand proportions necessarily reflect this functional duality. Therefore, insights into the hand shape of the *Pan-Homo* last common ancestor would almost certainly shed light on its locomotor, behavioral, and other adaptations. Here we combine the hand fossil record of Miocene apes (e.g., *Proconsul*) and early hominins (e.g., *Ardipithecus*) to more broadly study the evolution of the hand in the great ape and human clade. In this work we use a quantitative and phylogenetically informed approach to examine the intrinsic (thumb relative to ray IV) and extrinsic (thumb and ray IV relative to body mass) hand proportions of modern and fossil apes and hominins. Extrinsic hand proportions reveal two major groups: (1) the long-handed, more suspensory apes (hylobatids, Pongo, and *Pan*); and (2) a shorter-handed cohort of hominins, Proconsul, and *Gorilla*. Due to its short thumb, *Ardipithecus* shows closer affinities to gorillas or *Proconsul* (depending on the body mass estimate used) than to other hominins. Results on intrinsic proportions confirm a short thumb in *Ardipithecus* (within the range of African apes and hylobatids), shorter than that of *Proconsul* (the latter being intermediate between modern apes and humans). In combination, these data inform competing evolutionary scenarios for the origins of the human hand (e.g., modern humans are largely plesiomorphic, *Ardipithecus* is autapomorphic with *Gorilla*) and stress the importance of including fossil apes in combination with available early hominins in developing and testing models of ape and human evolution. Research funded by the AAPA Professional Development Grant; the Smithsonian Scholarly Studies Grant Program; Leakey Foundation; Wenner-Gren Foundation; the Spanish Ministerio de Economia y Competitividad (CGL2011-27343); and National Science Foundation (BCS 1316947, 1317029, 1317047).

Technical Session XV (Saturday, November 8, 2014, 8:00 AM)

A NEW TWIST ON A VERY OLD FAUNAL SIMILARITY INDEX

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Many paleoecological and biogeographic analyses depend on quantifying the similarity of faunal assemblages. Such comparisons are often based on indices that are a function of the number of species shared by two assemblages. However, most indices that are used frequently, such as the Jaccard and Dice coefficients, are inaccurate when some assemblages are better-sampled than others.

This problem was first recognized in 1943, but the proposed metric, Simpson's index, is unfortunately quite imprecise. An even older metric, Forbes' index, turns out to have much better properties. The original version was a[(a + b + c + d)]/[(a + b)(a + c)] where a = the number of species shared, b = the number only found in the first assemblage, c = the number only found in the second, and d = the number not found in either one.

Forbes' index can't be applied to fossil data because we have no way to fix the value of d. However, when this term is left out simulations show that the index performs rather well given incomplete sampling. The problem is that it is somewhat positively biased. A simple correction that involves adding two terms based on the log of a fixes most of the bias. In other words, this new version of Forbes' index is not only precise but highly accurate. Even better, it shows hardly any extra bias in simulations when sampling is much better in one assemblage than the other.

These advantages aren't merely hypothetical because preservation bias is common. For example, fossil mammal assemblages are biased not only by varying sample sizes but by unequal representation of large and small taxa. Because of this problem, when conventional metrics are used in a multivariate ordination of Late Pleistocene North American fossil mammal assemblages they have tend to segregrate large- and small-mammal dominated samples. Forbes' adjusted index performs better.

Patterns in ordinations are even more interesting when lists of species found today in different biomes are added and extinct species are removed. Older indices segregate these long lists at the edges of the scatter plot. However, the new index mixes them up with the fossil samples. Furthermore, lists of species from same the geographic region fall near to each other regardless of whether they are based on fossil data. These patterns combined with the simulation results suggest that the adjusted Forbes index could be used with some confidence even when sampling is very uneven.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

EXCEPTIONALLY WELL-PRESERVED HAPLOCHROMINI-LIKE FOSSILS (CICHLIDAE: PSEUDOCRENILABRINAE: HAPLOTILAPIINI: EAST AFRICAN RADIATION) WITH OTOLITHS IN SITU FROM THE MIDDLE MIOCENE LAGERSTÄTTE WARIL IN THE TUGEN HILLS (CENTRAL KENYA, EAST AFRICAN RIFT VALLEY)

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The Cichlidae represent one of the most diverse groups of freshwater fishes with a virtually worldwide distribution, and are of considerable economic importance. They can evolve into species flocks within a few thousand years and are an exceptionally useful model for the study of speciation processes. Among the African Pseudocrenilabrinae, molecular phylogenies have recognized the subclade of the Haplotilapiini, to which the lineage of the 'East African Radiation' (EAR) belongs. According to previous work, the Haplotilapiini originated in the Oligocene or Eocene, while the radiation of the EAR lineage began in the early or middle Miocene. However, almost none of the morphological synapomorphies for the extant cichlid clades, subclades, lineages and tribes can be recognized in fossils, which has made fossil cichlid assignments at higher taxonomic levels difficult. Our study is based on 250 newly collected fish specimens from the middle Miocene Lagerstätte Waril in Central Kenya. A few of these retain otoliths in situ, and several may represent larval stages. Our study is also based on a multivariate analysis of meristic data for a large dataset of extant Cichlidae (746 specimens) and a survey of cichlid otolith data. The fossil specimens from Waril reveal a divided lateral line, 16 (8+8) principal caudal fin rays, and tricuspid teeth, which, in combination, clearly demonstrate that they belong to the Haplotilapiini. Meristic characters include a dorsal fin formula with a comparatively low number of spines (XI-XIV+7-10), an anal fin formula of III+8-10, and 12-15+13-16 vertebrae. The ovate-shaped otoliths are characterized by a straight sulcus and a deeply incised excisura. Based on differences in body shape, three species might be present. The data derived from the extant specimens revealed that the number of spines in the dorsal fin is one of the most important characters for the separation of the tribes, and that a similar number of dorsal fin spines to that seen in the fossils (12.4±0.7) appears in in the Oreochromini and in four tribes of the EAR (Ectodini, Trematocarini, Haplochromini, Cyprichromini). However, the otolith morphology clearly indicates that the fossils are near to the Haplochromini. We anticipate that the new data can serve as a starting point for a thorough revision of previously described cichlid fossils, with a view to elucidating the evolutionary history of the African cichlids and, in particular, the East African Radiation. The research is funded by the German Research Foundation.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

FIRST PHYLOGENETIC APPROACH TO CRICETODONTINI (RODENTIA, MAMMALIA)

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The tribe Cricetodontini is a group of rodents characterized by the large size of their molars, found in Europe, northern Africa, and Asia. They originated in the early Miocene and became extinct in the Pliocene. Cricetodontini includes the genera *Cricetodon, Hispanomys, Ruscinomys*, *Byzantinia*, *Deperetomys*, and *Zramys*. The center of origin of the studied Cricetodontini is Anatolia, as they have been present there since the early Miocene. Three main intervals of the group's migration have been proposed. The first one, starting around 18 Ma, took *Cricetodon* out of Anatolia and gave rise to the species from Greece. The second one, starting around 15 Ma, took another branch of *Cricetodon* out of Anatolia and dispersed it through Europe. In the last interval (around 14 Ma), basal species from Anatolia migrated to south-western Europe. This last migration event is coincident with the rise in diversity observed on the tribe Cricetodontini in Asia and Europe, having its maximum at the MN 7/8. This diversification coincides also with the first occurrence of the genera *Hispanomys* and *Deperetomys* in Europe and *Byzantinia* in Asia Minor.

The controversial taxonomy of some genera and species, together with the complex paleobiogeographic history of Cricetodontini have generated many systematic issues. For example, *Cricetodon*, which previously included all known Cenozoic "cricetids", is considered by many authors to be polyphyletic. The problematic genus *Deperetomys* shows a discontinuous paleobiogeographical distribution, with a long absence in the fossil record (MN 2 to MN 7/8) interpreted as a misattribution of other species.

To understand Cricetodontini evolution we present a novel phylogenetic hypothesis of this group. The analysis includes 103 dental characters from 52 species, belonging to *Cricetodon, Hispanomys, Ruscinomys*, *Byzantinia*, and *Deperetomys*. They represent a wide range of Miocene and Pliocene Eurasian Cricetodontinae. We test the monophyly of each genus and the relationship of *Deperetomys* within Cricetodontini.

The analysis generates four most parsimonious trees with a length of 773 steps. Our results show that European species of Cricetodontini are divided into four main groups, which correspond to four studied genera. The cladogram reveals that *Deperetomys*, *Hispanomys,* and *Byzantinia* are monophyletic; *Cricetodon* is polyphyletic; and the position of *Ruscinomys* remains uncertain.

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Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

THE POSTCRANIUM OF *THLASSOCNUS*, THE MARINE SLOTH

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Thalassocnus is a genus that comprises five species of nothrotherid sloth known from the Neogene deposits of the Pisco and Bahia Inglesa Formations (central western coast of South America). This genus was initially interpreted as semi-aquatic to aquatic based on taphonomic arguments, along with a few morphological peculiarities. The subsequent description of the skull, mandible, and dentition suggested feeding specializations towards grazing on marine vegetation. The present study finishes the description of the skeleton of *Thalassocnus*, in considering both the internal and external morphology of the postcranium.

The internal microstructure of the bones of *Thalassocnus* is indicative of typical adaptations of shallow divers, namely osteosclerosis (compact bones) and pachyostosis (swelled bones). A thorough description of the gross anatomy of the postcranium allows the proposition of several hypotheses of its aquatic functions. As in modern sirenians, *Thalassocnus* was supposedly engaging underwater digging in order to feed on seagrasses. But the behavior purported for *Thalassocnus* differs from that of sirenians since the forelimb is interpreted as involved in the digging process. Several features of the postcranium of the late species of *Thalassocnus* are consistent with an increase of the occupation of submerged position at the bottom. Both hind and forelimbs were probably involved in paddling, either pectoral or quadrupedal paddling. Bottom-walking was also most likely used. Such underwater locomotion was helped by the presence of osteosclerosis, pachyostosis, and a tail reminiscent of that of the extant platypus.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

LARGE AETIOCETID IMPLIES A WIDE RANGES OF NICHE IN EARLY MYSTICETI

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Niche partitioning has long been considered a fundamental part of speciation and differences in body size is a straightforward proxy for ecology and niche partitioning. A specimen of a gigantic aetiocetid from the late Oligocene Morawan Formation (28–24 Ma), Ashoro, Japan revises our understanding on the early evolution of the archaic mysticetes. Aetiocetidae is a family of archaic mysticetes bearing functional teeth possibly with primitive baleen, and is morphologically transitional between archaic toothed Cetacea and baleen whales. The specimen, AMP 9, comprises a left squamosal and an associated disarticulated periotic. The gigantic size of the zygomatic process of the squamosal (length of the zygomatic process: 22.3 cm) implies a large body size, compared to the zygomatic process of other aetiocetids (e.g. *Aetiocetus cotylalveus*: 8.1 cm; *Aetiocetus weltoni*: 7.9 cm). All other reported aetiocetids are small, about 3 m based on skull dimensions (e.g., condylobasal length of *Aetiocetus cotylalveus*: 62.9 cm; *Aetiocetus weltoni*: 61.5 cm). The zygomatic process of the squamosal of AMP 9 is identical with that of *Morawanocetus yabukii*, the holotype and only described specimen of the genus: the process is mediolaterally thin and expands dorsoventrally in the middle; the anterior tip tapers rapidly; and the dorsal margin is twisted dorsomedially. These features distinguish AMP 9 from *Aetiocetus* spp., *Ashorocetus eguchii*, and *Chonecetus* spp. Further, the periotic of AMP 9 reveals structures that are otherwise poorly known in aetiocetids. On the anterior process, the anterior keel curves posteromedially from the anterodorsal angle to anteroventral angle, with the anteroventral angle situating at the mid-point of the anterior margin of the periotic and being gently rounded, and pointing anteriorly. The dorsal crest is virtually horizontal on the dorsolateral margin of the periotic. The mallear fossa is excavated with a well-defined margin. The posterior process is not fused with the posterior process of the tympanic bulla. The large body size

of AMP 9 implies a different niche from small-skulled contemporaneous aetiocetids. The disparate body size in aetiocetids suggested by AMP 9 indicates a wider range of ecological niches than previously expected for Oligocene toothed mysticetes.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

DIAGENETIC AND TAPHONOMIC INTERPRETATION OF DYROSAURID LONG BONES (ARCHOSAURIA, CROCODYLOMORPHA) FROM THE PARAIBA BASIN, NORTHEAST BRAZIL

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Dyrosauridae is a clade composed of long-snouted marine crocodiles considered survivors of the Cretaceous-Paleogene (K-Pg) event. In the Paraiba Basin, the record of the group extends from the Maastrichtian to the Danian. Many teeth and bones of dyrosaurids are found disarticulated in the Maria Farinha Formation (Danian), being restricted to Poty Quarry. Most taphonomic analyses are based mainly on field and external observations of bones such as skeletal articulation, breakage, and abrasion of the elements. The use of petrographic thin sections in such interpretations is a good method to identify the mineralogical components present in the fossil diagenesis, as these characterize the abiotic conditions where the minerals were formed. Here, we conduct a diagenetic analysis of a proximal portion of a right femur and a distal portion of the left tibia of a dyrosaurid. For petrographic slides, we use two samples of a block of carbonate rock surrounding the fossil material. All slides were analyzed under parallel and crossed nicols and cathodoluminescence microscopes. In the femur and tibia, the growth of spatic calcite that fills the erosion lacunae was identified in the spongiosa. Pyrite grains were also detected all over the sample, characterizing deposition in an anoxic environment. In the femur, the medullary cavity was filled by a compacted micritic matrix (calcite, siliciclastic grains, bioclasts), also containing pyrite grains, the same constitution as the rock samples. The comparison of both bone infill and the rock samples indicates that there were two distinct moments in the taphonomic history of these elements. The micritic matrix suggests a possible low energy transportation of these bones. During this time, the elements could have been broken, and then filled up; this matrix shows a high viscosity and granulometry that cannot enter the bones through pores or foramina on the external surface. This indicates an initial eodiagenetic stage of these bones. The spatic calcite indicates a second event. After transportation, these bones were deposited and exposed to a fluid saturated with ions that, by precipitation and chemical reaction, formed this mineral. The calcite filled the empty spaces that could not have been filled during the first event. This second stage indicates a more advanced level of the eodiagenesis. There is no mineralogical evidence that these bones underwent mesodiagenesis or telodiagenesis. The presence of oxidation and spread grains in the matrix supports the eodiagenesis stages.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

HOW MIGHT SPINOSAURIDS HAVE CAUGHT FISH? TESTING BEHAVIORAL INFERENCES THROUGH COMPARISONS WITH MODERN FISH-EATING TETRAPODS

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Since the 1983 discovery of the unusual dinosaur *Baryonyx walkeri* (Theropoda: Spinosauridae), there has been great interest in the feeding behavior of spinosaurids as the group exhibits various physical traits suggestive of piscivory, such as elongate crocodile-like jaws, retracted nares, weakly-serrated conical teeth, large digit I manual unguals, and large, robust forelimbs. However, despite a general consensus over spinosaurid piscivory, there have been few detailed behavioral comparisons with similarly adapted extant piscivorous tetrapods. An exception is the eponymous 'heavy claw' of *Baryonyx*, suggested to have been used in gaffing (hooking) fish out of the water in behavior akin to that of grizzly bears. However, this hypothesis is problematic as grizzlies do not gaff fish in this manner. To better characterize spinosaurid piscivory, we reviewed piscivorous adaptations and related behaviors in extant fish-eating tetrapods. We then assessed which of these behaviors were possible in spinosaurids based on their morphology. The antero-posterior head darting strategy employed by herons (genus *Ardea*) was found to be unlikely as spinosaurs lack a strong sigmoid neck curve and their orbits are poorly positioned for binocular vision. Rather, as in the Indian gharial (*Gavialis gangeticus*), the jaws may have instead been used in swift lateral sweeps to seize fish. In this model, the forelimbs of spinosaurids may have been useful in adopting a quadrupedal stance when feeding, bringing the jaws closer to the river or lake bed. Like grizzly bears (*Ursus arctos*) and fishing cats (*Prionailurus viverrinus*), spinosaurids may have employed their powerful forelimbs to stamp down on large fish, impaling them on the manual claws against the river or lake bottom, from which the prey could be manipulated with the jaws. As spinosaur teeth lack prominent serrations, they do not appear to be well-suited for prey dismemberment; it is likely that most fish would have been swallowed whole, as in the majority of longirostrine piscivores. However, the use of the forelimbs in breaking up prey items cannot yet be ruled out. These findings not only furnish insight into feeding behavior in spinosaurs, contributing to our understanding of these bizarre and highly specialized dinosaurs, but also provide a window into the evolution of piscivory in tetrapods.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

GEOSPATIAL PALEONTOLOGY: ENRICHING PALEONTOLOGICAL FIELDWORK WITH NEW APPROACHES FROM THE SPATIAL SCIENCES

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Vertebrate paleontology has long been an interdisciplinary science, relying on collaboration with a wide range of scientific specialties to develop our understanding of the evolutionary history of vertebrate animals. Collaborations between vertebrate paleontologists and geochronologists, stratigraphers and sedimentologists, geochemists, computer scientists, and even geneticists are now commonplace in our field, and these collaborations are often essential to the analytical and evolutionary work we do. We argue that the recent explosion of geospatial technologies and analytical methods from the geographic information sciences can enrich vertebrate paleontology in a number of significant ways, and provide evidence of the efficacy of some of these approaches from our recent work in Paleocene and Eocene deposits of the Great Divide Basin. We have developed predictive models for site location based on supervised classifications of both low (Landsat) and high (WorldView and Quickbird) resolution satellite imagery, and successfully ground truthed these models during the past three field seasons. We have utilized Google Earth to disseminate georeferenced locality and faunal assemblage data from ArcGIS databases, creating a simple workflow for sharing paleontological databases via kml files. We are currently developing protocols for the use of an unmanned aerial vehicle (UAV) equipped with high definition video camera in the field in order to ascertain the presence of exposed and potentially fossiliferous rock units within a one mile buffer zone. Finally, we discuss our development of a three dimensional digital outcrop model (3-D DOM) of a single extremely productive sandstone locality (Tim's Confession, WMU-VP 220) using terrestrial LiDAR. These models and approaches from the geospatial sciences can help us locate additional fossil localities, share spatial and fossil data with colleagues and the public, and better understand the geomorphological nature and taphonomic history of individual fossil localities. Supported by NSF-BCS 1227329 to RL Anemone and CW Emerson.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

THE MIDDLE PERMIAN DICYNODONT (THERAPSIDA, ANOMODONTIA) *BRACHYPROSOPUS BROOMI*: TAXONOMIC STATUS, PHYLOGENETIC POSITION, AND BIOSTRATIGRAPHIC SIGNIFICANCE

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Brachyprosopus broomi was described based on a specimen from the *Tapinocephalus* Assemblage Zone (AZ) (Karoo Basin, South Africa), but it was largely overlooked by subsequent workers. During museum research and fieldwork, we identified seven new skulls of *B. broomi*, three of which preserve mandibles. These specimens show that *B. broomi* is a valid taxon; autapomorphies include raised margins of the interpterygoid vacuity and a curled lateral edge of the squamosal that forms a lateral wall of the external adductor fossa. Other important characters are absence of anterior median palatal ridges; maxillary tooth rows bounded laterally by a shelf; unfused vomers; broad intertemporal region; pineal boss; dentary tables; and a long, wide posterior dentary sulcus that extends posterior to the dentary teeth. *Chelydontops altidentalis* is a junior synomym of *B. broomi*. A phylogenetic analysis places *B. broomi* among basal dicynodonts, and not as a close relative of *Endothiodon*. This challenges the hypothesis that *B. broomi* can provide insight into the evolution of the unusual suite of characters found in *Endothiodon*. However, it is noteworthy that some characters, such as well-developed maxillary tooth rows bordered by a lateral shelf and the shape of the palatines, are shared by *B. broomi*, *Endothiodon*, and *Niassodon*, hinting that a final resolution of relationships among toothed dicyndonts remains to be achieved. Our taxonomic and stratigraphic research in the *Tapinocephalus* AZ has recognized 11 valid dicynodonts in the biozone (*Eodicynodon*, *Colobodectes*, *Lanthanostegus*, *Brachyprosopus*, *Robertia*, *Eosimops*, *Prosictodon*, *Diictodon*, *Pristerodon*, *Emydops*, possibly *Endothiodon*). All *B. broomi* specimens are from the Abrahamskraal Formation, with most of the specimens originating in the Moordenaars and Karelskraal members (uppermost members of the Abrahamskraal Formation). One specimen is from lower in the sequence, just above the lowermost maroon mudrocks of the Beaufort Group, which occur above the stratigraphic range of *Eodicynodon*. This shows that the stratigraphic range of *B. broomi* extends throughout the *Tapinocephalus* AZ above the range of *Eodicynodon*. The revised faunal list indicates that all major Permian dicynodont clades except Bidentalia (Cryptodontia + Dicynodontoidea) are represented in the *Tapinocephalus* AZ. Our phylogeny implies that Bidentalia must have diverged by this time, but definitive bidentalian specimens have not been recognized in the *Tapinocephalus* AZ or coeval strata in other basins.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A NEW TURTLE ASSEMBLAGE FROM SWITZERLAND AND THE DIVERSITY OF EUROPEAN EUCRYPTODIRES IN THE KIMMERIDGIAN (LATE JURASSIC)

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Since 2000, controlled excavations along the future course of the A16 Transjurane highway (Porrentruy, northwestern Switzerland) have led to the discovery of a rich and diverse Kimmeridgian coastal marine vertebrate fauna (fishes, turtles, crocodilians, pterosaurs) and several extensive dinosaur track-bearing sites. With more than 80 shells, five crania, four mandibles, and thousands of disarticulated remains, eucryptodiran turtles are among the most abundant vertebrates collected during these excavations. However, the description of this new turtle assemblage was partly hindered by the complex taxonomy of Late Jurassic European eucryptodires.

Nineteenth century authors named a plethora of regional species (more than 60) and these turtles have not received global review for more than 100 years. We have revised the 15 species described in the Kimmeridgian of the Jura Mountains (Switzerland and France), recognizing 6 species as valid. New characters are proposed to differentiate *Plesiochelys etalloni*, *Craspedochelys picteti*, and *Craspedochelys jaccardi*. The presence of lateral plastral fontanelles is documented for the first time in *Thalassemys hugii*, calling into question the historical distinction between Thalassemydidae and Eurysternidae. Similar taxonomic revisions are necessary for contemporaneous turtle assemblages from northern Germany and southern England, but preliminary results suggest that the European turtle fauna was more homogenous than previously thought during the Kimmeridgian. For example, we have identified *Plesiochelys etalloni*, *Tropidemys langii*, and *Thalassemys* sp. in the Kimmeridge Clay of southern England.

The new assemblage from Porrentruy comprises a minimum of eight turtles representing the Plesiochelyidae (*Plesiochelys* sp., *Tropidemys langii*, *Portlandemys* sp., and one new species), the Thalassemydidae (*Thalassemys* sp. and '*Thalassemys*' *moseri*), and the Eurysternidae (*Solnhofia* sp. and *Eurysternum* sp.). *Plesiochelys* sp. is the most common taxon from Porrentruy. The plastron and proximal limb bones of *Tropidemys langii* are documented for the first time. Several complete shells can be confidently referred to '*Thalassemys*' *moseri*, greatly improving our understanding of this species. The relative abundance of eurysternids in Porrentruy is remarkable because they are usually rarely found in association with plesiochelyids. Finally, an isolated skull is tentatively identified as *Portlandemys*, which is the first occurrence of this taxon outside England and in the Kimmeridgian.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

SOFT-TISSUE ANATOMY OF THE PLESIOSAUR PECTORAL GIRDLE INFERRED FROM BASAL EOSAUROPTERYGIAN TAXA AND THE EXTANT PHYLOGENETIC BRACKET

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Plesiosaurians are highly derived secondarily-aquatic organisms with a long evolutionary history closely related to basal eosauropterygians. Therefore, attempts to reconstruct soft-tissue anatomy can be complicated, if various lines of evidence are not considered. Information extracted using the extant phylogenetic bracket revealed necessary but not sufficient data to clarify the muscle attachments in the pectoral girdle of plesiosaurians. To correctly infer muscle homologies, the data from the extant phylogenetic bracket had to be complemented with developmental and osteological information as well, with osteological transformations being traced back to basal Permian neodiapsids. As in secondarily-adapted aquatic modern analogues, several muscles atrophied (e.g., M. pectoralis, M. episternocleidomastoideus) and others specialized (e.g., M. coracobrachialis, M. clavodeltoideus) in order to attain a more determinant role to the stringent conditions of subaquatic locomotion. The M. subcoracoscapularis, M. scapulodeltoideus, M. scapulohumeralis, and M. supracoracoideus are inferred to be glenohumeral stabilizers. The M. clavodeltoideus is reconstructed as the main protractor muscle and the M. coracobrachialis as major retractor muscle, possibly in conjunction with the M. latissimus dorsi. Several heads of the M. triceps possibly atrophied, as in whales, serving mainly as a cubital joint stabilizer. Lastly, the M. trapezius, M. serratus and M. levator scapulae are reconstructed as pectoral girdle stabilizers. For three eosauropterygian taxa, the reconstructed pectoral girdle musculature presented here is, thus, significantly different from previous attempts.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

DEEP QUESTIONS, EXPLAINED EASY: THE EXAMPLE OF THE THERAPSID–MAMMAL TRANSITION

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Detailed anatomical work has been dedicated to compare modern mammalian skulls to extinct forms including their close relatives in the fossil record (basal mammaliaformes). However, it can be extremely difficult to communicate such complex, yet pivotal, evolutionary process to the general public. Therapsida, a group that experienced intense anatomical transformations throughout the past 270 Ma, offers profound insights into the evolution eventually leading to the mammalian skull bauplan. Using a broad phylogenetic sample of basal synapsid skulls, our project aimed to reveal the internal morphology of fossilized non-mammalian therapsid skulls and explore this chapter of evolution to the public. We have been using X-ray tube-based high-resolution micro-computed tomography and synchrotron radiation-based micro-computed tomography to reveal the morphological traits encumbered by the fossils rock matrix. The tomographic datasets can be effectively studied through interactive digital visualization. The highly visual content that are produced during this research project (e.g., 3D pdf, video animations, 3D reconstructions) offer an introductory platform for deeper scientific topics such as pre-mammalian evolution, anatomy, skull modularity, taxonomy, physiology, or phylogeny. Thus, this approach is a powerful tool to share information of precious well-preserved fossils not only within the scientific community but also the general public via temporary exhibits and tomographic database release. Funded in part by Fundacao para a Ciencia e a Tecnologia (FCT/MCE) through the scholarship SFRH/BPD/96205/2013 and the project EXPL/BIA-EVF/0665/2013.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

UNUSUAL CRANIAL AND POSTCRANIAL ANATOMY IN THE ARCHETYPAL ANKYLOSAURID *ANKYLOSAURUS MAGNIVENTRIS*

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Ankylosaurus magniventris is the last and largest of the ankylosaurid dinosaurs. *Ankylosaurus* has cranial sculpturing similar to the ankylosaurids *Anodontosaurus*, *Euoplocephalus*, and *Scolosaurus* that is characterized by rectangular to hexagonal frontonasal caputegulae, a large hexagonal median nasal caputegulum, a single pair of loreal and lacrimal caputegulae, and pyramidal squamosal and quadratojugal horns. However, the narial anatomy of *Ankylosaurus* is unique among ankylosaurs. The border of the external naris in derived ankylosaurids is typically formed by a distinct edge on the premaxilla, and the external surface of the supranarial caputegulum. Posterior to the external naris is a concave region (the nasal vestibule) roofed by the nasals, and within the nasal vestibule are the openings (narial apertures) for the airway and sinuses. *Ankylosaurus* and *Euoplocephalus* had single, folded narial apertures. In *Euoplocephalus*, the external nares are anteriorly to slightly anterolaterally oriented, but in *Ankylosaurus*, they face laterally and are not visible in anterior view. Small, rugose caputegulae anterior to the loreal and median nasal caputegulae are probably homologous to the supranarial caputegulae in other ankylosaurs; however, these do not form the dorsal borders of the external nares in *Ankylosaurus*. Instead, the external nares are roofed by expanded, laterally bulbous loreal caputegulae. This may indicate that the anterior portion of the looping nasal passage is laterally expanded in *Ankylosaurus* relative to *Euoplocephalus*.

The tail club of *Ankylosaurus* is also unique. *Ankylosaurus* handle vertebrae are twice as wide as those of *Anodontosaurus* and *Euoplocephalus*, but are not longer. As such, the tail of *Ankylosaurus* may have been shorter relative to body length compared to the tail of *Euoplocephalus*. The handle vertebrae of *Ankylosaurus* have U-shaped neural spines in dorsal view rather than V-shaped neural spines like those in *Anodontosaurus*, *Euoplocephalus*, *Pinacosaurus*, and most other ankylosaurids. The biomechanical implications of this change are unclear, but this morphology may have allowed for a larger tail club knob to be supported compared to other ankylosaurids. Although the skull of AMNH 5214 is more than twice the size of the largest skulls of *Anodontosaurus* or *Euoplocephalus*, the tail club knob, at about 45 cm wide, is not larger than the largest tail club knobs from Horseshoe Canyon and Dinosaur Park Formation ankylosaurids (e.g., AMNH 5425 is 59 cm wide, and ROM 788 is 57 cm wide).

Education and Outreach Poster Session (Poster displayed November 5 – 8)

DINO 101: A MASSIVE OPEN ONLINE COURSE ABOUT DINOSAUR PALEOBIOLOGY

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As of April 2014, more than 35,000 students from around the world have participated in Dino 101: Dinosaur Paleobiology, over its two offerings. As the flagship course for the University of Alberta's entry into the new world of massive open online courses (MOOCs), we were tasked with producing a high quality university course aimed at non-specialists that could also be taken by high school students and families with young children, but which could also be folded into the university's undergraduate Specialization in Paleontology program. Dino 101 is offered in several different formats, all utilizing the same core course materials: as a free course with a certificate of completion; as a free course with proctored exams for an additional fee; as an online-only credit course at the University of Alberta (PALEO 200); and as a blended-learning credit course (PALEO 201).

Twelve topic areas were identified as the basis for twelve weeks of lessons: skeletal anatomy and diversity, fossilization and taphonomy, feeding adaptations, locomotion, ontogeny, behaviour, taxonomy, evolution, geologic time and stratigraphy, palaeobiogeography, the origin of dinosaurs, and the extinction of the non-avian dinosaurs. The course consists of video lessons incorporating frequent student interaction via non-graded quizzes and interactives, as well as discussion forums and graded lesson quizzes. Interactive components include skeleton and phylogenetic tree puzzles, a zoomable geologic time scale, and 3D models of fossils. Most videos were shot on a greenscreen background, but location shooting in the lab, at field localities, and at the Royal Tyrrell Museum of Palaeontology enhanced the video lectures.

Pedagogical design, script writing, filming, interactives development, and post-production were completed over eight months and involved a team of more than 30 people. The short timeline and high production values presented many challenges to completion, but student responses to the Dino 101 MOOC have been overwhelmingly positive. MOOCs appear to be an effective outreach strategy for reaching a broad international audience, and can also form a solid foundation for building credit offerings in the university environment.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

***IBEROSUCHUS* (CROCODYLIFORMES) POSTCRANIAL MATERIAL FROM THE DUERO BASIN (EOCENE OF THE IBERIAN PENINSULA) AND ITS SEBECOSUCHIAN AFFINITIES**

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Since the original description of *Sebecus icaeorhinus* from the Middle Eocene from Patagonia, this crocodyliform and its close relatives, the Sebecosuchia, have attracted attention because of their peculiar cranial and dental morphology (ziphodont teeth) and great size. They are the main large predators in vertebrate assemblages of the Early Cenozoic, principally in South America, but fragmentary mesoeucrocodylians with ziphodont teeth are commonly present in Europe and Africa during the Eocene, associated with fishes, chelonians, rodents, creodonts, artiodactyls, perissodactyls and primates. Although the knowledge of the anatomy of the Sebecosuchia was restricted originally to cranial remains, recent studies on the postcranial skeleton of several more complete specimens of *Sebecus* and *Baurusuchus* revealed several unique characters for the group, like long limbs in a more parasagittal position. *Iberosuchus macrodon* from the Middle Eocene site of Vale Furado (Nazare, Portugal) is considered close to the sebecids and *Baurusuchus* based in cranial characters. During the last decades, abundant partly associated and fragmentary postcranial material of non-eusuchian crocodyliforms was collected from different localities in the Spanish Duero Basin (mainly Salamanca,

Zamora and Soria Provinces) that is possible to clearly differentiate from other contemporary eusuchian crocodyliforms, like *Asiatosuchus* or *Diplocynodon*. Recent phylogenetic analyses including postcranial characters has allowed a better understanding of the postcranial anatomy of these forms and a better understanding of how the postcranial autapomorphies are distributed in Sebecosuchia. The detailed anatomy of postcranial material attributed to *Iberosuchus* from the Duero basin localities is described with the aim to contribute to the discussion of the phylogenetic frame of the European Sebecosuchia.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

FIRST DESCRIPTION OF THE SPIRAL INTESTINE IN *SAURICHTHYS* FISHES: THE EFFECT OF AXIAL ELONGATION ON THE ANATOMY OF THE VISCERA

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The presence of a spiral valve in the intestine is a feature shared by most extinct and extant non-teleost fishes (including chondrichthyans, sarcopterygians, actinopterygians and probably placoderms and acanthodians) and is present in a few members of the teleost group as well. The function of the spiral valve is to increase the surface of the intestine without increasing its length and thus enhance its nutrient absorption capabilities. Moreover, the length of the intestine often correlates well with the preferred diet of organisms. Here we describe, for the first time, the spiral intestine of late Anisian - early Ladinian *Saurichthys* fishes from the Monte San Giorgio fossil Lagerstätte, in Switzerland. This locality is known for its exceptional preservation, including *Saurichthys* specimens preserving gastric contents, embryos, and soft tissue anatomy such as axial myosepta and intestinal casts. Most of our data come from a single specimen of *S. paucitrichus* that preserves a complete internal cast of the spiral intestine. Complementary observations and measurements were taken from other, incomplete, *S. paucitrichus* and *S. curionii* specimens. We compare the intestinal anatomy to that of the spiral intestines of extant chondrosteans (sturgeon and paddlefish), to which *Saurichthys* is thought to be closely related. The *Saurichthys* spiral intestine differs from that of other chondrosteans by being rather shallower and elongate (achieving a length over the 16% of an individual"s standard length) and spanning a higher number of vertebral segments (between 14 to 17). It also exhibits an unusually high number of turns that can be as high as 30, a number not seen in any other actinopterygian for which a good description of intestinal anatomy is available. The increased length of the intestine and the multiplication of turns in the spiral valve cannot be linked with the preferred (piscivorous) diet of *Saurichthys*, inferred based on gastric contents, as herbivorous fishes are known to have longer intestines than carnivores. We suggest that the increased intestinal length should be considered as an effect of the axial elongation characterizing the saurichthyid clade. This study provides rare insights into the comparative anatomy of the viscera in an extinct clade, and suggests that body shape may play an important role, together with diet and influenced by phylogenetic relatedness, in determining the morphology and arrangement of the viscera.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

DIET AND HABITAT FOR *DINOHIPPUS MEXICANUS* AND *NEOHIPPARION EURYSTILE* (PERISSODACTYLA, EQUIDAE) FROM TWO MEXICAN LOCALITIES.

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A collaborative project between Universidad Nacional Autónoma de México and Instituto Nacional de Anthropología has been initiated for reconstructing the paleoenvironments in Mexico during the Neogene. The initial approach is presented in this study. The diet and habitat for four individuals of the Hemphillian horses *Dinohippus mexicanus* and *Neohipparion eurystile* (Perissodactyla, Equidae) from the most important Mexican localities—Rancho El Ocote in the San Miguel Allende Basin, State of Guanajuato and several localities in the Tecolotlan basin, State of Jalisco—were inferred using carbon and oxygen stable isotopes. The specimens of *N. eurystile* at both localities had a mixed C_3/C_4 diet with an important intake of C_4 plants, and lived in open areas similarly to what was found for other individuals from the same species in Mexico. On the other hand, *D. mexicanus* from Tecolotlan had a mixed C_3/C_4 diet, with an important C_3 plant intake, preferring areas with some tree coverage similarly to the findings using mesowear studies for specimens from the same locality, but *D. mexicanus* from Rancho El Ocote only feed of C_4 plants and lived in open zones similar to the proposal by previous studies using stable isotopes on individuals from this locality, but these results suggest that *D. mexicanus* was more flexible in diet and habitat than *N. eurystile*, and also that in Tecolotlan there was the heterogeneous vegetation or the climate was more seasonal allowing the development of trees and shrubs along the savanna, while at Rancho El Ocote there was a grassland during the Hemphillian.

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Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

THE POSTCRANIAL ANATOMY OF THE SMALL EARLY TRIASSIC DICYNODONT *MYOSAURUS GRACILIS* (THERAPSIDA, ANOMODONTIA)

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Anomodont therapsids, the most abundant and taxonomically diverse clade of Permian–Triassic tetrapods, evolved many different body plans and ecological specializations. These include fully terrestrial, semi-aquatic, arboreal, and fossorial ecomorphs, which are mainly reflected in their postcranial skeleton, as cranial anatomy in the group remained largely conservative. Some of the most specialized anomodonts are the small, burrowing cistecephalid dicynodonts *Cistecephalus* and *Kawingasaurus*, which belong to the more inclusive clade Emydopoidea. In most recent phylogenies, the Early Triassic emydopoid dicynodont *Myosaurus gracilis*, known from South Africa and Antarctica, has been recovered as the sister taxon to Cistecephalidae, and therefore is crucial to understanding the evolution of fossoriality in the group. While the postcranial anatomy of *Cistecephalus* and *Kawingasaurus* is well known, the postcranial skeleton of *Myosaurus* has never been described. Here, we present the postcranium of *Myosaurus*, combining data from three specimens preserving postcranial elements. The most complete specimen is only slightly compressed dorsoventrally and consists of a small skull (4.1 cm long) and the anterior part of the postcranial skeleton, including part of the vertebral column, ribs, a virtually complete pectoral girdle (with both scapulae, procoracoids, coracoids, clavicles, an interclavicle, and a sternum), as well as two partial humeri. External morphology of this specimen has been supplemented by CT data. The *M. gracilis* syntypes further provide information on the ilium and isolated vertebrae and ribs. The postcranium of *Myosaurus* is characterized by a well-ossified and developed pectoral girdle, but an overall slender morphology when compared to cistecephalids. Both humeri are missing their distal ends, but display a broad proximal end and slightly enlarged processes for muscle attachments not developed to the extent seen in *Cistecephalus* and *Kawingasaurus*. While it is possible that *Myosaurus* was a facultative burrower, as trace fossils indicate this was common among small Permo–Triassic tetrapods, it clearly does not show the extreme mole-like specializations seen in the postcrania of cistecephalids.

Technical Session VI (Thursday, November 6, 2014, 10:45 AM)

PHYLOGENY, PALEONTOLOGY, AND PRIMATES: DO INCOMPLETE FOSSILS BIAS THE TREE OF LIFE?

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Paleontological systematics relies heavily on morphological data which have undergone taphonomic filters. Here, we apply a heuristic means to assess how a fossil's incompleteness detracts from inferring its phylogenetic relationships. We compiled a phylogenetic matrix for Primates and simulated the extinction of living species by deleting an extant taxon's molecular data and degrading its morphological character sample as if it were a fossil. Morphological data degradation was based on a particular fossil (template), whereby characters missing for that fossil defined those deleted in a living species (subject). By comparing the phylogeny produced by the complete matrix to those incorporating an 'artificial fossil', we assessed the extent to which artificial extinction of a living species led to poor resolution and/or topological rearrangements. As expected, increased missing data lead to a higher probability of both. However, all 85 fossil templates (with 15-92% missing data) applied to all 26 living species exhibited similarity to the combined-data topology. The most incongruent templates still shared a median 18 out of a maximum possible 23 splits, and 83 of 85 shared a median of 20 or more. *Tarsius* was the most incongruent subject, with a median of 16 shared splits. Interestingly, the template based on the Eocene primate *Darwinius masillae* performs better than most other templates with similar levels of missing data, likely due to availability of character data across multiple anatomical partitions. Our results support the interpretation of *Darwinius* as strepsirhine, not haplorhine, and suggest that paleontological datasets are reliable in primate phylogeny reconstruction.

Technical Session IV (Wednesday, November 5, 2014, 3:45 PM)

TALES OF A TINY KILLER: JAWS OF THE TASMANIAN TIGER'S COUSIN WERE SUITED TO CATCH LARGE PREY

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Thylacinidae is an extinct family of Australian and New Guinean marsupial carnivores, comprising 12 known species, the oldest of which are late Oligocene (24 Ma) in age. Except for the recently extinct Tasmanian tiger (*Thylacinus cynocephalus*), most are known from fragmentary craniodental material only, limiting the scope of biomechanical and ecological studies. However, a particularly well-preserved skull of the fossil species Dickson's thylacine (*Nimbacinus dicksoni*) has been recovered from middle Miocene (~16-11.6 Ma) deposits in the Riversleigh World Heritage Area, northwestern Queensland. Here, we ask whether *N. dicksoni* was more similar to its recently extinct relative or to several large living marsupial carnivores in a key aspect of feeding ecology, i.e., was *N. dicksoni* a relatively small or large prey specialist? To address this question we digitally reconstructed its skull and applied three-dimensional Finite Element Analysis to compare its mechanical performance with that of three extant marsupial carnivores and *T. cynocephalus*. Under loadings adjusted for differences in size that simulated forces generated by both jaw closing musculature and struggling prey, we found that stress distributions and magnitudes in the skull of *N. dicksoni* were more similar to those of the living spotted-tailed quoll (*Dasyurus maculatus*) than to its recently extinct relative. Considering the Finite Element Analysis results and dental morphology, we predict that *N. dicksoni* likely occupied a broadly similar ecological niche to that of *D. maculatus*, and was likely capable of hunting vertebrate prey that may have exceeded its own body mass. Potential prey of this fox-sized carnivore include small to medium-sized birds, frogs, lizards and snakes, as well as a wide range of marsupials, including possums, bandicoots, dasyurids, ancient ancestors of koalas, small wallabies, marsupial moles and wombats. The extinction of *N. dicksoni* may at least partly been attributed to competition with other large meat-eaters, including other thylacinids, small species of marsupial lion, and 'carnivorous' rat-kangaroos, together with the drying of the continent from the middle Miocene, resulting in the replacement of their rainforest

habitat with open forests, woodlands, and grasslands. This research was funded by two Australian Research Council grants and the Evolution and Ecology Research Centre Postgraduate Writing and Skills Transfer Award.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

NON-MAMMALIAN VERTEBRATE ASSEMBLAGE FROM THE MIDDLE JURASSIC OF BEREZOVSK QUARRY IN WESTERN SIBERIA

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The Berezovsk Quarry in Krasnoyarsk Territory, West Siberia, Russia has produced one of the most diverse Middle Jurassic vertebrate assemblages. The fossiliferous layers occur in the upper part of the Itat Formation (Fm), which has been dated as Bathonian by pollen. Chondrichthyans are represented by very few teeth of *Hybodus* sp., and there are also very few fragments of dipnoan toothplates. This markedly contrasts with the near shore paleoenvironment of the Callovian Balabansai Fm in Kyrgyzstan with numerous and diverse chondrichthyans and abundant dipnoans. The freshwater fishes are represented by acipenseriforms, paleonisciforms (complete skeletons and micro-remains of several taxa), and amiiforms. There are at least three taxa of amphibians, two stem salamanders (*Urupia monstrosa* and a new taxon) and a possible crown-group salamander. The most common taxon in the vertebrate assemblages is the xinjiangchelyid turtle *Annemys* sp. n. represented by fragmentary shells and skulls, as well as numerous isolated cranial and postcranial fragments. This vast material provides an unparalleled opportunity to study the infraspecific variability of this taxon in great detail. There are rare remains of basal lepidosauromorphs and squamates (Scincomorpha indet.). Choristoderes are a little more common, represented by a taxon similar to *Cteniogenys*. Surprisingly rare are crocodyliforms, known by few isolated teeth, scutes, and bone fragments, referable to Goniopholididae. Far more common are the teeth of pterosaurs, while bone fragments are extremely rare. Dinosaurs are represented by teeth of basal ornithischians, stegosaurs, sauropods, and non-avian theropods in the microvertebrate samples. The partially associated skeletal fragments of stegosaurs from the top of the Itat Fm are similar to the Upper Jurassic *Stegosaurus*. All identifiable theropod skeletal elements belong to the tyrannosauroid *Kileskus aristotocus*, one of the oldest representatives of the group. Tritylodontids are represented by numerous isolated teeth. The vertebrate assemblage from Berezovsk Quarry documents a flat wetland paleoenvironment some hundred km south of the Boreal Ocean. The bonebed was possibly accumulated by a heavy flooding event. The Berezovsk vertebrate assemblage is remarkably similar to that from the Bathonian Forest Marble Fm in England. Middle Jurassic microvertebrate assemblages are poorly known in Asia and North America, but the Laurasian vertebrate fauna was likely highly homogenous before the break up of this supercontinent.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

INTRA- AND INTERSPECIFIC MORPHOLOGICAL VARIATION IN PHYTOSAUR OSTEODERMS AS DEMONSTRATED WITH AN ARTICULATED SPECIMEN OF *ANGISTORHINUS ALTICEPHALUS*

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Osteoderms are found in multiple archosauriform taxa including the fully armored Late Triassic taxon *Vancleavea campi* and multiple members of the Archosauria. Isolated osteoderms of two major clades of archosauriforms, the phytosaurs and aetosaurs, are common in the Upper Triassic deposits of western North America. The taxonomic utility of aetosaur osteoderms is well established; those osteoderms are diagnostic to low-level taxa. Conversely, phytosaur osteoderms are rarely associated with diagnostic cranial material, and their morphological variation remains largely overlooked. Here we characterize the various osteoderm morphologies from a partially articulated specimen of *Angistorhinus alticephalus* from the Upper Triassic Otis Chalk localities of Texas. This specimen preserves triangular dorsal paramedian osteoderms with an external rugose pattern and slight dorsal flexion. Isolated subcircular osteoderms from the gular shield and smaller irregular appendicular osteoderms are also associated with this skeleton. Articulated dorsal paramedian osteoderms that are closely associated with the cervical vertebrae preserve a previously unrecognized 'lock-and-key' midline articulation and anteromedial projections. The paired dorsal osteoderms overlap the anterior edges of succeeding osteoderms, despite the lack of an articular facet. Additionally, a second set of osteoderms is confirmed in this specimen lateral to the paramedians and is preserved in articulation with the paramedian osteoderms. These lateral osteoderms have anteroposteriorly-directed, elongate dorsal keels that are undercut medially by deep fossae and overlap rather than suturally contact the lateral edges of the paramedian osteoderms as in aetosaurs. Initial comparisons with osteoderms that are associated with other phytosaur specimens (e.g., *Smilosuchus adamanensis*, '*Paleorhinus*' *sawini*) indicate that the sculpture and shape of these osteoderms may be distinct for *A. alticephalus*. This variation in osteoderm morphology observed within a single individual suggests a greater morphological disparity in and potential systematic utility of phytosaur osteoderms than previously appreciated.

Symposium 5 (Saturday, November 8, 2014, 1:45 PM)

ECOMORPHOLOGICAL STRUCTURE OF MAMMALIAN FAUNAS IN RELATION TO CLIMATE AND PHYSIOGRAPHY AT THE CONTINENTAL SCALE

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The ecological structure of mammalian faunas can be expressed by the number of species in size or trophic categories and by other distributions of ecological functional groups. Strong environmentally related gradients in ecological structure of mammalian faunas would suggest that ecological structure reflects environmental sorting processes at regional to local scales. We analyzed the ecological structure of modern mammalian faunas in relation to climatic, physiographic, and vegetation properties for terrestrial regions worldwide. One goal of our analysis was to identify which environmental variables are the best predictors of mammalian ecological structure for the purpose of developing mechanistic models of environmental sorting. A second goal was to identify which components of ecological structure are robust predictors of environmental variables for potential application to fossil faunas. We assembled a database of modern mammalian faunas from 344 localities distributed across five continents and representing all of the world"s major biomes. For over 2100 non-volant species, the database includes measures of body size, feeding habit, and habitat use. For each locality, 10 climatic variables, two physiographic variables, and three vegetation variables are recorded.

Among environmental variables, temperature seasonality, mean annual precipitation, and elevation are strong predictors of species richness in individual faunal categories. Among faunal variables, the number of obligate frugivores and of species in size class 2 (10-100 grams in body weight) predicted environmental variables well in several continental regions. The number of herbivores and species in size class 6 (100-1000 kg) predicts general biome (forest vs. grassland). Continental datasets show stronger relationships among faunal and environmental variables, and these relationships differ among continents, reflecting both the different bioclimatic attributes of each continent and the different evolutionary histories of their mammalian faunas.

Cenozoic climate variation and continental differences in biogeographic history imply that different variables and different geographic subsets of modern faunas are better suited for paleoenvironmental inference over different intervals of the Cenozoic. Direct inferences from the full global dataset are probably most appropriate for faunas younger than the Miocene climatic optimum, although many relationships should also be informative for earlier faunas.

Technical Session V (Wednesday, November 5, 2014, 2:30 PM)

IS HYPEROSSIFICATION CONCEALING THE PHYLOGENETIC SIGNAL OF OSTEOLOGICAL TRAITS IN ANURANS? A TEST-CASE FROM THE UPPER CRETACEOUS OF BRAZIL

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The bizarre neobatrachian frog *Baurubatrachus pricei* was collected in the Maastrichtian Marilia Formation near Uberaba, Mina Gerais State, and briefly described nearly 25 years ago. Although it is relatively complete and partially articulated, exostosis and fusion of the exocranial bones have made it difficult to evaluate its phylogenetic position. In addition, *Baurubatrachus* has a peculiar temporal region in which the tympanic membrane was completely circumscribed by bone, a configuration that is rare amongst anurans. Since its discovery it was suggested that it might be a relative of the South American ceratophryids, a phylogenetic placement endorsed by recent analyses. However, preparation of the preserved ilium, a bone frequently used for taxonomic identification in anurans, demonstrates features not compatible with this hypothesis. In order to test the putative evolutionary relationships of this frog, we scored 145 osteological characters (63 cranial, 12 of the hyobranchial skeleton, and 70 postcranial) for 66 fossil and extant anuran species and conducted a maximum parsimony analysis using TNT. Taxon sampling was focused on earliest branching lineages within Hyloides in accordance with recent large-scale hypotheses of anuran relationships based on molecular data, although ranoid taxa were also included. We selected taxa with well-ossified dermatocrania as well as less ossified members of main neobatrachian clades to explore the impact of hyperossification. Analyses under equal weights and implied weights (k = 5-15), with either unordered or ordered multistate characters, resulted in similar well-resolved trees. In these trees a large clade of hyperossified species within a monophyletic Neobatrachia includes *Baurubatrachus* and most other fossil taxa, although not allied with the well-supported ceratophryid clade. Because of the evident liability and homoplasy of many cranial features, we performed analyses based on different partitions of the data set, e.g., excluding cranial characters generally associated with hyperossification. Omission of the latter characters recovered some additional groupings of well-ossified species with their less ossified relatives. All in all, although these cranial traits mask some phylogenetic relationships, it is evident that the addition of cranial characters not associated with hyperossification with respect to previous matrices improved the recovery of clades supported by other data, thus suggesting that this area merits further exploration. Funded by PICT 1895/11.

Technical Session VII (Thursday, November 6, 2014, 10:45 AM)

ALLIGATOR (*ALLIGATOR MISSISSIPPIENSIS*) SHOULDER GIRDLE MOBILITY DURING HIGH WALKS

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Extant crocodylians have played a significant role in evolutionary studies of archosaurs. They provide an extant phylogenetic bracket for dinosaurs when combined with living birds and for early archosaurs when combined with extant lepidosaurs. Major locomotor transitions involving the forelimbs occur within Archosauria and thus functional understanding of the forelimb and shoulder girdle are needed. Previous X-ray investigations of walking alligators revealed substantial movement of the shoulder girdle, but since the sternal cartilages do not show up in X-ray, the source of the mobility could not be conclusively determined. Scapulocoracoid movement was interpreted to indicate independent sliding of each coracoid at the coracosternal joint; however, rotations of the entire shoulder girdle (sternal cartilages + interclavicle) could also produce a similar outcome. Here, we present new data employing marker-based XROMM (X-ray Reconstruction of Moving Morphology) wherein simultaneous biplanar X-ray video and surgically implanted radio-opaque markers permit clear measurement of the vertebral axis, sternum and coracoid during the high walk of *Alligator mississippiensis*. We found that rotations of the sternum and coracosternal joint movement both contribute to shoulder girdle mobility, but that coracosternal movement is more substantial. Only a few

studies have explored coracosternal movement relevant to archosaurs. These studies were limited to either single X-ray views or standard light cameras and revealed conflicting data in lepidosaurs. Thus, mobility of the shoulder girdle in ancestral archosaurs remains unresolved. However, the loss of the clavicle in Crocodylomorpha may explain the increased mobility in the alligator shoulder girdle, suggesting that the degree of mobility may be unique to this group. Funding: Rhode Island NSF EPSCoR.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

COMPLEX SUBSTRATES REDUCE THE SPECIFICITY OF THE GOLDILOCKS EFFECT IN TRACK FORMATION

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In ichnology, the Goldilocks effect describes a scenario in which a substrate must be "just right" in order for tracks to form—too soft and the animal will be unable to traverse the area, too firm and the substrate will not deform. Any given substrate can therefore only preserve a range of tracks from those animals which exert an underfoot pressure at approximately the yield strength of the sediment. However, the yield strength of a substrate is usually not constant, either due to heterogeneity across sediment layers, or from mechanical behavior such as strain hardening. Furthermore, with increasing depth of the imprint, the deformed substrate volume increases, causing a higher load-bearing capacity.

We used finite element analysis (FEA) to explore the specificity of the Goldilocks effect in a number of virtual substrates, incorporating strain-hardening, friction, and vertical heterogeneity. We found that the inclusion of strain hardening into the model increased the potential range of trackmaker sizes somewhat, compared with a simple elastic-perfectly plastic model. The simulation of a vertically heterogeneous, strain hardening substrate showed a much larger range of potential track makers than strain hardening alone. We therefore showed that the Goldilocks effect is lessened to varying degrees by the inclusion of more realistic soil parameters. However, we note that the effect is still present. For example, dinosaurs spanned several orders of magnitude in size, from < 1kg to many tens of thousands, it remains unreasonable to assume that sediment will provide a suitable surface for recording the full range of animal sizes present in the environment.

Symposium 1 (Wednesday, November 5, 2014, 9:15 AM)

***ARCHAEOPTERYX* AND THE EVOLUTION OF THE PARAVIAN BRAIN**

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Many of the characters that historically have been associated with crown-group birds, from anatomical structures such as feathers and a furcula to behaviors like brooding nests of eggs, are now known to have a much deeper evolutionary history, finding their origin among non-avian dinosaurs. A protracted evolutionary history also looks to be the scenario unfolding for the avian brain. Volumetric analyses of the endocranial space along the avian lineage reveal that a 'bird-like' brain volume first appears early within maniraptoran dinosaurs, yet the morphology of the brain throughout this group, which includes living birds, has not been thoroughly assessed. The modern bird brain exhibits a suite of characters that vary little across the avian tree. Such characters include, but are not limited to, laterally displaced optic lobes, retracted olfactory tracts and reduced olfactory bulbs, an enlarged cerebrum with a prominent sagittal eminence, and a highly folded cerebellum. Using endocranial renderings derived from computed tomography (CT) data of fossil and extant taxa, I examined the distribution of these and other characters along the entire maniraptoran lineage, including examples from Oviraptorosauria, Troodontidae, Dromaeosauridae, and Alvarezsauridae. Consistent with previously described character systems, most 'bird-like' features of the brain are not restricted to the crown group but have a much deeper evolutionary history. Furthermore, few morphological characters are found to diagnose the avialan clade. Instead, the base of Avialae as exemplified by the stem bird *Archaeopteryx lithographica* exhibits a generally plesiomorphic morphology that can be diagnosed only by characters shared with either maniraptorans or paravians.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

RESOURCE PARTITIONING FROM STABLE ISOTOPES IN A LATE PLEISTOCENE–EARLY HOLOCENE FAUNAL ASSEMBLAGE FROM THE GREAT PLAINS OF NEBRASKA

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Temperature and aridity fluctuated greatly during the Pleistocene–Holocene transition as the Holarctic continents transitioned from the Last Glacial Maximum to more equable climates. Knowing how changing environments affect mammalian ecologies during periods of climatic change may help predict future patterns of ecological change. The Red Willow fauna comes from several gravel pits along the Republican River in southern Nebraska and spans the Pleistocene–Holocene boundary, based on unpublished carbon-14 dates and the presence of Late Pleistocene (*Equus* and *Mammuthus*) and Holocene (*Bison bison*) taxa. The fauna is dominated by *Bison* spp., including the older and larger *B. occidentalis* and the extant *B. bison*. We use stable carbon and oxygen isotopes to infer the paleoecology and diets of the fauna. We find a significant correlation between $\delta^{13}C$ and $\delta^{18}O$ in *Bison* spp. ($n = 34$, $r^2 = 0.44$, $p < 0.0001$), which could be caused by either differences in temperature or aridity. Carbon values indicate that these bison consumed primarily C_4 vegetation, with all but two individuals showing a > 70% dietary component of C_4 and half the fauna showing a > 90% component. Such a high component of C_4 is unexpected because modern Nebraska grasslands contain a greater portion of C_3 grasses. Several bison have values > 2.0‰ suggesting that these individuals were feeding on water stressed C_4 grasses. In contrast, *Equus* sp. from the Red Willow fauna has much lower $\delta^{13}C$ values (-10.2‰ to -7.4‰; $n = 4$) suggesting that its diet consisted mainly of C_3 plants. Bison in this fauna also have high $\delta^{18}O$ values, ranging from 21.2‰ to 30.1‰ with a mean of 25.3‰ ($n = 32$). $\delta^{18}O$ in *Equus* sp. in the Red Willow fauna have a considerably lower mean of 22.6‰ ($n = 4$). Unpublished data from mammoths in the Red Willow fauna suggest that, like the equids, they also consumed primarily C_3 vegetation. The large separation of the $\delta^{13}C$ values of these three taxa, which are usually classified as grazers or hyper-grazers, suggests that these taxa are from different time intervals. *Equus* and *Mammuthus* appear to be from a cooler interval in the Late Pleistocene with less C_4 present, while *Bison* spp. appears to occur during an extremely warm and arid interval of the Holocene when C_4 grasses shifted northward based on the high $\delta^{13}C$ values of bison. The $\delta^{13}C$ values and a clustering of values near 2‰ suggest that these bison may have perished along the Republican River during an extended drought in the Holocene. Future work will use carbon-14 dating to place these taxa in a better temporal context to test the proposed hypotheses.

Romer Prize Session (Thursday, November 6, 2014, 12:00 PM)

THE PHYLOGENETIC POSITION OF *PROCONSUL* AND THE IMPORTANCE OF MOSAIC EVOLUTION IN THE ORIGINATION OF CROWN CATARRHINE LINEAGES

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Despite the wealth of material, extensive study, and apparent significance of the fossil catarrhine primate *Proconsul* for interpreting hominoid evolution, there continues to be a lack of agreement concerning its precise phylogenetic placement. There are three main hypotheses: (1) *Proconsul* is a stem hominoid; (2) *Proconsul* is a stem catarrhine; and (3) *Proconsul* is a basal hominid, most closely related to extant great apes and humans. The first of these represents the current consensus interpretation, but there have been few detailed phylogenetic analyses of catarrhines that include *Proconsul* as the primary focus of study. A phylogenetic analysis of 715 characters drawn from the cranium, forelimb, pelvis, and foot, and sampling across anthropoid primates, offers little support for a hominoid clade that includes *Proconsul*. Crown catarrhine synapomorphies lacking in *Proconsul* are found throughout the skeleton, contradicting previous assumptions that differing signals arising from distinct morphological complexes would complicate interpretation of the phylogenetic position of *Proconsul*. Individual structural-functional complexes are not enough to confidently support any given hypothesis. Within each complex mosaic evolution is evident, making it essential to analyze multiple structural-functional complexes throughout the skeleton. In addition to helping resolve the enduring debate about the phylogenetic position of *Proconsul*, these data provide key insights into the early stages of crown catarrhine evolution and demonstrate the importance of mosaic evolution.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

RHINO FACE SPACE

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Rhinocerotoid facial features, from *Hyrachyus* to *Indricotherium* to the extant rhinos, should reflect evolutionary adaptations related to size and skull functions, including vision, feeding, respiration, dental function, and combat-defense-display. Significant size increases, late aquisition of keratinous nasal horns, and divergence into clearcut grazing and browsing lineages are salient features of rhino evolution which may be reflected in facial structure. Face is defined here as the craniomandibular skull anterior to the orbits. The morphospace for this region is defined by 12 measured and derived variables characterizing face height, width, depth, interorbital distance, nasal size, narial dimensions, intertooth row widths, and premaxilla features. Skull size is estimated by a linear measurement from occipital condyles to the 2nd premolar of the maxillary tooth row. Sample sizes ranged from 306 to 451 individual specimens across rhinocerotoid genera (not all genera are included in each analysis). One measured reconstruction of *Paraceratherium* (*Pa*) is always a size outlier. Bivariate plots show multiple patterns of facial features across the size-time-ecology matrix implicit in the genera. Face length (orbit to nasal tips) shows a regular constrained increase with size leading to *Pa*. Posterior facial parameters (e.g., interorbital distance, cranial face height at M1) are constrained throughout the series with *Pa* plotting along a similar trajectory. However, mandibular height at M1, which would contribute to overall face height, deviates from this with *Pa* having a shallower mandible body for its skull size. Much greater variation is seen in rostral features, especially projection of the premaxilla, inter-second premolar distance, and length of the nasal incision. The ratio of nasal breadth to nasal incision breadth shows a preditable upturn with horned taxa (curvilinear data?). The oddest pattern observed is for infraorbital foramen size (calculated as elliptical area from height-width diameters). For smaller skull sizes, infraorbital size increase and variation is relatively typical, but at the largest skull sizes (excluding *Pa*, $n = 1$) there is a dramatic increase in variation for a given skull size range. *Pa* infraorbital foramen size plots approximately in the same range as the largest foraminae in *Diceros* and *Ceratotherium* (indicating that it is small for skull size).

Technical Session X (Friday, November 7, 2014, 11:00 AM)

CHARACTER DISPLACEMENT IN BODY SIZE AND CRANIODENTAL ADAPTATIONS AMONG NORTH AMERICAN FOSSIL CANIDS

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Among extant taxa, competition between ecologically similar species can lead to character displacement: a divergence in characters, such as body size and skull shape, that relates directly to the way in which the species compete. Character displacement likely acts also at longer time scales, leading to double-wedge diversity patterns in the fossil record of carnivorous mammals, such as canids. Body-size estimates and craniodental metrics of Oligo–Miocene canids were recorded to: (1) quantify the degree of morphological specialization for feeding abilities such as hypercarnivory; (2) determine the timing of, and potential temporal overlap among, morphological specializations; and (3) examine differences in diversity and disparity among time

intervals. A morphospace of extant carnivorans was generated using a principal component analysis of 38 linear measurements of the skull and dentition, against which component scores of fossil canids from five time intervals were superimposed. Time intervals of high canid species richness showed high disparity in body size and craniodental adaptations, suggesting that divergence in resource use enabled fossil canids to minimize interspecific competition and exist at high richness. High disparity resulted in significant part from the iterative appearance of hypercarnivorous morphologies. However, while discriminant function analysis classified 10 of these canids as hypercarnivores, it could not assign the remainder of the sample to a category more specific than 'omnivore', necessitating a more refined method for determining the exact diet of Oligo–Miocene canids.

Technical Session II (Wednesday, November 5, 2014, 11:15 AM)

TERRESTRIAL BIODIVERSITY IMMEDIATELY PRIOR TO THE END-CRETACEOUS MASS EXTINCTION IN CENTRAL CANADA: PATTERNS AND PROCESSES

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Paleomacroecology, the study of large-scale ecological patterns in the fossil record, is an important interface between paleontology and neobiology. Research in this field seeks to not only discern paleobiodiversity patterns, but also applies modern ecological theory to link these patterns to the abiotic and biotic processes that created them. Studies of this nature become critical when assessing the nature of large-scale ecological disturbances such as mass extinctions. The fine-scale, multidisciplinary study presented here explores paleobiodiversity patterns in Saskatchewan, Canada's latest Maastrichtian (66 Ma) Frenchman Formation. This formation, coeval with the upper Hell Creek and Lance formations in the USA, preserves a complete and continuous record of terrestrial ecosystems in the half-million years prior to the end-Cretaceous mass extinction event. Data collected from 31 stratigraphic sections in study area of Grasslands National Park (GNP), SK were used to designate seven lithostratigraphic units, each of which represents a discrete period of geologic time. Paleoclimate estimates were derived from x-ray flourescence analysis of paleosol samples, and from plant macrofossil physiogamy using the Climate Leaf Analysis Multivariate Program (CLAMP). In the latter analysis, two paleofloral assemblages were studied, one from GNP and the other from a coeval site 200 km to the northwest. Based on the presence of inertinite (fossil charcoal) associated with the GNP paleofloral assemblage, the marked disparity in floral diversity between the two sites is suggested to be reflective of secondary ecological succession following a disturbance by fire. Vertebrate fossil material collected from 38 vertebrate microsites in GNP, comprising some 7800 specimens, was used to quantify biodiversity trends across time. This study found that: (1) overall alpha diversity was relatively stable prior to the mass extinction, but with two sudden, temporally distinct declines; (2) temporal diversity trends varied among different vertebrate groups (fish, turtles, dinosaurs etc.); (3) faunal turnovers in certain groups suggest changing environmental conditions over time; and (4) local factors (e.g. fire) were just as important in creating paleobiodiversity patterns as regional or global drivers. These results have important implications for the understanding of the duration and cause of the Cretaceous mass extinction on local spatial scales, and demonstrate the benefits of assessing paleodiversity patterns on multiple ecological levels.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

NEW TAPHONOMIC METHODOLOGY FOR VERTEBRATE TEETH BASED ON MATERIAL COLLECTED OF THE MARIA FARINHA FORMATION, PARAÍBA BASIN, NE BRAZIL

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In the literature there are abundant taphonomic models proposed for preservation processes of invertebrate and vertebrate bodies. However, none of these methods can be effectively applied to teeth, which seem to suffer distinct preservational actions. We propose here a new methodology for analyzing different degrees of preservation in vertebrate teeth. Our method was successfully applied to samples collected from the Maria Farinha Formation (Paleocene, Paraíba Basin), mostly in the Poty Quarry, Northeastern Brazil. This study was based on specimens collected in outcrops of the Maria Farinha Formation. We analyzed a total of 37 shark and eight dyrosaurid teeth. These two distinct groups were chosen by us for possessing numerous specimens in different degrees of preservation. The aim of this work was the recognition of the main features of vertebrate teeth (crown, root, enamel, keel, and ornamentation). Each feature preserved was quantified, grouped, and encoded in a table with four classes. Lastly, none of the teeth has altered morphology due to diagenetic events. In our results, we noted that the root is the most fragile structure, being the first to suffer structural damage from exposure, weathering, and diagenesis. Only five shark teeth and a single dyrosaurid tooth were classified in the first class. This means a considerable loss of morphological information, where few structures—despite still being diagnostic—are complete. It was also verified that a coverage of enamel, being highly resistant, is present in all teeth, including those coded in class 4 (poor), both for shark and dyrosaurid teeth. The preservation of scratch marks and enamel, coupled with the fact that the teeth do not present evidence of abrasion on its surface, suggests a null or short distance transport. Some teeth in both taxa have wear on their bases, indicating they were exposed in the water/sediment interface before accumulate and final burial. The presence of enamel in all levels of our classification also corroborates this hypothesis. We conclude that our method shows teeth bioclasts differ from other bony elements. We therefore suggest they are an additional data source for understanding taphocoenosis and diagenetic behavior.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

NICHE PARTITIONING USING TOOTH MORPHOGUILDS IN MOSASAURID FAUNAS FROM THE MAASTRICHTIAN PHOSPHATES OF MOROCCO: A QUANTITATIVE APPROACH

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The phosphates of Morocco (Maastrichtian-Ypresian) are very rich in marine vertebrate remains, including selachians, bony fishes and various reptiles including plesiosaurs, squamates, crocodyliforms, chelonians, and avian dinosaurs. Among squamates, the Mosasauridae are the most abundant and diversified, being represented here by at least 10 species and seven genera, most ranging along the whole Maastrichtian series. These mosasaurid species also present several ecological trends that are illustrated by their tooth morphologies. Used to define morphoguilds in previous studies, the dentition of mosasaurs exhibits particular adaptations for piercing, crushing or cutting, and thus gives access to resource partitioning. However, as noted in older studies, the diagrams and the way in which the species were placed relative to each other was purely qualitative and subjective. Here we provide several approaches that allow us to better quantify the plotting process for each species. For the purpose of this study, several dozen mosasaur teeth have been gathered from the Maastrichtian of Morocco. Eight of the 10 species recognized in these strata have been sampled this way, including one russellosaurine, one halisauromorph, two mosasaurines, and four globidentines. To minimize variations in shape and proportions, 'average teeth', located in the middle of the jaws, have been selected in particular. Their detailed examination led to the building of a small character dataset. The results of a preliminary analysis are consistent with the classic ecological scheme established for marine reptiles, but allow us to go a step further by proposing for the first time a tool to quantify the adaptation of mosasaurids.

Technical Session X (Friday, November 7, 2014, 12:00 PM)

FOSSIL EVIDENCE FOR LASTING ECOLOGICAL TRANSFORMATION AS A RESULT OF DEFAUNATION

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Defaunation is a term coined by ecologists to describe the loss of megafauna from ecosystems as a result of anthropogenic impacts, analagous to deforestation describing the loss of trees. Studies that take place over the ecological time-scale document numerous effects of defaunation, especially on plant communities, but also in influencing abundances of smaller animals. However, in ecological time, reintroduction of megafauna can often reverse the effects of defaunation. Here we examine whether the same holds true over longer time scales, by using the rich Quaternary vertebrate paleontological and paleobotanical records that span the Pleistocene–Holocene transition, a time characterized by the extinction of nearly half of the big-bodied mammal species in the world. We compare the timing and nature of vegetation changes with large-mammal extinction chronologies in different regions, including southern South America, east-central South America, and the northeastern United States. We find that the efficacy of losing megafauna through extinction in triggering wholesale, lasting ecological changes is variable, and depends on the number of megafaunal species lost, their ecological niches, and the evolutionary history of the vegetation. An intriguing open question is whether the replacement of a diverse complement of extinct megafauna by fewer species at high abundances—such as occurs with domesticated megafauna like cattle and horses replacing endemic megafauna—ecologically compensates for the lost species in terms of overall ecological function and energy flow. This question has great bearing on such current conservation discussions as managed relocation and so-called Pleistocene re-wilding.

Technical Session XIV (Saturday, November 8, 2014, 9:30 AM)

A NEW ORNITHOPOD DINOSAUR FROM THE LATEST CRETACEOUS OF THE ANTARCTIC PENINSULA

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Antarctic dinosaurs are exceptionally rare, with only four named taxa described to date. Description of any new material is of potentially critical significance in understanding the paleobiodiversity of this region as well as the continent's role in large-scale paleobiogeographic scenarios. In 1989, a partial ornithopod dinosaur skeleton was collected from the Cape Lamb Member of the Lopez de Bertodano Formation (Campanian-Maastrichtian: Late Cretaceous), east of Cape Lamb, Vega Island, east of the Antarctic Peninsula, consisting of disarticulated skull bones, vertebrae, and forelimb and pectoral girdle elements, but despite its regional importance this specimen has not been fully described or incorporated into a phylogenetic analysis. Comparisons with other ornithopods indicate that the specimen represents a new taxon that can be distinguished on the basis of autapomorphic dental and humeral morphology, and that it can be further differentiated from other penecontemporaneous ornithopods, including the Antarctic taxon *Trinisaura*, by a unique combination of cranial and postcranial features.

The new taxon shares a number of features with other Gondwanan ornithopod taxa, including *Talenkauen*, *Macrogryphosaurus*, and *Trinisaura*. A preliminary phylogenetic analysis of ornithopod interrelationships indicates that these taxa might form an endemic clade of very basal iguanodontians, which would have persisted from the Turonian to the Maastrichtian in southern South America and Antarctica. These features include the possession of unusually elongate cervical vertebrae, the possession of epipophyses on cervical vertebra four, a sharp, prong-like acromion process, and a sternum with coossified sternal ribs. Possible examples of dinosaur endemicity at the clade level are relatively rare, but occur several times within Ornithopoda, with rhabdodontids confined to latest Cretaceous Europe and jeholosaurids found only in the Cretaceous of eastern Asia. It is possible that this endemicity may reflect barriers to small ornithopod dispersal,

such as the spread of extensive epicontinental seas that flooded many continental interiors during Cretaceous high-stands.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

ASSESSING THE RELATIONSHIP BETWEEN OUTLINE-BASED MESOWEAR, DIET, AND HABITAT IN EXTANT UNGULATES: WHAT INFLUENCES MOLAR CUSP MORPHOLOGY?

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Ungulate molar cusp morphology is thought to be primarily influenced by the type of vegetation comprising the diet of an herbivore. For instance, the high phytolith content of grasses has been proposed to significantly wear down molar cusps. However, other factors may have a significant effect on cusp morphology. Exogenous grit and dust, for example, have also been proposed to have an important abrasive effect, such that species living in dry environments may experience increased tooth wear from dust adhering to the vegetation relative to species living in more humid environments. In this study, we investigated the relationship between buccal cusp morphology, the amount of grass in the diet, and mean annual precipitation in a sample of 40 extant ungulate species. In addition to these variables, we also evaluated the relationship between cusp morphology and body mass, as this variable may have an important allometric effect on cusp morphology. Buccal cusp morphology was characterized through the application of outline-based geometric morphometric techniques (i.e., sliding semilandmarks and eigenshape analysis). Data on the amount of grass in the diet for each ungulate species and mean annual precipitation in their geographic distribution was obtained from the literature. The parameters were tested by general linear models using ordinary least squares and phylogenetic generalized least squares to account for phylogenetic influences. Body mass was not significantly correlated with cusp morphology in both ordinary least squares and phylogenetic generalized least squares analyses. In contrast, a statistically significant relationship was found in both analyses between cusp morphology and the amount of grass in the diet, but not between cusp morphology and mean annual precipitation. These results are consistent with those reported in a previous study. Unlike the hypsodonty index, which is significantly correlated to both mean annual precipitation and the amount of grass in the diet, buccal cusp morphology, as assessed in this study, is only correlated to the latter variable. Nevertheless, the relationship between cusp morphology and the amount of grass in the diet may not be direct, as there may be a correlation between the amount of grass eaten and the amount of grit eaten. Further examination of the variables investigated here, along with data on the amount and type of grit ingested by ungulates when feeding, will better identify the factors responsible for dental wear patterns.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

THE EVOLUTION OF DINOSAUR EGGS: EVIDENCE FROM A PHYLOGENETIC ANALYSIS UTILIZING TOPOLOGIC CONSTRAINTS

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Fossil eggs provide a unique source of information about the reproductive biology of extinct vertebrates. Dinosaur eggshell, eggs, and clutches are of particular interest because of their great diversity in size, shape, microstructure, and clutch configurations relative to extant amniotes. To investigate this diversity and to form more rigorous hypotheses about the identity of eggs lacking adult or embryonic associations requires an explicit phylogenetic framework. We performed cladistic analyses of 36 oological characters for 48 egg types. To achieve a broader taxonomic coverage than previous studies and to better polarize character states, we included pterosaur eggs for the first time in an outgroup with crocodilians and turtles. The first set of analyses did not restrict the positions of ingroup eggs; however, the second utilized a backbone constraint to restrict the positions of taxonomically identified eggs on the tree. The second set thus allowed unidentified ootaxa to fall out freely relative to a stable framework of relationships based on consensus osteological phylogenies. The results of all analyses reveal that Chinese spheroolithids and Mongolian dendroolithids group together to the exclusion of other members of those oofamilies (and in a clade with therizinosauroid eggs), suggesting that Spheroolithidae and Dendroolithidae are polyphyletic. On an Adams consensus tree, the constrained analysis also reveals *Ovaloolithus* and *Cairanoolithus* as the only egg types unresolved at the base of Dinosauria, indicating that they could belong to either saurischians or ornithischians. All other egg types fall out as saurischian. This suggests that the lack of ornithischian eggs in the fossil record results from preservational biases, rather than a lack of preserved embryos that allow identification. This lack of pre-Late Cretaceous ornithischian eggs potentially reflects the independent evolution of hard-shelled eggs within Dinosauria. Major transitions in dinosaur eggshell evolution include the acquisition of a second structural layer of calcite within Avetheropoda, and reversal to a single-layered condition within Therizinosauroidea. As in previous studies, a stepwise accumulation of avian-like character states within Theropoda precedes the appearance of extant avian clades. This study highlights the need for ongoing application of cladistic principles to the study of fossil eggs.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

A PATHOLOGICAL MOSASAUR SNOUT FROM THE TYPE MAASTRICHTIAN (SOUTHEASTERN NETHERLANDS)

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Here we report on the pathologies recognized from a disarticulated mosasaur skeleton from the Maastrichtian (Late Cretaceous) type section near Maastricht, The Netherlands. The specimen was discovered in September 2012 by quarry operator Carlo Brauer in the flint-rich Lixhe 3 Member of the Gulpen Formation. The disarticulated assemblage includes partial sections of the maxillae, dentaries, a parietal and various elements of the axial skeleton. The skeleton is disarticulated and only partially preserved. Dental morphology suggests affinities with *Prognathodon sectorius*. The premaxilla and left maxilla show elongate, healed lesions extending anteroposteriorly, starting near the left premaxillary-maxillary suture, slightly left from the anteroposterior central line. Furthermore, three distinct oblong pits on the left maxilla along with evidence of necrosis and exostiosal bone growth on the tip of the premaxilla are possibly related to smaller gouges located more posteriorly. A less conspicuous callus suggests additional damage to the anteriormost section of the left dentary.

The sheer size of the lesions, the state of bone remodeling, and the advanced degree of healing is most parsimoniously explained by a non-fatal interaction with one (or more) large mosasaur(s).

The lesions observed in this specimen prompted a categorization of pathologies in mosasaurs based on the age, position of the injuries along the skeleton, taxonomic affinities, geological age, and provenance. Lesions are most abundant in the lower jaws, the vertebrae (most often posteriorly in the tail section), and elements of the appendicular skeleton (most often involving the digits).

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

MORPHOLOGICAL AND ECOLOGICAL DIVERSITY WITHIN THE HYAENODONTIDAN GENUS *HYAENODON* WITH REMARKS AS TO ITS ORIGIN

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Hyaenodon is one of the most widespread hyaendontidan genera both in terms of time and space. Its presence in North America, Europe, and Asia from the late Eocene until the early Miocene resulted in a diversity of body sizes ranging from as small as a fox up to the size of a lion. While *Hyaenodon* certainly roots in the late early and early middle Eocene Asian genus *Propterodon*, very little is known of earlier Hyaenodontidae s.str. This makes the name-giving family of the order Hyaenodontida the most enigmatic one.

Hyaenodon occupied a range of different niches, which is reflected in its diversity of dietary habits. *Hyaendon´*s dentition shows secant molars and carnassials at the positions P4/m1, M1/m2 and M2/m3. For this study, we used traditional morphological methods as well as multivariate analyses to evaluate the microwear. Microwear analyses reveal that *Hyaenodon* was not only a meat specialist as previously supposed but also took in tougher parts of its prey such as tendons and bones. North American species are generally larger sized than the species in Europe and exhibit a diet similar to the recent lion, whereas the European species have dietary patterns more comparable to the recent spotted hyena. Analysis of the morphology of milk teeth provides clues to the phylogeny of European species. Deciduous teeth (DP3, DP4 and dp3 and dp4) exhibit a different morphology in the Oligocene European species *H. exiguus* versus *H. filholi,* identifying the latter as an Asian immigrant and suggesting a separate evolutionary lineage in Europe (*H. rossignoli* in the Eocene and *H. exiguus* in the Oligocene). The split between North American and European species is further evidenced by different tooth eruption sequences in both cranial and mandibular material from the Old and New World continents.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

THE FUNCTION OF THE INTEROSSEOUS TENDON IN MODERN GIRAFFE, AND ITS RELEVANCE TO EXTINCT GIRAFFOIDEA.

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Extinct and extant members of the artiodactyl clade Giraffoidea possess a longitudinal groove that runs along the caudal length of their metapodial bones. In modern giraffe (*Giraffa camelopardalis*) this groove houses the interosseous tendon, which is presumed to have a role in passive support. The interosseous tendon has no muscular component; it originates at the caudal carpus/tarsus, and has its main insertion onto the proximal phalanges.

In this study we examine cadaveric limbs from three individual giraffe. Specimens were donated by zoological institutions from giraffe that had been euthanized for reasons unrelated to this study. We tested the ability of the interosseous tendon, in isolation and in tandem with neighbouring structures, to passively resist loads that represent static weight-bearing forces. We tested three forelimbs and two hind limbs. Limbs were held in a rigid frame and loads between 1 to 2.5 kN (approximating the fraction of static body weight supported by a limb) were vertically applied using a hydraulic press. Force data and joint angles were simultaneously recorded. Our results show that the interosseous tendon alone is capable of passively resisting loads up to and in excess of those experienced during static weight-bearing, and that there is a complex interplay with adjacent flexor tendons.

Establishing the mechanical properties of the interosseous tendon in living giraffe is relevant to extinct members of Giraffoidea, which possessed metapodial grooves of varying depths. For example, the metacarpal bone of *Bohlinia attica* features a deep caudal groove when compared to the modest groove of *Samotherium boissieri.* A test with extant *Giraffa* indicates that the thickness of the tendon (and so stiffness) can be approximated from the depth of the metapodial groove. This enables the application of computed tomography (CT) to fossilized specimens, as we have done with fresh specimens, to measure the caudal groove and test the evolution of passive support within the clade. The presence of a functioning passive support apparatus has not yet been documented in extinct members of Giraffoidea, and understanding such mechanisms in modern taxa is of key importance when predicting locomotor characteristics of extinct taxa.

Technical Session VI (Thursday, November 6, 2014, 10:15 AM)

NONRANDOM BUT UNPARSIMONIOUS PATTERNS OF MAMMALIAN DISPERSAL BETWEEN ASIA AND AFRICA DURING THE LATER PALEOGENE

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The fossil record reveals that multiple Asian mammal clades colonized Africa during the interval spanning from the middle Eocene–early Oligocene, approximately 8–15 Ma prior to the tectonic collision between Africa and Eurasia. These taxa include one or two rodent clades (Hystricognathi and possibly Anomaluroidea), anthropoid primates, miacoid carnivorans, and anthracotheriid artiodactyls. In all cases, vicariance fails to explain the distributional data, because none of the relevant clades is sufficiently ancient for hypotheses of vicariance to be reasonable, and because primitive sister taxa for each clade occur in Asia but are absent in Africa. Geophysical data require that each of these clades had to cross the marine barrier formed by the Tethys Sea in order to reach Africa. Examination of the Asian mammal taxa that succeeded in colonizing Africa reveals these colonists to have been biased in terms of body size, locomotor regime, and taxonomic composition (with small-bodied, arboreal members of Euarchontoglires being favored).

Assuming that chance dispersal across the marine Tethyan barrier was a rare event, the African radiations that were derived from these Asian colonists would be expected to be monophyletic. Phylogenetic analyses of two of the most successful clades to colonize Africa during the later Paleogene, hystricognathous rodents and anthropoid primates, shows that neither group conforms to the biogeographically parsimonious pattern of African monophyly. Instead, multiple Asian anthropoid and hystricognath clades appear to have colonized Africa more or less simultaneously. This nonrandom but unparsimonious pattern of intercontinental dispersal likely reflects one or more aspects of the paleobiology of early anthropoids and hystricognaths, which conferred upon them a predisposition to succeed in crossing marine barriers and establishing viable populations in the newly colonized terrain. The fact that these two taxa were subsequently able to colonize South America from Africa underscores the nonrandom nature of success at transoceanic dispersal among these early Cenozoic mammals. Funding provided by NSF BCS-1441585.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

THE DEVELOPMENT OF THE ELGIN MUSEUM AS A PUBLIC AND SCIENTIFIC RESOURCE

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The Elgin Museum, the oldest independently run museum in Scotland, houses a 'Recognised' Collection of Devonian (Old Red Sandstone), Permian, and Triassic vertebrate fossils from the surrounding Moray area. This material was collected in the early–mid 19th Century attracting the interest of geologists and palaeontologists of the time who either personally visited the area or were sent material relating to their own studies. Subsequently, material has contributed to important discussions on tetrapod evolution, in a revision of the phylogeny of dicynodonts (Synapsida, Therapsida) and the affinities of *Saltopus* relative to the earliest dinosaurs, among other topics. Sadly, the majority, if not all, of the quarries sourcing these unique and diverse fossils have now closed or are inaccessible, meaning new examples are not likely to be recovered. In view of this, the entire geology collection at Elgin Museum, which includes the Recognised Collection, rocks and minerals from the local area, and a further range of non-Recognised fossils, is in the process of being re-organised to fully and better use the limited space available. The first step has been a thorough re-examination of the condition and potential use of specimens, for example, in displays, and school and public handling, leading to some unavoidable rationalisation of the rocks and minerals. The catalogue system has similarly been scrutinised to ensure all specimens are properly documented, particularly regarding their current location and the status of loans. Improvements to the building include the simple addition of new lighting in the West (geology) Store, to be followed eventually by strengthening of the floor in the larger North Store where rolling stacks will be installed to house more permanently the geology collection. The ultimate aim is to increase access to the geology collection for museum staff, volunteers, the interested public and academic community alike, and promote the collection as a valuable and versatile learning resource. Herein, the difficulties and successes of the developments are described so that other museums undergoing similar changes, now or in the future, can benefit from our experience.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

FEEDING ECOLOGY OF DESMOSTYLIA AS INFERRED FROM SPECIALIZATIONS FOR INGESTION, DENTAL MORPHOLOGY, AND DENTAL WEAR

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Stable isotopic studies have helped us discern the geochemical basis of diet and water use in the Desmostylia, but are limited in identifying variables of how those resources were partitioned. Recent insights into the morphology of new specimens of desmostylians has shown a greater diversity within the group than previously recognized, many of which were sympatric. Amidst this diversity is a greater diversity in body size, but also feeding specializations.

Desmostylians lack the horny pad that sirenians develop on the remains of their symphysis and vestigial incisor/premolar alveoli, and instead tend to all have a narrow oral commissure with few teeth, similar to the suction feeding specializations seen in *Odobenus*. The notable exceptions are the paleoparadoxiids that have an array of wide flat incisors suited for cropping vegetation in a way similar to that seen in many terrestrial grazing mammals. Rostral orientation in the Sirenia typically reflects the location of preferred food items in the water column, and among the Desmostylia there seems to be little indication of any ventral deflection as seen in benthic feeding sirenians.

Postcanine dental morphology in *Behemotops*, *Cornwallius*, and paleoparadoxiids retain a similarity between first and last molars, yet in paleoparadoxiids the tooth sizes do not seem to scale with the increase in body size seen in paleoparadoxiids throughout the Miocene. In contrast, *Desmostylus* has a dramatic increase in molar size associated with their its body size, and this ontogenetic pattern mimics the sequential eruption of molars seen in elephantids. Postcanine enamel thickness is greater in *Cornwallius*, *Desmostylus*, and to a lesser degree in paleoparadoxiids, which may be an indicator of a longer wear life of the individual teeth, possibly due to a more abrasive diet. Shear length of postcanine teeth increased with the pattern of cusp duplication seen in *Cornwallius* and *Desmostylus*, a feature seen in terrestrial herbivores that transition from eating soft plat foods to those of greater fracture toughness such as grasses. Wear on the lingual sides of postcanine teeth of *Cornwallius, Desmostylus,* and some paleoparadoxiids are similar to patterns of lingual wear seen in benthic feeding *Odobenus*. Lastly, remains of ingesta found in the infundibulae of some desmostylian postcanine teeth appear to have crushed hard-shelled invertebrates and some have the carbonized remains of plants, suggesting that their diets may have consisted of both, like a ‘chef’s salad of the sea.‘

Technical Session I (Wednesday, November 5, 2014, 10:45 AM)

ANATOMY AND FUNCTION OF THE TAIL IN THE PROTOCETID ARCHAEOCETE *MAIACETUS INUUS* (MAMMALIA, CETACEA): INSIGHTS INTO THE EVOLUTION OF TAIL-POWERED SWIMMING IN EARLY CETACEANS

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One of the keys to understanding the evolution of cetaceans involves elucidating the details of how their derived swimming mode evolved from that of a four-legged, terrestrial ancestor. Most modern quadrupeds swim using a modified terrestrial gait, in which all four of their appendages are used to paddle through the water. Modern cetaceans, on the other hand, oscillate a specialized horizontal tail fluke through the water to generate forward propulsion. Despite being composed of mostly fibrous and ligamentous soft tissue, the presence of a well-defined fluke can be inferred by the size and shape of terminal caudal vertebrae. Based on caudal proportions, it appears that basilosaurid archaeocetes (e.g., *Dorudon atrox*) possessed tail flukes before the end of the Eocene. However, the origination of this feature in cetacean phylogeny has been difficult to assess given the paucity of archaeocete fossils preserving terminal caudal vertebrae. *Maiacetus inuus* is a protocetid archaeocete known from the Habib Rahi Formation of Pakistan (Lutetian, 47.5 Ma). One known specimen of *Maiacetus* preserves all 21 of its caudal vertebrae, making it an ideal candidate for assessing tail use in a representative protocetid. Comparative analyses of the caudal vertebrae with those of over 75 specimens of modern mammals suggests a significant amount of muscular control in the tail of *Maiacetus*. The large number of ventrally-projecting chevrons (14) in *Maiacetus* is a characteristic shared by mammals that have extensive tail control, including dolphins, porpoises, and prehensile-tailed mammals. Multivariate statistical analyses of caudal vertebrae demonstrate that the vertebrae of *Maiacetus* occupy a unique area of morphospace in the vicinity of some prehensile-tailed mammals and semiaquatic taxa (such as otters). The proportions of the terminal caudal vertebrae, however, do not indicate a well-defined tail fluke as they do in basilosaurids and modern cetaceans. Thus, the tail of *Maiacetus* appears truly intermediate in form and function between terrestrial and aquatic mammals. It appears to have had significant epaxial musculature for controlling its movement, and though a well-defined tail fluke may not have been a present, a tail with a poorly defined nascent fluke cannot be ruled out. *Maiacetus* represents an early archaeocete that likely used its muscular tail to supplement paddling of the hind limbs for generating propulsion during swimming.

Technical Session IV (Wednesday, November 5, 2014, 3:30 PM)

THE SKULL AND SKELETON OF A LARGE-BODIED DIPROTODONTIAN MARSUPIAL FROM THE LATE OLIGOCENE OF CENTRAL AUSTRALIA AND THE ORIGIN OF WOMBATS

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In the early 1970s, the late Dick Tedford and colleagues collected the partial skull and skeleton of a large diprotodontian marsupial from the late Oligocene (~24-26 Ma old) Namba Formation near Lake Frome in central Australia. This specimen represents one of the oldest marsupials known from associated cranial and postcranial remains anywhere in Australia, but it has never been adequately described or illustrated. The skull is crushed and lacks the lower jaw, but the upper postcanine dentition is well-preserved, and much of the appendicular skeleton is intact. Depending on the regression equation used, estimated body mass is at least 28 kg. Its craniodental morphology appears approximately intermediate between that of the extinct vombatiform wynyardiids and wombats (Vombatidae): three upper incisors were present, but the first was greatly enlarged; a canine was present; the P3 is bicuspid and lacks a 'hypocone'; the upper molars are clearly not open-rooted, but their roots are elongate and there is no clear distinction between the root and crown; the occlusal morphology of the molars shows striking similarities to unworn molars of the living wombats *Vombatus* and *Lasiorhinus*; although damaged, the ear region appears vombatid-like in that, if a zygomatic epitympanic sinus of the squamosal was present, then it was very shallow. The postcranial skeleton shows some evidence of probable burrowing adaptations, notably a distally wide humerus with an enlarged deltopectoral crest, and a quadratic discriminant analysis of skeletal measurements suggests that it was at least partially fossorial. Phylogenetic analysis of a novel 72 character craniodental dataset places the new taxon as sister to vombatids, with wynyardiids and diprotodontids successively more distantly related; in contrast to most previous analyses, marsupial lions (Thylacoleonidae) are recovered as the first vombatiform family to diverge. Ancestral state reconstructions on the phylogeny suggest a single origin of fossoriality in the lineage leading to vombatids,

and also indicate that large body size (> 7 kg) evolved independently at least three times within Vombatiformes; there is no support for the hypothesis that the large size of the living koala and wombats is the result of long-term maintenance of ecological niche differentiation within Diprotodontia.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

TURTLES FROM THE ARKADELPHIA FORMATION-MIDWAY GROUP CONTACT (MAASTRICHTIAN-PALEOGENE) OF HOT SPRING COUNTY, ARKANSAS, USA

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The Arkadelphia Formation-Midway Group contact near Malvern, Arkansas preserves one of the youngest Mesozoic testudinate faunas yet reported from the Gulf Coastal Plain of the United States. This assemblage consists of skull, shell, and non-shell postcranial skeletal elements that were recovered by scuba diving an outcrop along a meander bend of the Ouachita River. The assemblage is similar to contemporaneous nearshore faunas found across eastern North America and elsewhere and includes these taxa: *Taphrosphys* cf. *sulcatus*, *Adocus*, *Euclastes, Trionyx*, and ? *Dollochelys atlantica*. The Malvern turtles are preserved within a coquina lag deposit that occurs along a series of submerged, recumbent fold limbs that strike obliquely to water flow. This lag deposit also contains an abundance of other reptiles, as well as osteichthyans and chondrichthyans that co-existed with the Malvern turtles in a shallow marine shelf and patch reef environment. The Arkadelphia Formation-Midway Group assemblage extends the known geographic range of some of these taxa in North America and indicates that these marine reptiles were living at or near the time of the Cretaceous-Paleogene mass extinction in the region.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

DIVERSITY OF EUROPEAN MIDDLE AND LATE MIOCENE HOMINIDS: EVIDENCE OF IN SITU EVOLUTION OR MULTIPLE DISPERSALS?

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In Europe the Miocene was once the dominion of *Dryopithecus* alone. Currently, at least nine genera are recognized. *Anoiapithecus* and *Pierolapithecus* are known exclusively from a number of closely spaced localites at Can Mata, in the Vallès Penedès of Catalonya. *Dryopithecus* has also been identified at Can Mata. I have suggested that all European Miocene apes evolved in situ from a *Griphopithecus*-like ancestor, which dispersed into Europe about 17.5 million years ago. In contrast, other researchers have suggested that many of these taxa represent separate dispersals from Africa from the late early Miocene through to the late Miocene. *Ouranopithecus* is said to have evolved from the late Miocene African taxon *Nakalipithecus*, and dispersed separately into Europe. *Hispanopithecus*, *Pierolapithecus, Anoiapithecus* and *Dryopithecus* have been variously attributed to pongines, hominines and stem hominids. *Anoiapithecus*, *Pierolapithecus* and *Dryopithecus* from Can Mata differ dentally in canine robusticity. The face is said to distinguish all three from each other but it is fragmented in *Anoiapithecus*, highly distorted in *Pierolapithecus*, and only the palate of *Dryopithecus* is preserved. *Anoiapithecus* has a voluminous frontal sinus, probably of ethmoidal origin, while *Pierolapithecus* appears to lack one, though this remains to be confirmed by high resolution ct scaning. Details of facial and dental microanatomy in the impressive collection of Miocene apes from the Vallès Penedès presented here support the hypothesis of in situ evolution, at least for thinly enameled European apes. *Anoiapithecus* and *Pierolapithecus* share a crest along the inferior orbital margin. The region below the interorbital space is gently concave and gorilla-like in both *Pierolapithecus* and *Anoiapithecus*. In all three taxa the premaxilla is stepped with a gorilla-like overlap. Unique to *Pierolapithecus, Anoiapithecus*, and *Dryopithecus* is a double P4 protocrista. In all three taxa the P3 have a mesial notch approaching the morphology of a canine groove, with an intermediate morphology in younger Can Mata specimens relative to *Hispanopithecus*. M3 have strongly developed preprotocones and M2 have long, distinct preprotocrista. *Hispanopithecus crusafonti* is intermediate in most aspects of dental morphology between pre-Vallesian dryopiths and *Hispanopithecus laietanus*. Overall, the morphology of the dentition of Vallès Penedès apes strongly suggests that they evolved in situ from a single African ancestor.

Preparators' Symposium (Saturday, November 8, 2014, 1:45 PM)

TEACHING FOSSIL PREPARATION WITHOUT FOSSILS

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The process of training a new fossil preparator involves an inherent risk of damage to a number of valuable fossil specimens as students learn the new preparation techniques. When large breaks occur, they can be repaired and used as a teaching moment during the training process. However, surficial damage to the fossil due to poor techniques is a different type of damage not easily repaired. If only there was a way to train new preparators in the proper techniques without damage to fossils. I wanted to find an alternative training program—one that would work without damage to any fossil materials, provide a realistic preparation experience, is easily evaluated by both the trainer and trainee, and is made of common items that are available to any institution.

My first attempt was done using blocks of wood embedded in Plaster of Paris. The blocks were then mechanically prepared with a pin vise to see how well the removal of wood from plaster approximated the removal of fossils from matrix. I used three different types of wood; pine, medium density fiberboard, and plywood.

All iterations yielded useable results, in that the plaster separated from the wood similar to fossils from any very fine grained matrix (e.g. Niobrara Formation). The plaster is an excellent synthetic chalky matrix. The different wood samples were not as promising. Preparation damage was easily identified on the pine blocks, but was harder to identify on the engineered wood blocks. As the wood is not as brittle as a fossil, it bent, whereas a fossil would break. A more accurate fossil substitute is needed to better approximate the experience of preparing fossil material.

My second attempt will be completed using fragments of a more fragile material: terracotta. I will again use Plaster of Paris for the matrix as it made a realistic substitute.

It is possible to teach fossil preparation techniques without damaging fossils. Training can be completed using common materials to produce adequate analogs. This research is the first in a series of projects to train future preparators using these techniques.

Symposium 4 (Friday, November 7, 2014, 8:45 AM)

ARE TEMNOSPONDYLS MORE ENDEMIC THAN AMNIOTES IN GONDWANA DURING THE PERMIAN AND TRIASSIC?

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Being anamniotes, temnospondyls rely heavily on water for reproduction, which could make them more susceptible to allopatric speciation than amniotes. As a result, temnospondyls might be predicted to display higher levels of endemism than amniotes over evolutionary timescales. Previous work has shown an increase in average endemism for tetrapods across the Permo-Triassic mass extinction, but it is uncertain how this increase was parsed between temnospondyls and amniotes. Recent fieldwork has yielded endemic temnospondyls spanning the late Permian through Middle Triassic (e.g., *Arachana, Kryostega, Nigerpeton, Uruyiella)*, suggesting stasis in endemism. We compiled biogeographic occurrence data for Gondwanan tetrapods from three time intervals, the late Permian (Wuchiapingian), Early Triassic, and Middle Triassic, and then used these data to assess variation in levels of endemism between temnospondyls and amniotes.

We created a presence-absence matrix of all valid species from 14 Gondwanan formations to assess large-scale patterns of biogeographic structure. We calculated mean values of endemicity (i.e., the number of endemic taxa over the total number of taxa) for the tetrapod clades Temnospondyli, Synapsida, and Sauropsida from the Early Triassic, and repeated this calculation for previously published data sets from the late Permian and Middle Triassic. We assessed the significance of these values by using a chi-squared statistical test of homogeneity. Our results indicate that Gondwanan temnospondyls of the late Permian and Early Triassic were highly endemic when compared to the contemporaneous synapsids or sauropsids. Moreover, synapsids and sauropsids show no change in average endemicity across the end Permian mass extinction, and continue so until an increase in the Middle Triassic. We note that all Gondwanan temnospondyls were endemic to their individual basins throughout the time interval studied, with the exceptions of four genera: *Rhinesuchus, Lydekkerina, Parotosuchus* and *Eryosuchus*. We also note that temnospondyls display a static, albeit high, levels of endemism during the shift from cool and seasonally wet-dry in the late Permian to a drier and warmer climate in the Early Triassic, contrary to what we expected. This research is supported by the National Science Foundation PLR-0838762, PLR-1146399, and EAR-1337569.

Technical Session II (Wednesday, November 5, 2014, 9:15 AM)

EXTRATROPICAL PEAKS IN CRETACEOUS TERRESTRIAL VERTEBRATE DIVERSITY: THE INFLUENCE OF PRIMARY PRODUCERS ON VERTEBRATE SPECIES DISTRIBUTION

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A poleward decline in species richness, the Latitudinal Biodiversity Gradient (LBG), is well documented in the modern world, but poorly understood. This pattern has been attributed to temperature, seasonality, the geographic extent of landmasses, and other causes. Previous studies have shown that the modern-type LBG is not a consistent pattern through time, with paleotemperate peaks (or shallower diversity gradients) prevalent in greenhouse worlds. Examining how LBGs change and develop through a variety of environmental conditions is necessary to better understand the drivers of the modern day pattern. The Cretaceous represents a period of global greenhouse conditions with a relatively well-constrained global climate history. As such it provides an important counterpoint to the modern LBG, and allows examination of the effects of climate change. Here, we examine the evolution and causes of the Cretaceous LBG in terrestrial vertebrates, expanding on a previous study of Mesozoic dinosaurs.

For this study, we employed the most comprehensive dataset of Cretaceous terrestrial vertebrate fossils with more than 17,000 generically determinate fossil occurrences, representing ~2500 species. Estimates of latitudinal diversity were calculated at 10º intervals using raw species counts, Shareholder Quorum subsampling, and residuals calculated using a rock record modelling approach. Generalized least-squared regression was used to examine the fit of variables representing the latitudinal distribution of fossil sampling, non-marine land area, temperature, and other variables.

Species diversity shows a palaeotemperate peak at 45º in the northern hemisphere across the entire dataset, and in all taxonomic, physiological, and temporal subsets. This peak becomes more prominent throughout the Cretaceous. Sampling-corrected diversity curves also recover this peak and support a similar peak in the southern hemisphere, along with a much smaller equatorial spike. Multivariate modelling supports plant diversity, with an Akaike (AICc) weight of 0.70, is a better explanation of subsampled vertebrate diversity than any other explanatory variable or combination of variables. Plant diversity is best explained by a combination of non-marine area and sampling (AICc weight = 0.61). These results suggest that latitudinal climatic distribution did not directly cause the Cretaceous extratropical peak in terrestrial vertebrate diversity, but that primary producers controlled terrestrial vertebrate distributions.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

HISTOLOGICAL CHARACTERIZATION OF OSTEODERMS OF TARDIGRADA (MAMMALIA, XENARTHRA) FROM PLEISTOCENE DEPOSITS OF BRAZIL.

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Like cingulates, members of the family Mylodontidae (ground sloths) also have osteoderms in their skin that are found in Brazilian Pleistocene deposits. The use of histological techniques in cingulate osteoderms has grown; however, the use of this method is still scarce in Mylodontidae. In this work, five Brazilians Mylodontidae osteoderms were analyzed in order to characterize their microstructure: two of *Mylodonopsis ibseni* and one of *Valgipes* sp., *Ocnotherium giganteum* and *Glossotherium* sp. For the analysis of bone microstructure, the osteoderms were impregnated with resin and cut for observation in petrographic microscope. The sections of *M. ibseni* revealed compact bone tissue at the cortex with some growth lines and many bundles of mineralized fibers, most of them perpendicular to the surface. At the core, there is some trabecular bone with bone remodeling and several osteons, with osteocyte lacunae between lamellae. *Valgipes* sp. shows only compact bone, with large mineral impregnation. There are some Sharpey's fibers and some random bundles of fibers. The core contains a large number of osteons, with thick layers of lamellar bone. Many osteocytes lacunae are visible in these lamellae and in the cortex. *O. giganteum* is composed of compact bone with bundles of fibers randomly dispersed within the osteoderm. Some fibers are close to the cortex, parallel to the surface, and there are also some Sharpey's fibers. In the core, some osteons are visible, and also Harver's canals. Osteocyte lacunae are present all over the osteoderm. *Glossotherium* sp. is also composed only on compact bone and has some small fiber bundles throughout the osteoderm, mainly in the cortex. Some spaced Sharpey's fibers can be observed. It contains several osteons, mostly near the cortex. Only a few osteocyte lacunae were identified. Comparing this one with *G. chapadmalense*, already described in the literature, the microstructure is very similar, except for the absence of growth lines in *Glossotherium* sp. *M. ibseni* differs from the others mainly for the presence of some trabecular bone in the core. The presence of Sharpey's fibers indicates development of fixation mechanisms of the osteoderms, like in Cingulata, although the typical diploe-like structure of this group is not observed. The specimens can be distinguished mainly by the quantity of Sharpey's fibers and degree of vascularization. This work contributes to the knowledge of the microstructure of osteoderms Mylodontidae that while frequent in the fossil record, are poorly explored. [Funded by FAPERJ, CNPq].

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

METATARSAL IMPRESSIONS IN MODERN RATITES: GAIT, BEHAVIOUR AND POSTURE INFLUENCES

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The study of footprints and trackways, modern and fossil, allows insights into several aspects of the trackmaker"s locomotion, ecology and behaviour. Track morphology is determined by the complex interaction between the sediment and the trackmaker, and in the case of fossil prints lithification and weathering processes. Also, the behaviour of the trackmaker has a profound influence on the resulting track. Partial metatarsal impressions, for example, are quite common in dinosaur tracks and often a purely sedimentological cause (very soft sediment) has been inferred. However, things may not be so simple.

Direct observation of modern ostriches highlights a strong behavioral component in the formation of metatarsal impressions. Experiments were made with juvenile and adult ostriches walking on the same sediment, a fine silty sand. The substrate was raked and part of the area was pressed in order to create a different substrate response to loading for the adult ostrich. The animals were left free to walk in the yard and then allowed to exit from it. Via 3D photogrammetric modelling and the subsequent elaboration of contour lines and depth maps of the surfaces helped identification of metatarsal prints.

Despite walking on looser substrate, the juvenile ostrich tracks never show metatarsal impressions, even in the deepest tracks. In contrast, in the adult metatarsal impressions are randomly present among the footprints, without any clear relationship with the gait or the compactness of the substrate. Such impressions, in fact, occur both in deeper (comparable to the juvenile ones) and shallower tracks, on left and right pes, on loose or compacted substrate, both when standing and walking. Even within one trackway some tracks show metatarsal impressions, while others do not.

These preliminary results show clearly that the behavior of the trackmaker has a profound impact. This aspect is, of course, not only related to the metatarsal impressions but can potentially affect any morphological feature of a trace, e.g. the absence or occurrence of digits, digital angle variations, or width of a trackway. Further investigations are being carried out with other ratites to strengthen the case study and sort out a closer relation between behavior and trace formation.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

BONES IN A HOLE: A NEW LATE TRIASSIC REPTILIAN FISSURE ASSEMBLAGE FROM A BOREHOLE IN SOUTH WALES, UK.

BENITO MORENO, Juan, University of Barcelona, Barcelona, Spain; EVANS, Susan, Univ College London, London, United Kingdom

The Bristol Channel area, UK, is characterized by the presence of important Late Triassic and Early Jurassic microvertebrate sites, where commercial quarrying of the Carboniferous Limestone platform revealed fissures containing an abundant array of mainly disarticulated bones. At the time of deposition, the Carboniferous Limestone formed a series of small islands which were gradually submerged by a marine incursion. In Glamorgan, South Wales, two main islands have been recognised: Cowbridge which yields a Late Triassic assemblage dominated by rhynchocephalians, archosaurs, and procolophonids, and St. Brides, where the fissures yield a Lower Jurassic assemblage composed primarily of mammals and rhynchocephalians. The topography of the area to the south has remained uncertain and is blank on most paleobiogeographic maps.

In 1955, the British Geological Survey drilled a series of boreholes in the vicinity of Aberthaw on the South Wales coast, during survey work for a nuclear power station. At a depth of 213 m, one of these boreholes passed through a fossiliferous fissure infill within the Carboniferous Limestone. The relevant bore section was passed to University College London.

Examination of the block has revealed two distinct types of jaws and dentition, as well as other skeletal elements, including osteoderms. The most complete jaw is a rhynchocephalian dentary resembling that of 'basal' taxa like the Late Triassic *Diphydontosaurus* and *Planocephalosaurus* (UK), and *Whitakersaurus* (US). Several cranial bones, for example squamosals, may belong to this taxon. The second set of jaws is more enigmatic but seems attributable to a procolophonid. It includes maxillae, and a dentary bearing three conical anterior teeth and five rather rectangular posterior teeth that are labio-lingually compressed with a shallow lingual concavity. Closely similar dentaries are known from Ruthin, one of the quarries on Cowbridge island, roughly 10 km to the north. This suggests the Aberthaw assemblage may be of similar age to that of Ruthin, and provides the first evidence of a more southerly upland in the Late Triassic. Whether this was connected to, or separate from, Cowbridge Island remains unknown.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

NEW SMALLEST SPECIMEN OF THE PTEROSAUR *PTERANODON* AND MULTI-NICHE ONTOGENY IN PTEROSAURS

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An earlier study of all available specimens of the pterosaur *Pteranodon* from the Smoky Hill Chalk Member of the Niobrara Formation found a bimodal size distribution. The small size class with estimated wingspans in life of ~3.1-4.8 m was twice as abundant as the large, with wingspans of ~4.8-6.7 m, and immature specimens formed ~15% of each class suggesting that they cannot be age classes. The bimodal distribution was interpreted as evidence of sexual dimorphism and the absence of specimens smaller than ~3 m wingspan was interpreted as evidence of bird-like parental care during rapid growth to adult size before flying and feeding independently.

A new immature specimen of *Pteranodon* with an estimated wingspan of only 1.76 m demonstrates that juveniles were capable of flying and feeding independently, contradicting the interpretation of parental care during rapid growth. Instead *Pteranodon* apparently was precocial, flying and feeding independently during several years of growth to adult size as previously observed in *Rhamphorhynchus*, *Pterodactylus*, and *Pterodaustro*. Therefore, the absence of *Pteranodon* juveniles and a similar absence of *Nyctosaurus* juveniles from the Smoky Hill Chalk indicates those taxa had multi-niche ontogenies, occupying distinct niches in different locations and environments at different stages of their life history. Thus, the Smoky Hill Chalk represents a pelagic feeding environment of *Pteranodon* and *Nyctosaurus* adults whereas hatchlings and juveniles presumably fed on smaller prey in lacustrine, riverine, estuarine, or coastal environments.

The pterosaur records of most other Lagerstätten are consistent with multi-niche ontogeny being the norm in pterosaurs. For example, the record of *Azhdarcho* in the Bissekty Formation consists of hatchlings and adults and represents a breeding ground, that of the Solnhofen Limestone consists primarily of hatchlings and juveniles and represents a nursery environment of juveniles in sheltered lagoons near breeding grounds whereas those of the Romualdo and Cambridge Greensand Formations consist of adults and represent coastal feeding environments of adults. One exception seems to be the record of *Pterodaustro* in the Lagarcito Formation, which consists of eggs, hatchlings, juveniles, and adults in a single location and environment; however, that may reflect a special environment required to effectively utilize the filter-feeding specializations of the taxon.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

DINOSAUR BODY SIZE MAXIMA DRIVEN BY GLOBAL TEMPERATURE

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Interactions between organismal evolution and physical climatic variation have been extensively studied in the Cenozoic fossil record, which is composed primarily of extant clades with well-constrained physiologies. These studies suggest, for example, that maximum body sizes within large-bodied mammalian orders were greatest during global cooling events, concordant with latitudinal body size patterns of living endotherms. However, the effect of climate change on evolution in extinct groups, with potentially non-uniformitarian physiology and biology, has received less attention. To estimate the relationship between maximum body size and global climate in dinosaurs, we used a comprehensive dataset of dinosaurian body masses estimated using the robust scaling relationship of tetrapod body mass with femoral and humeral shaft circumferences. For this study, we expanded on our published dataset, which included circa 600 masses, using phylogenetic generalised least squares models to estimate body mass in more fragmentary taxa. During an initial expansion phase beginning in the Triassic, maximum body masses increased from plesiomorphic values of 10-50 kg to apparent quasi-equlibrium masses in the Late Jurassic. These exceeded 50 tonnes in sauropodomorphs, five tonnes in stegosaurian ornithischians, and three tonnes in allosauroid theropods. Subsequently, ornithischians attained their body size maximum around 15 tonnes during globally cool intervals in the Early Cretaceous, and again in the Campanian-Maastrichtian. In contrast, sauropodomorphs attained their body size maximum, exceeding 50 tonnes, during globally warm intervals, in the Late Jurassic and early Late Cretaceous. Theropod maximum body size apparently increased gradually from the Late Jurassic to a maximum exceeding seven tonnes in the latest Cretaceous *Tyrannosaurus rex*. The positive association of body mass and temperature seen in sauropodomorphs is distinct from the negative association seen in ornithischians and modern endotherms. However, it resembles patterns in modern ectotherms, which might be larger at warmer latitudes. Our results indicate distinct evolutionary responses to climate change among major groups of dinosaurs, and suggests that sauropodomorph physiology was distinct from that of ornithischians, and also from that of mammals.

Symposium 1 (Wednesday, November 5, 2014, 11:30 AM)

KEY CHARACTERS AND EVOLUTIONARY RATES IN THE ORIGIN OF BIRDS

BENTON, Michael, Univ of Bristol, Bristol, United Kingdom; PUTTICK, Mark, Univ of Bristol, Bristol, United Kingdom; PRIETO MARQUEZ, Albert, Univ of Bristol, Bristol, United Kingdom; HONE, David, Univ of Bristol, Bristol, United Kingdom

Discovery of new bird and theropod fossils has shown that the list of some thirty characters formerly identified as unique to *Archaeopteryx* and birds now spread back down the phylogenetic tree to the root of Theropoda. Comparative phylogenetic analyses of character evolution across the theropod tree show how these avian characters emerged, and their relative evolutionary significance. For example, the earlier discovery that one key avian character - reduction in body size - occurred at the root of Paraves is confirmed, and this miniaturization event was associated with elongation of the forelimb. Comparative analysis shows that both features stand out as unusual character shifts, indicated by a remarkable increase in evolutionary rate at the point of origin of Paraves. This marked a time of experimentation with various flight modes within several paravian lineages. It is well known that other avian characteristics such as the furcula, feathers, semilunate carpal, hind limb posture and center of mass, and enlargement of orbits and optic regions of the brain also occurred before the divergence of *Archaeopteryx* and other birds. Continuing through the Mesozoic, further avian characters are also assessed for their importance, such as the loss of the bony tail in Pygostylia, and further modifications to the limbs associated with flight at higher points in the cladogram. The array of new numerical comparative phylogenetic approaches allows these anatomical novelties to be assessed in sequence across the phylogeny of Theropoda to determine which were associated with pulses of rapid evolution (diversification shifts), and which are associated with models of directional or driven evolution (e.g. Trend and Ornstein-Uhlenbeck models). Such approaches provide a means of testing functional-evolutionary hypotheses.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

THE MICROSTRUCTURE OF THE OSTEODERMS OF THE OLDEST CINGULATE, *RIOSTEGOTHERIUM YANEI*, FROM THE ITABORAÍ BASIN, BRAZIL (LATE PALEOCENE)

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Riostegotherium yanei, the oldest xenarthran, was recovered from the late Paleocene Itaboraí basin of Rio de Janeiro, Brazil. The species was based on isolated movable and buckler osteoderms, but some postcranial bones later assigned to the group revealed the presence of two cingulate species in the basin. The goal of this work is to characterize the microstructure of osteoderms of *R. yanei* employing two different methods: histology and X-ray micro-CT (employed here for the first time to cingulate osteoderms). Three movable and one buckler osteoderms were analyzed. Due to its rareness, only two movable osteoderms were cut for histological observation, but all were analyzed under Skyscan 1173 Micro-CT. The average maximum length of movable specimens is 11.3 mm and the length of the buckler one is 12.7 mm. The base of the movable osteoderms comprises about 1/3 of the total length. Two specimens present a smooth surface due to taphonomic alteration while the other two present a very rough surface. Histological analyses of both osteoderms revealed a similar structure, consisting of the typical diploe-like structure of cingulates, with the three layers of approximately equal thickness. The superficial and deep compact layers are composed of disorganized woven bone matrix, enclosing a core of poorly developed cancellous bone with few osteons, mostly secondary. The fiber bundles of the core are parallel, transversely oriented to the main axis, and curved anteriorly at the posterior 1/3 of the osteoderm. In the remaining 2/3, the fibers are oriented randomly. Reconstructed Micro-CT images showed a fine resolution of distribution, extension, direction, and size of internal cavities. The frontal plane of UFRJ-DG 317M exposed a dense pack of interconnected large and rounded cavities filling about 80% of its base, while the tongue is mainly formed by compact bone with scattered small cavities (possibly primary osteons or neurovascular channels). This pattern is similar to that observed in *Dasypus* species. The other three specimens, including the buckler osteoderm, present a net of imbricated cavities of approximately the same size scattered all over the osteoderms, the majority possibly corresponding to secondary osteons. This analysis showed that the diploe-like structure of cingulates has been conserved since the earliest form and the frontal view provided by Micro-CT unveiled two different patterns of internal organization that can be of taxonomic significance or indicate different positions in the carapace. Financial Support: CNPq, FAPERJ and CAPES

Symposium 5 (Saturday, November 8, 2014, 2:00 PM)

DIACHRONOUS EVOLUTION OF MOLAR CROWN HEIGHT IN OLD WORLD *HIPPARION* LINEAGES UNDER CLIMATE CHANGE

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North American *Cormohipparion* extended its range into the Old World 11.5 Ma. *Hipparion* first appearances are locally recorded at 11.5 Ma in Central Europe, 10.7 Ma in the Siwalik and Turkey, and 10.5 Ma in North and East Africa. *Hippotherium* is the earliest definable lineage and evolved very slowly in Central Europe and the eastern Mediterranean. On the contrary, Sinap Turkey records a "punctuated" evolutionary burst at 9.9 Ma. including 4-5 species of undefined, perhaps monospecific lineages. *Sivalhippus* evolved in the Siwalik Hills beginning at 10.3 Ma, underwent a local evolutionary radiation that included 4 defined species, and extended its range into East Africa in the late Miocene. Other major multispecific lineages include *Cremohipparion*, ranging from the eastern Mediterranean to China in the late Miocene and early Pliocene, *Eurygnathohippus,* which underwent a late Miocene-Pleistocene radiation in Africa, and *Plesiohipparion* and *Proboscidipparion,* which originated in China in the late Miocene-early Pliocene, ranged there into the Pleistocene and extended their range into Europe in the Pliocene. Mean recorded molar crown height showed a steadily rising trend throughout the Eurasian history of hipparionines, from a minimum of 45 mm to a maximum of 90 mm. Species with a crown height of 50 mm persisted throughout the Miocene while the maximum stayed just at or below 70 mm until less than 8 million years ago. A rapid increase of the mean value occurred in the Pliocene, driven first by the extinction of lineages with low tooth crowns and later by rapid increase in the remaining lineages. The distribution of rainfall estimates associated with hipparionine horses, derived from the mean hypsodonty of the large plant-eaters of their localities of occurrence, shows a falling mean trend from 6 Ma onwards. Values in the semidesert range of 250-500 mm/a are seen throughout history but maximum values decrease from over 1000 mm at 10 Ma to 600 mm/a by 5 Ma and 350 mm/a by 2.5 Ma. Both the history of recorded crown height and the associated rainfall estimates suggest that hipparionines occupied a wide range of habitats in the Miocene but became increasingly restricted to arid habitats and abrasive diets from the Pliocene onwards.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

A RARE EARLY OLENEKIAN (EARLIEST TRIASSIC) MARINE VERTEBRATE ASSEMBLAGE FROM THE KOCKATEA SHALE OF WESTERN AUSTRALIA.

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The Kockatea Shale is Australia′s only Triassic marine rock unit to have produced vertebrate fossils. It therefore represents a significant record of coastal faunal composition around eastern Gondwana very shortly after the P–T boundary. The Kockatea Shale was laid down in the early Olenekian within a series of rift and sag basins skirting the northwestern margin of the Australian Triassic landmass between the Timor orogen and Perth Basin. Scant skeletal fragments of vertebrates have been reported from these strata before, and include actinopteryigian fish debris together with an incomplete rhytidostean temnospondyl skull extracted from a drill core. More recent surveys of Kockatea Shale surface exposures near Geraldton in Western Australia have subsequently focused upon collecting a broader range of material. The recovered remains are prolific yet mainly incorporate isolated bones, scales and teeth. Actinopterygian fishes are most common and comprise both dentigerous elements and thick rhombic scales with peg and socket articulations indicative of palaeonisciforms. Coelacanthid sarcopterygians are likewise evidenced by scales with a broad oval outline and exposed field of elongate ridges covering about one third of the total scale length; superimposed fibrous layers are also oriented in juxtaposition. Tetrapod fossils are limited to a tiny mandible with "temnospondyl-like″ bone surface ornamentation, a short postgenoid region, and well developed dentary sulcus that underlies a single row of unusually elongate teeth. The precise affinities of this specimen are unclear but its size is reminiscent of diminutive Early Triassic rhytidosteans and lapillopsids. Broader compositional comparisons of the Kockatea Shale biota suggest a mixed marine-terrestrial assemblage that occupied a shallow marginal marine palaeoenvironment. The predominance of palaeonisciforms and rare rhytidosteans, which are known from brackish deposits, further accords with such a setting. Finally, the recognition of coelacanthiforms constitutes the first identification of this clade from the Triassic of Australia, and affords palaeobiogeographical compatibility with Early Triassic marine faunas found elsewhere around the globe.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

THE NEARLY COMPLETE SKELETON OF THE HADROSAUR *GRYPOSAURUS NOTABILIS* AT THE MUSEO DI STORIA NATURALE DI MILANO: REDESCRIPTION AND NEW INVESTIGATIONS IN THE CENTENNIAL OF THE SPECIES

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The specimen MSNM V345, a nearly complete skeleton of *Gryposaurus notabilis* from the Dinosaur Park Formation, Alberta, Canada, arrived at the Museo di Storia Naturale di Milano (MSNM) in 1958, after an exchange of paleontological specimens with the Field Museum of Chicago. A preliminary study of the fossil was conducted while part of it was still under preparation. This was later followed by a better, although not complete, osteological description. On the occasion of the centennial of the discovery of the first *Gryposaurus notabilis* by Lambe, we decided to re-study in detail the MSNM specimen.

The whole history of this specimen is reviewed, from the 1922 excavation led by George Sternberg, to the diorama on display in the museum nowadays. A complete osteological redescription is provided, focusing on still unpublished elements, such as metapodials, phalanges, sacral vertebrae, and some caudal vertebrae relocated in the MSNM collection. Some pathological bones are described and analyzed, including the fifth dorsal vertebra extensively fused to the left rib, and the fractured and healed neural spine of a caudal vertebra. The centrum of this vertebra shows also a strap of bone growing along the side of the preceding centrum, a non-pathological condition that falls within the cases of diffuse idiopathic skeletal hyperostosis (DISH). A histological analysis, aimed to define the ontogenetic stage of the individual, is based on two samples taken from a proximal pedal phalanx and a femur applying the histological coring method. The results show a high amount of Haversian systems and a decrease in spacing between the lines of arrested growth (LAGs) towards the surface of the bone, indicating a mature individual. The comparison between the MSNM specimen and the other *Gryposaurus* fossils improves our knowledge of intra- and interspecific variation, contributing to the taxonomic debate.

Technical Session VI (Thursday, November 6, 2014, 9:15 AM)

VIRTUAL ENDOCAST OF *PARAMYS DELICATUS* (RODENTIA, ISCHYROMYIDAE) AND BRAIN EVOLUTION IN EARLY RODENTS

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Understanding the evolution of the brain in early rodents is central to reconstructing the ancestral condition of the brain for Glires, and for other members of Euarchontoglires including Primates. Ischyromyidae has been recognized as one of the oldest and most primitive rodent families. The ischyromyid *Paramys delicatus* from the Bridgerian (middle Eocene) of North America is represented by large amounts of cranial and postcranial material, which can help to accurately reconstruct its ecological habits. Those inferences can then be related to the form of the brain.

The body mass of *P. delicatus* is 2.9 kg using skull length. The virtual endocast volume is 9.4 cm^3 and the encephalization quotient (EQ) using Jerison's equation is 0.37. The Oligocene rodent *Ischyromys typus* had an EQ of 0.38, while modern squirrels' EQs can be above 1.0. Generally, extant rodents have larger brains relative to their body mass compared to extinct taxa, consistent with the observation in other mammalian lineages that EQ generally increases through time.

Concerning the external morphology of the virtual endocast, the caudal colliculi are visible in *P. delicatus*. This feature has often been inferred to be primitive for mammals, and this observation suggests it was primitive for rodents as well. Furthermore, the orbitotemporal canal (and so presumably the rhinal fissure) in early rodents is positioned more dorsally than in modern rodents, supporting the inference that the neocortex also increased in size in rodent evolution. This observation implies that changes in fundamental organization accompanied changes in size through time.

However, the similarity in the EQ of the Eocene *P. delicatus* and Oligocene *I. typus* imply that factors other than time must also be responsible for changes in EQ. Extant arboreal rodents have higher EQ on average compared to terrestrial species. *Paramys delicatus* has been inferred to be scansorial and *I. typus* to be completely terrestrial, which may help to account for the higher than expected value in the Eocene form. Interestingly, however, the olfactory bulbs are larger in *P. delicatus* (6.42% of total endocast volume) compared to *I. typus* (3.12%). This result is unexpected, as larger olfactory bulbs are usually found in terrestrial species. Consequently, having large olfactory bulbs might be a primitive feature retained in *P. delicatus*.

The virtual endocast of *P. delicatus* sheds light on the evolution of early rodents and shows that diversity in brain anatomy already existed in the early radiation of the group.

Education and Outreach Poster Session (Poster displayed November 5 – 8)

THE ROLE OF MUSEUMS IN (RE)TELLING THE TALE OF THE DODO

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The Dodo (*Raphus cucullatus*) has become one of the most famous birds in the world, as a symbol of evolution and extinction. Although endemic to the small island of Mauritius and despite limited and often contradictory accounts and evidence, after its discovery, the Dodo quickly became the subject of scientific and ornithological enthusiasm. While the Dodo obtained a near-mythical status in the 18th century, the scientific interest in procuring Dodo specimens intensified after the publication of a monographic description. This interest culminated in the discovery of the first fossil material in 1865 at the Mare aux Songes, a marshy area in the southeastern part of the island. European museums played a major role in raising scientific and public interest by presenting the fossil specimens found during the 1865 excavations. But even today, museums have a responsibility in giving opportunities for visitors to obtain science-based experiences and gain educational insights.

In 2005 a joint Mauritian and European research team, the Dodo Research Programme (DRP), re-discovered the Mare aux Songes dodo mass grave, where an intact layer of bones and botanical remains was found. The DRP provided science-based content for an up-to-date exhibition in the Natural History Museum at Port Louis: the Dodo Gallery. This gallery will be part of the future 'Dodo Trail', which leads from the Natural History Museum to the place where the Dutch first landed in 1598, the first settlement on Mauritius VOC fortress Fort Hendrik, and to a to-be-built Dodo Museum and Eco Theme Park on the grounds of the Mare aux Songes.

This primary aim of this museum is to depict the lost world of the dodo and let visitors experience the pristine Mauritian ecosystem before the arrival of humans, using data gathered from Mare aux Songes. Visitors will be able to walk the actual grounds of the dodo mass grave, and see the bones that have been found during the excavations. Scientific content will be presented in a dynamic way, using a genuine museographical language based upon real objects. The realization of this Dodo Museum will help the inhabitants of Mauritius to fully appreciate the richness of their heritage, but also cater to the 1 million tourists that visit Mauritius each year. Moreover, it's a unique opportunity to give visitors a sense of the vulnerability and resilience of an insular ecosystem.

Technical Sesssion XII (Friday, November 7, 2014, 3:15 PM)

FOSSIL EVIDENCE FOR A DIAPSID ORIGIN OF THE ANAPSID TURTLE SKULL

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The reptile skull is an increasingly utilized model for understanding the evolution and development of vertebrate adaptation. Turtles are an important yet enigmatic piece of this puzzle. The earliest uncontroversial stem turtles exhibit a fully anapsid skull with an adductor chamber concealed by bone. If this lack of fenestration reflects conservation of the ancestral condition, then turtles are an extant remnant of an early reptile radiation that excludes the other living forms. If turtles are nested within crown Diapsida, then their anapsid skull is a secondary configuration built on a diapsid structural plan. No direct paleontological evidence yet exists for this reversal, a situation that epitomizes a general lack of consilience between the fossil record and the molecular signature of living taxa and one that obfuscates attempts to synthesize broad evolutionary patterns across Reptilia.

Eunotosaurus africanus is a 260 Ma fossil reptile whose status as an early stem turtle continues to be strengthened by new cranial and postcranial synapomorphies. Here we use computed tomography (CT) to study the temporal region of *Eunotosaurus* and to formulate a model for the origin of the anapsid and diapsid skulls of modern amniotes. Expression of a lower temporal fenestra (LTF) supports the hypothesis that the closed cheek of modern turtles is secondary. The ventrally unbounded nature of the LTF places *Eunotosaurus* at odds with parareptiles, but also with pandiapsids where an unbounded LTF is known only in conjunction with the more conservative upper temporal fenestra (UTF). The region housing the diapsid UTF is overlain by an elongate supratemporal in *Eunotosaurus*. In contrast to the plesiomorphic condition, digitally removing the supratemporal reveals a moderate-sized opening circumscribed by the same elements that define the UTF. Additional evidence that this covering is secondary is drawn from the observation that in *Eunotosaurus* the supratemporal overlaps the postorbital, whereas plesiomorphically these two elements are abutting or the postorbital overlaps the supratemporal. We propose *Eunotosaurus* captures an early step in the evolution of the anapsid turtle skull in which the UTF was secondarily covered by the supratemporal before being obliterated through expansion of neighboring dermal elements. The recognition of such a critical transitional form facilitates the articulation of meaningful transformational and functional models that can be tested with future paleontological discoveries and rapidly emerging developmental data.

Symposium 1 (Wednesday, November 5, 2014, 11:15 AM)

A SIMPLE MOLECULAR MECHANISM FOR THE ORIGIN OF THE AVIAN ROSTRAL AND PALATAL SKELETON

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Key evolutionary innovations are distinctive novel traits that permit accelerated speciation and radiation into a range of new ecological niches, and a full understanding of their origins must incorporate both the nature of morphological transformation at their appearance and the mechanism of their developmental construction. The reconfiguration of the facial skeleton that contributes to the bird beak is among the most recognizable such innovations, but little has been done to trace its evolutionary and developmental origins. We used fossil data to show the morphological distinctiveness of the bird rostrum as fused, elongate premaxillae, examined cases of convergence in bird relatives, and exploited this insight to guide an investigation of molecular development. Our gene expression data indicated that the bird facial skeleton is associated with a uniquely avian (among extant amniotes) median signaling zone involving several signaling molecules in the early embryonic face. Restoration of the ancestral signaling pattern in birds generated a facial skeletal phenotype quantitatively resembling ancestral fossil forms in both the snout and the palate. Indeed, the range of phenotypes for both the premaxilla and the palatine may well predict the morphology in unknown or incompletely known fossil forms along the avian stem. Thus we have deployed a research program in which morphometric analysis of the fossil details the origin of an essential morphological innovation, its precise developmental mechanism is revealed by comparative embryology, and this mechanism is directly tested and validated using functional experiments. We concluded that a simple regulatory molecular adjustment produced multiple bird-specific skeletal alterations of the reptilian snout that allowed the beak to diversify as an independent module.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

PALEOECOLOGY OF LATE MIOCENE HORSES FROM MARAGHEH LAGERSTATTE, EASTERN AZERBAIJAN PROVINCE, NORTHWEST IRAN: A STABLE ISOTOPE PERSPECTIVE

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The diets and environments of the fossil horses *Hipparion gettyi*, *H. matthewi*, and *H. campbelli* from the late Miocene Maragheh lagerstatte, located in the eastern Azerbaijan Province, Northwest Iran, were reconstructed based on serial carbon and oxygen isotope analyses of tooth enamel. Such paleoclimatic and paleoecological proxy records are crucial for understanding the effects of regional uplift on climate and on the evolution of mammalian species in Iran. Geologically, the fossil-bearing beds of Maragheh are flanked by Mount Sahend, a volcanic complex between 9 and 7 Ma, which has allowed acquisition of high precision single crystal argon ages for the fossil-bearing deposits. Maragheh is a late Miocene fauna of Pikermian aspect comparing closely with the two classical Turolian age faunas of Pikermi and Samos, Greece. The carbon isotopic results suggest that fossil taxa from the eastern Azerbaijan Province lived in habitats with a significant C_4 vegetation component prior to 7.89 Ma and that C_4 grasses disappeared from local ecosystems by 7.68 Ma. These data support a shift to a cooler climate and possible tectonic uplift in the region after 7.88 Ma. The oxygen isotope values reveal a decrease in seasonality after 7.97 Ma, which also indicates a regional cooling trend throughout the Miocene. Recent research on the Howard University-National Museum of Natural History, Tehran, Iran (MMTT) collection of the diverse Maragheh ungulate assemblage using the mesowear method revealed that these taxa were mostly adapted to browsing and mixed feeding consistent with a woodland habitat. Likewise, the carbon and oxygen isotope results are consistent with a woodland/grassland ecosystem.

Technical Session I (Wednesday, November 5, 2014, 9:00 AM)

PHYLOGENY OF FOSSIL AND LIVING RUMINANTS BASED ON A LARGE MATRIX OF OSTEOLOGICAL CHARACTERS

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Though ruminant artiodactyls today comprise a major component of terrestrial herbivore diversity and biomass, their phylogeny remains elusive. Resolution of relationships among living species has benefitted greatly from molecular phylogenetic work, but the lack of a comprehensive morphological matrix means large numbers of extinct fossil taxa from North America, Europe, Asia, and Africa have not been satisfactorily incorporated into a single phylogenetic framework. As a result, the timing of origination and divergence of many characteristic clades, as well as the timing and sequence of evolution of key morphological features and ecological characteristics, remain poorly resolved. We here present a large morphological matrix (> 400 osteological characters) that we developed for the incorporation of living and fossil ruminant species into a single phylogenetic framework. We scored these characters for over 20 living species and several fossil taxa, including *Archaeomeryx optatus*, *Parablastomeryx gregorii,* an Oligocene stem pecoran, and an extinct fossil wildebeest. The resulting tree is well-resolved and, despite a few differences such as a more basal position for moschids, the results mostly match those of molecular studies. The resulting tree allows, for the first time, the optimization of osteological character evolution across the ruminant clade at the species level, and the identification of morphological synapomorphies for several clades for which morphological support was previously ambiguous. The inclusion of Eocene *Archaeomeryx optatus* into the analysis suggests that tragulids might be derived postcranially and therefore may not constitute an ideal outgroup for the rest of Pecora. This reaffirms the importance of fossil taxa for accurate reconstruction of phylogeny. We also combined our morphological matrix with existing molecular sequences (mainly complete mitochondrial DNA), in a Bayesian analytical framework. This allowed for the addition of many more living species, and the final presentation of both living and fossil ruminants in a single, time-calibrated tree. This work shows that molecular and morphological approaches to ruminant phylogeny are largely in agreement, and that the incorporation of both types of data provides a richer (and probably more accurate) view of evolution than either alone.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

GIANT TUSK-TOOTH SALMON AND GALAPAGOS-SIZED TORTOISES FROM THE LATEST MIOCENE OF CENTRAL CALIFORNIA

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The late Miocene Mehrten Formation is exposed in the low foothills of the northern San Joaquin Valley of California southeast of Sacramento. The Mehrten consists of volcanic-sedimentary deposits representing lahar flows, stream, lake, and floodplain deposits. The mammals from the Mehrten are numerous and well documented, and are Hemphillian in age (North American Land Mammal Age). However, the fish and herpetofauna have been less studied, yet provide important paleoenvironmental, paleoclimatic, and paleogeographic information. We report them here. All fossils described here are from the upper-most Mehrten, the Modesto Reservoir Member (~5 Ma), are found in fluvial-floodplain deposits exposed at Turlock Lake, near Turlock, California, and are housed at the University of California Museum of Paleontology, Berkeley. Two fish species are identified: the cyprinid *Orthodon* and the salmonid *Oncorhynchus rastrosus*. *O. rastrosus* is a large (3m) tusk-toothed salmon found from the western United States, and has been interpreted to be planktivorous. It is known from California, Oregon, Idaho, and Washington, from both freshwater and marine deposits. The Turlock Lake specimens are all from one site, and total approximately 46 cranial and post-cranial elements, including 13 teeth and 13 vertebrae. The teeth from the upper jaws range in size from 1 to 3 cm long and protrude from massive osseous bases, while the centra have diameters ranging from 3 to 4 cm. The site is a fluvial deposit, thus the salmon had traveled upstream to spawn, as salmon do today. Late Miocene/Pliocene paleogeographic reconstructions for California show a marine embayment in the southern San Joaquin Valley. There are two common turtle species from the Turlock Lake sites, the pond turtle *Actinemys* cf. *A. marmorata* and the giant tortoise *Hesperotestudo* sp., of which large carapace fragments are abundant. Giant tortoises like *Hesperotestudo* generally require a higher ambient environmental temperature to maintain their body heat due to ectothermy, meaning that temperatures were likely warmer. Tortoises also tend to indicate a climate with rare frost which corresponds to paleoclimatic interpretations based on the flora, in particular frost-sensitive specimens related to the avocado. The Turlock Lake sites are the last record for *O. rastrosus* and *Hesperotestudo* sp. for this particular area. These extinctions reflect the paleoclimatic and paleogeographic changes that occurred at the Miocene-Pliocene boundary.

Technical Session XV (Saturday, November 8, 2014, 11:00 AM)

THE MORPHOLOGICAL VARIATION OF SOME SELECTED CHARACTERS OF THE BONY LABYRINTH IN PLACENTALS AND THEIR PERTINENCE FOR PHYLOGENETIC ANALYSES

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The incorporation of characters of the bony labyrinth of the inner ear into cladistic analyses of placental mammals is not very common, even in recent extensive morphological matrices. This is mostly because this anatomical region has long been unknown for many taxa. As the amount of available data is rapidly growing, more characters in this anatomic region will certainly be included into matrices in future years. Analysis of the bony labyrinth in a selected sample composed of extant and fossil placentals reveals that several characters of this structure are subject to non-negligible intraspecific variation and allometric relationships, questioning the pertinence of these characters for phylogenetic analyses.

First, the investigation of the intraspecific variation of selected characters in five extant species reveals notably that the aspect ratio of the semicircular canals has a substantial intraspecific variation—for each species, the roundest identified semicircular canal varies according to the specimen considered. On the other hand, the relative sizes of the semicircular canals are more stable in this sample and may be scored more confidently in taxa documented by just one specimen (e.g., many fossil taxa), depending at which precision the character is defined.

Second, the analysis of scaling relationships among linear measurements of the auditory region in a sample of more than 40 specimens (covering Afrotheria, Euarchontoglires, Laurasiatheria, and Xenarthra) evidences a clear negative allometry of the inner ear with the surrounding petrosal. This detected differential growth directly influences the length of the vestibular aqueduct and cochlear canaliculus. This shows that these latter aspects should better not be coded in cladistic analyses.

Therefore, these results illustrate that a better knowledge of the intraspecific variation and of the allometric processes modeling the shape of the inner ear may be of great importance for the selection of cladistic characters. There is a crucial need for more in-depth studies on these aspects in order to enable a cautious use of bony labyrinth data in future phylogenetic analyses.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A LARGE BALAENOPTERID SKELETON FROM THE EARLY PLIOCENE OF THE NORTH SEA SHEDS LIGHT ON THE AFFINITIES OF *'BALAENOPTERA' SIBBALDINA* (MAMMALIA, CETACEA, MYSTICETI)

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A large balaenopterid skeleton was found in the early Pliocene Kattendijk Sands Formation at Kallo, a few kilometers from Antwerp (Belgium). The skeleton includes most of the skull, earbones, the dentary, some vertebrae, hyoid, some carpals, scapula, humerus, radius, ulna, some chevrons, and a number of ribs. The supraoccipital is around 570 mm in length and 1070 mm in width (at the level of the posterior end of the lambdoid crest). The transverse diameter across the occipital condyles and the foramen magnum is 240 mm. The specimen is gigantic in size. The rostrum shows long ascending processes of the maxillae with have balaenopterid-like shapes. The periotic has balaenopterid-like characters in the shape of the anterior process and of the pars cochlearis. However, differing from Balaenopteridae, the supraorbital processes of the frontal are narrow. Compared to other balaenopterids, this specimen shows clear affinities with *'Balaenoptera' borealina*, a taxon based on fragmentary materials. This specimen adds new morphological information to the study of balaenopterid systematics and phylogeny. A phylogenetic analysis revealed that it was close to *'Balaenoptera' siberi* and that both were well nested within Balaenopteridae.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE EARLIEST RECORD OF THE ENDEMIC AFRICAN FROG FAMILY PTYCHADENIDAE FROM THE OLIGOCENE NSUNGWE FORMATION OF TANZANIA

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Ranoidea is a cosmopolitan radiation of frogs comprising nineteen families and more than 2400 extant species (nearly 40% of all anurans). Studies using time-calibrated molecular phylogenies suggest a Cretaceous origin for the Ranoidea, but the Mesozoic and early Cenozoic fossil record of this diverse clade remains poor. Although many fossils have been attributed to the Ranoidea, typically few diagnostic characteristics are provided to assign fossils to specific taxa within the clade. The Ranoidea is thought to have initially diversified in Africa, but the African fossil record of anurans in the Mesozoic and Paleogene is generally poor, with the Afro-Arabian record limited primarily to pipoid frogs or taxonomically enigmatic fossils. Here we report the earliest record of the endemic African ranoid frog family Ptychadenidae from the late Oligocene Nsungwe Formation in the Rukwa Rift Basin of southwestern Tanzania. Paleogene anuran fossils are typically rare, but constitute approximately 13% of materials collected from localities in the Nsungwe Formation. Radiometrically dated at ~25 Ma, the Nsungwe Formation localities preserve a diverse vertebrate fauna and a number of novel invertebrate taxa. The Nsungwe Formation anuran fossils include vertebrae preserving a unique sacral morphology that provides the earliest record of the Ptychadenidae, the earliest definitive record of any family within the diverse ranoid clade Natatanura, and the first late Oligocene record of anurans from Africa below the equator. This research was supported by National Geographic Society (CRE), LSB Leakey Foundation, Ohio University African Studies Program, Ohio University Heritage College of Osteopathic Medicine, and the National Science Foundation (EAR 0617561; EAR 0933619; BCS 1127164; EAR 1349825).

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

FIRST POSTCRANIAL REMAINS OF *ALLODAPOSUCHUS* (EUSUCHIA, CROCODYLOMORPHA): PHYLOGENETIC IMPLICATIONS

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At the end of the Cretaceous, the crocodylomorph fauna from Europe was taxonomically diverse. One of the most common but puzzling taxa is the eusuchid *Allodaposuchus*, whose remains have been recovered from several latest Cretaceous (Campanian to Maastrichtian) fossil localities of Romania, France and Spain. Although postcranial elements attributed to *Allodaposuchus* were mentioned in the initial description, currently this genus is only known from cranial elements. The recent

discovery of two new specimens attributed to *Allodaposuchus* in the Maastrichtian strata of the Southern Pyrenees (Fumanya-Sur and Casa Fabàlocalities, Catalonia, northeastern Iberian Peninsula), both represented by skull and postcranial elements, shed new light on this enigmatic European taxon. As a whole, the newly recovered material includes two partial skulls, several vertebrae, cervical and dorsal ribs, and several pelvic and appendicular elements. The characteristic osteological configuration of the post-cranial elements suggests a robust animal with massive limb bones with enlarged surface for muscles attachment, and several unique features along the vertebral column. Our phylogenetic analysis recovered all *Allodaposuchus* species as the sister-group of *Borealosuchus* and Pristichampsidae, all of them located at the base of the crocodylian linage. Such results significantly differ from previous studies placing *Allodaposuchus* as a basal eusuchian. These differences in the phylogenetic position of the studied taxa when considering only cranial or both cranial and postcranial data might be explained because 1) *Allodaposuchus* shares some cranial features with basal eusuchids such as *Hylaeochampsa* and *Goniopholis*, but 2) this taxon also shows derived postcranial features making it closer to modern crocodiles, such as *Alligator* and *Crocodylus*. If so, and according to our results, we conclude that *Allodaposuchus* exhibits a unique mosaic of features from both ancient and more derived crocodylomorphs.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

LIMB BONE CURVATURE IN GORGONOPSIAN THERAPSIDS: FUNCTIONAL SIGNIFICANCE OF SIZE-CORRELATED LIMB BONE STRAIGHTENING

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Gorgonopsians were a diverse lineage of early therapsids that were among the first to show postcranial traits indicating a shift away from the habitual use of sprawling limb posture. In contrast to the condition in sprawling, pelycosaur-grade synapsids, the femora of gorgonopsians are morphologically distinctive, exhibiting a sigmoidal (S-shaped) curvature that shows varying degrees of strength in different specimens, but is often particularly pronounced in the plane perpendicular to knee flexion and extension. Because curvature can affect the stresses that limb bones must withstand, what are the functional consequences of differing degrees of femoral curvature in this lineage? Newly recovered femora of indeterminate gorgonopsians from the Upper Madumabisa Mudstone Formation of the Luangwa Basin of Zambia provided an opportunity to examine this question. The two most complete specimens were dramatically different in length (~120 mm vs. ~350 mm), with the larger specimen showing considerably reduced sigmoid curvature. To quantify the impact of bone curvature on femoral stresses, we evaluated the curvature-induced moment arm for bending at the femoral midshaft. This measurement reflects the tendency of an axial force to cause bending in a curved beam, with larger values producing increased bone stress. We determined this moment arm as the distance between the line of action of forces acting along the long axis of the bone (from one articular surface to the other), and the midpoint along the diameter of the bone at its midshaft. We found the bending moment arm of the small specimen to be over 8% of femoral length, whereas that for the larger specimen was only 5% of femoral length (i.e., only two-thirds as large relative to body size). Moreover, comparisons to values measured from other gorgonopsid femora of intermediate size showed the moment arm value of our small specimen to be among the largest relative to femoral length, and that of our large specimen among the smallest relative to femoral length. Sigmoidal curvature thus appears to be substantially reduced in our large gorgonopsian, potentially decreasing axially-induced bending stresses by as much as one-third. Although bending from perpendicular forces, rather than axial forces, is often greater in sprawling taxa, reduction in sigmoid curvature could have decreased femoral stresses significantly if larger species used more upright posture that oriented loads more closely with the femoral long axis. Supported by NSF EAR-1337569.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

OLDEST NORTH AMERICAN RECORD OF THE GIANT FLIGHTLESS BIRD *DIATRYMA* (*GASTORNIS*) FROM THE PALEOCENE-EOCENE THERMAL MAXIMUM

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The fossil record of large flightless birds classified in Gastornithidae includes *Gastornis* from the Paleocene and Eocene of Europe, *Zhongyuanus* from the early Eocene of Asia, and *Diatryma* from the early Eocene of North America, with both *Zhongyuanus* and *Diatryma* being possible junior synonyms of *Gastornis*. Though this record is consistent with a European origin for the clade, with later Eocene dispersals into North America and Asia, the timing of these intercontinental dispersals is not well resolved. Here we document the presence of a partial tibiotarsus (distal width: ~90 mm) and several phalanges, similar in size and morphology to those previously described for *Diatryma*, from three localities within the Paleocene-Eocene Thermal Maximum (PETM; ~56 Ma) in the Cabin Fork area of the southern Bighorn Basin, Wyoming. Sampled from a high-resolution stratigraphic section, carbon and oxygen isotopes in tooth enamel, carbon isotopes in bulk organics and n-alkanes, and fossil leaf climate proxies document a prominent negative carbon isotope excursion and associated shifts towards warmer and drier climate at the onset of the PETM, a sustained warm and seasonally dry interval during the body of the PETM, followed by a shift back to cooler and wetter conditions during the recovery. About 40% of mammal lineages exhibit smaller body size in the body of the PETM when climate was warmest, and subsequently increase in size in the recovery phase. A major faunal reorganization occurs during the PETM as many species of terrestrial plants, turtles, and mammals make their first appearance in North America. Immigrants from Europe and/or Asia comprise ~20% of the total North American PETM mammalian fauna, with the most notable taxa including the first perissodactyls (1 species), artiodactyls (1 species), and euprimates (2 spp), as well as 'miacid' carnivoramorphans (4 spp), hyaenodontid creodonts (4 spp), and amphilemurid insectivores (1 species). All of the *Diatryma* fossils were collected from within the recovery phase of the PETM, when the climate became cooler and wetter, and some mammals became larger. The occurrence of *Diatryma* in the recovery phase suggests that it dispersed into North America during the PETM when climate was warm at high northerly latitudes, and moved southward with cooling. A similar pattern has been documented for two plant species that have a Paleocene record in Western Europe, are thought to have dispersed to North America across Arctic land bridges during the body of the PETM, and then moved to mid-latitudes during the recovery.

Technical Session XI (Friday, November 7, 2014, 2:15 PM)

HABITAT TRACKERS, NICHE ENGINEERS OR FLEXIBLE ALL-DOERS? ISOTOPIC INSIGHT (C, N) ON THE PALAEOECOLOGY OF THE LATEST PLEISTOCENE AND HOLOCENE WOOLLY MAMMOTHS *MAMMUTHUS PRIMIGENIUS*

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From 15,000 to 4,000 BP, the distribution range of woolly mammoths *Mammuthus primigenius* contracted dramatically until they ultimately became fully extinct. This time range coincides with major climatic changes, from cold to warm episodes. Earlier during the Pleistocene, mammoths survived similar climatic changes, reduced their range during warming episodes and expanded again during colder periods. To document the level of ecological flexibility of this species when confronted to climate warming, we analyzed $\delta^{13}C$ and $\delta^{15}N$ values in fossil bone collagen from the last mammoths in the following regions: western Europe, eastern Europe, southern Siberia, northern Siberia, and Wrangel Island. These isotopic ratios provide an indirect record of the actual ecology of individuals; therefore, comparing these ratios through time and across regions allows us to test hypotheses regarding how mammoths reacted to climate warming, either by tracking habitat, modifying the environment to suit their needs (ecological engineer) or by being flexible enough to survive. We found clear evidence for the disappearance of the preferred mammoth niche in Europe, southern, and northern Siberia, for the last mammoth individuals in the respective areas, but the mammoths survived, even if for a short time, under such conditions. In contrast, the mammoth population from Wrangel Island does not exhibit any clear ecological change from 10 to 4 ka BP, even during times of climatic change in the Holocene, such as between 6 ka and 4 ka when the summer temperature was probably lower than in the early Holocene. By comparison with coeval ungulates, it seems that the mammoths from Wrangel Island were able to maintain a position in the $\delta^{13}C$–$\delta^{15}N$ isospace similar to that of the Late Pleistocene populations in Europe and Beringia. A combination of climatic conditions, absence of predation and low competition, as well as the impact of the mammoths themselves on the plant community, likely allowed this remote population of megaherbivores to survive despite climatic fluctuations. Similar conditions may have allowed mammoths and other cold adapted ungulates to survive previous interglacial episodes in small refugia and expand again when climate became globally colder. The expansion of a new predator, modern humans *Homo sapiens*, into the refuge areas probably increased the stress level of this surviving population to a level beyond survival capabilities and contributed to the final extinction. This study was supported by the DAAD, Project # 54751123 and by the Academy of Finland, grant #SA259548.

Technical Session V (Wednesday, November 5, 2014, 4:00 PM)

DEVELOPMENT OF THE VERTEBRAL COLUMN IN AMPHIBIANS REVEALS MECHANISMS FOR THE EVOLUTIONARY TRANSITION FROM WATER TO LAND

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The transition from water to land in vertebrates is characterized by major morphological transformations in the axial skeleton such as the evolution of a recognizable neck and a distinct sacrum. As an adaptation to a terrestrial lifestyle, the skull is separated from the pectoral girdle, resulting in the appearance of a mobile cervical region in tetrapods while the pelvic girdle became a weight-bearing structure. Fossils of Devonian tetrapods and their closest fish relatives have greatly improved our understanding of these morphological transitions, including the progressive regionalization of the axial skeleton. However, we are just beginning to gain a picture of the genetic basis of these morphological changes across the fish-tetrapod transition. From a developmental perspective, the evolutionarily conserved *Hox* genes are considered key genetic factors behind the morphological evolution of the axial skeleton and the anterior limits of *Hox* gene expressions have been shown to correlate with the regionalization of the vertebral column in vertebrates. In fishes, two axial regions (precaudal and caudal) are distinguished and only few different anterior expression boundaries have been reported. In amniotes, the axial skeleton may contain up to five (cervical, thoracic, lumbar, sacral, caudal) or more distinct regions and genetic analyses revealed a correspondingly higher number of anterior expression limits. However, data on axial *Hox* gene expression patterns in amphibians is lacking thus far, but is a key to understanding the genetic changes behind the evolution of vertebral regionalization of tetrapods. We investigated the *Hox* code for the formation of the presacral vertebral column in extant amphibians via whole-mount in situ hybridization experiments on embryos of the Mexican axolotl. We chose a salamander model for this study as they display the most conserved morphology among the three extant amphibian groups. *Hox* gene expression patterns were compared with the axial morphology along the vertebral column. The results show that the vertebral *Hox* code of salamander is differentiated, corresponding to

the increased regionalization of the axial skeleton as compared to fish. The degree of regionalization is however less differentiated than in amniotes, indicating that increased axial regionalization may have evolved gradually within the tetrapod lineage, providing new insights into patterns of axial patterning in amphibians and the evolution of vertebral regionalization in tetrapods.

Technical Session I (Wednesday, November 5, 2014, 9:45 AM)

THE HIPPOPOTAMINE EVENT

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The Neogene palaeoecosystems of Africa receive a great deal of the ongoing efforts for understanding the interplay between environmental changes and vertebrate evolution. This is linked to a rich fossil record as well as to a long-lasting interest for African fossil hominoids in relation to human evolution. African faunal changes are prominently used in environmental reconstructions as well as for testing correlations with global climate changes. Recent and ongoing paleocological studies, notably using stable isotopes, are preferentially applied to fossil collections that allowed identifying major faunal events. Yet, our knowledge of these faunal events is partial, because it is mostly based on a limited number of abundant and diversified mammalian taxa (bovids and primates). Other major components of African extinct ecosystems are more often neglected. This is notably the case of megaherbivores, such as the Hippopotamidae. The revision of the African hippopotamid fossil record provides a striking example of a significant faunal event not considered in previous faunal analyses. Between 21 Ma and 8.5 Ma, hippopotamids are only known by scarce and fragmentary remains of archaic forms, mostly from sites in Kenya. The Hippopotaminae, including all Plio–Pleistocene and extant species, appeared in the fossil record at circa 8 Ma. The sudden burst of this subfamily, hereafter termed the "Hippopotamine Event" or HE, is characterized by a geographical expansion (reaching African high latitudes and Eurasia at the Mio–Pliocene transition), by a rising diversity (three- to fourfold by the end of the Miocene), and by a spectacular increase of their abundance (they include the most abundant mammal species collected in the late Miocene deposits of Lothagam in Kenya, Toros-Menalla in Chad, and other major Mio–Pliocene sites). Stable isotopic and microwear analyses of HE hippopotamines indicate that their diet included a significant amount of grass. Hippopotaminae dentally differ from other hippopotamids in enamel thickness, crown height, and wear pattern. These dietary and morphological features suggest that the late Miocene grass expansion was a potential environmental driver of the HE. Together with other recent examples (e.g., carnivorans), the HE illustrates how systematic and phylogenetic revisions of African fossil mammals provide fresh cases for testing the impact of environmental factors (climate, tectonics, biotic interactions) on mammalian evolution.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

COPROLITES FROM THE MAIN FOSSILIFEROUS LAYER OF THE CRETACEOUS–PALEOGENE (K–PG) HORNERSTOWN FORMATION, NEW JERSEY

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Coprolites can provide a great deal of information concerning trophic interactions in ancient ecosystems. Here, we describe coprolites collected from the Main Fossiliferous Layer of the Cretaceous–Paleogene Hornerstown Formation in New Jersey. Coprolites from this marine bonebed have been previously interpreted as having been produced by sharks and crocodilians. Examination of 105 specimens reveals seven general morphotypes. Three morphotypes can be attributed to sharks based on their heteropolar spiral morphology. Inclusions are not evident in preliminary analyses except in the largest specimen, which contains well-preserved fish material including vertebrae, fin spines, and scales. Morphotype 4 coprolites are amphipolar and were likely produced by bony fish. Morphotypes 5, 6, and 7 range in shape from small pellets to amorphous or ellipsoidal structures with the lattermost resembling previously reported crocodilian coprolites and feces. No identifiable inclusions were observed in coprolites referred to these three morphotypes although small brown structures representing possibly highly digested bone fragments are present. Enamel-less teeth have been suggested to be a diagnostic characteristic of crocodilian feces, but none were observed in morphotypes 5–7. Consequently, sea turtles, mosasaurs, and other fish cannot yet be ruled as out potential producers of these coprolites. The lack of identifiable inclusions in most specimens indicates either a preference for soft-bodied prey or a highly acidic and/or efficient digestive tract. Nearly all of the coprolites exhibit some pre-fossilization damage including flattening, breakage, borings, and feeding traces. Several specimens display shallow scoring indicating coprophagous activity. One well-preserved ellipsoidal coprolite exhibits tooth marks from a large fish or crocodile. Shallow depressions and borings on some coprolites suggest the coprolites provided a hardground substrate for certain sessile taxa. Similar markings attributed to sponges are also present on the skeletal material from the bonebed.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A NEW ANGUINE LIZARD FROM THE MIOCENE OF THE VALLÈS-PENEDÈS BASIN

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Anguines are legless anguimorph lizards with a ubiquitous record in the Neogene of Europe, and a more restricted fossil record in Asia, North America and Africa. We report here the presence of a new anguine lizard from the locality of Trinxera Nord Autopista (late Vallesian, MN10) in Terrassa (Catalonia, Spain). In the Miocene of Europe, only the genera *Pseudopus*, *Ophisaurus* and *Anguis* have been recognized. The overall shape of the recovered maxilla suggests anguine affinities, and the dentition, composed by short and slightly curved columnar teeth in anterior positions and posterior blunt and robust crowns, contrasts with the high, slender and curved teeth of *Ophisaurus* and *Anguis*. The morphology of the anterior dentition is thus similar to that of *Pseudopus*, but the new form stands out in presenting an extremely enlarged fifth tooth (counting from the first preserved tooth) and also in having two posterior teeth presenting a flat apical surface. The shape and size of the fifth tooth are inferred from a subcircular section because the crown is broken. The performed morphology-based phylogenetic analysis recovered, from lower to higher percentage, the following positions for the new taxon: 1) sister taxon of the group formed by *Pseudopus*, *Ophisaurus* and *Anguis*; 2) well-nested within the genus *Pseudopus*, as the sister taxon of *Pseudopus apodus*; and 3) sister taxon of the genus *Pseudopus*. Thus, most of the recovered positions suggest a close relationship between the new taxon and *Pseudopus*. However, the analysis is not conclusive as to whether the new form may be interpreted as a new species of *Pseudopus* or as a new, closely-related genus. This new taxon increases the known diversity of fossil anguines from Europe, which in light of recent studies, had been probably underestimated. This work has been supported by the Spanish Ministerio de Economia y Competitividad (CGL2011-28681, CGL2011-30069-C02-01, RYC-2009-04533) and the Generalitat de Catalunya (2009 SGR 754 GRC).

Technical Session II (Wednesday, November 5, 2014, 10:45 AM)

A TOTAL EVIDENCE PHYLOGENY OF MULTITUBERCULATA

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Multituberculates are by far the most common group of Mesozoic mammals, yet there is little consensus as to their phylogenetic relationships. The few studies that have been published have supported different sets of relationships, a result likely caused by the combination of poorly known taxa, extensive homoplasy, and the difficulty of establishing the polarity of many characters.

Here a new approach was taken; a previously published craniodental character matrix was combined with 95 postcranial characters to create a matrix of 197 characters coded for 38 multituberculate taxa. There is ample evidence for homoplasy among some dental characters, thus it is preferred that these characters be down-weighted. Implied weighting is the most objective character weighting methodology, yet weights can be biased due to uneven distribution of missing data. For example, in this multituberculate matrix, postcranial characters often get higher weights simply because they are preserved for so few taxa. To address this problem, the entire character matrix was analyzed using the recently published, extended implied weighting method in the application TNT, which adjusts dynamic, implied weights by extrapolated levels of homoplasy. This method yielded 7 most parsimonious trees, with 33 out of 37 nodes resolved. In contrast to several recent studies, three North American taxa, *Cimexomys*, *Mesodma*, and *Stygimys*, were placed inside the “Djadochtatheria”, a clade principally composed of Mongolian taxa. In a previous study, *Cimexomys* was instead included in paraphyletic “Paracimexomys” group that was situated at the base of Cimolodonta. *Pentacosmodon*, the only North American taxon that had been placed inside “Djadochtatheria” was here found nested in the clade that includes taxa from Cimolomyidae and Taeniolabidae. Future work will test these hypotheses by adding additional ingroup and outgroup taxa.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

THE EFFECT OF BODY POSITION ON DISTAL PHALANX SHAPE: A GEOMETRIC MORPHOMETRIC ANALYSIS IN THE RUMINANTS

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In the Ruminantia, the eight toes in the fore- and hind limbs support weight differently and have different biomechanical interactions with substrate. The shape of the plantar surface (i.e. the surface in contact with the ground) of the distal phalanx may vary between digits as a consequence of differences in weight support and stabilization. This study seeks to quantify the morphological differences in the plantar surface of the distal phalanx between forelimb, hind limb, medial, lateral, and right and left positions in 14 species belonging to four of the six extant families (i.e., Antilocapridae, Bovidae, Cervidae, and Giraffidae). Outlines consisting of 100 landmarks along the distal phalanx were collected, Procrustes superimposed, and subjected to a principle components analysis. A total of 95% of shape variance was explained by the first four PCs. Toe shapes are somewhat variable in all families, and cervids tend to have the greatest variation within forelimbs and within hind limbs. MANOVA and Bonferonni post-hoc analyses show that the shape of different digits of the same animal does not differ significantly relative to the variance in shape between species (medial/lateral: $p = 0.78$ forelimb/hind limb: $p = 1.00$: right/left limbs: $p = 0.44$). Thus, there appears to be no significant difference between the plantar surface outline shapes of different digits. Relative differences in shape were therefore tested with a Levene’s test to determine whether some pairs of digits were more different than other pairs (e.g., medial–lateral vs. fore–hind limb). Results show that fore- and hind limb toes are more different than are medial and lateral toes in the same hoof. Furthermore, the medial digit was more different between fore- and hind limb than the lateral digit. The medial digits of the forelimbs support more weight than either the lateral digits or the hind limb digits, which may contribute to the greater difference in the medial position. However, the difference between lateral digits in the fore- and hind limbs is significantly larger ($p = 0.004$) than the difference between medial and lateral in the hind limb. Further investigation is needed to confirm whether the shape of individual digits plays a specific functional role in weight support or locomotion.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

THE ONTOGENY AND EVOLUTION OF THE DENTITION OF COLLARED LEMMINGS

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Collared lemmings (*Praedicrostonyx*-*Dicrostonyx* lineage) are arvicolines with hypselodont molars with no cementum in reentrant angles, which exhibit general

evolutionary trends towards complication of all molars by adding new prisms. Along with *Lemmus*, *Myopus*, and Synaptomys, they differ from other arvicolines in the lingual position of the alveolar portion of the lower incisor relative to the cheek tooth row, and by the presence of dentine tracks at the vertices of all salient angles on all cheek teeth. Those features were already formed in Pliocene lemmings because they are clearly distinguishable and attain their maximum expression in the mandible samples of the early Pleistocene *Praedicrostonyx* and *Lemmus* from Western Siberia.

Our comparative morphological study in recent newborn arvicolines shows that, in the course of ontogeny in lemmings, the formation of the crown of the lower third molar happens more quickly than the development of the incisor and blocks the protrusion of the alveolar portion of the incisor towards the condylar process. In all other hypselodont arvicolines, the incisor development happens more quickly than and precedes the formation of m3 such that, in newborns, the third lower molar develops above the incisor, which has already reached the base of the condylar process. As the result, the m3 alveolus forms lingually to the incisor.

The molars of the early Pleistocene *Praedicrostonyx* exhibit occlusal surface patterns comparable in complexity to modern *Microtus*. Our study of the juvenile specimens of *Praedicrostonyx meridionalis* from the Skorodum locality (Western Siberia) reveals considerable differences between the complexity patterns established on the occlusal and basal (alveolar) surfaces of the same molar. In the early ontogenetic stages of the first upper molar (dentine tracks do not reach the occlusal surface) the occlusal surface consists of 5 isolated dentine fields; at a later stage, when the dentine tracks reach the occlusal surface, there is an additional element formed posteriorly of the T4 prism. In the first lower molar, the occlusal surface of the juvenile specimens (dentine tracks do not reach the occlusal surface) exhibits a more complex pattern than the basal (alveolar) surface of the same tooth. Ontogenetic variability patterns revealed in *P. meridionalis* are comparable with the differences among the specimens of the rooted arvicoline species *Phenacomys deeringensis* at different tooth-wear stages.Funded by a grant the Russian Foundation for Basic Research 13-04-00847.

Technical Session VIII (Thursday, November 6, 2014, 3:30 PM)

THE PHYLOGENETIC RELATIONSHIPS AND BIOGEOGRAPHY OF AFRICAN HYAENODONTIDAE

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Until carnivorans appeared in Afro-Arabia in the late Oligocene (~23 Ma), species from the diverse placental mammalian family Hyaenodontidae filled most terrestrial carnivore niches on the continent. Ranging from weasel to polar bear size, species from Hyaenodontidae are also found in Europe, Asia, and North America through the Paleogene. The earliest record of this diverse, widely spread family is from the late Paleocene of Morocco, represented by species belonging to the subfamily Koholiinae. The observation that Afro-Arabia was isolated for much of the Paleogene and the observation that the earliest occurrence of the group is in Afro-Arabia have lead to speculation that the group originated in Africa, where significant diversification of the family occurred before spreading to other continents. However, this biogeographic hypothesis has never been rigorously tested. Part of the difficulty associated with testing the Afro-Arabian origin of hyaenodontids is that very few Afro-Arabian hyaenodontid species have been incorporated into phylogenetic analyses of the clade. Further, much of the character data used to support hyaenodontid relationships is drawn from dental morphology. Here, a phylogenetic analysis for Hyaenodontidae is presented with a broader sample of Afro-Arabian taxa than has been previously incorporated into a single analysis. Characters based on cranial and postcranial morphology are also incorporated into the analysis, informed by new specimens of Afro-Arabian taxa including a near-complete skeleton of *Apterodon,* crania of *Masrasector,* and the latest recorded specimens of Koholiinae. This new cranial and post cranial material is primarily from Locality 41, a latest Eocene (late Priabonian) locality in the Fayum Depression, Egypt. A partial skeleton and skull of *Hyainailouros* from the lower Miocene of Meswa Bridge, Kenya is also incorporated. Preliminary biogeographic analyses based on the recovered topology suggest basal nodes in multiple lineages of Hyaenodontidae are optimized with Asian origins rather than African origins. For example, the subfamily Apterodoninae, once thought to be endemic to Africa with dispersal to Europe, is recovered as part of a clade including Asian *Sinopa* and *Kyawdawia.* This suggests that multiple dispersal events from Asia to Africa occurred during the early and middle Eocene, a result consistent with current hypotheses of primate and rodent dispersals from Asia to Africa during this interval. Supported by the NSF (DDIG DEB-1311354, BCS-0819186) and the Turkana Basin Institute.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

TAPHONOMICAL AND PALEOECOLOGICAL INVESTIGATION OF THE LATE CRETACEOUS IHARKUT VERTEBRATE ASSEMBLAGE

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The Iharkut vertebrate locality, an open-pit mine in the Bakony Mountains (western Hungary), has provided a rich and diverse assemblage of Late Cretaceous (Santonian) continental vertebrates. The isolated and associated remains represent 31 different taxa including fish, amphibians, turtles, mosasaurs, lizards, pterosaurs, crocodilians, non-avian dinosaurs and birds. Sedimentological investigations pointed out that the depositional environment could have been the floodplain of a very low-gradient river system. The 10 to 50 cm thick bonebed of site SZ-6, the most important fossiliferous layer in the open-pit mine, indicates alternating energy conditions during the bone accumulation which resulted in fossils of different states of preservation having been deposited in the same layer. The vertebrate assemblage of site SZ-6 includes three main different groups of subsets with widely different taphonomical history. The bone pebbles were theoretically hydraulically equivalent with the dominant size of quartz grains of the channel fill sediment, thus they could have been transported for a long time with the ancient stream from the background area. The second group includes 88% of the Iharkut assemblage, containing most of the identified isolated bones and teeth, and represents polytypic attritional remains which were transported and deposited by high density flow during the ephemeral flood events. The monospecific associated and articulated ankylosaur skeletal material of Iharkut may represent a mass death assemblage because six associated and one articulated skeletons of *Hungarosaurus* were discovered from an area of approximately 400 m^2 and in many cases close to each other in the same layer. The sedimentological and taphonomical investigations suggest that the vertebrate assemblage of site SZ-6 represents a group of animals which lived approximately at the same time in and around an ancient fluvial system, thus the paleoecological interpretation of Iharkut fauna can be regarded as well-established. The taphonomical analysis of the abundant ankylosaur material from Iharkut further strengthens the theory that some of the ankylosaurs preferred wetland habitats such as areas along ponds and fluvial systems, while members of the other two groups of herbivorous dinosaurs (ornithopods and ceratopsians) probably lived in more distal, less wet habitats characterized by different vegetation.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

THE LIFESTYLE OF PERMO–TRIASSIC *LYSTROSAURUS*

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The End-Permian Mass Extinction (EPME) is considered to be the most catastrophic mass extinction in the geological record. It had a considerable effect on both marine and terrestrial ecosystems, substantially changing community structure in multiple phases, causing a severe reduction in global biodiversity. The terrestrial post-extinction environment was harsh and unpredictable, characterized by increased aridity and temperature extremes. One of the few therapsids that survived the EPME was the dicynodont *Lystrosaurus*. It is the only dicynodont that has been recovered from both sides of the Permo-Triassic boundary and is thus an ideal model for testing theories about various survival strategies in the face of dramatic environmental perturbation. The discovery of *Lystrosaurus* remains within fossilized burrows during the past few years has led researchers to propose a burrowing lifestyle for at least the Triassic species. However, these comments were made either on field observations where the taphonomy of the specimens could not be ascertained, or they were based on recovered specimens comprising disarticulated scattered remains, casting doubt as to the burrow maker. Moreover, based on osteohistological evidence, an aquatic lifestyle for *Lystrosaurus* has also been put forward. As a result, the habitat preference of *Lystrosaurus* remains controversial with aquatic, fossorial, or a combination being proposed. I present here the first articulated skeleton of *Lystrosaurus* found within a fossilized burrow from the Lower Triassic Palingkloof Member, Balfour Formation, Karoo Basin of South Africa. The size and articulated nature of the skeleton suggests that the specimen was the burrow maker. This finding has prompted a review of the habitat preferences of Permo–Triassic *Lystrosaurus*. Histomorphometric traits are combined with morphology and taphonomic evidence to suggest that a burrowing and not an aquatic lifestyle aided *Lystrosaurus* in surviving the harsh, arid conditions of the Early Triassic.

Technical Session XIV (Saturday, November 8, 2014, 8:15 AM)

AIRFLOW RECONSTRUCTION AND HEAT-TRANSFER POTENTIAL IN THE ELONGATE NASAL PASSAGES OF THE ANKYLOSAURS *PANOPLOSAURUS MIRUS* AND *EUOPLOCEPHALUS TUTUS*

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The nasal passages of ankylosaurs are impressive for their extensive convolutions, forming multiple loops in some taxa prior to reaching the pharynx. Hypermineralization in ankylosaurs allows for remarkably faithful reconstructions of nasal capsule shape in these taxa. Evidence of extensive vasculature within the nasal cavity suggests the potential for an effective heat exchange apparatus in the nose. To test this potential, we modeled the nasal cavities of the ankylosaurs *Panoplosaurus mirus* and *Euoplocephalus tutus* based on computed tomography (CT) data. The resulting 3D digital models were used in a computational fluid dynamic analysis to ascertain fluid-flow patterns within the nose. Comparisons were made to a phylogenetic sample of extant sauropsids, including *Uromastyx aegyptiacus* which has a similarly shaped nasal capsule. Heat transfer was modeled within the nose based on assumptions of core body temperature and blood-flow distribution. A variety of environmental temperatures were compared to assess potential nasal thermoregulatory capacities. Estimated respiratory variables suggest that *P. mirus* and *E. tutus* would require 229-682 calories to warm one breath of 15°C air to an estimated body temperature of 35°C. Results of our analysis indicated that the constricted and convoluted nasal passages of both *P. mirus* and *E. tutus* produced largely laminar flow through the nasal airway, coupled with standing vortices along the various contortions. These airflow patterns resulted in increased air transit times that enhanced airway-nasal-wall interactions. Assuming extensive blood flow to the nasal airway, such airway-nasal-wall interactions indicate that both ankylosaurs had the potential to extensively modify the heat content of respired air, affecting its moisture-holding capacity and reducing respiratory evaporative water loss. This potential to warm inspired air would, in turn, provide a reservoir of cooled blood that could be shunted to the brain, maintaining stable cerebral temperatures during times of heat stress. The ability of these convoluted airways to modify the heat content of respired air in lieu of traditionally conceived respiratory conchae supports the position that conchae are one of multiple solutions for air conditioning. These potential thermal properties of the airway do not rule out other functions, such as vocal resonance, and may provide a means of discriminating their relative importance. Airways that were 'overbuilt' for air conditioning could suggest alternative functions for their morphology.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

DENTAL MICROWEAR TEXTURE ANALYSIS OF PECCARIES ACROSS SPACE AND TIME: ASSESSING DIETARY VARIATION OF EXTANT AND EXTINCT PECCARIES IN THE AMERICAS

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Glacial and interglacial periods of the Pleistocene document rapid climate fluctuations, forcing some species to adjust their diets in response to alterations in vegetation. For example, geochemical analyses have demonstrated that peccaries, such as *Platygonus*, increased the proportion of C_4 vegetation they consumed with interglacial warming. Further, both modern and extinct members of the clade Tayassuidae are known to heavily influence landscape composition through seed dispersal and seed predation; however, little is known about how their diets vary over both space and time. Dental microwear texture analysis (DMTA), the three-dimensional analysis of microscopic wear features resulting from food processing, provides information on approximately the last two weeks of an animal's diet and can help clarify if both modern and fossil peccaries had similar diets. Here, we assessed whether *Platygonus* consumed harder food items than *Mylohyus*, consistent with morphological interpretations, during the Pleistocene. Further, we compared these extinct peccaries to the extant white-lipped peccary (*Tayassu pecari*) and the highly generalized collared peccary (*Pecari tajacu*). DMTA suggests differences in dietary preferences within and among extant and extinct taxa. Diets of extinct peccaries were highly generalized and they likely consumed both tough and brittle food items, as evidenced by variable anisotropy and complexity, respectively. In particular, *Platygonus* may have consumed more brittle food items than *Mylohyus*, consistent with morphological differences. *Platygonus* also had greater complexity than white-lipped peccaries, suggesting they consumed harder objects than white-lipped peccaries do today. Amongst extant peccaries, white-lipped peccaries may consume tougher and less brittle food items than the collared peccaries, although dietary behavior of both peccaries can vary spatially and temporally. Collectively, these data suggest that extinct peccaries had highly generalized diets similar to peccaries today; however, *Platygonus* may have been more generalized in its diet and consumed food items with similar textural attributes to those consumed by the extant generalist collared peccary.

Education and Outreach Poster Session (Poster displayed November 5 – 8)

BRINGING FOSSILS TO LIFE: INTERACTIVE OUTREACH IN THE CLASSROOMS OF ALBERTA

BRADLEY, Gavin, University of Alberta, Edmonton, AB, Canada, T6G0X6; CAMPBELL, Michelle, University of Alberta, Edmonton, AB, Canada; BURNS, Michael, University of Alberta, Edmonton, Edmonton, Canada

The University of Alberta recently saw its 50th anniversary and the launch of its first Massive Open Online Course. Building on this successful year for paleontology, new approaches were assumed to broaden the reach of paleontological knowledge in Alberta. To reach a generation for whom information is readily available and increasingly tactile, the challenge of modern outreach is to present research in interactive and dynamic ways. This ideology was adapted in numerous ways by the University of Alberta across the province during the past year.

In conjunction with Edmonton Science Outreach Network, palaeontology was incorporated into the recently revised Alberta Elementary School Curriculum, under the 'Investigation & Interpretation' module. An interactive 'dinosaur footprints activity' in which children, grades 3–6, interpreted trackways and created their own scenarios with moveable footprint cut-outs, developed their critical thinking and problem solving skills using palaeontological examples. While an interactive core to these outreach visits was important, the activity was also not reliant on expensive teaching aids, making it accessible to schools of varying incomes and demographics.

Expanding the range of our interactive outreach, 'Fossils in the Classroom' visits were made to elementary and high schools. Varying in skill level, the hands-on investigations such as determining an animal's diet, shape, and locomotion based on fossils proved the most stimulating aspect of these visits. During tours of the Palaeontology facilities at the University, students not only received a traditional presentation, but also undertook 'mineral hunts', worksheets based on museum specimens, fossil rubbings, and reconstructions of disarticulated fossils. Culminating this interactive approach was our involvement in 'The School of Witchcraft and Wizardry', hosted by 'Let's Talk Science'. Over 800 children participated in a 'mythical creature bingo' designed to familiarise them with fossil organisms through the medium of Harry Potter, receiving overwhelmingly positive feedback.

Traditional lectures remain an effective educational tool at niversity level, but rarely fulfill the teaching objectives desired by elementary school curriculums, nor reach the levels of creative stimulation conducive to higher learning amongst younger students. Thus, based on outreach efforts by the University of Alberta in the past year, an interactive approach involving hands-on activities is recommended to truly bring fossils to life in the classroom.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

GREGARIOUSNESS IN *GORGOSAURUS*: STUDYING SOCIAL BEHAVIOUR IN NON-AVIAN THEROPOD DINOSAURS (DINOSAURIA: SAURISCHIA)

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The conspicuous lack of research concerning the behavior of juvenile theropod dinosaurs is not a quirk of the interests of palaeontologists, but rather the culmination of two well recognized problems within the discipline: the sparseness of the juvenile fossil record, and the subjectivity of behavioral evidence. Predominantly using two specimens of *Gorgosaurus libratus* (UALVP 49500 and UALVP 10), a juvenile and adult collected by the the University of Alberta, a multi-disciplinary analysis was undertaken in order to reveal how dependent on a pack environment juvenile *Gorgosaurus* may have been.

Due to the subjectivity of what constitutes social behavior, a comprehensive review of extant animals was conducted and a relative scale of sociality compiled, ranging from limited social behavior, for example nest emergence in iguanas, to complex social behavior, for example pack hunting in lions. A similar review has been made of fossil evidence and a juvenile *Gorgosaurus libratus* (UALVP 49500) from the Campanian-aged Dinosaur Park Formation, Alberta was described, identifying morphological features with potentially social applications, such as the genus-specific orientation of the lacrimal horns.

As the level of precociality of juvenile dinosaurs would have heavily influenced their ability to survive independently of a pack environment, the most comprehensive reconstruction of *Gorgosaurus* growth rates to date was undertaken. From histological sections of amedullar bones from numerous specimens, including UALVP 49500 and UALVP 10, age at death estimations were made by counting lines of arrested growth. These were plotted against body mass estimations, constructed using femoral circumferences, to give an impression of *Gorgosaurus libratus* life history; initial results suggest more rapid juvenile growth rates than previously thought. Similarly, tooth replacement rates based on lines of von Ebner observed in thin sections of maxillary teeth suggest more rapid replacement in juveniles than adults.

The implications of these increased growth and tooth replacement rates in juveniles may be contextualized using the previously mentioned modern analogues. For example, they may be a product of early independence, as with modern tigers, or a response to early agonistic behaviour, akin to modern alligators. Whichever interpretation is supported, we here demonstrate that through the use of modern analogues, description and histology, the historical problems of studying social behavior in dinosaurs may be circumvented.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

REUNITING THE 'HEADLESS WONDER' *CORYTHOSAURUS EXCAVATUS* (DINOSAURIA: HADROSAURIDAE) HOLOTYPE SKULL WITH ITS DENTARY AND POSTCRANIUM

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In 1920 a *Corythosaurus* skull was 'head hunted' from Alberta, Canada by George F. Sternberg. This skull is now part of the University of Alberta collection (UALVP 13). Based on this skull and comparisons with the *Corythosaurus casuarius* holotype (AMNH 5240), a new species was named: *Corythosaurus excavatus*. In 1992 a right dentary was collected from a multitaxic bonebed in Dinosaur Provincial Park, Alberta, whereas associated postcranial material was left behind. Nine years later archeological evidence lead researchers to believe the dentary and postcranial material may belong to the *C. excavatus* holotype skull. With this information available, the University of Alberta collected the postcranial material in 2012. Using measurements from other corythosaurs, bivariate correlations were used to determine if these elements belong to the holotype skull.

For all corythosaurs, the Spearman's rho significantly correlates the skull length and the length of the dentary as well as the height of the coronoid process. When the UALVP 13 skull and potential dentary measurements are added, the correlation between the skull length and length of the dentary decreases whereas the the correlation between the skull length and height of the coronoid process increases. The results lead us to conclude that it is possible that the dentary and skull belong to the same specimen. However, it is equally possible that the dentary merely belongs to a skull from a similarly sized corythosaur.

There are statistically significant correlations among postcranial elements and also with multiple cranial and postcranial measurements for all corythosaurs. With the addition of UALVP 13, there are fewer statistically significant cranial/postcranial correlations, although there are more statistically significant correlations with the postcranial material. These results indicate that the postcranial material collected in 2012 belongs to the same corythosaur but they do not belong to the UALVP 13 skull.

Because many large vertebrate fossil specimens were and are not always collected in their entirety, holotype and other significant specimens among them, this method may be used to add to the body of anatomical knowledge that may be lacking for some taxa.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

BUILD-A-BIRD: QUANTIFYING HARD AND SOFT TISSUE PARAMETERS IN MODERN AVES TO IMPROVE 3D FOSSIL RECONSTRUCTIONS

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The reconstruction of body mass and segment inertial properties in fossil species is a fundamental challenge facing paleontologists. Body mass is an important pre-requisite upon which detailed biomechanical studies (including finite element analyses, multibody dynamic analyses and aerodynamic performance studies) rely. Yet disagreement still exists over how to calculate this basic descriptor of size for extinct species. With the increasing availability of 3D imaging techniques (such as computed tomography, LiDAR and photogrammetry), volumetric methods for estimating mass have become popular. Volumetric methods benefit from incorporating the maximum amount of information available from the skeleton into calculations, and are less liable to biasing due to exceptionally robust/gracile bones than methods based on isolated elements. Yet volumetric reconstructions are heavily influenced by the skeletal mount upon which they are based and require input values for density derived from relevant modern species. Unfortunately, such data from modern specimens are sparsely available and inconsistently reported.

In this study, I investigate the variation in hard and soft tissue parameters in modern Aves in order to provide a solid groundwork upon which future volumetric reconstructions of fossil birds and dinosaurs may be built. Using a CT dataset comprised of whole carcass scans of palaeognaths and neognaths (including Anseriformes, Galliformes, Columbiformes and Passeriformes), I quantify parameters of interest such as maximum carcass density (as defined by skin envelope extent), ribcage convexity, intervertebral spacing and sternal placement.

Avian carcass density values calculated here are both higher and less variable than previously published values, suggesting air-sacs and feathers act not only to decrease density but also introduce variability into live bird body density. Intervertebral spacing as a percentage of total neck length is variable, both across avian orders and between

closely-related taxa, contributing 2-8% of total length. Convexity of the ribcage is highly conserved across sampled avian taxa, suggesting trunk volume can be accurately estimated in instances of articular facet preservation. When ribs are extensively damaged of absent, the position of the sternum may be estimated on the basis of vertebral and pelvic landmarks. The data presented here are of interest to those working in the field of fossil reconstruction, for whom the loss of soft tissue structures and fossil deformation are on-going challenges.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

LONG-TERM AVIAN EGG DECAY EXPERIMENT: ACTUOTAPHONOMIC DATA FOR THE INTERPRETATION OF THE FOSSIL RECORD

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Sauropsid eggshells are relatively common in the fossil record, whereas eggs and embryos are less frequently encountered. Aside from paleobiological reasons, differential preservation of eggs, eggshells and embryos in the fossil record may be the result of taphonomic processes. A long-term experiment has been carried out in order to explore early taphonomic alteration mechanisms on a sample of avian eggs. Eight hen eggs were buried in containers filled with coarse grained sands or grey marls and saturated with either fresh or marine water. The containers were covered and kept isolated under stable conditions over more than six years. At the end of the experiment, important differences are appreciated, according to the sediment and water conditions. Eggs covered by marine water tend to remain complete, whereas all eggs covered by freshwater are fragmented. Likewise, eggs buried in sand rose to the surface, whereas eggs buried in marl tended to remain mostly or completely buried. Egg contents are preserved in all cases as dried membranes and tissues, bones and feathers, or mummified embryos. However, those buried in marls are better preserved, their remains even distinguishable by differential tissue coloration and consistency. No sediment was found inside the eggs, which suggests that the sediments dried before cracks appeared on the eggshells. In summary, the results suggest that sediment granulometry and water characteristics may influence some early taphonomic processes, such as egg displacement and breakage. Thus, some features that have historically been interpreted as of biological origin (e.g., egg openings described as hatching windows) might have actually been the result of early stages of decomposition. As a conclusion, this kind of actuotaphonomic experimentation provides useful tools for the interpretation of the paleoenvironmental conditions of a vertebrate fossil site where eggs have been preserved.

Technical Session XIII (Friday, November 7, 2014, 4:00 PM)

THE HYOID ARCH AND BRAINCASE OF *ACANTHODES* AND THE CHONDRICHTHYAN AFFINITIES OF ACANTHODIANS

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Acanthodes bronni from the Permian of Lebach, Germany, has been central to the debate on modern gnathostome origins for most of the past 100 years. It is the only acanthodian taxon for which well-preserved, three-dimensional braincase material is known. Because of this, it has been pivotal to the question of the systematic placement of acanthodians and the character transformations leading to the origin of osteichthyans and chondrichthyans. In spite of the quality and quantity of *Acanthodes* braincase material, a satisfactory braincase reconstruction has remained elusive. Even the most recent reconstructions imply problematic relationships between visceral arches and cranial nerves. The overall appearance of the braincase is superficially osteichthyan-like, but recent work has revealed previously unrecognized chondrichthyan-like characters. Unfortunately, many of these chondrichthyan-like traits, are not demonstrable chondrichthyan synapomorphies, leaving some conflict in phylogenetic trees placing *Acanthodes* on the chondrichthyan stem. Using a combination of computed tomography scanning and direct examination of specimens, we offer a new reconstruction of the otic side wall and hyoid arch of *Acanthodes bronni*. We revise the morphology of the hyoid arch, demonstrating that it lacks an unossified segment seen in most previous reconstructions. This allows us to establish its correct orientation with the braincase and upper jaw. By direct re-examination of three-dimensional braincase material, we are able to substantially revise interpretations of the otic capsule sidewall. Consistent with our reconstruction of the length and orientation of the hyomandibula, we show that it articulated on the otic capsule sidewall, beneath the jugular vein, a condition seen only in shark-like chondrichthyans. The significance of these reinterpretations lies in the consistent alternative conditions in outgroups, such as placoderms and osteichthyans. This clear polarity corroborates the recently revived hypothesis that all acanthodians are in fact stem chondrichthyans, helping to settle one of the long-standing problems in early gnathostome evolution. Furthermore, it demonstrates that osteichthyan-like conditions in the braincase of *Acanthodes* are either convergent or gnathostome symplesiomorphies.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

WYOMING MEGATRACKS AND MEGATRACKSITES: WHEN SIZE MATTERS HOW DO THEY MEASURE UP?

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Megatracks and megatracksites are unique ichnological phenomena. Megatracks (i.e., tracks over 1.25 meters in size) form by the dynamic interaction of a large animal with a pliant substrate creating oversized footprints. Megatracksites are regionally extensive track-bearing horizons representing complex community dynamics. Although true megatracks and possible megatracksites were not reported in Wyoming until the 1990s, spectacular claims and sporadic ichnological discoveries were noted since the first dinosaur track was discovered by F.V. Hayden in 1868. The enormous megatracks (sauropod pes impressions) from the Morrison Formation at Como Bluff closely resemble in size and morphology those of *Gigantosauropus* from the Upper Jurassic Tereñes Formation of the Asturias region of Spain. Although it is unlikely that these tracks represent the footfalls of unknown gigantic sauropods, they are taphonomically unusual ichnological features that deserve thorough documentation and comparison. Also at the end of the end of the 20th century, reports of dinosaur tracks in the Middle Jurassic Sundance Formation of Wyoming's Bighorn Basin eventually led to thousands of primitive tetanurine theropod footprints (*Carmelopodus*) being documented in the Sundance Ichnofaunal Province, which is moderately extensive and rich in dinosaur tracks where gregarious activity is preserved. More prospecting of the track-bearing unit may prove this to be part of a megatracksite, although high concentrations of tracks alone do not qualify it as such. Fortunately, documenting Wyoming"s largest tracks and tracksites no longer requires a mega effort or expense, as combining traditional techniques with state-of-the-art-digital data collection methods is very efficient. Photogrammetry has proven to be a noninvasive, cost effective and highly accurate method of collecting 3D digital data. Overlapping stereoscopic imagery capture for areas of large aerial extent can be systematically captured utilizing a variety of platforms to achieve submillimeter precision. These platforms include monopods, tripods, blimps, helicopters, ultralights, airplanes, robotic imaging heads (e.g., Gigapan) and unmanned aerial systems (UAS). These digital data are being used to document, analyze, interpret, and compare the unique ichnological features in Wyoming and the West with those from Europe and around the world to better understand ichnomorphological characters, track formation, and taphonomy, as it relates to behavioral dynamics and dinosaur paleoecology.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

PHYLOGENETIC ASSESSMENT OF *BATHYGNATHUS BOREALIS*, A DERIVED SPECIES OF *DIMETRODON* FROM CANADA

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Bathygnathus borealis, is one of the first vertebrate fossils known from Canada. The holotype and only known specimen is a partial snout with upper dentition of a presumed sphenacodontid from the Kungurian-aged redbeds of Prince Edward Island. Due to its incomplete nature, assessment of the systematic position of *Bathygnathus* within the context of a cladistic analysis has never been performed. However, recent recognition of the phylogenetic utility of tooth characters in sphenacodontids now allows for a modern phylogenetic evaluation of *Bathygnathus*. The specimen has at least one precaniniform tooth, an enlarged caniniform tooth twice the apicobasal length of the postcaniniforms, and nine or more postcaniniform teeth. The teeth are labio-lingually compressed, convex labially, and possess mesial and distal carinae with large denticles. CT data shows that the tooth roots are elongate and do not possess plicidentine. These tooth characters suggest a close relationship between *Bathygnathus* and *Dimetrodon*. However, *Bathygnathus* appears to have a large facial exposure of the septomaxilla, which is typically viewed as a characteristic of therapsids. Phylogenetic analysis of sphenacodontids and basal therapsids suggests that *Bathygnathus* is more closely related to *Dimetrodon* than to basal therapsids, and is deeply nested within the *Dimetrodon* clade as the sister to *D. grandis*. The presence of the enlarged septomaxilla may be autapomorphic for *Bathygnathus*, or may be a characteristic of derived species of *Dimetrodon*, never before preserved in articulation in *D. grandis*. Furthermore, the generic name *Bathygnathus* has precedence over *Dimetrodon* in the literature, and the results of this analysis reinforce the need for a taxonomic overhaul of *Dimetrodon*.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

COMPARISON OF CRUSHING FUNCTION IN PSEUDOTRIBOSPHENIC MOLARS OF *HALDANODON EXSPECTATUS* (MAMMALIAFORMES, DOCODONTA) WITH TRIBOSPHENIC MOLARS OF *DIDELPHIS MARSUPIALIS* (MAMMALIA, MARSUPIALIA)

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The Mesozoic pseudotribosphenic docodonts evolved a crushing function in their molars convergent with tribosphenids in an early stage of mammalian evolution. This study compares the molar crushing function of the Late Jurassic docodont *Haldanodon exspectatus* with that of the extant *Didelphis marsupialis* with tribosphenic tooth morphology. For the comparative reconstruction of the chewing paths, Occlusal Fingerprint Analyser (OFA) 3D models and striation maps were used.

In contrast to tribosphenic occlusion, where the protocone moves into the basined talonid, the pseudoprotocone (large cusp X) of *Haldanodon* occludes mesiolingually to the mesially placed pseudotalonid basin. Only the more distally situated small cusp Y occludes into the pseudotalonid basin where it conducts a grinding function. In *Didelphis*, grinding occurs at the distolingual and distobuccal margin of the proportionally much larger talonid. Simultaneously, crushing also occurs within the talonid basin and the hypoconid conducts a crushing function within the closed trigon basin. In *Haldanodon*, crushing mainly takes place within the distally open pseudotrigon basin and is conducted by cusp b.

For both taxa, the OFA analysis showed two phases during the power stroke separated by centric occlusion, although they differ in angle and direction. By tracing the contact area for each facet through time, the change from shear-cutting to grinding in phase I of *Didelphis* is very well pursuable. In phase II only grinding occurs. In *Haldanodon,* shear-cutting and crushing cannot be distinguished because they occur at the same time and the crushing motion produces no facets. Grinding only occurs at the very end of phase I immediately before centric occlusion. In phase II only shearing occurs.

While the crushing is not yet comparable, the amount of grinding in *Didelphis* is much higher than in *Haldanodon* and the basins involved are more closed. That is why compression seems to be carried out more efficiently in *Didelphis* molars. Nevertheless,

the crushing function in *Haldanodon* molars is much more prominent than suggested so far.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

DETRITAL ZIRCONS PROVIDE MAXIMUM DEPOSITIONAL AGE BRACKET FOR THE XIASHAXIMIAO FORMATION, SICHUAN, CHINA

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The Xiashaximiao Formation of Zigong, Sichuan, China has produced a diverse vertebrate fauna including an array of articulated dinosaurs (e.g., the sauropods *Shunosaurus* and *Omeisaurus*, and stegosaurid *Huayangosaurus*). The formation has long been assigned to the Middle Jurassic based on palynomorphs, bivalves, conchostracans and dinosaurs. We test the Middle Jurassic age hypothesis by providing the first radiometric ages for the formation. These ages were obtained by LA-ICP-MS (laser ablation inductively coupled mass spectrometry) techniques at the LaserChron Center at the University of Arizona.

Five sedimentary rock samples were collected from the Zigong Dinosaur Museum site, two of which yielded abundant detrital zircons. A well-sorted sandstone from near the base of the museum"s bone-bearing lithosome (i.e., the quarry matrix) yields a youngest peak age of 178.3 ±1.7 Ma based on 11 euhedral zircons. A clay-rich sandstone bed circa 10 m higher in the section yields a youngest peak age of 177.1 ±1.7 Ma based on 23 euhedral zircons. These ages are indistinguishable from each other, suggesting the zircons were derived from the same source. Abundant muscovite, lesser garnet, epidote, strained polygranular quartz, and small clasts with granoblastic textures and accessory minerals in both samples indicate a metasedimentary source for the clastics. Cathodoluminescence (CL) images of the youngest zircons appear to have normal magmatic zonation. Thus, the crystals providing the youngest ages may be magmatic, not metamorphic, in origin.

These latest Early Jurassic ages provide a maximum depositional age for the Xiashaximiao Formation and do not argue against the standard biochronologic ages for the Xiashaximiao Formation. The youngest zircons may have been reworked from a nearby Early Jurassic igneous source that remains unidentified. This research was supported by NSF award EAR 0922187.

Symposium 3 (Friday, November 7, 2014, 11:30 AM)

GHARIAL BIOGEOGRAPHY, CONFLICTING SIGNALS, AND PHYLOGENETIC ENTMOOTS

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Although morphological and molecular data sets are strongly congruent over most aspects of crocodylian phylogeny, they conflict over the relationships and divergence timing of the living gharials *Gavialis gangeticus* and *Tomistoma schlegelii,* both of which are currently found only in fresh water in Asia. These support very different historical biogeographic scenarios; either the two gharials share an Asian freshwater-dwelling ancestor during the Cenozoic, or they last shared a common ancestor in the Late Cretaceous and independently became limited to nonmarine settings from North Atlantic shallow marine ancestors. Combined-data and molecular scaffold analyses including fossils both support the close relationship between *Gavialis* and *Tomistoma* preferred by molecular data, but they also put the Late Cretaceous through Paleocene 'thoracosaurs' on the *Gavialis* line, as supported by morphological data, suggesting that the common gharial ancestor was a coastal Laurasian crocodylian. But whether these reflect actual relationships or a topological compromise between strongly conflicting signals is an open question - they support a clade recovered in molecular analyses, but with a divergence time 20 or more million years older than the dates supported by the same data. Analyses with fossils that constrain *Gavialis* and *Tomistoma* to a late Paleogene split may more precisely reflect molecular evidence, but they require arbitrary decisions about clade membership not independently supported by either data set. They do, however, continue to support a common gharial ancestor that was at least capable of crossing substantial marine barriers, which is consistent with the presence of oral and glandular features in both gharials that allow tolerance of salt water. Studies using the results of phylogenetic analyses often use one tree, but in cases like this, it might be more advisable to consider trees supported by different data sets and combined-data trees independently, and to regard different scenarios supported by these trees as equally viable, while further information is collected to resolve remaining conflicts intrinsic to the data.

Romer Prize Session (Thursday, November 6, 2014, 11:45 AM)

INNOVATION, EXTINCTION AND RATES OF CLADOGENESIS IN EARLY AMNIOTES

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Tree shape analyses are a popular method of inferring the timing of shifts in the rate of cladogenesis and their location within the Tree of Life. Many such studies have attempted to infer a causal relationship between these diversification shifts and temporally coincident events such as the evolution within that clade of "key innovations". However, the evidence for such causal relationships is often circumstantial. It is more beneficial to first examine the more general patterns of cladogenesis and diversification within a larger group.

In this study I investigated the patterns of cladogenesis during the early evolution of the Amniota from the Carboniferous until the Triassic, testing whether diversification rate shifts tend to coincide with the appearance of evolutionary innovations. A supertree of amniote relationships was generated and subsequently subjected to an analysis of tree topology to infer the timing and location of diversification shifts. Origination rates within clades that have evolved evolutionary innovations such as herbivory and a secondarily aquatic lifestyle are compared to background rates. These analyses demonstrate that shifts in the rate of diversification within early amniotes tend to occur during periods of elevated extinction. There is a significant correlation between extinction rate and the number of substantial diversification shifts identified within the amniote phylogeny during each substage. Mass extinction events, such as Olson's extinction, the end-Permian mass extinction and a Ladinian extinction, all coincide with numerous and large diversification shifts. While there are shifts coinciding with the evolution of innovations and origination rates are higher within those clades that evolve innovations such as herbivory and an aquatic lifestyle, the elevation of origination rates again occurs during times of elevated extinction, rather than at the first appearance of such novelties. It is suggested that such innovations do not cause diversification shifts, but allow the survival and subsequent radiation of the lineage following extinction events. This study highlights the importance of performing such analyses on a larger scale to observe the general patterns of diversification before interpreting specific shifts.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE BRAINCASE OF *SATURNALIA TUPINIQUIM* AND THE EVOLUTION OF THE BRAINCASE IN SAUROPODOMORPHA

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The morphological disparity among sauropodomorph dinosaurs represents an interesting case to study morphological change within a lineage. The 'prosauropods', basal representatives of the group, were generally regarded as conservative with respect to their general morphology. Recent studies show that the evolution of the peculiar postcranium and feeding apparatus of the sauropods happened through a series of morphological transformations that took place within basal sauropodomorphs. However, the modification of the braincase from basal saurischians to sauropods has not yet been analyzed in detail in a phylogenetic framework. In this context, the braincase of *Saturnalia tupiniquim,* a basal sauropodomorph from the Late Triassic of Brazil, provides important information on the evolution of this complex structure within the lineage. *Saturnalia* shows a mixture of characters seen in basal and more derived sauropodomorphs. In lateral view, the components of the braincase floor are not aligned as in the basal sauropodomorphs *Efraasia* and *Pantydraco.* In *Saturnalia,* the occipital condyle is positioned above the level of the basal tuberae, and the latter slightly above the level of the basipterygoid processes and the parasphenoid rostrum, similar to the condition of more derived forms, such as *Plateosaurus.* As in *Efraasia* and *Pantydraco* the basipterygoid processes are shorter than the height of the braincase. However, in *Saturnalia,* the basipterygoid processes project not only ventrolaterally but also anteriorly. The basal tubera project ventrolaterally and there is a depression in the basiphenoid between them. In posterior view, this depression is continuous with an inverted V-shaped incision between the tubera. A unique condition of *Saturnalia* is the presence of a well-developed horizontal lamina projecting laterally in the basisphenoid, resulting in a concavity in the lateral wall of the bone in this region. Recoding braincase characters of *Saturnalia* in previously published datasets did not result in any substantial modification regarding the relationships of basal sauropodomorphs. However, initial comparisons with other taxa reveal the great potential of characters related to this part of the skeleton, which so far represents less than 5% of the characters employed in phylogenetic analyses of basal Sauropodomorpha.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

DENTAL DEVELOPMENT PRESERVES POPULATION FLUCTUATIONS IN WILD UNGULATES: THE PRESENT IS THE KEY TO THE PAST

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Although species abundance is notoriously difficult to ascertain from fossil assemblages because of biases in preservation (e.g., body mass or habitat preference), teeth may provide a window into relative population density. Mammalian teeth fossilize exceptionally well and are sensitive to metabolic stress during their formation, yielding an indelible record of an individual's health during development. In particular, the formation of enamel and dentine can be inhibited by food limitation, a condition that often characterizes high-density ungulate populations. To characterize the impact of food limitation on dental development, we focused on two exceptionally well-studied populations for which fluctuations in density and environmental factors are known: moose (*Alces alces*) of Isle Royale National Park, Michigan (born 1959 -1998) and elk or wapiti (*Cervus canadensis*) of Yellowstone National Park, Wyoming (born 1979-2009). Data from the study of 80 Isle Royale moose document a significant increase in enamel defects (hypoplasias) under high-density conditions relative to low-density on the island and mainland Ontario. Post-weaning enamel hypoplasias were unequally distributed across the crowns. Under high-density conditions, variance in mandible length increases as a result of a greater number of individuals with short mandibles in both sexes. A variety of osteological signs point to food limitation in 123 surveyed elk from Yellowstone, albeit at much lower frequencies than in the Isle Royale samples. Elk hypoplasias were not constrained to a particular tooth or cusp. Additionally, the elk teeth are distinguished by enamel that was chipped and subsequently worn during life. Tooth roots from a subset of the surveyed animals were histologically analyzed to examine the relationship between circadian dentine appositional growth rates and population density during the post-weaning period, an approach that generates a higher-resolution record of development. In conjunction with dental attrition data from predators, this two-part approach has the potential to elucidate the relative densities of extinct predators and their prey, a vital insight into the ecology of ecosystems in the past.

Romer Prize Session (Thursday, November 6, 2014, 11:30 AM)

QUANTITATIVELY TESTING EVOLUTIONARY MODES IN CENTROSAURINE CERATOPSIDS (ORNITHISCHIA, DINOSAURIA) FROM THE DINOSAUR PARK FORMATION (LATE CRETACEOUS) OF ALBERTA, INCORPORATING ANALYSES OF MISSING DATA IN MORPHOMETRICS, AND STRATIGRAPHIC UNCERTAINTY

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Discerning modes of evolution and patterns of speciation through deep time remain enduring questions in paleobiology. Recent work has focused on developing robust methods for testing and fitting evolutionary models to samples of fossils across stratigraphic axes to permit more rigorous testing of evolutionary hypotheses in the fossil record, but applications have largely been restricted to invertebrates.

Modes and mechanisms of Late Cretaceous dinosaur evolution are hotly debated since the proposal that North American diversity could be accounted for by high rates of anagenensis in few lineages. However, this hypothesis has yet to be tested in a statistically robust model-based framework. The fossil record of *Centrosaurus apertus* represents an ideal dataset upon which to quantitatively test these predictions due to large sample sizes from stratigraphically staggered monodominant bonebeds, with at least 16 bonebeds through 28 m of strata representing ~500 000 years. These bonebeds represent mass kills, allowing the unique possibility of measuring morphological variation in a time series of population-level samples. Analyses were also performed to quantify limitations such as missing data, small sample size, and stratigraphic error, and to inform best practices for overcoming them. Simulation studies of extant data indicate that removal of incomplete specimens introduces more error than proper estimation of missing landmarks, and document the rate of type I and II errors resulting from sample size.

Morphometric variables for the entire skull, nasal horn, postorbital horn, and parietal were tested against their stratigraphic occurrence utilizing traditional correlation methods and evolutionary model fitting using time-series analysis. This is the first implementation of these methods to a dinosaur sample, and one of the few studies possible in terrestrial vertebrates. Importantly, this is the first study of its kind to be carried out on an entire suite of non-dental skull characters, including diagnostic cranial ornamentation. Results find no support for a directed morphological change predicted by the anagenesis hypothesis, but indicate morphological stasis and/or stochasticity over the studied interval. These results are also robust to multiple simulations of stratigraphic uncertainty and error (i.e., down-cutting relationships), and indicate that the well-documented faunal turnovers in the Dinosaur Park Formation are likely due ecological replacement of related taxa due to habitat tracking during a transgressive cycle.

Preparators' Symposium (Saturday, November 8, 2014, 2:00 PM)

A BETTER MODEL FOR TEACHING PALEONTOLOGICAL LABORATORY METHODS IN NORTH AMERICA

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Laboratory training in paleontology has historically been limited to apprenticeship and on-the-job training models, with options for academic or professional credentials being non-existent in much of the world. The absence of standardized training has impeded opportunities for the professional development of career track laboratory workers. In contrast, similar fields, such as art conservation, have been practicing research based advances and training since the early 20th century. The Fogg Museum at Harvard established one such program in the same year as alandmark work on modern methods in paleontology. However, training in art and artifact conservation continued to expand through the rest of the century, resulting in graduate level university instruction supported by an active literature and professional organizations. In the modern era, it has only been in recent decades that paleontology methods have had a popular venue, through platform and poster presentations at professional meetings. Many of the techniques, philosophy, and best practices shared in these formats have not been committed to print outside of published abstracts.

To help facilitate the creation of a body of knowledge in the field, The University of Texas at Austin (UT) has coordinated several initiatives aimed at teaching core methods in laboratory, field, and collections practices. The cornerstone of this program is the Paleontological Lab Techniques course, now in its third semester of curriculum-based instruction; separated into lab and lecture components. This curriculum is based in part on past projects with California State University, San Bernardino, the United States National Museum, and the results of the 2011 Society of Vertebrate Paleontology Preparator's Grant Workshop. By formalizing the Paleontological Lab Techniques course, and proposing new field and collections courses in the Department of Geological Sciences, in addition to working with faculty in Anthropology and the Information School, UT has taken major steps forward in building an interdisciplinary program aimed at training the next generation of museum scientists.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A CLADE OF LONG-SNOUTED TYRANNOSAURIDS RANGED ACROSS ASIA DURING THE LATEST CRETACEOUS

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The iconic tyrannosaurids—the clade of large-bodied carnivorous dinosaurs including *Tyrannosaurus rex* and kin—were apex predators in Asia and North America during the final 20 million years of the Cretaceous. Their characteristic deep skulls and muscular jaws permitted extreme bite forces, thought to be key to tyrannosaurid success. Two peculiar specimens of *Alioramus* from Mongolia indicate that some tyrannosaurids may have had long and lightly built snouts, and thus a distinct bauplan and perhaps ecological niche relative to more conventional tyrannosaurids. Alternatively, because these rare and geographically restricted fossils are both subadults, they could instead demonstrate that a transient longirostrine growth stage occurred during the ontogeny of deep-skulled tyrannosaurids. We report new fossil and phylogenetic evidence that the long-snouted morphology is a genuine feature of a major subgroup of tyrannosaurids. A remarkable new specimen of a nearly complete, articulated tyrannosaurid from the Maastrichtian Nanxiong Formation of Ganzhou, southern China, exhibits the long-snouted morphology of *Alioramus*. The uniqueness of the long snouts in these specimens is confirmed by regression analysis, which demonstrates that they have significantly longer skulls relative to body size than all other tyrannosaurids. The new specimen is substantially larger (twice the estimated body size) and more skeletally mature than either *Alioramus* specimen, indicating that the longirostrine bauplan is not merely a juvenile condition. A comprehensive phylogenetic analysis of tyrannosauroids places the new specimen and both species of *Alioramus* into a novel longirostrine tyrannosaurid clade, which is now known from a ~3000 kilometer transect from Mongolia into southern China. This clade, therefore, was geographically widespread and formed an important and previously under looked component of Asian terrestrial ecosystems immediately prior to the CretaceousÂ□-Paleogene event, potentially as second-tier predators beneath the classic deep-snouted tyrannosaurids on the food chain. Long-snouted tyrannosaurids are unknown, however, from North America. The phylogenetic analysis places the long-snouted clade within the derived tyrannosaurid subclade Tyrannosaurinae, and alternative analyses slotting *Alioramus* outside of Tyrannosauridae may be due to an over-emphasis on characters relating to the deep skull shape of most tyrannosaurids.

Technical Session I (Wednesday, November 5, 2014, 11:45 AM)

GLOBAL REPATTERNING OF THE AXIAL SKELETON IN *TRICHECHUS* (SIRENIA, MAMMALIA)

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The generation of variation essential to the process of natural selection is constrained by the architecture of the developmental process. An example of evolutionary constraint is the nearly universal fixation of vertebral count at seven in the cervical column of mammals. With six cervical vertebrae, the genus *Trichechus* (manatee) has apparently broken this constraint, although the developmental mechanism of constraint escape is unknown. Developmental hypotheses of simple homeotic movement of the cervicothoracic boundary, the repatterning of abaxial relative to primaxial mesodermal components of the axial skeleton, and rib 7 repatterning make different anatomical predictions that can be tested. We documented cervicothoracic morphology, ossification patterns of vertebral neural arches and centra, axial skeleton regionalization, brachial plexus location, and the relationship of thoracic ribs 1 and 2 to the component parts of the sternum in a large data set of fetal and adult *Trichechus* and *Dugong* specimens. These observations forced rejection of all three hypotheses. We therefore propose an alternative developmental hypothesis, the global slowing of the rate of somitogenesis, resulting in reduced somite count and disrupted alignment of *hox*-generated anatomical markers relative to somite (and vertebral) boundaries throughout the column. This hypothesis is consistent with *Trichechus* morphology, but has been documented experimentally only in zebrafish. It also argues for the developmental independence of segmentation and axial regionalization. If supported, it suggests that *Trichechus* (like the tree sloths *Choloepus* and *Bradypus*) has followed a non-traditional route to an adaptive morphology (an elongated or foreshortened neck) that is accompanied by morphological disruption of other skeletal structures.

Technical Sesssion XII (Friday, November 7, 2014, 4:00 PM)

A SMALL ARCHOSAUROMORPH WITH ARCHOSAUR-LIKE FEATURES FROM THE MIDDLE-LATE TRIASSIC OF KYRGYZSTAN (CENTRAL ASIA)

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Reptile fossils from the lacustrine shales of the late Middle to early Late Triassic Madygen Formation of Kyrgyzstan, Central Asia, are famous for soft tissue preservation (e.g., *Longisquama*, *Kyrgyzsaurus*), but bones are often severely crushed and hard to interpret. Here we report an almost undeformed, articulated pelvis and hindlimb excavated in fluvial deposits of this unit. The new specimen with a femoral length of 84 mm possesses an anterior trochanter on the femur, a prominent cnemial crest on the tibia, and an ankle with a crurotarsan-like appearance. The articulation between astragalus and calcaneum is convex-concave (concavity on astragalus) and the calcaneum possesses a long, posteriorly-deflected calcaneal tuber and a ball-shaped fibular facet. However, several features suggest an assignment to non-archosauriform archosauromorphs, namely the short and plate-like pubis and ischium that together define a thyroid fenestra, a perforating foramen between astragalus and calcaneum, a large medial centrale that does not contact the tibia, and at least three distal tarsals.

A phylogenetic analysis including 14 archosauromorphs and 30 further amniote taxa finds the new reptile fossil nested within Archosauromorpha as the sister-taxon of a clade including rhynchosaurs, *Trilophosaurus*, *Prolacerta* and archosauriforms, but not protorosaurs. In addition, the most comprehensive available data matrix focused on basal archosauriforms finds the new specimen among its outgroup taxa and outside Archosauria. The affinities of the new specimen with the allegedly arboreal Madygen reptile taxa *Longisquama* or *Kyrgyzsaurus* cannot be properly determined because both genera are only known from anterior skeletons and their systematic position within diapsids is problematic.

Morphological disparity analyses find that multiple archosauromorph groups invaded a similar morphospace during the Middle-Late Triassic, including the new Madygen archosauromorph, early avemetatarsalians, and poposauroids. The convergently acquired archosaur-like features of the Madygen specimen seem to be functionally related to a semi-erect to erect posture, suggesting that it was a ground-dwelling reptile. The new Madygen archosauromorph clearly departs from the morphospace of other non-archosaur archosauromorphs and possibly represents a member of a previously unknown group of Triassic reptiles.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

RECONSTRUCTING MOLECULAR PHYLOGENIES OF EXTINCT VERTEBRATES USING COLLAGEN SEQUENCES

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We have previously demonstrated that collagen fingerprints can be obtained from extinct vertebrates and that they can be retrieved from sub-fossil material dating back to the Pliocene. Our early work investigated their potential as a tool to identify species from fragmentary material beyond the scope of ancient DNA techniques and the amenability of this technique to high-throughput species identification, culminating in a study that investigated ~14,000 bone fragments from a single archaeological assemblage (Pin Hole Cave, UK). However, we have more recently shown that the collagen retrieved has the potential for phylogenetic reconstructions.

Here we investigate the potential for the partial collagen sequences obtained by proteomics-based (LC-Orbitrap-MS/MS) techniques in recovering molecular phylogenies, and how they compare with known vertebrate phylogenies obtained from traditional morphological characterisation as well as more recent molecular phylogenies recovered from DNA sequence analysis. Case studies include a range of extinct megafauna from the Americas as well as biodiversity hotspots worldwide, including extinct taxa from the Caribbean and enigmatic megafauna from Madagascar. The results offer unique insights into the evolution of mammals that may only be possible from ancient protein sequencing and could equally be applied to a wide range of other Quaternary vertebrates.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

NEW LOCALITIES OF THE UPPER PERMIAN GLIDING DIAPSIDS (WEIGELTISAURIDAE) IN EUROPEAN RUSSIA

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Gliding reptiles of any kind are extremely rare in the fossil record. The oldest known gliding diapsids, Weigeltisauridae (Coelurosauravidae), are not exception to the common rule. Since the description of the first member of the family from Madagascar, no more then 20 specimens have been collected in the Upper Permian of Germany and the United Kingdom. Most of them were preserved as articulated skeletons, which had not been extensively disarticulated by biotic and abiotic factors during burial. All of the specimens, in fact, reflect occasional mortality and produce no significant concentration at the localities.

The first localities with accumulations of weigeltisaurids were discovered in Upper Permian of Russia (Orenburg Region) in 2005. Fossil remains of the gliding reptiles clearly predominate in this oryctocenosis, where the bones of other tetrapods are almost absent. The material collected consists predominantly of isolated bones. According to preliminary information, new localities contain hundreds animals of different ontogenetic stages. All remains were accumulated under subaqueous conditions in an open lake basin at a short distance from the land, after the animals fell into the water as a result of failed flight paths.

Based on this fragmentary material, a weigeltisaurid genus, *Rautiania,* was previously established. Despite its incompleteness, the new collections provide new information on the morphology of cranial and postcranial skeleton of weigeltisaurids. In addition, the ontogeny of Weigeltisauridae could be partially characterized for the first time based on the presence of animals of different individual ages in the accumulation.

Romer Prize Session (Thursday, November 6, 2014, 11:15 AM)

OSTEOLOGICAL, MYOLOGICAL, AND PHYLOGENETIC TRENDS OF FORELIMB REDUCTION IN NONAVIAN THEROPOD DINOSAURS

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Limb reduction and vestigialization have occurred multiple times in the evolutionary history of Tetrapoda, often related to a change in mode of locomotion. However, little is known about the functional shifts of reduced limbs or the morphological signals of vestigialization. The forelimbs of nonavian theropod dinosaurs diversified into a wide variety of morphologies including extreme reduction relative to body size, but whether these limbs were functional or merely vestigial is a matter of contention. Using phylogenetic inference in a statistical framework, I constructed a complete reconstruction of the pectoral and forelimb musculature of an early theropod to establish the plesiomorphic arrangement of the musculature in Theropoda and trace myological shifts in two theropod lineages exhibiting extreme forelimb reduction. Whereas the ceratosaurian lineage shows some signs of the advanced stages of forelimb reduction preceding limb loss, the forelimb musculature of derived tyrannosaurids was well developed despite reduction of the limb. Many of the myological features that characterize Tyrannosauridae correspond to relative development of some muscle groups and are not consistent with the hypothesis of a functionless limb. Patterns in the myological shifts allowed testing of existing functional hypotheses and show support for the demands of close-quarters grappling with struggling prey or a potential mate. I also investigated evolutionary trends of forelimb reduction using phylogenetic comparative methods to assess the allometric relationships of the forelimb, modeling various scenarios of forelimb evolution as Ornstein-Uhlenbeck processes to test for specific adaptive regimes within clades, and using Bayesian ancestral state reconstruction (ASR) to investigate the patterns of forelimb evolution over time. The phylogenetically informed regressions revealed an overall pattern of isometry of the forelimb across Theropoda. The best-fitting evolutionary model and the results of the ASR both show at least three distinct optima of relative forelimb length and demonstrate that the forelimbs of tyrannosaurs and ceratosaurs were undergoing active selection for their distinctive proportions. The results of these studies indicate that the reduced forelimb proportions and muscular development of some nonavian theropods were the result of selection for a suite of features allowing them to remain functional even at their small size, maintaining roles in prey acquisition, reproduction, or other intraspecific interactions.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A PHYLOGENETIC REANALYSIS OF *SIAMOSUCHUS PHUPHOKENSIS* FROM THE APTIAN OF THAILAND

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Modern crocodyliforms are characterized by a uniform body shape and semi-aquatic lifestyle. The extinct goniopholidids are neosuchian crocodyliforms known from the Jurassic and Cretaceous of Laurasia that are superficially similar to living crocodylians in body shape. To date, most of what we know of goniopholidid phylogeny and morphological evolution is based on North American or European specimens, but the group has also been reported from Asia. One putative Asian goniopholidid, *Siamosuchus phuphokensis* from the Aptian of Thailand, is based on substantial amounts of the skull and postcranial skeleton, and when first described, a phylogenetic analysis placed it closer to European *Goniopholis* than to North American goniopholidids. A new phylogenetic analysis, based on 301 morphological characters and 85 ingroup taxa, recovers *Siamosuchus* not as a goniopholidid, but as the sister to a clade including the longirostrine, estuarine-marine pholidosaurids and dyrosaurids. A monophyletic Goniopholididae (excluding *Siamosuchus*) was recovered and placed as the sister group to Eusuchia, with *Bernissartia* more closely related to Eusuchia than to Goniopholididae.

Education and Outreach Poster Session (Poster displayed November 5 – 8)

HAVE BONES WILL TRAVEL: BRINGING THE MUSEUM TO THE CLASSROOM

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Not all children have the opportunity to visit a museum. The solution to this dilemma is simple—bring a museum to them. The Paleo Porch Mini Mobile Museum houses a representative sample of invertebrates, dinosaurs, mammals, marine reptiles, and pterosaurs. The museum travels to school classrooms and public libraries for workshops and exhibits for people of all ages. Since its founding, I have presented talks at universities, secondary schools, and libraries. Paleo Porch is especially useful in getting science outreach to small rural schools that have little or no budget for large programs or field trips to natural history museums. Fossil casts and photographs allow school age children to see that there is more to education and science than portrayed within the walls of their schools. In addition to paleontology, the fossil casts allow students to make connections between fossils, dinosaurs, and other topics such as mathematics, history, and art. By using paleontology to bridge the worlds of science and humanities, nearly every student comes away feeling they have learned something particular to their interest. The true power paleontology has as science outreach lies in its natural interdisciplinary state. Most students are already familiar with dinosaurs and other fossils, so it is simply a manner of connecting their knowledge to the subjects they are studying in almost any class. When physics and geometry are used to reveal how prehistoric animals move, they suddenly become more interesting. Social media platforms allow a constant interaction with the public, which is especially useful in building excitement for upcoming events as well as maintaining contact after an exhibition has ended. Such a platform paired with physical models and casts create a dynamic interaction with almost endless possibilities. The success of this project and outreach program can serve as a model for other regional mini mobile museums, as a single venture could never visit all the schools and libraries that need this type of outreach.

Education and Outreach Poster Session (Poster displayed November 5 – 8)

UNDERGRADUATE RESEARCH AND CITIZEN SCIENCE AT THE DANEK *EDMONTOSAURUS* BONEBED, AN URBAN DINOSAUR LOCALITY

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The Danek *Edmontosaurus* Bonebed is a large, monodominant late Campanian assemblage exposed along the Whitemud Creek, within the city limits of Edmonton, Alberta, Canada. Discovered by Danek Mozdzenski while walking his dog, the site was first investigated by the Royal Tyrrell Museum of Palaeontology in 1989, followed by excavation using a backhoe in 1991. The site lay dormant until 2005, when it was investigated by the University of Alberta Laboratory for Vertebrate Palaeontology. Since 2005, the bonebed has been annually excavated by hand, yielding almost 700 catalogued specimens that form an important, single locality collection in the vertebrate fossil collections housed at the University of Alberta. Because of its location and easy site access within the urban center of Edmonton, the Danek Bonebed has served as the site for numerous student and public outreach programs. A university field school (PALEO 400) instructs students in data collection, field excavation techniques, and primary curation. Students also have the opportunity to undertake meaningful research on topics related to aspects of the bonebed and present them for academic scrutiny; many of the topics generated in this manner form the basis for contributions to an in-progress special issue of the Canadian Journal of Earth Sciences. Additionally, BP Canada Energy Company partnered with the University of Alberta for three years to help fund the field school program, and in return employees of the company were eligible to volunteer at the excavation for one-week periods.

An overwhelming abundance of material collected at the site led to the creation of a volunteer fossil preparation program at the University of Alberta's "DinoLab". Begun in 2007, this programme, supervised by university students, has in the last two years alone benefited from over 3500 hours of time given by 190 volunteers (including both students and the general public). Poorly consolidated sediments and good fossil preservation have yielded specimens that can be easily prepared by novices. Besides producing highly useful finished elements, the volunteer program has helped to free up a great deal of critical storage space, and produced a cadre of highly motivated individuals who also contribute their time to other projects within the research program. Volunteers are recruited via print and digital signage around the university, and influxes of new volunteers frequently follow major news stories about our lab. A DinoLab Facebook page keeps volunteers up to date on yearly fieldwork, research news, and lab events.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

INTERNAL CRANIAL ANATOMY OF NODOSAURID ANKYLOSAURS (DINOSAURIA: ORNITHISCHIA)

BURNS, Michael, University of Alberta, Edmonton, AB, Canada, T6G 2E9; CURRIE, Philip, University of Alberta, Edmonton, AB, Canada

Due to the extensive ossification of the skulls of armoured dinosaurs, little is known about their internal cranial anatomy. Although computed tomography (CT) scanning has greatly improved our understanding of the morphology of this region in ankylosaurs, such methods have not been able to reveal fine details of this anatomy in nodosaurs. In addition, although the braincase has been described for nodosaurids, there have been few descriptions of cranial endocasts. Here we describe the detailed anatomy of the nasal cavity, endocranium, and otic region in Late Cretaceous nodosaurids.

Impressions on the roof of the nasal cavity demonstrate two loops, anterior and posterior, to the airway that have been described previously for nodosaurids based on a 3D CT scan reconstruction. Vascular impressions show that the anterior portion of the airway was highly vascularized, with several prominent parasagittal vessels extending along and perforating the skull roof in this region. The posterior portion of the airway, unlike in *Euoplocephalus*, shows no vascular grooves, indicating that the mucosa was not intimately appressed to the bone or that this region was poorly vascularized.

Just anterior to the orbits, the airway is flanked by two posterolateral chambers. As in *Euoplocephalus*, olfaction may have been restricted to these posterolateral chambers. Olfactory turbinates within these chambers are similar to those reported for *Euoplocephalus*. Furthermore, because the medial airways were not involved with this sensory function, the dense anterior vascularization likely served in counter-current heat exchange and/or osmoregulation. This hypothesis is supported here in nodosaurids by the extensive blood supply to the anterior non-olfactory portion of the nasal vestibule, although an additional acoustic function cannot be dismissed. Extensive blood vessel irrigation in the looping part of the nasal cavity has been reported for *Euoplocephalus* and another nodosaurid specimen. Cranial endocasts in *Euoplocephalus* show little variation, and so endocranial anatomy can serve as an important source for taxonomic/phylogenetic characters in derived nodosaurs.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

ISSUES OF HOMOPLASY AND SUPPORT IN PHYLOGENETIC ESTIMATION AS EXEMPLIFIED BY A NEW TESTUDINOID TURTLE FROM THE MIOCENE (CLARENDONIAN) OF CALIFORNIA

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Phylogenetic relationships within Testudinoidea, the clade containing the majority of extant turtle diversity, remain uncertain. Two issues affect resolution of phylogenetic relationships in this clade: selection of an appropriate outgroup, because ingroup taxa are quite divergent, and resolution of the relationships between pond, river, and box turtles contained within the group. Historically, two clades of aquatic and box turtles have been recognized, the North American and European Emydidae and the South American and Asian Geoemydidae. Recent phylogenetic analyses of both molecular and morphological data have suggested that these two groups in fact may not be distinct monophyletic clades. Because they can preserve combinations of character states not found in extant taxa, fossils have an important role to play in helping to solve this problem. Here we report a new fossil turtle from the Blackhawk Quarry (Miocene of California). This fossil was originally identified as a specimen of the extant pond turtle, *Emys marmorata*, found in western North America. However, the shell shape of the fossil, including its flat dorsal surface, shows that the specimen is distinct from *E. marmorata*. The specimen has a distinct suite of characters that it shares with both emydids and geoemydids including: lack of mid-dorsal keel (emydid), a first vertebral that is wider than long (emydid), and a square posterior margin of the plastron (emydid and geoemydid). When included in a morphology-based phylogenetic analysis of all extant genera found in Testudinoidea the phylogenetic placement of this taxon is inconclusive. This lack of resolution is likely driven by high levels of convergence with respect to shell characters used to identify taxa in both clades. Particularly with respect to aquatic testudinoid taxa, a high degree of convergence is known to occur in shell shape as a result of hydrodynamic efficiency. This taxon also impacted previously resolved relationships of aquatic emydid taxa. Because the fossil has a mix of emydid and geoemydid characters, groups that were united by each of those characters are no longer recovered. This underscores the continued need to investigate both fossils and extant specimens to identify a robust set of morphological characters for phylogenetic estimation within turtles.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

NEW CLADE OF ENIGMATIC EARLY ARCHOSAURS YIELDS INSIGHTS INTO EARLY PSEUDOSUCHIAN PHYLOGENY AND THE BIOGEOGRAPHY OF THE ARCHOSAUR RADIATION

BUTLER, Richard, University of Birmingham, Birmingham, United Kingdom; SULLIVAN, Corwin, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; EZCURRA, Martin, University of Birmingham, Birmingham, United Kingdom; LIU, Jun, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; LECUONA, Agustina, Museo Paleontológico "Egidio Feruglio", Trelew, Argentina; SOOKIAS, Roland, University of Birmingham, Birmingham, United Kingdom

The origin and early evolutionary radiation of archosaurs and their close relatives (Archosauriformes) during the Triassic was a critical event that led to the dinosaur-dominated ecosystems of the Jurassic and Cretaceous. The timing and dynamics of this evolutionary radiation are currently obscured by the poorly constrained phylogenetic positions of several key early archosauriform taxa, including several species from the Middle Triassic of Argentina (*Gracilisuchus stipanicicorum*) and China (*Turfanosuchus dabanensis*, *Yonghesuchus sangbiensis*). Morphological phylogenetic analyses of early archosaurs have identified these species as unstable 'wildcards' that reduce phylogenetic resolution. We present new anatomical data for the type specimens of *Gracilisuchus*, *Turfanosuchus*, and *Yonghesuchus*, and incorporate these data into a revised phylogenetic analysis. Our results indicate that these three previously enigmatic taxa form a well-supported clade of Middle Triassic archosaurs that we refer to as Gracilisuchidae, which is placed basally among suchian archosaurs. The approximately contemporaneous and morphologically similar *Gracilisuchus* and *Yonghesuchus* may be sister taxa within Gracilisuchidae. Our results provide increased resolution of the interrelationships of early archosaurs, with increased levels of phylogenetic support for several key early pseudosuchian clades. Moreover, they falsify previous hypotheses suggesting that *Turfanosuchus* and *Yonghesuchus* are not members of the archosaur crown group. The recognition of Gracilisuchidae provides further support for a rapid phylogenetic diversification of crown archosaurs by the Middle Triassic. The disjunct distribution of the gracilisuchid clade in China and Argentina supports the hypothesis that early archosaurs were distributed over much or all of Pangea, although they may have initially been relatively rare members of faunal assemblages.

Romer Prize Session (Thursday, November 6, 2014, 11:00 AM)

BIOMECHANICAL INSIGHTS INTO THE CRANIODENTAL EVOLUTION OF SAUROPODOMORPH DINOSAURS

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The Sauropodomorpha included the largest known terrestrial vertebrates and were the first dinosaur group to achieve a global distribution by the Early Jurassic. This success is often attributed to the early adoption of a herbivory by the group. Whilst basal 'prosauropods' were relatively unspecialized omnivores, the origin of Sauropoda is associated with characters hypothesized to have increased cranial robusticity as part of a shift towards bulk-feeding and obligate herbivory. Derived diplodocoid and titanosaur lineages then show convergent characters hypothesized to represent functional convergences towards a specialized diet.

To test these hypotheses in a rigorous biomechanical context, 31 craniodental biomechanical characters measured from 60 taxa were subjected to Principal Coordinate analysis to yield a multivariate 'functionspace'. 'Prosauropod' taxa are characterized by gracile jaws and low relative bite forces. However, they show significant disparity potentially related to variation along the omnivory-herbivory spectrum. A functional shift towards increased cranial robusticity and mandibular mechanical advantage is observed at the base of the Sauropoda, culminating in gravisaurians with the development of dental occlusion, consistent with a shift towards bulk-feeding on coarse plant matter. Whilst more basal eusauropods remained adapted towards accommodating high bite forces the diplodocoids and titanosauriforms show convergent functional trends towards lower bite forces, more gracile jaws and shearing dentitions. However the Diplodocinae remain functionally distinct from all other taxa. Finite-element modelling of the skulls of the exemplar taxa *Plateosaurus, Camarasaurus* and *Diplodocus* reinforce these results. The skull of *Camarasaurus* is 'stronger' under static biting and exhibits higher bites force due to osteological and myological specializations. These functional differences between the sympatric *Camarasaurus* and *Diplodocus* would have formed the basis of niche partitioning between them.

Modelling of biomechanical character evolution demonstrates no change in evolutionary rate associated with the functional shift at the base of Sauropoda or Titanosauria. However, a significant increase to above-background levels is observed within Diplodocoidea resulting in the exceptional disparity observed in this clade.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

NEW COELUROSAURIAN THEROPOD REMAINS FROM THE UPPER CRETACEOUS MUSSENTUCHIT MEMBER OF THE CEDAR MOUNTAIN FORMATION, CENTRAL UTAH

BUTTON, Khai, North Carolina State University, Raleigh, NC, United States of America, 27612; ZANNO, Lindsay, North Carolina Museum of Natural Sciences, Raleigh, NC, United States of America; MAKOVICKY, Peter, Field Museum of Natural History, Chicago, IL, United States of America

The Cedar Mountain Formation is comprised of five members spanning approximately 30 million years of dinosaur evolution in western North America. The sequence is of particular interest for bracketing the transition from Early to Late Cretaceous vertebrate faunas in the region and for refining the appearance of taxa with putative Asian affinities. Recent work continues to reveal new information about the diversity, paleobiogeography, and extinction patterns of theropods in the otherwise poorly understood mid-Cretaceous gap. To date, the best species-specific theropod record derives from the Aptian-aged Yellow Cat Member, which preserves the large-bodied dromaeosaurid *Utahraptor*, the primitive therizinosaurian *Falcarius*, and the indeterminate coelurosaurian *Nedcolbertia*. However, the greatest diversity record stems from the youngest and westernmost unit, the Cenomanian-aged Mussentuchit Member. Intensive sampling of teeth from microvertebrate localities in the Mussentuchit indicates the presence of a diverse theropod fauna minimally comprised of dromaeosaurids, troodontids, tyrannosauroids, avialans, and putative therizinosaurians.

Recent expeditions to the Mussentuchit have generated new data on the theropods inhabiting North America at the dawn of the Late Cretaceous, including discovery of the Cenomanian megapredator *Siats meekerorum*. However, much remains to be learned about the small theropod fauna at this time. Here we describe the hind limb osteology of a new, gracile species of coelurosaurian theropod with an estimated hip height of 1.2 meters. The specimen is an associated right hind limb consisting of a partial femoral shaft, nearly complete tibia, distal two-thirds of metatarsal IV, and pedal phalanges IV-2 and IV-4. The tibia possesses a robust and acuminate cnemial crest. The pes is slender, arctometatarsalian, and the metatarsus extends over 230 mm in length. Metatarsal IV most resembles *Coelurus* (YPM 2010) from the Upper Jurassic Morrison Formation in general proportion, mediolateral compression of the distal aspect, and near absence of a lateral collateral ligament pit, yet is unique in possessing an obliquely oriented groove marking the extensor surface and a dorsally bulbous distal condyle. Additional small theropod material from the Mussentuchit may help solidify the taxonomic affinities of several indeterminate, basal-grade coelurosaurians from the Jurassic-Cretaceous transition in North America.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

WHY THE *ALLOSAURUS* WENT EXTINCT: AN ASSESSMENT OF A MESOZOIC 'JUST-SO STORY'

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The biotic transitions from the Late Jurassic to Early Cretaceous and from Early Cretaceous to Late Cretaceous have been the subject of considerable research, especially on the North American faunas from those periods. While most work has focused on herbivorous dinosaur biodiversity (the decline in sauropod abundances and the radiation of derived ornithischians), assessments of the carnivorous biota have received less attention due to the scarcity of fossil material from the Early Cretaceous: the decline of the allosaurids and their replacement by tyrannosaurids at the apex of the food chains has always been characterized as a simple biotic replacement. Recent fossil discoveries have qualitatively supported this model, showing that the extinction of the allosaurid theropods allowed the tyrannosauroids to radiate and fill vacant predatory niches. Preliminary results from quantitative maximum likelihood models of changing global morphologic disparity illustrate passive, stochastic processes acting within the evolutionary lineages of both coelurosaurian theropods and non-coelurosaurian tetanurans. These global patterns, when corrected for phylogenetic incompleteness, show substantial increases in trait variances that are independent of taxonomic diversity, supporting a hypothesis of ecological release, in which stratigraphically younger taxa filled the void when the older taxa became extinct. Whether or not this was driven by a decline in sauropods and a diversification of ornithischians that resulted in a change in predatory strategy is difficult to assess, but these results provide some support for one of the classic evolutionary stories from the Mesozoic.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A NEW PROTOSTEGID TURTLE FROM THE EARLY CRETACEOUS (LATE BARREMIAN) OF COLOMBIA, AND THE PHYLOGENY AND EVOLUTION OF SKULL SIZE IN MARINE TURTLES RADIATIONS

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We present here a new protostegid turtle from the Early Cretaceous (late Barremian) of Colombia, represented by an almost complete skeleton (skull, lower jaw, and postcranium) and five additional skulls with lower jaws. This new protostegid was found in marine shales of the middle segment of the Paja Formation, at the town of Villa de Leyva, BoyacáDepartment, Colombia, and constitutes the earliest record so far known for protostegids. We add the new taxon and almost all complete Cretaceous protostegids to a new modified global character-taxon matrix of turtles, running different phylogenetic analyses considering percentage of missing data for characters and molecular scaffold. The new taxon is found to be most closely related to *Desmatochelys lowi* (a protostegid from the Late Cretaceous sequences of North America). Contrasting with recent hypotheses, protostegids are found to be most closely related to the Dermochelyidae (the extant *Dermochelys* and its fossil relatives). If protostegids are within crown-group Chelonioidea, then the new taxon would be the oldest known member of that clade. However, we urge caution on this interpretation, as other data suggests that this result may be an artifact of convergent pelagic specializations among marine turtles. We also study the change in skull size through time for the taxa included in the phylogenetic analysis showing that the cranial gigantism in turtles started at the Late Jurassic-Early Cretaceous in at least two different lineages (protostegids and trionychoids). Funding from the Paleontological Association Research Grant, Welles Research Fund UCMP, Paleontological Research Institution grant, Chicago Herpetological Society, Western Interior Paleontological Society, and Alexander von Humboldt Foundation Germany.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

EXPLORING DEVELOPMENT IN THE FOSSIL RECORD WITH ANCESTRAL STATE RECONSTRUCTION OF CRANIAL APPENDAGES

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Horns, antlers, ossicones, and pronghorns (cranial appendages) present an unresolved evolutionary mystery: their presence is a defining characteristic of many terrestrial even-toed hoofed mammals, or artiodactyls, yet the evolutionary transformations and even the homology of different appendage types are unclear. Hypothesized interrelationships of artiodactyl families profoundly influence the interpretation of cranial appendage homology, and implementation of combined evidence morphological and molecular phylogenies have provided new topologies to study the origins and evolution of these enigmatic structures. Morphological disparity arises through changes in the timing, direction, or rate of development of structures; however, few studies of cranial appendages focus on developmental explanations of their morphological diversity. The major challenge of studying development in the vertebrate fossil record is the rare preservation of ontogenetic series of individuals and the typical inability to observe soft tissues and behaviors in fossils. Ancestral state reconstructions offer a powerful yet underutilized tool for studying development in the fossil record, through the inference of past characters and their changes from evidence of traits in extant relatives. Correlations of these developmental characteristics with morphological changes suggest proxies for the study of behavioral and soft-tissue characters that would be otherwise unavailable for extinct taxa.

This study tested the hypothesis that horn shape and size correlate with the onset of sexual maturity, or the ability to reproduce. I compiled published data for cranial appendage size and shape, reproductive strategy, and the timing of sexual maturity. Correlations between these data were explored using a variety of mapping and statistical methods to determine if predicted patterns withstand testing using different analytical methods as well as phylogenetic topologies. Results suggest correlations between cranial appendage length relative to body mass and the age at which animals show initial signs of sexual maturity. Such analyses of artiodactyl cranial appendage evolution may provide evidence for the importance of heterochrony in the origin of the remarkable diversity of cranial appendages in extinct and extant members of this clade. These techniques also are applicable to a wide variety of problems in which unpreserved important biological traits have shaped the diversity of morphology in the past and present.

Technical Session IX (Thursday, November 6, 2014, 3:00 PM)

THE OLDEST KNOWN FOSSIL SNAKES: A TEMPORAL RANGE EXTENSION OF 70 MILLION YEARS

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Previous reports identifying the oldest known fossil snake specimens were based on isolated vertebrae from sediments in North Africa and North America (Albian to Cenomanian: ~105-100 Ma). Bathonian (Middle Jurassic; 167 Ma) to Barremian (Lower Cretaceous, 143 Ma) squamate fossils from Colorado, Portugal and England are here recognized as the geologically oldest known fossil snakes, extending the fossil record of snakes by approximately 70 million years. The cranial, dental and postcranial anatomy of these well-preserved but fragmentary fossil snakes indicates that the basic architecture of the modern snake skull and dentition had evolved as early as 167 million years ago. These oldest fossil snakes show unmistakable features of the snake skull (e.g., recurved teeth with labial and lingual carinae, teeth attached to margins of distinct alveoli with interdental plates, long toothed suborbital ramus of maxillae, laterally emarginated dentary, well developed descensus frontalis with suboptic shelves). There are also several lizard-like features (e.g., pronounced subdental shelf/gutter, multiple mental foramina on the dentary) as would be expected in early snakes not long after their divergence from a lizard ancestor. These vertebrae show critical similarities to much younger Mesozoic snakes such as *Coniophis*, *Dinilysia, Najash, Pachyrhachis*, *Simoliophis,* etc., and to all extant snakes (e.g., wide neural arch, low neural spines, prominent arcual ridges well developed zygosphenes, zygosphenal tectum with festooned anterior margin, condyles and cotyles are circular and offset from centrum ventral margins that are strongly rectangular in outline, with a squared margin immediately anterior to the condyle). The paleobiogeography (e.g., islands in epicontinental seas and continental Laurasia) and paleoecology (e.g., coal swamps, lacustrine and fluvial systems) of these earliest snakes is diverse and complex, and suggests that snakes had already undergone significant habitat differentiation and geographic radiation by the mid-Jurassic. Phylogenetic analysis recovers these early snakes as basal to all other snakes (fossil and modern). The snake origins debate, both in terms of ancestral forms and environments, is strongly impacted as these most ancient snakes show unexpected anatomies and paleoecologies.

Technical Session IX (Thursday, November 6, 2014, 2:15 PM)

EVIDENCE OF CONVERGENCE IN THE MIDDLE EAR ANATOMY OF LATE CRETACEOUS MOSASAUROIDS (SQUAMATA)

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Approximately 95 million years ago, the terrestrial, impedance matching squamate ear of mosasauroid lizards responded to radical adaptive pressures when they transitioned from the land to the sea. The evolutionary transformations of the mosasauroid auditory system are poorly understood, in part because the middle ear osteology is seldom completely preserved in any one specimen. Fortunately, several mosasauroid specimens have been found preserving some or all middle ear elements in articulation. Their combined data reveal a unique and very massive middle ear skeleton. The curved quadrate conch cups a large, flattened extracolumellar element made of a greatly expanded and fused pars superior, pars inferior, anterior processes and posterior process. This quadrifurcation meets, tapers and extends through the stapedial notch. Continuing internally, the extracolumellar shaft meets the process internus, an element that articulates with the stapedial pit of the quadrate - a feature unique to higher mosasauroids. The shaft of the process internus appears to continue internally for some distance until tapering medially to meet the delicate, ossified columella. Our observations provide no evidence for the presence of a tympanic membrane - the greatly expanded and calcified extracolumella lies beneath the epidermis and dermis in a position approximating that of the ectodermal tympanum of extant terrestrial lizards; this is potential evidence for the functional replacement of the tympanic membrane by a bony plate as seen in other large secondarily aquatic groups (such as cetaceans and phocid seals). These data suggest that mosasauroids had a derived underwater ear, where sound reached the inner ear through the skin, extracolumellar plate, quadrate, and middle ear ossicles. It is unlikely that derived mosasauroids retained any capacity for impedance matching with such a massive middle ear skeleton. It is possible that early transitional mosasauroids retained the terrestrial, impedance matching ear and used bone conduction underwater. This refinement of mosasauroid middle ear anatomy has important implications for the evolution of the aquatic ear in squamates and for acoustic convergence with other secondarily aquatic taxa.

Technical Session XIV (Saturday, November 8, 2014, 9:00 AM)

QUANTIFYING BODY SIZE EVOLUTION IN ORNITHOPOD DINOSAURS

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Dinosaurs span the largest size range of any terrestrial vertebrate and have thus become a model for investigating patterns of body size evolution in deep time. Here we examine body size evolution in ornithopod dinosaurs within a comprehensive phylogenetic context for the first time. This group spans four orders of magnitude in body mass, has an extensively sampled fossil record, and includes multiple putative cases of gigantism and dwarfism. Thus, ornithopods are a model clade for testing Cope"s Rule and incidences of insular dwarfism within a phylogenetically and morphologically constrained clade. Based on a dataset of 89 ornithopods (~75% of known diversity), we apply a series of phylogenetic comparative methods to test these long-standing hypotheses, including ancestral state reconstructions and model-fitting techniques.

Analyses found little support for insular dwarfism in ornithopods. Notably, the famous "dwarf" hadrosaurid, *Telmatosaurus transsylvanicus*, is recovered as being

primitively small-bodied. Patterns within rhabdodontids are equivocal, and contingent on phylogenetic resolution of putative rhabdodontid *Muttaburrasaurus*. Overall patterns support a tendency for ornithopods to increase in size throughout their evolutionary history. However, a detailed examination of evolutionary model-support using a novel iterative approach ascending the main stem of the tree indicates that characterizing body size evolution as a simple single trend is a considerable oversimplification. Our analyses recovered two incidences of rapid bursts of body size evolution in ornithopods. The first, and strongest, burst occurs in the early stages of ornithopod evolution, near the origin of Iguanodontia. It correlates with a rapid increase in upper body-size limits in this clade, and may be due to ecological release associated with sauropod extinctions in Laurasia at the end of the Jurassic. The second rapid burst is near the origin of Hadrosauridae and, although a more detailed investigation is required, may support a key innovation in the emergence of an efficient oral processing mechanism. On a broader scale, support for early-burst models of evolution in ornithopods contradicts recent studies on extant taxa proposing that such patterns of evolution are rare in the history of life. As a result, our study adds to the mounting evidence that understanding tempo and mode of evolution requires the deep time perspective offered by the fossil record.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

INSIGHTS INTO THE PALAEOBIOLOGY OF MIDDLE PERMIAN PAREIASAURS FROM STABLE LIGHT ISOTOPE ANALYSIS AND BONE MICROSTRUCTURE

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Pareiasaurs were abundant in Permian terrestrial ecosystems, yet many aspects of their biology remain debated. Earlier studies based on anatomical and taphonomical work suggested that these parareptiles had a short juvenile period. Ecological hypotheses have included aquatic to fully terrestrial lifestyles.

Long bone microstructure and stable light isotopes are tools used to assess aspects of tetrapod palaeobiology. Although bone histology has been extensively applied to the non-mammalian therapsids from the vertebrate fossil-bearing sequence of the Karoo Basin, South Africa, very few studies have been conducted on parareptiles. A few stable isotope studies have been reported for middle and late Permian dicynodonts, but our study represents the first for middle Permian parareptiles and coeval dinocephalians and therocephalians.

Through complementary analyses of pareiasaurian long bone microstructure and stable isotopes we assessed previous interpretations pertaining to their palaeobiology. In order to document growth patterns, lifestyle adaptations and bone histovariability of these animals, our study material encompasses a diversity of South African pareiasaurs. The isotopic data was obtained from the enamel, dentine, and bone of pareiasaurs and contemporaneous therapsids (dinocephalians and therocephalians) recovered from middle Permian deposits of South Africa.

The bone histology studies suggest that the diversity of middle Permian pareiasaurs may have been underestimated, and that they experienced a rapid growth early in ontogeny, which later slowed down and became periodically punctuated. The bone microanatomy assessments along with oxygen stable isotope analyses reveal that middle Permian pareiasaurs were terrestrial.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

A PALEOBIOGEOGRAPHIC APPROACH TO THE VALLESIAN MAMMAL TURNOVER AT A CONTINENTAL SCALE

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The late Miocene brought about the aridification of most of the Mediterranean environments. Nevertheless, the Vallès-Penedès basin (Catalonia, Spain), escaped this harshening and held humid and forest-adapted faunas until around 9.6 Ma. By combining large datasets of macro- (817 localities and 99 genera) and micromammals (456 localities and 107 genera), we elucidate the broader context of this biogeographic and ecological uniqueness. To visualize the Vallesian turnover through time, we mapped Raup-Crick similarity indices of all the localities to Can Llobateres 1, which is the reference locality of the MN9 and represents the apex of the Vallesian faunas. Our results suggest that the waxing of the Vallesian faunas is slightly decoupled in macro- and micromammals. For the micromammals, the first Vallesian elements are observed in Central Europe during MN5. The first Vallesian-related macrofauna appeared in Central Europe in the MN6, although patterns are less clear than for the micro. During the MN7–8, the pattern became sharper for both groups, with a clear Eastern Mediterranean province and a Central European one, which in turn includes the Vallès-Penedès. Many Vallesian relicts were inherited from the Aragonian, rendering a high resemblance between the MN7–8 faunas and the Vallesian. At this time, the Vallesian-related macrofauna had completely spread across the Iberian Peninsula, while the entrance of the Vallesian microfauna into Iberia is restricted to the Vallès-Penedès basin, differentiating an inner Iberian province. Whereas the Vallesian faunas became widespread in Western Europe in the MN9 and MN10, their geographic range began to shrink from the east, as the more arid-adapted Pikermian faunas spread. The disappearance of the Vallesian microfauna had already culminated by the MN11, with some scarce relicts in Central Europe. However, a significant part of the Vallesian macrofauna persisted in Iberia and Central Europe in the MN11, its presence being sporadic during the MN12 and MN13.

Preparators' Symposium (Saturday, November 8, 2014, 2:30 PM)

IMPROVING EFFICIENCY AND OUTPUT OF INDOOR SCREEN WASHING FACILITIES

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Microvertebrate fossil localities, or microsites, have always been an integral part of the research program at the Royal Tyrrell Museum of Palaeontology (RTMP). The museum's screen washing facility has gone through many alterations since the RTMP was founded in 1985. In the 1980's and 1990's, the majority of the museum's screen washing was done in the field, utilizing water sources near the microsites or using plastic bins onsite. In 2005, all of the RTMP's screen washing was moved indoors due to the restrictive field season in Alberta. An indoor setting is ideal for screen washing because it can be conducted year-round in a controlled environment. However, space, water supply, and the frequency and ease in which sediment that has already passed through the screens can be removed are all factors that have to be considered when an institution is setting up an indoor screen washing facility. The RTMP has addressed some of these issues by using plastic recycling bins with wheels and livestock watering troughs on elevated wooden platforms with heavy-duty castors to hold the water for screen washing and allow for easy transportation of screened sediment outside for dumping. Since 2012, all screen washing boxes have been built using plastic siding and stainless steel components as a long term replacement for the aging wooden screen washing boxes. Increasing the number of usable boxes is critical for increasing efficiency since indoor labs do not have access to the sun and wind to accelerate the drying of microvertebrate matrix. Extra boxes allow screens to be changed out while previously washed matrix finishes drying. The RTMP has experimented with several different techniques to try and increase the efficiency of their indoor screen washing facility, including using bubblers, shaker screens, and garden sprinklers. While many institutions have had great success with each of these methods, the RTMP has cast off each of these approaches, largely due to the difficulty of long-term maintenance. Since 2013, the RTMP has been washing all microvertebrate concentrate in three percent hydrogen peroxide to further reduce the microvertebrate matrix concentrate that needs picking. The RTMP currently has 61 screens, with 12 troughs, in two rooms, allowing the museum to process over 12 metric tons of material in the last two years. Although this represents a large-scale, indoor screen washing facility, any institution can reap the benefit from indoor screen washing by optimizing their set-up in any space that is available.

Symposium 1 (Wednesday, November 5, 2014, 10:15 AM)

***ARCHAEOPTERYX* IN 4D**

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From x-ray scanning to scanning electron microscopy (SEM), technological advances have greatly expanded the scope and scale of imaging fossil material, providing for reconstructions of digital 3D anatomy and even original coloration. Here we report on both such spatial and spectral reconstructions of *Archaeopteryx*. First, we revisit the available evidence involving the original color of the isolated feather (MB.Av.100), particularly with respect to two recent alternative interpretations: namely, that the feather was both black and white, and that the fossilized microbodies therein represent microbes instead of melanosomes. Based on new molecular evidence for the preservation of melanosomes in fossil integument using time-of-flight secondary ion mass spectrometry, as well as SEM results on the location of eumelanosomes in the feather, we reaffirm our original conclusion that the *Archaeopteryx* feather was black with a greater degree of melanization at the distal tip. Additionally, this black color was likely matte and not iridescent, based on the lower mean aspect ratio of the melanosomes (3.9 ± 0.1 SE; $n = 108$).

Preliminary results will also be shared from the 3D *Archaeopteryx* Project, which involved multiplanar x-ray microtomosynthesis of the Thermopolis specimen (WDC-CSG-100) at the Lawrence Livermore National Laboratory in Livermore, California. This scanning procedure yielded high-resolution digital datasets comprising the entire skeleton, which were subsequently segmented using Avizo Fire software (FEI). Complementary surface data was also acquired using photogrammetry of the London specimen (NHMUK PV OR 37001). Results provide new insights into the pneumatization of *Archaeopteryx* as well as characters of biomechanical importance, such as a previously undescribed bifurcation of the scapular acromion process that buttressed the robust furcula and stabilized the pectoral girdle. The 3D *Archaeopteryx* Project was funded by grants from the National Science Foundation (EAR-0917538 to RMC and JAG; GRFP to RMC), Sigma Xi (GIAR to RMC), and the Society for Experimental Biology (COB to RMC), and supported by a software donation from FEI.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A NEW SPECIES OF *DASPLETOSAURUS* FROM THE UPPER TWO MEDICINE FORMATION (LATE CAMPANIAN, CRETACEOUS) OF MONTANA AND EVIDENCE FOR ANAGENESIS IN TYRANNOSAURINE EVOLUTION

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The taxonomic identity and phylogenetic position of an undescribed tyrannosaurine from the upper Two Medicine Formation (TMF) of Montana are longstanding paleobiological questions. This taxon is important given its pivotal geological position, which is intermediate in age between units that have well-sampled and well known

tyrannosaurids, such as the earlier portions of the Dinosaur Park Formation (DPF), and the later Horseshoe Canyon (HCF) and Hell Creek Formations. It has been hypothesized that the dinosaur fauna of the upper TMF represents transitional forms of anagenetic lineages, including tyrannosaurids. Until now, the tyrannosaurid has not been closely studied to test that hypothesis. This taxon has an excellent fossil record that includes a growth series of nearly complete skulls and skeletons, and isolated bones. The four primary specimens all come from the upper portion of the TMF; three occur within 14 m above and below a bentonite (TM-4). The fourth skeleton occurs within the disturbed belt on the eastern flank of the Rocky Mountains where folding and faulting make determining exact stratigraphic positions difficult. Nevertheless, it appears similar in age to the other specimens.

We found that the Two Medicine taxon is diagnostic and cladistic analysis recovers it as the sister species of *Daspletosaurus torosus*. These taxa are distantly related to *Tyrannosaurus rex*; therefore the new taxon is not transitional between *D. torosus* and *T. rex*. Regardless, the evidence supports the hypothesis that the two *Daspletosaurus* species represent the early and late points of an anagenetic lineage, given that a stratigraphic gap (~0.358 Ma) separates the older *D. torosus* from the younger new taxon. The DPF represents deposition from 76.9 Ma to approximately 75.7 Ma and correlates to the upper portion of the TMF. Recalibrating the age of the TMF bentonite to those used for the DPF dates gives an age of 75.242 Ma +/- 0.079 Ma. Consequently the Two Medicine specimens represent a time post-dating the DPF and is equivalent in Alberta to the overlying Bearpaw Formation. We conclude that the *Daspletosaurus* lineage was an important apex predator in the late Campanian dinosaur faunas of the Northern Rocky Mountain Region. The fossil record indicates *Daspletosaurus* had a minimum duration of 0.958 Ma, but given its absence from later units, such as the HCF, *Daspletosaurus* was extinct before *T. rex* dispersed into Laramidia from Asia.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

FIRST DEFINITIVE PRESENCE OF OSTEODERMS OF THE TITANOSAURIAN SAUROPOD DINOSAUR *ALAMOSAURUS SANJUANENSIS*

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The titanosaurian sauropod dinosaur *Alamosaurus sanjuanensis* has long been considered 'unarmored' given the absence of any associated osteoderms despite the overall abundance of skeletal material. However, a recent re-discovery in the collections of the National Museum of Natural History reveals that osteoderms were originally collected with USNM 15660, a well-known articulated specimen of *Alamosaurus*. The largest and best-preserved piece is ca. 24 x 13 x 10 cm and closely resembles the 'bulb' portion of ellipsoid osteoderms from Europe, Brazil, and Madagascar. Two additional, smaller fragments are also present.

A review of titanosaur- and osteoderm-bearing geological formations underscores the difficulty in determining whether osteoderms were truly absent in any given titanosaur species. Associated osteoderms occur with a minority of titanosaur specimens, even though parsimoniously most taxa are likely to have had osteoderms. We recommend enlisting two taphonomic criteria when assessing the armored/'unarmored' status of a titanosaur taxon: (1) whether it is known from multiple individuals with bones representing all major body regions; and (2) whether it is known from multiple facies and/or geographic areas. Finally, the armored status of *Alamosaurus* calls into question previous suggestions that 'unarmored' titanosaurs were significantly smaller than their osteoderm-bearing relatives.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

OLDEST ASSOCIATED NOTOUNGULATE SKELETON FROM SOUTH AMERICA

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While fossil remains of endemic South American mammals are abundant in the South American Paleogene, relatively complete and associated remains of a single individual are extremely rare. Previous estimates of isotemnid anatomy have been based on multiple individuals, species, and/or genera to infer diversity in this cladistically basal notoungulate group. Here, we report the discovery of a single individual of *Thomashuxleya externa* (Isotemnidae) from the Vacan subage of the Casamayoran SALMA (likely within the Lutetian Stage and close to the Bridgerian NALMA in age), from Cañadón Vaca, a locality east of Lago Colhué Huapi in Chubut Province, Argentina. Parts of nearly all elements of the skeleton are represented, including the skull, jaws, vertebrae, fore- and hind limbs, shoulder and pelvic girdles, and pes. Associated skeletal remains of other individuals, found at the same locality, include a partial articulated manus and contribute additional cranial material with which variation in *Thomashuxleya* can be assessed. Data from our single individual skeleton are consistent with recent reconstructions of forelimb and pedal anatomy in *Thomashuxleya*, in particular regarding the previously uncertain association of an astragalus with other skeletal elements. The associated astragalus is consistent with a plantigrade posture without significant running adaptations and lacks a cotylar fossa. Forelimb anatomy is congruent with an erect posture for *Thomashuxleya*, as opposed to a crouching posture inferred for other Vacan isotemnids. This discovery provides an unusually complete anatomical basis for further studies of the long-ambiguous phylogenetic position of endemic South American Mammals.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A NEW EARLY MIOCENE CHONDRICHTHYAN ASSEMBLAGE FROM THE GUAJIRA PENINSULA (COLOMBIA): PALEOENVIRONMENTAL AND PALEOBIOGEOGRAPHIC IMPLICATIONS

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We report the discovery of a new early Miocene (Aquitanian) chondrichthyan fauna from the Uitpa Formation, Guajira Peninsula, Colombia. This is the unit with the greatest extent in the Alta Guajira and its facies represent the maximum Cenozoic transgressive event for the region. Our preliminary taxonomic results show that this assemblage is characterized by at least 14 taxa (88 specimens) including the family Heptranchidae, Centrophoridae, Dalatiidae, Pristiophoridae, Lamnidae, Otodontidae, Alopiidae, Hemigaleidae, Carcharhinidae, Sphyrnidae and Mobulidae. The fauna found in the Uitpa Formation possessed a cosmopolitan tropical and warm-temperate distribution during the Early Neogene and its taxonomic composition indicates similarity, and hence biogeographic relationships, with other early Miocene assemblages from the Caribbean (Barbados, Trinidad, Venezuela). The presence of taxa with deep-water affinities such as *Heptranchias*, *Centrophorus*, *Dalatias* and *Pristiophorus* suggests an open marine environment, which contrasts with previous interpretations that have inferred an external platform environment to the Uitpa Formation based on the sedimentary structures and microfossil composition. This paleoecological interpretation is significant, because at the time, this region was the gateway between the Atlantic and Pacific Oceans before the definitive closure of the Central American Seaway (CAS). In addition, this new assemblage provides a view of the chondrichthyan diversity inhabiting the Proto-Caribbean during the early Miocene and increases the fossil record known from the region.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

SCOTTISH MAMMOTH TUSKS AT NATIONAL MUSEUMS SCOTLAND

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Conservation treatment was undertaken on one complete pair of tusks (possibly from the same animal), and two separate fragments from two specimens of mammoth tusk from the National Museums Scotland, Edinburgh, in preparation for a travelling exhibition, *Mammoths of the Ice Age*, originating from the Field Museum in Chicago. The specimens were registered in the museum in the early 19th Century and the early 20th Century respectively. One of these was the first mammoth discovered in Scotland. Both were suffering from the results of degrading historic treatments, including an epoxy-based coating which is now insoluble in conventional organic solvents. No written records of previous storage or treatment exist for these tusks; however the problematic nature of past conditions were clear, given the physical state of the tusks when they came into the lab.

C-14 dating was carried out to establish whether the specimen was mammoth or modern elephant based on aging. Further investigations, using ultraviolet light and Fourier transform infrared spectroscopy, were carried out in order to determine the chemistry of surface dirt, paint residues, and coatings prior to developing a treatment proposal for reversing historical treatments and stabilising the tusks.

Cleaning proved problematic due to the aging of these early treatments. Experimentation was therefore carried out with pineapple juice, a technique used in ceramic conservation and the boat industry, in order to attempt the breakdown of the cross-linked epoxy, and this treatment proved very successful.

Ethyl methacrylate co-polymer of varying concentrations in acetone was used as an adhesive and consolidant. Large voids created by the warped and delaminated layers had led to diminished contact points, requiring a bulked adhesive to effectively join the two surfaces together. Pulled threads of Kozo Japanese tissue paper were used in an ethyl methacrylate co-polymer 10% in acetone mixture to create a strong but flexible backing for the top layer.

The successful conservation treatment of the mammoth tusks means that they can be used in an upcoming lecture series about the history of the discovery and study of mammoths in Scotland and they are currently featured on the National Museums Scotland website.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

PTERODACTYLOID DIVERSITY IN THE TWO MEDICINE FORMATION (CAMPANIAN) OF MONTANA

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Pterosaurs were a highly successful and diverse group of Mesozoic reptiles that reached peak diversity in the Late Jurassic-Early Cretaceous. Following a decline in diversity into the Late Cretaceous, they went extinct at the Cretaceous/Paleogene boundary. Pterosaur diversity and morphologic disparity are often characterized as being severely depleted by the Late Cretaceous, and dominated by azhdarchids in the terrestrial realm. Excavations conducted by Museum of the Rockies crews in the Two Medicine Formation from 1980 to 2007 have yielded multiple pterosaur specimens from multiple quarries. Here, new evidence is presented from this collection that suggests the pterosaur diversity of the Two Medicine Formation and the Late Cretaceous of North America is not as low as previously thought. A description of a new species of azhdarchid adds a distinct genus to the ranks of azhdarchids known from the Late Cretaceous, and adds to the synapomorphies of this group. A reappraisal of *Montanazhdarcho minor* as a non-azhdarchid member of Azhdarchoidea implies that the Late Cretaceous pterosaur fauna

was not entirely dominated by azhdarchids and recognizes important post-cranial characters that better define Azhdarchoidea. The recent reassignment of *Piksi barbarulna* as an ornithocheiroid pterosaur rather than a bird also reaffirms the higher diversity and morphological disparity within pterosaurs in the Late Cretaceous of North America. Although its adult status awaits histological verification, the diminutive size of *Piksi* (~1.5 m wingspan) challenges previous studies claiming that pterosaurs and birds did not exist in the same morphospace in the Late Cretaceous. This collection of pterosaurs from the Two Medicine Formation of Montana adds morphological and taphonomic support to the hypothesis of the terrestrial affinities of azhdarchids, but that these terrestrial environments were at least occasionally shared with other pterosaur clades.

Technical Session VI (Thursday, November 6, 2014, 11:15 AM)

THE END OF THE MIOCENE HOMINOID RADIATION IN EURASIA: NEW INSIGHTS PROVIDED BY STABLE ISOTOPE ANALYSIS OF TOOTH ENAMEL IN MUROID RODENTS

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Hominoids originated in Africa, but they quickly expanded their distribution and diversity after connections with Eurasia formed during the middle Miocene. The dense and continuous record of land mammals in the Vallès-Penedès Basin (Catalonia, Spain) and the Siwalik region (Pakistan) provide unique opportunities to study the evolution of this group in relation to Miocene paleoenvironmental changes. The first occurrence of hominoids in both areas is approximately contemporaneous, around 12.5 Ma in the Siwaliks and 12.3 Ma in the Vallès-Penedès. In contrast, their last record is earlier in the Vallès-Penedès (9.6 Ma) than the Siwaliks (8.4 Ma).

Here we use stable isotopes of molar enamel of muroid rodents to reconstruct the climate and vegetation for both regions. We analyzed a total of 175 samples from the Siwaliks (13.8 to 6.5 Ma) and 113 samples from the Vallès-Penedès (12.5 to 9.1 Ma), covering the whole record of hominoids in those areas. The carbon isotope ratios of the Siwalik muroids indicate mostly C3 diets before 7.4 Ma, although there are already some taxa with mixed C3/C4 diets around 8 Ma and even earlier. Between 7.4 and 7 Ma there is a pronounced shift in $\delta^{13}C$ indicating significant amounts of C4 plants in their diet. This isotopic shifting pattern is more similar to that of soil carbonates than that of large mammals. Thus, dietary behaviors of the muroid rodents seem to reflect overlying vegetation more closely than most of the large mammals. The hominoid extinction in the Siwaliks occurs early in the spread of C4 ecosystems. Compared to Siwalik rodents, carbon isotope values of Vallès-Penedès rodents are consistently more negative, indicating mostly pure C3 diets with limited mixed C3/C4 consumers. The shift to C4 diets is not observed in this area, maybe because it occurred after 9.1 Ma or did not occur at all. However, the fact that there is no evidence for mixed C3/C4 diets is notable. In both regions, a slight negative shift of carbon isotope values is observed from the middle to late Miocene, suggesting this could be a global phenomenon in middle latitudes (30 to 45 degrees) at that time. With current isotopic evidence, the extinction of hominoids in the Vallès-Penedès Basin cannot be related to the expansion of C4 ecosystems. Moreover, although this extinction event has been previously linked to a significant cooling around 9.5 Ma, our oxygen isotope data do not show any noticeable temperature changes during the studied time span. Therefore, the cause of extinction of hominoids in the Vallès-Penedès remains unclear.

Technical Session XV (Saturday, November 8, 2014, 11:15 AM)

THE FRONTAL BONE: PROBLEMS AND SOLUTIONS IN AMNIOTE SKULL HOMOLOGY

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The *Gallus gallus* (chicken) embryo is a central model organism in evolutionary developmental biology. Its anatomy and developmental genetics have been extensively studied and many relevant evolutionary implications have been made so far. However, important questions regarding the developmental origin of the chicken skull bones are still unresolved such that no solid homology can be established across organisms. This precludes evolutionary comparisons between this model and other avian systems in which skull anatomy has evolved significantly over the last millions of years. A classical example is the disputed origin of the frontal bone. Different lineage tracing studies present dissimilar results. The first hypothesis claims that a population of cells exclusively derived from neural crest forms this bone. Other authors advocate for a double ontogenetic contribution from neural crest and paraxial mesoderm derived cells. In mice the results are unanimous attributing the origin of the entire frontal bone to cells derived from neural crest, while the posteriorly contiguous bone (the parietal) is formed exclusively by paraxial mesoderm derived cells. At the same time the posterior region of bird's adult skull misses one bone when compared with other archosauria and mammals. This absence has been traditionally interpreted as an evolutionary lost of the interparietal. Nevertheless, it is not obvious whether the bird's frontal is homologous to one (frontal), or to a fusion of two skull bones (frontal + parietal). Here, we present data from new gene expression studies by in situ hybridization comparing mouse and chicken. In addition, embryos from quail, chicken, duck and crocodile were incubated and stained for bone and cartilage every four hours. These experiments, in combination with a thorough examination of the published fossil material available, can help to establish more complete homology relationships between the skull bones of Aves and Mammalia, shedding new light on our understanding of the evolution of development of the amniote skull since their last common ancestor.

Education and Outreach Poster Session (Poster displayed November 5 – 8)

THE PALNIASSA PROJECT: SCIENCE, EDUCATION, AND OUTREACH FROM MOZAMBIQUE

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The PalNiassa Project is a collaborative scientific program aimed at: 1) prospecting, collecting and studying the paleontological heritage of Mozambiqu; 2) collaborating to improve the museological facilities in Mozambique in order to properly store and display the material collected; 3) contributing to the training of new scientists and capacity building between the countries involved; 4) promoting science outreach and working with local communities to preserve Mozambican paleontological heritage. Besides being very rich in natural recourses (coal, natural gas, and recently oil), Mozambique has a vast and diverse geological landscape. There are many geological formations to be explored; some of which have not been prospected for fossil vertebrates over the last four decades. The national government is keen in promoting science and in 2013 officially included paleontology as a priority for investment over the coming years. We are committed to using the rich fossil record as a vehicle for integrating the Mozambican and international scientific communities and increasing paleontological research by Mozambican academics. Our previous collecting efforts, carried out between 2009 and 2012, have been very successful. We recovered several complete skulls and skeletons of upper Permian therapsids (ca. 255 Ma), including the recently published new dicynodont *Niassodon mfumukasi*. We also began the training of new Mozambican students in vertebrate paleontology (the first fossil preparators have received training), raised funds to improve the museological facilities in Mozambique, and promoted outreach through diverse public exhibitions and direct contact to the media. These endeavors will continue with the ambition to create a center of excellence with regional and continent-wide objectives. All fossils collected under PalNiassa project belong to the Republic of Mozambique.

Technical Session VII (Thursday, November 6, 2014, 11:00 AM)

PEERING INTO THE PAST: SOFT-TISSUE RECONSTRUCTION, 3D MODELING, AND THE VISUAL APPARATUS OF THE EXTANT RELATIVES OF DINOSAURS

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Dinosaurs were clearly visually oriented animals based on the ubiquity of obvious visual display structures and often-large orbits. Understanding dinosaur vision is complicated by the fact that soft tissues tend not to preserve as fossils, confounding behavioral interpretation. Previous studies of the visual apparatus of dinosaurs looked at either the orientations of eyeballs restored within the orbit or morphometrics of the scleral ossicles and orbital walls. These studies provided important advances but a missing element was an analysis of all the orbital soft tissues that constrain eyeball size and location and thereby impact the visual apparatus. Here, the orbital regions of alligators, turkeys, ostriches, and hawks were dissected, taking care to note the position of the eyeball, attachments of extraocular muscles, the extent and attachments of the supraorbital membrane and tensor periorbitae, and position of the membranous lacrimal duct in relation to the eyeball, among other attributes. High-resolution, iodine-enhanced micro-computed tomography (CT) scans were taken of intact heads of an alligator, turkey, ostrich, and savannah monitor, and the soft tissues were segmented in Avizo and modeled in Maya. These investigations revealed the osteological correlates for these soft tissues that, when supplemented with similar findings from other extant diapsids, will form the basis for interpretation of dinosaur orbital anatomy in a later phase of this project. Another source of information derives from the fact that the visual system is linked to the balance organs of the inner ear, the semicircular duct system, providing further clues potentially assessable in fossils. This linkage relates to the vestibulo-ocular reflex (VOR), which functions to stabilize gaze by activating the extraocular muscles to make compensatory movements of the eyes as the head turns. To test for the symmetry, alignment, and coplanarity of the eye muscles and bony semicircular canals (SCCs), orientations of these components were digitally measured in the microCT-scanned extant sample, revealing variable amounts of coplanarity between the oblique muscles and ipsilateral caudal SCC, between the dorsal and ventral rectus muscles and ipsilateral rostral SCC, and between the medial and lateral rectus muscles and lateral SCC. Future studies of SCC/extraocular muscle coplanarity will broaden the sample to investigate the link to phylogeny and behavior, and, if substantiated, used to help restore dinosaur visual systems as the project progresses.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A REVISION OF *OPHISAURUS ULMENSIS* FROM THE EARLY MIOCENE OF ULM (MN 2A, SOUTHWEST GERMANY)

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The locality Ulm Westtangente (MN 2a) is well known for the richest vertebrate fauna (especially mammals - more than 45 taxa) from the Lower Miocene ever found in Germany. From this locality, a new species of the genus *Ophisaurus*, *O. ulmensis*, was described. The type material consists mainly of dentary bones. However, this taxon has become problematic. The type material was lost for a long time, but several specimens of the original collection have been recently relocated. The preservation of the type specimens is poor, most likely due to conservation methods at the beginning of the 20th century. Meanwhile, the specimens of *O. ulmensis* from Obere Eselsberg (MN 2,

Germany) have been referred to the genus *Palaeocordylus* (Cordylidae). This creates doubts regarding its taxonomy, and justifies a reevaluation of this taxon. Here, we present new, undescribed lizard material from the *O. ulmensis* type locality, including material which can be attributed with certainty to the enigmatic *O. ulmensis*. The material was discovered during field work in the 1980s. The material consists of lower jaws, upper jaws, parietals, frontal, quadrate, jugals, a pterygoid, postorbitofrontals, zeugopodial bones and a supraocular osteoderm. Our preliminary studies indicate that *O. ulmensis* is in fact a lizard of lacertid affinity. Besides this taxon, the new material from Ulm also contains a second lizard consisting of the parietal, frontal, maxilla, dentary and plenty of osteoderms. This specimen probably represents a member of Anguinae, of *Ophisaurus* affinity (the marginal teeth are recurved posteriorly and pointed). The new finds shed new light not only to the taxonomy of *O. ulmensis*, but also on the biodiversity of squamates during the so called Dark Period in the mid-Cenozoic.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

WALKING WITH BIRDS: HINDLIMB EVOLUTION WITH LOSS OF FLIGHT

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The loss of flight in birds is associated with several distinct character changes. These include a relative reduction of the wing bones and a decrease in the size of pectoral muscle attachments. However, the changes that occur in the leg bones are less intensively studied. These may be related to changes in size, the need for more efficient terrestrial locomotion, or the amount of time since the loss of flight occurred.

These hypotheses were tested in a dataset of 35 species of flightless birds including 23 extinct taxa. Measurements of length and shaft eccentricity ($\log_{10}$ medio-lateral diameter minus $\log_{10}$ antero-posterior diameter) were taken for the femur, tibiotarsus (tbt), and tarsometatarsus (tmt). nineteen volant relatives of these birds were measured to provide ancestral models for the flightless taxa. Measurements were size-corrected and input into a factor analysis (FA) and flightless species paired with their flying relatives. Differences (Δ) in FA scores between paired species were then entered into multiple regressions. Independent variables for regressions were: Δ femoral circumference between species pairs (as a proxy for Δ body size), area of the land mass on which the species evolved, and the estimated time since the loss of flight. One-sample Wilcoxon Signed Rank (WSR) tests were carried out on Δ factor scores and femoral circumferences to test for directionality in the evolution of limb bone proportions and body size.

Multiple regressions showed strong relationships between Δ FA scores and Δ femoral circumference with little relationship with land area and no relationship to time since loss of flight. WSR tests found positive directionality in median Δ femoral circumference and tbt eccentricity. Separate analyses of palaeognaths and neognaths revealed differences in the loadings of variables, opposite directions of the relationships between Δ FA scores for a similarly loaded factor 1 and land area, and differences in directionality of Δ FA scores. In the latter, palaeognaths showed directionality in both Δ FA scores and Δ femoral circumference whereas in neognaths only Δ femoral circumference exhibited directionality. These results indicate varied trajectories in the evolution of leg proportions in birds after loss of flight. In palaeognaths these changes are associated with variation in cursoriality and body size, whereas flightless neognaths exhibit no clear patterns in the evolution of leg bone proportions.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed November 5 – 8, judging occurs Thursday, November 6)

THE FIRST DETAILED CRANIAL DESCRIPTION OF *MASSOSPONDYLUS CARINATUS* USING A COMPUTED TOMOGRAPHY (CT) SCAN AND 3D DIGITAL REPRESENTATION

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Massospondylus carinatus is a basal sauropodomorph dinosaur from Lower Jurassic deposits in South Africa and Zimbabwe. Although *Massospondylus carinatus* is an important taxon for understanding early sauropodomorph evolution, anatomical descriptions of its abundant cranial material were lacking until relatively recently. Additionally, focused descriptions of its braincase have been relatively topical because adhering matrix in key specimens obscures anatomical details. There is limited fossil braincase material across basal Sauropodomorpha, and hence a scarce number of braincase characters used for phylogenetic analyses in basal sauropodomorph dinosaurs. To perform a detailed investigation of braincase anatomy in *Massospondylus carinatus*, we used computed tomography (CT) scans and 3D digital representations to reconstruct the bones of the braincase of a complete, undistorted specimen (BPI/1/5341). These methods revealed details that are not visible in external examination and allowed for the determination of its internal osseous anatomy as well as other endocranial structures such as the inner ear. These data were then used to establish a detailed braincase description of the genus. Our study yielded information about *Massospondylus carinatus* that was previously missing or unclear, notably with regard to the orbitosphenoid and prootic bones of the braincase. We compared the braincase of *Massospondylus carinatus* to relevant sauropodomorph taxa, such as *Plateosaurus*, and were able to identify previously unknown braincase autapomorphies for it as well as increase the braincase character dataset. Our research forms a strong basis for future studies of the growth and development of this important dinosaur taxon. This project was funded by the National Research Foundation as well as the Palaeontological Scientific Trust.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A NEW SPECIMEN OF *PUPPIGERUS CAMPERI* FROM THE LONDON CLAY OF WALTON ON THE NAZE, ESSEX, UNITED KINGDOM AND THE PALEODISTRIBUTION OF MARINE TURTLES DURING THE EOCENE

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A well preserved skull identified as *Puppigerus camperi* (NHMUK R14375), is housed in the Natural History Museum, London, UK (NHM). It is Ypresian (Early Eocene) in age and was collected as a nodule from the London Clay at Walton on the Naze in Essex, England, UK in 1970 and presented to the NHM in 1977. This skull adds a new record to a rich turtle assemblage of cheloniids in northwestern Europe. The London Clay is dated to ~50 million years by the analysis of the volcanic ash beds found throughout the sequence and in the area of Walton on the Naze is comprised of fine grained, clay-rich deposits that yield invertebrates, fossil plant debris and seeds together with disarticulated skeletons of fish, birds, mammals, and reptiles. Poorly preserved turtle shells and skulls belonging to the Cheloniidae and the Erquelinnidae are mostly recorded from the lower levels of the London Clay in the Harwich area of Essex. The preparatory work began in 1977 and produced a complete 3 dimensional skull, limb and girdle material, hyoid bones, some vertebrae and an incomplete shell. Several years elapsed before the specimen was ready for study but its research potential has only recently been recognized by the authors. We believe the shell belongs to a juvenile due to its small size and thin plates having typically nine neural plates decreasing in size from the anterior margin with well developed pygals and suprapygals. Fish teeth identified as belonging to *Striatolamia macrota* were also found in the sediment. Published discoveries of cheloniids *Puppigerus nessov* from Russia and *Tasbacka ouledabdounensis* and more recently *Puppigerus camperi* from North Africa drew our attention to the similarities between the cheloniids of northwestern Europe and those of the North Africa. This skull is comparable to the largest skulls of *Puppigerus* found in the London Clay of the Isle of Sheppey, Hampshire, UK or the Eocene sediments of the Belgian Basin. The dorsal surface of the skull shows fine grooves and epidermal scute sulci but it is dorso-ventrally crushed, giving an artificially flat appearance. It is triangular and elongate in shape with a slightly less pointed snout than the acutely pointed snout seen in adult skulls like *Puppigerus camperi* (IRSNB. IG8402) housed in the Institut Royal des Sciences Naturelles, Bruxelles. An earlier study examined an endocranial cast taken from the brain case of *Puppigerus camperi* IRSNB. IG8402 and to extend this study we reconstructed the braincase from recent computed tomography (CT) scans of this *Puppigerus camperi* skull NHMUK R14375 at the NHM.

Technical Session XV (Saturday, November 8, 2014, 11:45 AM)

GENE DUPLICATIONS, CO-OPTION, AND THE EVOLUTION OF VERTEBRATE BRAINS

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Here we trace vertebrate brain evolution from phylogeny, neural morphology, ecology, and gene expression. Two rounds of whole genome duplication in the stem lineage of vertebrates, followed by cooption and expansion of homeobox genes, have been linked to the origins of vertebrate brains from neural crest and placode tissue. Cladistic analyses suggest a stepwise progression of brain evolution from cephalochordates, which have a hollow dorsal neural tube with a cerebral vesicle at the rostral end. The first brains appeared in benthic agnathans during the Cambrian explosion and were fairly large and bipartite, but lacking a hindbrain. Large tripartite brains evolved in predatory gnathostomes in the Devonian. Expression of one homeobox gene marked the forebrain and hindbrain, while a second gene marked the hindbrain and midbrain/hindbrain boundary. From lobefin fish to tetrapods, the advent of terrestrial life in the Carboniferous brought about the reorganization and expansion of the tripartite brain, as sight, sound, and smell became important for exploiting new adaptive zones. The number of homeobox genes remained stable throughout the evolution of tetrapods, but the functional complexity of brains in higher vertebrates could have resulted from an increase in the number of gene expression patterns. From the basic tetrapod design, brains increased in size independently in two terminal lineages of amniotes—birds and mammals—during the Mesozoic, possibly in response to arboreal adaptation. The enlargement of forebrain in birds and mammals reflected the increasing role of somatosensory information and coordinated motor outputs required to navigate the three-dimensional arboreal world. In birds, the cerebrum is highly enlarged, contacting the cerebellum and displacing the optic lobes ventrally and laterally. Visual acuity is heightened in birds at the expense of olfaction. Mammals, too, developed a large neocortex for sensory and motor processing. Increasing sophistication of the cerebrum culminated in primates during the Cenozoic with the development of a profoundly expanded neocortex. Front-facing, trichromatic eyes and the expansion of size and number of cortical visual areas allowed stereoscopic color vision and hand-eye coordination. Hearing became an important sensory cue for primate communication, and accelerated recruitment of new developmental genes led to the large and complex brains of *Homo*, ultimately supporting the development of speech and language in modern humans.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

DIVERSITY PATTERNS IN THE EVOLUTION OF PENGUINS

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Penguins are seabirds usually associated with polar environments; however only two of the seventeen species of extant penguins live permanently in the Antarctic continent. Penguins originated and radiated under greenhouse conditions during the Paleocene and by the late Eocene, the stem Sphenisciformes were already diverse and spread in a similar range to that occupied by extant penguins. But by the late Miocene, the modern family Spheniscidae and their closest relatives became the dominant penguins. This turnover in the penguin faunas is particularly clear in South America, where we can compare the Paleogene assemblages with the abundant Neogene record. Most of these penguins develop a much shorter and bulkier beak along with a substantial reduction in body size. However, the correlation between penguin diversity and large scale environmental changes has never been evaluated in a deep-time scenario. Even so, global cooling and Antarctic glaciations have been constantly mentioned as potential drivers of their radiation. In this context, a global study of the diversity of penguins through time will be essential to elucidate the relations between these birds and their environment, particularly during the Neogene. In order to identify the potential drivers of the paleodiversity signal, raw and time-bin corrected diversity data have been analyzed. The data have been compared with sampling proxies like number of marine formations and marine formations with a record of vertebrates, and with environmental factors such as diatoms

and nannoplankton diversity and $\partial^{18}O$ as a proxy of temperature and global ice volume. Potential correlations between pairs of variables have been tested using Spearman-rank correlations, as well as by fitting a set of a priori models and assessing their explanatory power using the second-order Akaike"s Information Criterion and Akaike weights. The results suggest that, despite the existence of a weak correlation between the diversity data and sample proxies, the diversity of diatoms, as a broad-scale metric of productivity, was a major driver of crown penguin diversity.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A NEW LATE EOCENE LEUCISCINE FROM CENTRAL CHINA

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A new leuciscine fish from the late Eocene Hetaoyuan Formation in Henan Province, central China is recognized. It is represented by several nearly complete skeletons with or without pharyngeal teeth in situ, detached pharyngeal bones and teeth, and several disarticulated bones. The main characteristics of the fish are: body small, elongated and laterally compressed; head length exceeding body depth; mouth terminal; two branches of preopercle about equal in length; depth of opercle larger than its length; postcleithrum and coracoid well developed; both dorsal and anal fin with no spine; origin of the dorsal fin posterior to insertion of pelvic fin with seven branched fin rays; two tips of forked pelvic bone spread apart and length of forked part slightly shorter than half the length of the bone; anal fin with nine branched fin rays inserted behind the posterior end of dorsal fin base; two anterior pterygiophores of anal fin suspended from the anterior hemal spines; at least two rows of pharyngeal teeth, five teeth in main row, crowns of all teeth laterally compressed, with oblique and narrow grinding surface and tapering, recurved tip; total number of vertebrae around 36. Consequently, it can be referred to the Leuciscinae. It differs, however, from all known subgroups of the Leuciscinae. It differs from rasborins in that its infraorbital 5 is disconnected from the supraorbital, and the dermopterotic is elongated. It differs from leuciscins and phoxinins in its reduction in the fork of the pelvic bone and the well-developed postcleithrum. It is distinguished from cultrins and xenocyprins in that its first unbranched dorsal fin ray is not modified into a knob-like structure and in contact with the second one, the anal fin base is shorter than that in cultrins, and the pharyngeal teeth are obviously unlike those from xenocyprins in which the number of the main row pharyngeal teeth is six or seven, the teeth are very compressed laterally, with extensive, flat lateral surfaces and a long, straight, narrow grinding surface with no recurved tip. It differs from gobionins and achelognathins in its developed coracoid blade, elongated body, and the higher number of branched anal fin rays.

The discovery of this new leuciscine, associated with previous known middle-late Eocene cyprinids, for example *Palaeogobio zhongyuanensis*, *Cyprinus maomingensis*, *Tianshanicus liui*, and various kinds of pharyngeal teeth from coastal region of Bohai Sea and North Vietnam, show that the Cyprinidae is already rather diversified by the late Eocene in East Asia.

Technical Session V (Wednesday, November 5, 2014, 2:15 PM)

AN EARLY CRETACEOUS FROG FROM NORTHERN CHINA AND THE EARLY EVOLUTION OF ANURANS

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The Early Cretaceous marks an important period in frog evolution, when many clades of crown-group frogs first appeared in the fossil record. These include species affiliated with the Discoglossidae, Pipidae, Paleobatrachidae and those that have unresolved relationships with living lineages. The Early Cretaceous Jehol Biota of Northern China previously yielded several frog taxa, all characterized by having nine presacral vertebrae and expanded sacral diaphophyses. Here we report a new fossil frog from the Lower Cretaceous Guanghua Formation (equivalent of the Yixian Formation) of Dayangshu Basin, Hulunbuir, Inner Mongolia, China. The skull of the new frog is plesiomorphic in appearance, with an unsculptured skull roof, medially articulated nasals, presence of a quadratojugal and columella, dentate upper jaw and edentate mandible. Postcranial morphology is more derived than the Jehol frogs, characterized by eight presacral vertebrae, non-imbricated neural arches, and non-expanded sacral diapophyses. Geographically, the new taxon documents the most northern distribution of Early Cretaceous frogs in East Asia. Preliminary cladistic analysis anchored this frog as the sister-group of Neobatrachia + Pelobatoidea, a phylogenetic position not previously occupied by fossil frogs, thus providing a new calibration point for estimating the divergence time between the Pelobatoidea and Neobatrachia. The new locality also yielded several juvenile specimens, which apparently represent the same species as the adults. Besides being smaller and having weaker ossification than the adult specimens, they retain unfused ribs associated with presacrals V to VIII, providing ontogenetic evidence that the loss of ribs on these posterior vertebrae in adults is a post-embryonic event.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

COMPUTED TOMOGRAPHIC ANALYSIS OF A COMPLETE SKELETON OF THE LATE MIOCENE MUSK DEER, *LONGIROSTROMERYX WELLSI* (ARTIODACTYLA, MOSCHIDAE), WITH IMPLICATIONS FOR PALEOHABITAT AND ECOLOGY

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Ashfall Fossil Beds State Historical Park in northeastern Nebraska preserves the most complete known skeletons of the rare blastomerycid, *Longirostromeryx wellsi* (Artiodactyla, Moschidae). These specimens come from a lagerstätte faunal assemblage in the Ash Hollow Formation (11.95 Ma), which represents mass mortality and rapid burial by aeolian ash from the Bruneau-Jarbidge Eruptive Center in Idaho. The exceptionally preserved biocenosis at the Ashfall locality is particularly useful for paleoecological analyses, including paleohabitat reconstruction. The presence of a musk deer, which today live in densely vegetated areas, in this assemblage is inconsistent with the open environment suggested by isotopes and other proxies from Ashfall. We analyze the ecology of *L. wellsi* using anatomical evidence to infer locomotor and dietary behavior. Specimens of *L. wellsi* come from the lower part of the 3 m ash deposit, indicating that *L. wellsi* was among the first to perish from inhalation of ash. Femur length indicates that *L. wellsi* had a body mass of about 10 kg. Oblique fractures of the humeri, missing scapulae and proximal humeri, and dislocation of the limbs, rib cage, and at the base of the neck indicate scavenging before burial. Several features suggest cursoriality in *L. wellsi*, including fused cannon bones, the absence of lateral digits, a reduced fibula, a high crural index (119), and a high femorometatarsal index (90). Because cursorial taxa typically occupy open habitats these observations suggest that *L. wellsi* was adapted to feeding in more open areas than modern moschids, which agrees with previous interpretations of open-area feeding based on its long neck, long snout, and an enlarged molar row. While preliminary analyses suggests that *L. wellsi* was adapted to an open habitat, such as a C_3 dominated savannah, lack of fusion in the radius and ulna as well as the carpals indicates *L. wellsi* may not have been fully cursorial. Future work will focus on analysis of a digital 3D reconstruction of *L. wellsi* from computed tomography (CT) images, which will allow for further anatomical and ecological analyses. Habitat reconstructions for this and other North American moschid species should provide a better understanding of selectional pressures influencing the evolution of this clade.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A NEW NON-PTERODACTYLOID PTEROSAUR WITH SOFT TISSUE FROM THE LATE JURASSIC, INNER MONGOLIA, CHINA

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Daohugou (Ningcheng, Inner Mongolia) is a locality that yielded several important fossils, including vertebrates, insects and plants, regarded as part of the Jurassic Yanliao Biota. So far only two pterosaurs have been described, the anurognathid *Jeholopterus* and the non-pterodactyloid *Pterorhynchus*. Here we report a new pterosaur specimen from this region (IVPP V12537), consisting of a partial skeleton lacking the wings and hind limbs. The skull and lower jaw are articulated, dorsoventrally compressed, and lack the rostral end. The skull is clearly laterally compressed, differing from *Jeholopterus*. The orbit is large and rounded, and the antorbital fenestra is incomplete but larger than in *Pterorhynchus*. The upper temporal fenestra is unusually small. No evidence of a cranial crest such as the one reported in *Pterorhynchus* is observed. The cervical vertebrae are short and bear thin cervical ribs, indicating that the new specimen represents a non-pterodactyloid. The sternal plate is triangular, being much wider than long, more than in any non-pterodactyloid reported so far. The deltopectoral crest of the humerus is positioned proximally and does not extend further down the shaft, a typical feature of basal pterosaurs. Several elements such as the scapula and coracoid, and the proximal carpals are fused, suggesting that it represents an adult individual. IVPP V12537 also differs from all pterosaurs reported from the Linglongta area of the Tiaojishan Formation, regarded to be about the same age as the Daohugou beds. The new specimen has much shorter cervical vertebrae than the wukongopterids reported from that region (e.g., *Wukongopterus*, *Darwinopterus*). It further has a comparatively larger antorbital fenestra relative the size of the orbit than the scaphognathid *Jianchangnathus*. It also differs from scaphognathid *Fenghuangopterus* which has a comparatively smaller and more rounded sternum and is also much larger. IVPP V12537 shows portions of soft tissue preserved as a dark matter around the cervical vertebrae that appear to be of two distinct natures. Some show parallel fibers that are likely actinofibrils while in other parts the fibers are more irregular and more consistent with pycnofibres. The new specimen increases the Jurassic non-pterodactyloid pterosaur diversity of the Yanliao Biota and is the smallest flying reptile reported from this biota reported so far. This study was supported by National Basic Research Program of China, the Hundred Talents Project of CAS; and CNPq and FAPERJ (Brazil).

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

CELL IMPRINTS ON THE EXOSKELETAL ELEMENTS OF THE PALEOZOIC SHARKS

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The imprints of cells are extremely rarely recorded for the exoskeletal elements of fossil fishes. Cell imprints of a polygonal pattern were found in the teeth of elasmobranch *Adamantina foliacea* from the Late Pennsylvanian of the South Urals (Russia) and the Robledo Mountains (New Mexico, USA), from the Early Permian of the Middle Urals and the Middle Permian of the Guadalupe Mountains (Texas, USA); in the teeth of shark *Isacrodus marthae* from the Middle Permian of the Guadalupe Mountains. The imprints are isometric penta- or hexagonal polygons, up to 10 μm in size, and form a network on the lower part of the tooth crown, at the crown/base junction. Similar imprints of cells occur in the scales of protacrodontid type from the Late Devonian of the Middle Urals, the Late Mississippian of Moscow Syneclise (Russia), Early Permian of the Middle Urals and the Middle Permian of the Guadalupe Mountains. The imprints are from isometric to considerably elongated polygons, occupying the external surface of the scale crown or only depressions between the odontodes. The protacrodontid type is the growing scale. The nongrowing scales from the same samples do not bear such imprints.

The cell imprints could possibly be formed as a result of the pressure of the epithelial layer on the unmineralized external surface of growing scale or of the ameloblast layer into dental lamina on the unmineralized external surface of a tooth. The similar cell imprints can be observed in the squamation of the modern chondrichthyans.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

COMPARING STABLE ISOTOPE COMPOSITIONS OF HAIR IN A MOTHER-CALF PAIR OF ELEPHANTS (*LOXODONTA AFRICANA*) DURING NURSING AND WEANING

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Mammalian nursing affects the stable isotope chemistry in both mothers and offspring. Isotopic changes associated with onset, gradual reduction, and complete cessation of nursing are preserved in biological tissues generated by both lactating mothers and their suckling young. These changes are preserved in continuously growing tissues that are not reworked, such as hair and tusk dentin. Tusks of young individuals and broken off tusk tips sometimes preserve dentin growth from the first years of life and contain patterns of isotopic variation associated with nursing and weaning. These data can be used to identify duration of nursing and a calf's age at completion of weaning. Ongoing work aims to compile weaning ages for wooly mammoths from the Late Pleistocene to see if those near the time of extirpation from mainland Siberia are more consistent with climate stress or hunting stress. To develop a framework for identifying weaning in fossil tusks we have been sampling tail hairs from a mother-calf pair of zoo elephants (*Loxodonta africana*) to document the isotopic signatures of weaning in a living proboscidean. We expected to see calf hair δ15N increase during nursing due to trophic level enrichment that occurs when the calf metabolizes proteins from its mother's milk. We expected to see a similar trophic enrichment in $\delta^{13}C$ but were unsure how much it would be neutralized by the isotopically light fat content of milk. In hair formed prior to birth, calf $\delta^{15}N$ values track the mother's but are about 1‰ (air N_2) higher. After birth, calf and mother $\delta^{15}N$ diverge with the calf's increasing and mother's decreasing. When the calf was just a few months old, the spread between calf and mother $\delta^{15}N$ was greatest, at almost 3‰. Following peak offset, mother and calf $\delta^{15}N$ gradually converged to a difference of just over 1‰ when the calf was about one and a half years old. Calf $\delta^{13}C$ records during this same interval track the mother fairly consistently with an offset of about 1‰ (VPDB). Around the time of birth, there is a brief convergence in $\delta^{13}C$ when mother and calf values are nearly equal. This is followed by divergence approximately synchronous with that in $\delta^{15}N$ but less extreme, with peak separation at about 2‰. These data will provide a comparative framework for investigating not only weaning in tusk records of juvenile extinct proboscideans, but also birthing records in adult female tusks.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

NEW SPECIES OF *MIMATUTA* ("CONDYLARTHRA," PERIPTYCHIDAE) FROM THE EARLIEST PALEOCENE OF MONTANA

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The early Puercan (Pu1) mammalian recovery fauna during the first ~100,000–200,000 years of the Paleocene has been documented as species-poor in the Tullock Member of the Fort Union Formation, northeastern Montana. Here we report discovery of a new Pu1 species of *Mimatuta* from a locality informally known as Camel Butte in the Tullock Member of Fallon County, southeastern Montana. Camel Butte has yielded the stratigraphically youngest in situ non-avian dinosaur (a ceratopsian brow horn) 13 cm below the palynologically defined Cretaceous–Paleogene boundary and 125 cm below the Hell Creek–Fort Union Formation contact. Surface collecting and screen-washing efforts have also produced hundreds of early Puercan mammal specimens and a rich assemblage of other vertebrates in a coarse structureless sandstone bed 29 cm above the formation contact. Several partial dentaries of *Mimatuta* have been recovered, including a dentary that preserves portions of the jaw between p1–m3 (p1 single-rooted, p2–m3 double-rooted). These specimens are referred to *Mimatuta* and can be differentiated from *Oxyprimus* and *Protungulatum* based on features including a p4 with a wide and developed talonid basin and a distal transverse crest, and molars with relatively shorter talonids. Specimens further differ from *Oxyprimus* in being larger and having more expanded convex lower molar cingulids, and differ from *Protungulatum* in having a p4 protoconid that is considerably larger than the paraconid and metaconid, and an m2 with a more labially positioned paraconid. Among species of *Mimatuta*, the new specimens have a p3 and p4 that exceed the size ranges documented for *M. morgoth* and *M. minuial*, but have an m1 that is within the size range of both species. Therefore, proportions of the known premolar positions are relatively larger in area than what has been previously documented in *Mimatuta*. The p3 is quite wide and has a small talonid basin that has a distal transverse crest. The p4 appears most like that of *M. minuial* in having a pronounced metaconid, but is relatively wider and more molariform with a well-developed talonid basin that has three cusps. These relatively wide and more molariform premolars are likely derived among species of *Mimatuta* and were probably more effective for grinding and crushing food items. This discovery increases the number of species known during the species-poor (Pu1) mammalian recovery fauna in the Tullock Member, and may serve to document evolutionary transitions among basal Periptychidae and help clarify relationships within this family.

Technical Session XIII (Friday, November 7, 2014, 3:45 PM)

HOW DID DEVONIAN ACANTHODIANS GROW? THE DEVELOPMENTAL HISTORY OF THE SKELETON OF *TRIAZEUGACANTHUS AFFINIS* FROM THE MIGUASHA-FOSSIL-FISH LAGERSTÄTTE

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Since its original description as a chordate and probably a vertebrate, the Late Devonian *Scaumenella mesacanthi* (Escuminac Formation, eastern Canada) has been interpreted alternately as a prochordate, a larval ostracoderm or a larval-juvenile acanthodian. However, for the past 30 years, these minute specimens were generally considered as decay stages of the acanthodian *Triazeugacanthus affinis*. Among the abundant material of '*Scaumenella*', we identify unambiguous specimens of *T. affinis* based on otolith characteristics. Morphological, morphometric, histological (ground sections, SEM) and chemical (mass spectrometry, EDS stoichiometry) data are gathered on a size series of 197 *Triazeugacanthus* (larvae: 3.91-17.22 mm, juveniles: 17.55-31-47 mm, adults: 26.52-52.72 mm). These findings allow us to confirm that this size series represents a fossilized ontogeny. Size range, state of preservation, and abundance of specimens position *T. affinis* as one of the best known fossilized ontogenies of early gnathostomes. Proportions between skeletal structures (e.g., pelvic fin spines) and total length proxy display different growth rates for larvae, juveniles and adults. The presence of cartilaginous and bony tissues, discriminated based on histological and chemical signature, is used to establish chondrification and ossification sequences. Larvae show no squamation but a progressive chondrification of neurocranial and vertebral structures, whereas juveniles progress in terms of ossification and squamation. Progression of body squamation is described in both juvenile and adult specimens. Developmental patterning is identified for various skeletal elements: circular ('box-in-box') growth of scales, distal accretion of odontodes on spines, antero-posterior and proximo-distal direction of squamation in fin webs, and postero-anterior direction of squamation on the body. Finally, chondrification and ossification sequences allow us to analyze the stability and variability of developmental sequence within *Triazeugacanthus*. Developmental patterns are interpreted considering the recent phylogenetic remodeling of the acanthodian grade and the putative close relationship of acanthodiforms with osteichthyans.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

DIFFERING GROWTH STRATEGIES BETWEEN SYMPATRIC, LARGE-BODIED HERBIVOROUS ORNITHISCHIAN DINOSAURS FROM THE OLDMAN FORMATION (CAMPANIAN), ALBERTA, CANADA

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The anatomy and systematics of the North American Cretaceous dinosaur fauna have been studied in detail, but information on its ecology, such as niche partitioning and interactions between sympatric dinosaur species, remains poorly understood. Here we use bone microstructure to compare growth strategies between two contemporaneous herbivorous dinosaurs in the Late Cretaceous of North America in order to assess its potential as an ecological indicator. We histologically sampled multiple radii and tibiae of ceratopsid and hadrosaurid specimens recovered from the monodominant *Centrosaurus apertus* McPheeters bonebed (Campanian; Oldman Formation, Alberta). Full midshaft thin-sections were made to assess the bone microstructure, identify lines of arrested growth (LAGs), and retrocalculate missing LAGs using the monomolecular, von Bertlanffy, Gompertz, and logistic growth models. Body mass growth curves were generated using Developmental Mass Extrapolation based on LAG circumferences.

Results show that both *C. apertus* and the hadrosaurid specimens have zonal bone separated by prominent LAGs. However, in *C. apertus*, each zone contains a distinct cyclical pattern of vascular orientations including radial, reticular and laminar canals, whereas the hadrosaurids display a gradual change from reticular to laminar vascular orientation towards the outer cortex. The bone microstructure of the *C. apertus* specimens suggests that growth rate varied greatly within a year and that the cycle continued for multiple years. Conversely, the gradual vascular orientation change in hadrosaurid specimens suggests that they grew more consistently throughout their lifespan. Comparisons of growth curves indicate that hadrosaurids grew significantly faster than *C. apertus*; a one-year-old hadrosaurid exceeds a five to six-year-old *C. apertus* in terms of body mass. The differing vascular orientation and growth rates between *C. apertus* and the hadrosaurids could reflect resource availability variation and niche partitioning. Ceratopsids are subject to resource competition with other herbivorous dinosaurs in terms of feeding height stratification and a more restricted geographical distribution, while hadrosaurids have a much larger feeding envelope. Alternatively, the variation in growth strategy could reflect differences in annual resource allocation between the two groups, perhaps related to reproduction or migration.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

VOLCANIC TUFFS FROM THE ELLIOT FORMATION: IMPLICATIONS FOR THE TRIASSIC–JURASSIC TERRESTRIAL BOUNDARY

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The Elliot Formation of South Africa is hypothesized to straddle the Triassic–Jurassic boundary, making it an important sequence for investigating the terrestrial effects of the end-Triassic extinction. The youngest possible age of the Elliot Formation is constrained by the overlying Drakensberg Lavas, but the age of its fossil bearing strata are based on loose correlations (often footprints) with similar deposits in South America, China, and North America. The lack of suitable volcanoclastic layers within the Elliot stratigraphic section have precluded absolute age determination of its fauna. We report here on the discovery of a regionally extensive series of ash layers within the Elliot Formation in the Lady Grey area, Eastern Cape. The tuffaceous horizons extend laterally over our entire focus area (one large farm), and we are currently doing more regional work to determine their overall extent. Our current understanding of the placement of these tuffs is that they are close to the lower Elliot/upper Elliot boundary, and thus possibly can provide an idea of where the end-Triassic may sit within the Stormberg sequence. Preliminary stratigraphic work on these tuffs shows that they are the result of at least three separate eruptive events, with minimal to extensive reworking of sediments in between them. The overall thickness of the tuffaceous horizon is over 3 m, suggesting a substantial amount

of ash was laid down during deposition of the layers. Microscopic examinations of thin sections cut from the tuffs shows a cryptocrystalline groundmass, consistent with interpretation as devitrified volcaniclastic material. Reworked sedimentary layers between the tuffs have coarser grains of subangular detrital quartz within a very fine-grained matrix. We have recently sent samples for zircon separation; results suggest that datable zircon populations are present. Our efforts are currently focused on increasing our stratigraphic resolution of the tuffaceous layers, obtaining radioisotopic dates from them, and sampling the fauna above and below them.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

BIG FISH IN THE SILURIAN. LARGE SIZE AND TROPHIC SPECIALIZATION IN OSTEICHTHYANS FROM THE LUDLOW KUANTI FORMATION OF YUNNAN, CHINA.

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Until recently, Silurian gnathostomes have been scarce and highly fragmentary in the fossil record. The apparent rarity and small size of Silurian fishes, coupled with a supposed increase in body size and diversity in the Devonian, has led to suggestions that gnathostomes were a relatively minor component of marine faunas prior to the Emsian (in the latter part of the Early Devonian). It has also served as a proxy for paleoatmospheric modelling, with implied low Silurian oxygen levels imposing constraints on maximum vertebrate body size.

Ongoing discoveries from the early Ludlow Kuanti Formation, near the city of Qujing, Yunnan, southwest China, including the earliest articulated jawed fishes, are overturning long held ideas of Silurian vertebrate diversity. Stunning fossil discoveries from this stratum include multiple taxa of placoderms and osteichthyans, including forms such as *Entelognathus* and *Guiyu,* that have drastically reduced the morphological gaps between these two groups. Bony fishes are represented by at least five species and display a broad range of body size and dentition. Of particular interest is a roughly 1-metre long sarcopterygian based on isolated mandibles and a maxillae, representing the largest known pre-Devonian gnathostome and possibly the earliest vertebrate apex predator. The new form displays adaptations for durophagy, with large rounded coronoid teeth as opposed to the fang-like dentition of *Guiyu.* This reveals that Silurian gnathostomes not only attained considerable body sizes, but had achieved a striking degree of trophic diversity and specialization, well before the Devonian 'Age of Fishes'.

Symposium 2 (Thursday, November 6, 2014, 2:00 PM)

SAUROPOD NECKS: MECHANICS AND BENEFITS OF AN EXTREME STRUCTURE.

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A huge body size and an extreme neck length are characteristic of most sauropod dinosaurs. The very long neck appears to be a crucial feature for the evolution of gigantism among sauropods. However, posture and usage of the neck are still controversial. The wide distribution of sauropods across more than 135 million years with more than 100 currently known genera living in different habitats indicate that the selective advantage of a very long neck was not limited to special living conditions.

McNeill Alexander was a pioneer in using biomechanical methods for reconstructing the behavior of dinosaurs. Biomechanical analyses like calculations of forces acting along the neck and reconstructions of neck mobility are applied to reveal the usage of sauropod necks. For some sauropods, like *Diplodocus*, *Euhelopus*, *Giraffatitan*, and *Mamenchisaurus,* energy expenditures are estimated based on mechanical laws, physiological comparisons with recent vertebrates and allometric relations in order to compare energy costs during different activities like moving the neck, walking a distance, accelerating and resting. Assuming a mammalian-like or a high reptilian metabolism, the calculations indicate that energy costs for movements of the neck were much lower than the basic metabolic rate or the energy needed for walking a distance of several body lengths. However, expenditures for vertical movements increase steeply with body size, so that large sauropods probably avoided such movements as long as resources were not very far apart. During high browsing, the metabolic rate was increased due to the high blood pressure that was necessary for supplying the brain with blood, making feeding at great heights expensive. For a large sauropod, energy expenditures for feeding a few minutes with a steeply inclined neck were higher than the energy costs for walking a distance of one body length with a horizontal neck unless structures existed that allowed sauropods to increase the blood pressure in the neck independently from the body.

In summary, the results indicate that the long sauropod neck possibly was used in different ways depending on the habitat. High browsing and vertical movements of the neck were economical only if resources were far apart or if obstacles increased the costs of locomotion. Browsing with a long neck was beneficial at any height if resources were far apart. A long neck might also have served primarily for increasing the rate of feeding. Different scenarios for the evolution of a very long neck in sauropods appear possible. The study was funded by DFG.

Technical Session XVI (Saturday, November 8, 2014, 11:30 AM)

EVOLUTION OF THE TETRAPOD APPENDICULAR SKELETON: NEW EVIDENCE FROM ROMER'S GAP

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Devonian tetrapods were relatively large, aquatic animals with paddle-like limbs. In contrast, the earliest recorded terrestrial tetrapods from the Carboniferous were small with relatively longer walking limbs. Until recently, evidence of the intermediary stages was missing. The discovery of tetrapods at five localities in the Tournaisian of southern Scotland, and continued collecting from rocks of similar age at Blue Beach, Nova Scotia, is providing new information on the evolution of the tetrapod appendicular skeleton. The new material represents a broad adult size range and small forms show the greatest divergence from the pleisiomorphic condition. In all the earliest Carboniferous taxa the cleithrum and scapulocoracoid are no longer co-ossified, and in the smallest the cleithrum is splint-like. The flattened, L-shaped humerus, characteristic of the Devonian forms *Acanthostega* and *Tulerpeton*, is retained in the largest of the Tournaisian taxa, but in small forms from two coastal sites in Scotland, Burnmouth and Tantallon, there is greater torsion between the humeral head and distal condyles, the deltopectoral crest occupies a more proximal position, and a shaft is beginning to appear. An unusual departure from the typical L-shaped form is seen in *Pederpes* and some humeri from Blue Beach. Here the entire anterior edge is unfinished and was presumably capped in cartilage. A similar condition is seen in *Crassigyrinus*. By the Early Carboniferous, the unitary pelvic girdle of Devonian tetrapods has been replaced by a tripartite girdle comprising ilium, ischium, and pubis. A biramus ilium is retained in all known Tournaisian taxa. A uniramus ilium is first recorded in Visean colosteids and temnospondyls. Femora from four of the Tournaisian localities show a range of morphologies, but all retain the deep adductor blade characteristic of Devonian forms. By the Early Carboniferous, digit number has reduced. A small articulated specimen from Burnmouth is the earliest example of a five-digit foot. From the available evidence, it would appear that during the Tournaisian changes to the tetrapod limb skeleton first began in small taxa, beginning a trend that continued throughout the Carboniferous.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

NEW INSIGHTS INTO THE PALEOBIOLOGY OF THE DODO (*RAPHUS CUCULLATUS*) BASED ON THE ONLY EXISTING SKELETON OF A SINGLE INDIVIDUAL AND OTHER REMAINS DISCOVERED BY ETIENNE THIRIOUX

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More than a century ago, while collecting near Le Pouce Mountain, amateur naturalist Etienne Thirioux purportedly discovered the only known near-complete skeleton of a single individual of the dodo, an extinct large flightless columbid once endemic to the island of Mauritius. This specimen, housed at the Natural History Museum in Port Louis, Mauritius, has never been described, and many details regarding its provenance and its collector have remained obscure. Thirioux assembled another exceptional, partially associated (sub)fossil skeleton, now housed at the Durban Museum of Natural Science in South Africa, and sent a small number of dodo bones to European museums. The Thirioux dodos contain previously unknown or undescribed skeletal elements, including the patellae and tarsal sesamoids. They also preserve relative skeletal proportions that cannot be gleaned from the composite skeletons assembled from dodo remains excavated from the Mare aux Songes, a fossil concentration Lagerstätte first discovered in 1865, nor from the remnants of dodos collected alive before the bird′s extinction in the late 17th century. We used a Konica Minolta Range7 laser surface scanner to generate digital models with a point cloud density of approximately 100 µm of both Thirioux skeletons, which are mounted and on display. Examination of the scans supports the interpretation that the Port Louis specimen largely derives from a single individual, and that the Durban skeleton is a partial composite that contains a large number of associated bones, including the pectoral girdle. The relative proportions of the dodo hind limb skeleton are similar to smaller flying columbids, but the bones are much more robust. The wing skeleton of the dodo is small and in the same order of magnitude as that of the much smaller crowned pigeon *Goura*, the largest extant columbid. The dodo′s sternum still possesses a vestigial keel, but lacks an anterior keel apex, unlike flying pigeons. However, the closely related extinct flightless Rodrigues Solitaire, which was known to have used its wings in combat, does have a sternal keel apex, indicating that the dodo may have shown less intraspecific antagonistic behavior. Together with new information regarding dodo population structure, derived from the study of disarticulated remains from the Mare aux Songes, the Thirioux dodos open a new window upon an evolutionary experiment in rapid increase in body size and shift in locomotor mode, cut short by human-induced ecosystem destruction.

Romer Prize Session (Thursday, November 6, 2014, 10:45 AM)

ELEVATED RATES OF MORPHOLOGICAL EVOLUTION AND GREATER MORPHOLOGICAL INNOVATION IN FOSSIL TELEOSTS WITH DUPLICATE GENOMES

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Neopterygian fishes represent over half of all extant vertebrate species, and comprise the diverse teleost lineage with ~29 000 species and their taxonomically depauperate holostean sister group with 8 species. This pattern of extreme contrast, gleaned from living taxa alone, has provided the basis for assertions of teleost superiority and fuelled a series of evolutionary scenarios. The most fashionable hypothesis at present claims a causal relationship between the duplicated genomes of modern teleosts and their evolutionary success. Specifically it has been argued that genome duplication facilitated their morphological diversification, predicting that teleosts display elevated rates of phenotypic evolution and a greater capacity to generate novel phenotypes.

To test these hypotheses, I quantified body shape for 398 neopterygian species across 150 million years of the Mesozoic and constructed a supertree of 631 fossil neopterygians. I then applied three separate comparative methods to the dataset, including model fitting, phylomorphospace simulations and a Bayesian reverse jump Markov chain Monte Carlo approach. Specifically, I tested whether species known to have duplicate genomes (i.e. fossil crown-group teleosts) (i) exhibit higher rates of body shape evolution relative to other neopterygian taxa, and (ii) display a greater ability to evolve novel body shapes relative to other neopterygian taxa.

Crown teleosts consistently show elevated rates of morphological evolution and greater morphological innovation compared to other neopterygians. However, specific results are sensitive to different approaches to time-calibrating phylogenies. Under timescales derived from palaeontological data, crown teleosts show higher evolutionary rates and a greater capacity for morphological innovation than other neopterygians. When timescales are constrained to match molecular clock estimates, differences in rates of

evolution become less pronounced, and crown teleosts no longer show an elevated capacity for innovation. This highlights the importance of timescale selection in comparative analysis of fossil data.

These results support the hypothesis that teleosts with duplicate genomes show elevated capacity for morphological diversification, but the link between these evolutionary patterns and genome duplication remains purely correlational.

Symposium 3 (Friday, November 7, 2014, 9:15 AM)

METHODS FOR THE QUANTITATIVE COMPARISON OF MOLECULAR ESTIMATES OF CLADE AGE AND THE FOSSIL RECORD

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Approaches quantifying relative congruence, or incongruence, of molecular divergence estimates and the fossil record have been limited. Previously proposed methods are largely node specific, assessing incongruence at particular nodes for which both fossil data and molecular divergence estimates are available. These existing metrics, and other methods that quantify incongruence across topologies including entirely extinct clades, have so far not taken into account uncertainty surrounding both the divergence estimates and the ages of fossils. They have also treated molecular divergence estimates younger than previously assessed fossil minimum estimates of clade age as if they were the same as cases in which they were older. However, these cases are not the same. Recovered divergence dates younger than compared oldest known occurrences require prior hypotheses regarding the phylogenetic position of the compared fossil record and standard assumptions about the relative timing of morphological and molecular change to be incorrect. Older molecular dates, by contrast, are consistent with an incomplete fossil record and do not require prior assessments of the fossil record to be unreliable in some way.

Here, we compare previous approaches and introduce two new descriptive metrics. Both metrics explicitly incorporate information on uncertainty by utilizing the 95% confidence intervals on estimated divergence dates and data on stratigraphic uncertainty concerning the age of the compared fossils. Metric scores are maximized when these ranges are overlapping. MDI (minimum divergence incongruence) discriminates between situations where molecular estimates are younger or older than known fossils reporting both absolute fit values and a number score for incompatible nodes. DIG range (divergence implied gap range) allows quantification of the minimum increase in implied missing fossil record induced by enforcing a given set of molecular-based estimates. These metrics are used together to describe the relationship between time trees and a set of fossil data, which we recommend be phylogenetically-vetted and referred on the basis of apomorphy. Differences from previously proposed metrics and the utility of MDI and DIG range are illustrated in three empirical case studies from angiosperms, ostracods, and birds. These case studies also illustrate the ways in which MDI and DIG range may be used to assess time trees resultant from analyses varying in calibration regime, divergence dating approach or molecular sequence data analyzed.

Technical Session XV (Saturday, November 8, 2014, 10:15 AM)

MISSING DATA ESTIMATION IN MORPHOMETRICS: HOW MUCH IS TOO MUCH?

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Fossil-based estimates of diversity and evolutionary dynamics mainly rely on the study of morphological variation. Unfortunately, organism remains are often altered by post-mortem taphonomic processes such as weathering or distortion. Such a loss of information often prevents quantitative multivariate description and statistically controlled comparisons of extinct species based on morphometric data. A common way to deal with missing data involves imputation methods that directly fill the missing cases with model estimates. Over the last several years, several empirically determined thresholds for the maximum acceptable proportion of missing values have been proposed in the literature, whereas other studies showed that this limit actually depends on several properties of the study dataset and of the selected imputation method, and is by no way generalizable.

We evaluate here the relative performances of seven multiple imputation techniques through a simulation-based analysis under three distinct patterns of missing data (missing completely at random, anatomically, and taxonomically biased patterns). By contrast with commonly used imputation techniques, multiple imputations methods allow (through Monte Carlo procedures) estimating the uncertainty associated with imputed specimens. Overall, Fully Conditional Specification, and Expectation-Maximization algorithms provide the best compromises between imputation accuracy and coverage probability. Multiple imputation (MI) techniques appear remarkably robust to the violation of basic assumptions such as the occurrence of taxonomically or anatomically biased patterns of missing data, making differences in simulation results between the three patterns of missing data much smaller than differences between the individual MI techniques. Based on these results, rather than proposing a new (set of) threshold value(s), we develop an approach combining the use of multiple imputations with Procrustes superimposition of principal component analysis results, in order to directly visualize the effect of individual missing data imputation on an ordinated space (from either geomorphometric or linear measurements).

Technical Session XVI (Saturday, November 8, 2014, 11:00 AM)

BUCCAL-PUMP AIR GULPING IN DEVONIAN LUNGFISHES (SARCOPTERYGII; DIPNOI): INSIGHTS FROM TOMOGRAPHIC DATA

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Lungfishes are known for, and indeed take their name from, their bimodal respiratory abilities. All three extant genera can use their lungs to extract oxygen from the atmosphere, although their reliance on this capability differs between taxa. Lungs are considered primitive for the Osteichthyes, however the distinctive buccal-pump mode of air gulping exhibited by extant lungfish appears to be a specialization. It is associated with a number of derived skeletal characters (cranial ribs, long parasphenoid stalk, midline gap between palatal tooth plates) that first appeared during the Devonian. These have been described individually, but in no Devonian lungfish has their three-dimensional spatial relationship been reconstructed.

Here we present the 3D morphology of *Rhinodipterus*, a Late Devonian (Frasnian) lungfish from Australia and Europe, based on synchrotron microtomography and conventional computed tomography (CT) scans. *Rhinodipterus* is one of the most crownward fossil lungfishes with a solidly ossified braincase, which allows the spatial relationships of buccal pump components to be reconstructed. One of our specimens, a braincase from the Gogo Formation of Western Australia, is perfectly undistorted; the other, from Bergisch-Gladbach in Germany, is slightly flattened but includes an articulated anterior vertebral column and shoulder girdle.

Unlike less crownward Gogo lungfishes such as *Griphognathus* and *Chirodipterus*, *Rhinodipterus* has a full set of skeletal buccal pump components that can be directly compared to those of extant lungfishes, suggesting that it made more extensive use of air-breathing that the other Gogo genera. This is interesting in relation to the environmental context: Gogo and Bergisch-Gladbach are both marine, contrasting with the frequently hypoxic tropical to subtropical fresh water environments inhabited by modern lungfishes. The evolution of buccal-pump-supported lung ventilation was evidently not associated with a transition to non-marine habitats; a better functional model might be the extant tarpon, *Megalops*, a primitive marine teleost that uses air breathing to boost its metabolic rate and endure temporarily hypoxic environments.

Technical Session XI (Friday, November 7, 2014, 1:45 PM)

CALCIUM ISOTOPES AND TROPHIC DIVERSITY OF CETACEANS IN MODERN AND ANCIENT MARINE FOOD WEBS

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Cetaceans are one of the few mammal groups to have fully adapted to the marine environment, having diversified into two major clades that exploit distinct ecological niches: the Mysticeti, which filter-feed at the base of marine foodwebs, and the Odontoceti, which prey upon fish, squid, and warm-blooded vertebrates. Looking at living species alone, it is difficult to understand the evolution of these disparate feeding methods, which are traced back to the earliest appearance and diversification of these groups during the Eocene–Oligocene Transition. Though well documented in the fossil record, methods of testing whether the radiation of these groups was accompanied by an increase in trophic diversity are lacking. Interpretations based on morphology, body size, or comparisons with extant taxa can give a rough approximation of trophic position, but these methods cannot be tested when dealing with extinct species or clades that have no modern analogues. Here, we explore how stable isotope analysis of biogenic hard parts, specifically calcium isotopes ($\delta^{44/40}$Ca values) of bone and other bioapatites, is one method that may shed light on the trophic levels and feeding habits of early cetaceans and other marine consumers.

Recent work suggests that calcium isotopes are fractionated during mineralization of biogenic hard parts, the $\delta^{44/40}$Ca values of which are ~1.0‰ lower than that of the diet consumed. To test the effectiveness of this approach for defining trophic levels, $\delta^{44/40}$Ca values of bone from several modern species of cetaceans (Mysticeti: n = 11; Odontoceti: n = 8) were measured and compared with values for Oligocene odontocetes and mysticetes (both toothed and baleen-bearing species) from the Ashley and Chandler Bridge Formations. Among modern species, mysticetes consistently yielded higher $\delta^{44/40}$Ca values than odontocetes, with those species of myticetes that favored smaller zooplankton (copepods) typically yielding the highest $\delta^{44/40}$Ca values. This pattern was also evident among the fossil specimens sampled; mysticetes exhibited much higher $\delta^{44/40}$Ca values than odontocetes, with the observed range in $\delta^{44/40}$Ca values (~4.0‰) being of similar magnitude to that determined for modern species of cetaceans. Overall, these results indicate that $\delta^{44/40}$Ca values of modern and fossil bone can serve as a proxy for trophic position of cetaceans. More importantly, they suggest that a trophic diversity similar to that of present-day cetacean faunas was established by at least the early Oligocene, shortly after the appearance of the Neoceti.

Technical Session XVI (Saturday, November 8, 2014, 9:45 AM)

A REMARKABLE NEW BEAKED TETRAODONTIFORM FISH FROM THE EARLY EOCENE LONDON CLAY FORMATION

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The earliest crown-group tetraodontiform fishes (pufferfishes and their allies) are early Paleogene in age, and consist almost exclusively of highly compressed body fossils and isolated dentitions. To date, only a single three-dimensionally preserved specimen has been described from this important interval of tetraodontiform history: an incomplete skull from the early Eocene (Ypresian) London Clay Formation of the Isle of Sheppey, United Kingdom. Assigned to the extant genus *Triodon* (Triodontidae; three-toothed puffers), this fossil contributes comparatively little to our understanding of early morphological divergences among crown tetraodontiforms despite its antiquity. Other tetraodontiform material has since been recovered from the London Clay, but has not been formally examined. The most striking of these undescribed specimens is the skull of a new taxon of beak-toothed ('gymnodont') tetraodontiform that exhibits an unusual combination of primitive and derived characters. We studied this specimen using computed tomography (CT) scanning. The new taxon from the London Clay shares features with triodontids (including a number of internal structural features of the beak-like dentition, together with the presence of a well-developed pelvic girdle and pleural ribs), diodontids (both upper and lower jaws are fully fused along the midline) and molids (striated, poorly-ossified bone and vertebrae with transverse processes). However, it also bears a remarkable dorsal fin that inserts above the orbit and bears broad, plate-like

spines. Inclusion of the new taxon in a morphological character matrix for Tetraodontiformes finds it to be the sister of all other beaked-toothed puffers except for the most primitive known gymnodont, the Eocene *Eoplectus*. The unusual combination of characters disrupts traditional relationships, shifting numerous non-gymnodont taxa within the clade subtended by *Eoplectus*. This implies either character-reversal or homoplasy in the development of coalescent dentition. The unusual and unexpected morphologies apparent in these early Eocene specimens are particularly relevant in the context of recent molecular analyses that strongly contradict hypotheses of tetraodontiform interrelationships based on anatomy.

Technical Session XVI (Saturday, November 8, 2014, 10:15 AM)

STEP BY STEP TOWARDS A TETRAPOD SKULL: A HEAD-START FOR *ELPISTOSTEGE*

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Over the past 10 years, the fish-to-tetrapod transition has been probed in order to understand anatomical transformations associated with locomotion, breathing, hearing, and feeding with regard to this major change in habitat from water to land. Because of their general anatomical completeness, the terrestrialization of vertebrates has been primarily a matter of comparing five relatively well-known Devonian taxa along the tetrapod stem: a true piscine sarcopterygian, *Eusthenopteron foordi* (middle Frasnian), a piscine elpistostegalian, *Panderichthys rhombolepis* (late Givetian), a near-tetrapod elpistostegalian, *Tiktaalik roseae* (early-middle Frasnian), and two true basal tetrapods, *Acanthostega gunnari* and *Ichthyostega* sp. (Famennian). A great deal of attention has been given to the modification of the pectoral and pelvic girdles and limbs, whereas changes to the skull roof are still poorly investigated in piscine tetrapodomorphs owing either to the usage of reconstructions rather than observation of specimens (e.g., *Eusthenopteron*), the limited number of specimens (e.g., *Panderichthys*), or the partial information available on the material (e.g., *Tiktaalik*). In order to understand cranial disparity among Devonian tetrapods (e.g., *Ventastega, Acanthostega, Ichthyostega,* and *Ymeria*), it is essential to compare with a pre-tetrapod taxon. The recent discovery of a complete specimen of the middle Frasnian *Elpistostege watsoni* from the Escuminac Formation (Miguasha, eastern Canada) provides the opportunity to investigate cranial features at the elpistostegalid-tetrapod transition. Skull roofs of *Elpistostege* are reinterpreted based on detailed morphological observation, SEM and high energy computed tomography (CT) scan imaging and 3D imaging techniques. Cranial ornamentation and sutures, dermal skull-roofing bone proportions, and teeth patterns are compared among elpistostegalids and basal tetrapods. Both quantitative and qualitative characters corroborate the close sister-group relationships between *Elpistostege* and basal tetrapods.

Technical Session XVI (Saturday, November 8, 2014, 8:00 AM)

***GLADBACHUS*: UNCONVENTIONAL CONDITIONS IN AN EARLY CHONDRICHTHYAN**

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Phylogenies of early gnathostomes are changing, and although results of this research might be described as immature, the new trees exhibit consistent features. Notably, acanthodians, the so-called spiny sharks, are repeatedly found to be paraphyletic with several or all members branching from the chondrichthyan stem. This result makes intuitive sense: *Acanthodes* is now known to have a shark-like braincase, and sharks plus acanthodians in general share micromeric dermal skeletons, minimal endoskeletal bone, numerous fin spines, and, in certain genera, shark-like dentitions. However, the discovery that stem-sharks resemble crown-sharks leaves a gap at the base of the Chondrichthyes. The latest trees of early gnathostomes predict as yet unknown taxa with characteristics historically linked to placoderms and osteichthyans. Here, we show that *Gladbachus adentatus*, from the Middle Devonian of Germany, displays features consistent with these envisaged conditions. The single, dorsoventrally flattened, specimen has been computed tomography (CT)-scanned, revealing details of the braincase and an almost complete visceral skeleton. The broad neurocranium has widely spaced otic capsules and a short notochordal canal, but no ventral fissure or trace of enclosed aortic canals. Despite a shark-like posterior placement, the gill skeleton has osteichthyan-like anteriorly directed pharyngobranchials, as in the recently described *Ozarcus*, while the large basihyal and broad hypobranchials resemble those of the phyllolepid placoderm *Cowralepis*. Unexpectedly, the upper jaw, while cleaver shaped in lateral aspect, also has a large, placoderm-like, medial fossa for jaw adductor muscles. Moreover, these jaws show no chondrichthyan dental trough, or suggestion of a mandibular knob on Meckel's cartilage. Histologically, the endoskeleton consists of sub-cuboidal, non-globular calcified cartilage: barely the hallmark of chondrichthyans let alone euchondrichthyans. As might be predicted, the scales, as well as mandibular and branchial denticles, lack any diagnostic features of chondrichthyans or osteichthyans whatsoever. In summary, *Gladbachus* might be presented as the first shark to be discovered with placoderm-like jaws, but perhaps its greater significance is as corroborative support for an emerging, more coherent view of early gnathostome phylogeny.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

A STATISTICAL AND MASS SPECTROMETRIC CHARACTERIZATION OF THE MOLECULAR PRESERVATION OF MELANIN

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Melanin is the most common source of pigment in the integuments of vertebrates and has various ecological and biological functions including display, camouflage, UV protection, and structural support. Melanosomes, the organelles that contain melanin, have been described in fossil specimens of various taxa, yet it is poorly understood how these structures are preserved or affected by diagenesis. Identification has been primarily based on melanosome morphology, with more recent studies seeking to identify key chemical constituents that are indicative of melanin. However, methods for identifying molecular species, such as conventional mass spectrometry, can be too destructive and non-destructive methods that identify metals chelated to organic molecules are not specific to melanin. We have utilized time-of-flight secondary ion mass spectrometry (ToF-SIMS) to compare the molecular signatures of modern, experimentally matured, and fossil examples of melanin. ToF-SIMS is a minimally destructive technique, which allows intact fossil specimens or small samples to be analyzed yielding molecular fragments from the sample surface. The complex spectrum of secondary ions obtained presents an analytical challenge, which we show can be characterized in a principal component space. We observe that fossil and Recent melanin produce characteristic spectra relative to fossil and modern negative organic samples, with different sample types plotting in distinct regions of principal component space. We show that with artificial maturation experiments that mimic diagenetic alteration, modern melanin plots progressively closer to fossil melanin at higher temperature conditions. We hereby demonstrate that the variation in molecular preservation of melanin can be displayed across a number of avian and non-avian taxa in deep time and can be reconstructed with experimental diagenesis.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

PALEOBIOGEOGRAPHIC INFLUENCE OF THE PARIETAL EYE ON MOSASAURS

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Modern day squamates (Reptilia) use their parietal eye (PE) to regulate their body temperature, maintain circadian rhythms, and orient themselves relative to the sun"s polarized light. High-latitude dwelling lizards tend to have a large parietal foramen (PF) compared to low-latitude lizards presumably to better maintain their circadian rhythms. This study principally investigated the circadian rhythm hypothesis by comparing the size of the PE, through the PF, among four different genera of mosasaurs: *Clidastes, Platecarpus, Plioplatecarpus,* and *Tylosaurus*. If there was a correlation, then mosasaurs with a large PF should inhabit high latitudes compared to mosasaurs with a small PF. *Plioplatecarpus* had the largest PF followed by *Platecarpus*, *Tylosaurus*, and *Clidastes*. *Plioplatecarpus* had the most northerly occurrence (78 degrees) and *Tylosaurus* and *Plioplatecarpus* had the most southerly occurrences (64 degrees and 61 degrees respectively). As such, the circadian rhythm hypothesis is not supported among genera. A second test was done by comparing specimens within the same genus. The results were also negative as there is no relationship between PF size to latitudinal distribution. We also investigated a possible link between PF size and deep diving behavior. There was no relationship as the deep-diving *Tylosaurus* had a PF size similar to the shallow-diving *Clidastes.* There is a possible relationship though between PF size and local dwelling temperatures. Polar southern oceanic waters were generally warmer relative to polar northern oceanic waters. As such, this could explain why *Tylosaurus*, which had a small PF, could inhabit extreme southern latitudes (64 degrees) but not as extreme northern latitudes (53 degrees) while *Plioplatecarpus*, which had the largest PF, could inhabit extreme northern latitudes (78 degrees). This tentative hypothesis can be elucidated when more data of Late Cretaceous oceanic temperatures are known. Finally, there could be a relationship between PF size and homing capabilities. Perhaps *Plioplatecarpus* used their large PE for homing orientation and maybe even for migrational purposes. Further research on mosasaur migration needs to be done before we can be confident of our hypothesis.

Technical Session IX (Thursday, November 6, 2014, 2:45 PM)

THE LIZARD (SQUAMATA) IN *COMPSOGNATHUS* (THEROPODA) IS A NEW SPECIES, NOT *BAVARISAURUS*

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Bavarian limestone deposits represent some of the few areas preserving articulated Jurassic squamates. *Bavarisaurus*, two species of *Eichstaettisaurus*, and *Ardeosaurus* have been recognized from those deposits. Although usually identified as *Bavarisaurus macrodactylus* or *Bavarisaurus* cf. *macrodactylus*, a lizard preserved as a cololite in the theropod *Compsognathus longipes* (BSPHM ASI 563) shows important differences from the type specimen of *Bavarisaurus macrodactylus*. This cololite lizard specimen (hereafter, 'cololizard') is preserved as a combination of bone and bone-impressions, some of which are extremely clear. The skull preserves the premaxilla, maxilla, prefrontal, frontal, parietal, postfrontal, jugal, pterygoid, ectopterygoid, and mandible. The humerus and much of the thoracic skeleton, tail, pelvis, and hind limb are preserved. Comparative studies demonstrate that the ingested form is a new species. A cladistic analysis of 133 fossil and living lepidosaurs scored for 1318 morphological characters suggests that *Eichstaettisaurus gouldi* and *Bavarisaurus macrodactylus* are sister species. *Eichstaettisaurus schroederi* and the cololizard form a polytomy with that clade in an holophyletic Eichstaettisauridae with the unambiguous synapomorphies of paired premaxillae, angulated jugals, and presence of a hook-like postglenoid humeral process. *Eichstaettisaurus gouldi* and *Bavarisaurus macrodactylus* are united by the shared presence of a straight frontoparietal suture. The cololizard differs from *Bavarisaurus macrodactylus* in possessing an anteriorly arching (rather than a W-shaped) frontoparietal suture, a fused (unpaired) parietal, and anteroposteriorly-oriented parietal supratemporal processes. The cololizard differs from *Eichstaettisaurus schroederi* in possessing a weakly inclined maxillary nasal process, an anteroposteriorly elongate (rather than tall) prefrontal, a longer prefrontal orbital process, absence of cristae cranii, and an anteriorly arched (rather than transverse) frontoparietal suture. The cololizard will soon be named as a type specimen within the type specimen for *Compsognathus*, and further expands known Jurassic Bavarian lizard diversity.

Technical Session IV (Wednesday, November 5, 2014, 3:15 PM)

COULD THE GIANT KANGAROO HOP?

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It is thought that the process of saltation, or hopping, was an evolutionary breakthrough in terrestrial locomotion through its ability to confer energy efficiency at relatively high speeds. While some studies have suggested an upper body mass limit to effective hopping, larger extant species such as *Macropus rufus*, whose body mass exceeds the cited limit for effective hopping, can achieve higher speeds than smaller species. However, whether the largest fossil kangaroo, the Pleistocene giant *Procoptodon goliah* (~250 kg), had the ability to hop has been questioned by some. Other studies have argued that *P. goliah* was a very specialized hopper. More recent studies have focused on muscle and tendon elasticity to evaluate limitations on saltation and have argued that *P. goliah* could not withstand the amount of stress generated during hopping. Here, we apply novel biomechanical analyses based on data from 19 extant macropodoids and *P. goliah* to predict and compare peak forces in the femur during saltation and other types of locomotion. Our findings suggest that larger marcropods are able to withstand relatively higher forces than smaller species due to allometric increase in bone size. We predict that *P. goliah* could hop.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

THE SIGNIFICANCE OF THE OLIGOCENE–MIOCENE TRANSITION IN THE DIVERSIFICATION AND SPREAD OF THE CHALICOTHERIIDAE (MAMMALIA, PERISSODACTYLA)

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Like the Equidae and Rhinocerotidae, Chalicotheriidae reached their acme of diversity during the Miocene Epoch. The basal chalicotheriid genus *Schizotherium*, restricted to Eurasia, dominated the Oligocene. By the beginning of the Miocene the two chalicotheriid subfamilies, Chalicotheriinae and Schizotheriinae, had become clearly delineated. Members of the Chalicotheriinae existed in Asia (in the early Miocene of Pakistan and China), and by ~20 million years ago the chalicotheriine *Butleria rusingensis* was present in East Africa. Among the Schizotheriinae, the genera *Borissiakia*, *Phyllotillon*, and *Moropus* were all in evidence at the beginning of the Miocene. *Moropus* had joined the rhinocerotid *Menoceras* and the carnivores *Ysengrinia*, *Cynelos*, and *Cephalogale* as immigrants to North America, where it is found in faunas of late Arikareean age in the John Day Basin of Oregon, the Great Plains of western Nebraska and eastern Wyoming, and the Gulf Coast region of Texas and Florida.

Despite the centrality of Eurasia to chalicotheriid evolution at this time, our understanding of what happened on this vast supercontinent remains flawed, though promising progress has been made over the past two decades. For example, we know that the schizotheriine lineage that fuses the proximal and middle phalanges of digit II of the manus to form a duplex bone had appeared by the earliest Miocene. Fossil material of early Miocene Eurasian members of this clade (which includes *Moropus*, *Phyllotillon*, *Metaschizotherium*, *Tylocephalonyx*, and *Ancylotherium*) has been fragmentary, but this situation is changing. In Europe, good schizotheriine material from a MN3 fauna in the Chomutov Basin of the Czech Republic is aiding understanding of less complete specimens, aged MN2–MN4, from Spain, Portugal, France, and Germany that have variously been referred to *Moropus*, *Phyllotillon*, or *Metaschizotherium*. In Asia, careful stratigraphic work on chalicothere-bearing strata in the Bugti region (Pakistan), the Betpakdala Steppe (Kazakhstan), and fossiliferous basins of Gansu Province (China) is also yielding insights into schizotheriine evolution during the Oligocene–Miocene transition.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A GEOMETRIC MORPHOMETRIC ANALYSIS OF ARCHOSAUR CLAW SHAPE AND ITS IMPLICATIONS FOR KERATINOUS SHEATH MORPHOLOGY IN EXTINCT TAXA

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There is a large amount of literature on the topic of pedal ungual morphology in archosaurs and its relation to niche occupation; however, the relationship between the bony unguals and keratinous sheaths of claws remains poorly understood. It is especially critical to understand this relationship since extant avian datasets of keratinous sheath shape have been applied to the bony unguals of fossils to determine likely niches for extinct animals. The vast majority of previous studies examining claw shape have focused on angle measurements on either the inner, outer, or central aspects of the claw. These analyses failed to remove either size or phylogeny from their datasets, which is critical to do before attempting to understand shape. This study is the first to quantify the shape of the keratinous sheath as it relates to the bony ungual using two-dimensional geometric morphometrics. Geometric morphometrics is an ideal technique to use in the analysis of shape because it removes differences between specimens that are the result of rotation, translation, and size, leaving only shape data. A preliminary dataset of pedal digit three claws of 503 avian and crocodilian specimens were x-rayed in lateral view. By x-raying the specimens, it was possible to visualize both the shape of the keratinous sheath and bony ungual simultaneously. Additionally, 45 fossil avian and non-avian theropod digit three claws were photographed in lateral view in order to reconstruct the missing keratinous component of the claws using bony ungual shape and to test hypotheses about niche occupation among these taxa. Landmarks and semilandmarks were applied to the images in order to capture shape digitally. An exploratory principal components analysis has shown shape partitioning between both the unguals and keratinous sheaths of claws based on locomotory mode, demonstrating the potential for using this dataset to understand niche partitioning in extant species. Future analyses will explore the extent to which phylogeny is driving the shape change in the dataset and the degree of modularization within the ungual and keratinous sheath.

Technical Session II (Wednesday, November 5, 2014, 11:00 AM)

TESTING DEVELOPMENTAL BIOLOGY PREDICTIONS WITH FOSSILS: DENTAL COMPLEXITY AND EVOLUTIONARY RATES OF THE MULTITUBERCULATA

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The increase in maximum complexity of tooth morphology through evolutionary history, both within individual clades and across most vertebrates, especially mammals, is marked. However, recent genetic and developmental studies suggest increases in morphological complexity are developmentally constrained and more difficult to achieve than reductions. Thus, over evolutionary time scales, we might expect increases in morphological complexity to occur less frequently than decreases. To address this hypothesis we studied patterns of change of tooth complexity and other parameters in the extinct mammalian order Multituberculata. Multituberculates were both the most successful Mesozoic mammal clade and the longest-existing mammalian order known. Recent work suggests an increase in multituberculate species richness, disparity, abundance, and ecological and dietary niche range occurred ca. 20 million years before the K-Pg boundary, continuing until shortly into the Cenozoic, and possibly linked with the diversification of angiosperm plants and the evolution of multituberculate herbivory.

Here, we used diversification rate, phylogenetic comparative, and evolutionary rate analyses, allied with a comprehensive multituberculate phylogeny and dataset recording functional parameters including toothrow dental complexity, tooth cusp number, and estimated body mass, to determine patterns and rates of morphological evolution and change in complexity for these animals. Dental complexity was quantified and analysed using 3D digital tooth models produced from laser-/CT-scanning lower toothrows and a recently developed measure of morphological complexity, orientation patch count (OPC). Results show significantly more increases in dental complexity than decreases across Multituberculata, suggesting selection for higher complexity outweighed developmental constraints. However, within the only clade to acquire sufficient dental complexity to become predominantly herbivorous (containing Taeniolabidoidea, Djadochtatherioidea, and other groups), equal decreases and increases in complexity occurred. It appears that once selection pressures for further complexity increases were relaxed, reassertion of developmental constraints balanced selection. Results from this fossil clade can be used to test developmental results and predictions regarding rates and direction of change of morphological complexity and offer hope for bridging the gap between micro- and macro-evolutionary studies.

Technical Session I (Wednesday, November 5, 2014, 11:15 AM)

THE ECOMORPHOLOGY OF NEW ZEALAND KEKENODONTIDS AND IMPLICATIONS FOR NICHE PARTITIONING WITH EARLY NEOCETI

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Late Oligocene kekenodontid cetaceans from New Zealand represent a clade of late-surviving Archaeoceti. Previously, archaeocetes were thought to have become extinct around the Eocene/Oligocene boundary, concurrent with the appearance of the Neoceti (Odontoceti and Mysticeti). The kekenodontid source horizon (the Kokoamu Greensand, ~28–26 Ma) has produced archaic mysticetes (baleen whales) and odontocetes (toothed whales and dolphins). The coexistence of late-surviving archaeocetes with crown-group cetaceans raises questions on niche partitioning; how did structurally archaic kekenodontids cohabit with odontocetes and mysticetes that employed more specialized feeding strategies (echolocation and filter-feeding, respectively)? Some characteristics of the kekenodontid skull and dentition are sufficiently like those of smaller basilosaurids (e.g., *Dorudon*, *Zyghoriza*) to suggest macrophagous raptorial predation, as inferred for basilosaurids. Additionally, a multivariate principal component analysis of cranial and mandibular measurements from extinct and extant cetaceans with varying feeding methods grouped kekenodontids with basilosaurids. However, details of kekenodontid skull and dental morphology suggest differences from basilosaurid raptorial predation. The relatively flattened skull of kekenodontids has a low-lying and shallow supraoccipital, with a poorly developed sagittal crest that suggest a different lever action and muscle power compared to basilosaurids. Furthermore, the slender rostrum and gracile mandible indicate a possible forceps-like action to capture prey. The posteriormost teeth in kekenodontids lie anterior to the orbit, rather than on a maxillary tubercle ventral to the orbit, implying less-powerful molar occlusion. Large diastemata between the posterior cheek teeth are similar to those in some stem odontocetes and toothed mysticetes. The resulting alternation of upper and lower teeth in occlusion possibly formed a sieve suited to consume multiple smaller prey items rather than single, larger prey. Micro-wear analysis of the anterior and posterior dentition should elucidate feeding habits. The survival of archaeocetes into the late Oligocene could reflect a shift in predation on organisms from lower trophic levels, while still using a similar method of raptorial feeding shared with basilosaurids.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

NEW RODENTS OF THE FAMILY ANOMALURIDAE (MAMMLIA, RODENTIA) FROM THE PALEOGENE OF CENTRAL LIBYA

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Anomaluroid rodents are represented by three living genera that are endemic to western and central equatorial Africa. The Paleogene fossil record of this clade is sparse. The oldest African anomaluroids acknowledged so far come from the late middle Eocene of Bir El Ater in Algeria (*Nementchamys*) and the earliest late Eocene Birket Qarun Locality 2 in the Fayum Depression of Egypt (*Kabirmys* and *Shazurus*). Anomaluroids have also been reported from the Oligocene of Oman but these fossils have not yet been published. Younger anomaluroids are known from Miocene localities in East Africa. The

only known occurrence of an anomaluroid outside of Afro-Arabia is the late middle Eocene *Pondaungimys* from Myanmar.

Paleontological expeditions conducted in later Paleogene deposits exposed in the Sirt Basin of central Libya have yielded two new anomaluroid taxa, which are the first members of this clade to be described from Libya. The new taxon from the late middle Eocene Dur At-Talah escarpment constitutes one of the oldest representatives of this clade known from Africa. It appears most similar in dental morphology to the roughly contemporaneous taxa *Pondaungimys* and *Nementchamys*. It also shares many dental characters with *Kabirmys*, although the latter genus is more derived.

A second new anomaluroid taxon has been recovered from the early Oligocene Libyan site of Zallah 7. Diagnostic jaws and teeth of anomaluroids have never been reported from the well-sampled early Oligocene faunas of Fayum, where they are thought to have gone extinct near the end of the Eocene as a response to the cooler, drier climate of the early Oligocene. The discovery of anomaluroids in the Zallah 7 fauna shows that anomaluroids persisted across the Eocene–Oligocene boundary in Libya, indicating either that the Fayum record remains incompletely sampled or that marked regional provincialism characterized faunas of this age across North Africa.

Anomaluroid rodents are among the few mammal clades known from both Southeast Asia and North Africa during the later Paleogene. The new taxa from Libya yield a fuller picture of this clade's biogeographic history and phylogenetic relationships, while highlighting their usefulness in biostratigraphic correlation and paleoenvironmental reconstruction. Funding provided by NSF BCS-1441585

Technical Session I (Wednesday, November 5, 2014, 9:30 AM)

LARGE SCALE MICRO-CT BASED RECONSTRUCTIONS OF THE INNER EARS OF LIVING AND FOSSIL RUMINANTS GIVE NEW INSIGHTS INTO PECORA PHYLOGENY

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Modern pecoran ruminants find their origins in the diversified Late Oligocene-Early Miocene hornless taxa. Most of the latter look so primitive and convergent that they never really could be confidently classified, even as stem taxa of the living groups. This lack of agreement has led to problems in understanding the relative phylogenetic positions of the extant families. A still-remaining major issue is the unresolved affinity of the musk-deer family, Moschidae. While morphological data tend to favour close ties with cervids, genomic data rather plead for *Moschus* to be closely related to bovids. The mammalian petrosal bone is known to yield relevant characters for both phylogenetic and functional purposes, but the inner ear embedded within it remains poorly investigated in studies dealing with the evolutionary history of Ruminantia. The inner ear is the organ of hearing and balance. Besides these ecological functions, this structure has been recently shown to bear significant morphological information for phylogeny. The inner ear is virtually unknown in living and fossil ruminants because of its difficult accessibility. Recent advances in non-destructive high-resolution x-ray computer tomography have rendered this organ more accessible. Here, we reconstruct the inner ear of all 21 living ruminant families and tribes together with that of many fossil taxa either attributed to stem groups of the living families or sampled within the late Oligocene-early Miocene pecoran radiation. We show that non-pecoran Tragulina have a different inner ear than that of Pecora in having a dorsally branched posterior limb of the lateral semi-circular canal. We trace back the morphology of the moschid inner ear down to the Middle Miocene crown moschid *Micromeryx*. This is particularly relevant to the debate on moschid affinities. Fossil stem and crown deers and bovids like *Dicrocerus*, *Heteroprox*, or *Eotragus* help us understand the evolution of the structure in Pecora. First, morphological observations do not clearly support a relationship of *Palaeomeryx* with Giraffidae. The stem Pecora *Prodremotherium*, *Dremotherium*, and *Amphitragulus* share a junction of the lateral and posterior semi-circular canals. It is distinct from the basal condition of a secondary common crus seen in early artiodactyls. This feature interestingly also occurs in the living deers Cervini and Muntiacini. This study is the first large-scale investigation of the ruminant inner ear including all the living taxa at the tribe to family level and a large set of fossil taxa.

Technical Session VI (Thursday, November 6, 2014, 11:00 AM)

***LIMNOPITHECUS EVANSI* IS NOT *LOMORUPITHECUS HARRISONI*: IMPLICATIONS FOR ENDEMISM IN THE FOSSIL CATARRHINE COMMUNITIES OF EAST AFRICA**

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Multiple early Miocene fossil localities in East Africa richly document the evolution of stem catarrhine primates and the early divergence of cercopithecoid and hominoid clades. *Limnopithecus* is widespread throughout early Miocene sites in East Africa, but it is anatomically poorly known. Two species have been described—*L. legetet* (type species) and *L. evansi*. It has recently been suggested that *L. evansi* be transferred to *Lomorupithecus*, another stem catarrhine known only from a worn palate and a juvenile mandible discovered at Napak, Uganda (~20 Ma). Morphological comparisons of these taxa have been hampered by the limited upper dentition of *L. evansi* available to compare with the type specimen of *Lomorupithecus.*

Here, we describe two maxillae of *Limnopithecus evansi* (KNM SO-22259 and KNM SO-22736) discovered in the 1990s at the type locality of Songhor in Western Kenya (~19.5 Ma). Together, these specimens preserve both the anterior and posterior dentition from I2 to M3. The teeth are well-preserved and only lightly worn, adding greatly to our knowledge of the dental morphology of *L. evansi* and permitting more detailed comparisons with *Lomorupithecus*. We find that *Lomorupithecus* can be distinguished from *L. evansi* by several features of the upper premolars including: a reduced buccal cingulum, a less voluminous protocone, and most importantly the overall proportions of the teeth, which are buccolingually elongated. Furthermore, the genus *Limnopithecus* appears to be united by a shared I2 morphology that is distinct from all other early Miocene catarrhine taxa.

We conclude that *L. evansi* and *Lomorupithecus* do indeed represent separate taxa. This further supports the distinctiveness of the fossil catarrhine communities at Napak and Songhor, despite their apparent contemporaneity. In general, the distribution of stem catarrhines, cercopithecoids, and hominoids at localities throughout East Africa during the early Miocene suggests endemism, as many taxa are restricted to one or a handful of localities. This pattern is likely rooted in habitat differences between localities, and may further indicate that fossil localities are geographically isolated and not connected by blocks of suitable primate habitat. This work is a contribution to the REACHE Project, and is supported by the National Science Foundation (BCS #1241807). Additional support came from the Fulbright Scholar Research Grant Program, Leakey Foundation, Boise Fund, Kenya Museum Society, and Bill Bishop Trust.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

PLEISTOCENE TROPHIC SYSTEMS IN THE PAMPEAN REGION (BUENOS AIRES PROVINCE, ARGENTINA): INSIGHTS FROM C AND O STABLE ISOTOPES.

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The Pleistocene of South America presents a unique fauna of mammals composed of endemic taxa as well as species that invaded the continent from North America since the Pliocene. There have been multiple studies on the palaeoecology of these mammal faunas, but the position of carnivorous mammals within the ecosystems and their position within the food webs is still not fully understood. Here we measured the carbon and oxygen isotopic signatures in tooth enamel of carnivores as well as their possible prey species. The rich fossil assemblages of the Pampean region (Buenos Aires Province, Argentina) have yielded specimens of early Pleistocene (Ensenadan) and Late Pleistocene (Lujanan) age that allow a comparison of ecosystems in the region through time. To give a more comprehensive view of the food webs and ecosystems, we try to reconstruct the habitat and diet of the animals as well as the broader climatic conditions. We found that some predatory taxa seem to prefer some specific environments, like *Smilodon* who was more restrained to prey from wet areas with pure C3 environments such as early Pleistocene equids or toxodontids. Large canids, like *Theriodictis* on the other hand, seemed to prefer prey like camelids from mixed C3-C4 environments that were more arid. Other herbivorous taxa show a spread in different environments such as Late Pleistocene toxodontids and proboscids. The short faced-bear *Arctotherium* presents isotopic values similar to those of *Smilodon*, at least during the early Pleistocene, therefore suggesting dietary competition between both taxa.

Technical Session IV (Wednesday, November 5, 2014, 3:00 PM)

EXAMINING THE DEVELOPMENTAL ORIGINS OF EVOLUTIONARY REVERSAL IN THE MOLAR TEETH OF MACROPODOIDS (DIPROTODONTIA: MARSUPIALIA)

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The loss and re-emergence of traits is an unusual pattern of evolutionary change. Mammalian dentitions can offer excellent insights into how trait loss and reversal occur because we can integrate macroevolutionary insights from a well-sampled fossil record with information about dietary ecology and tooth development. Macropodoids (kangaroos, wallabies, and rat-kangaroos) are interesting in this regard because previous work suggests instances of dental trait reversal. The lower teeth of basal fungivorous macropodoids, such as potoroos and musky rat-kangaroos, possess a distinctive U-shaped posterolingual depression (PD) which helps crush food against the metaconule (= placental hypocone). The PD is subsequently lost in more derived Miocene macropodids, before the origin of lagostrophine, sthenurine and macropodine kangaroos. However some derived macropodine kangaroos in the genus *Macropus* (e.g., *M. robustus, M. pearsoni*) and sthenurines (giant extinct short-faced kangaroos) in the genus *Procoptodon* (*P. goliah, P. rapha*) possess a V-shaped PD on their lower molars reminiscent of that in basal macropodoids. We examined if PD-like features in derived macropodids were developmentally and morphologically homologous to that of basal macropodoids and how tooth development might facilitate PD reversal. MicroCT scans of 17 fossil and modern macropodoid species reveal that the PD in basal macropodoids and PD-like features in *Macropus* and *Procoptodon* have a similar enamel-dentine junction morphology reflecting establishment early in tooth morphogenesis. Combined with similar spatial and topographic relationships to major occlusal features, this suggests they are developmentally and morphologically homologous and supports two instances of evolutionary reversal. Using dental measurements from 34 macropodoid species we test an inhibitory cascade model of tooth development and find that species which re-evolve the PD have smaller than predicted posterior molars suggesting early arrest of posterior molar development. In *Procoptodon* and early Pleistocene *Macropus* sp., lingual offset of the PD relative to the hypoconid and emergence of a neomorphic dentine protuberance at the posthypocristid-hypolophid crest junction suggest changes in spatial patterning accompanied heterochronic shifts. We propose that reversal occurs primarily because early arrest of molar development prevents complete integration of crests bounding the PD into the posterior molar margin leading to retention of earlier stage architecture in mature teeth.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

FAUNAL ASSESSMENT AND PALEOECOLOGY OF THE ELIZABETHTOWN LOCALITY: A LATE CRETACEOUS (CAMPANIAN) MICROVERTEBRATE SITE IN SOUTHEASTERN NORTH CAROLINA.

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A significant fossil site containing Late Cretaceous (Campanian) vertebrate fossils has been discovered near Elizabethtown, Bladen County, North Carolina. The site is at a landfill 6 km from a previously studied correlative site at Phoebus Landing and preserves greater vertebrate diversity and abundance, allowing an improved assessment of species abundance as well as paleoecological, biogeographical, and chronostratigraphic interpretations of the Campanian vertebrate fauna throughout the Atlantic and Gulf Coast regions of North America.

The 10 cm thick bonebed is at the top of the Bladen Formation, a fluvially-dominated estuarine system in the Black Creek Group. Bulk samples of the bonebed yield a diverse assemblage of fresh water, euryhaline, stenohaline, and terrestrial organisms, including bony fishes, sharks, lissamphibians, mammals, turtles, plesiosaurs, squamates, crocodyliforms, and dinosaurs. The material exhibits little or no abrasion, implying a short transport duration and distance from the source area. This faunal assessment allows for regional correlation with Campanian age faunas from the Marshalltown Formation (Ellisdale Site) of New Jersey and the Blufftown Formation (Hannahatchee Creek) of Georgia. Of particular note, the Elizabethtown faunal assemblage exhibits affinities with Campanian age microvertebrate fossil localities in the western United States including the Aguja Formation of Texas, the Mesaverde Formation of Wyoming, the Judith River Formation of Montana, and the Oldman Formation of Alberta.

Technical Session I (Wednesday, November 5, 2014, 12:00 PM)

REWRITING THE HISTORY OF AN EXTINCTION: WAS A SECOND ISOLATED POPULATION OF STELLER'S SEA COWS (*HYDRODAMALIS GIGAS*) DRIVEN TO EXTINCTION FIRST?

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In one of the most infamous recent anthropogenic extinctions, Steller's sea cows (*Hydrodamalis gigas*) were exterminated by humans around 1768. Steller's sea cows were restricted in historic times to only the Bering and Medney Islands, Russia, with other records in the last millennium from the western Aleutian Islands. However, Steller's sea cow bone has now been obtained from St. Lawrence Island, Alaska, which is significantly farther north. Bone identity was verified using analysis of mitochondrial DNA. The stable isotope levels were obtained and the nitrogen-15 ($\delta^{15}N$)/ carbon-13 ($\delta^{13}C$) values for bone samples from St. Lawrence Island were significantly ($p \leq 0.05$) different from Bering Island samples, indicating a second population. The bone samples were dated to between 1030 and 1150 BP (= 800–920 AD). The samples date from close to the beginning of the medieval warm period which could indicate that the population at St. Lawrence Island was driven to extinction by climate change that may have changed the availability of kelp or by expansion of the Inuit from the Bering Strait region, possibly due to opening waterways, maybe following bowhead whales (*Balaena mysticetus*) or possibly searching for mineral resources, like iron. This study provides evidence for a new population of sea cows in the North Pacific within the past 1000 years.

Technical Session XVI (Saturday, November 8, 2014, 8:45 AM)

CONVERGENCE AND COMPLEXITY IN CHONDRICHTHYAN VERTEBRAL COLUMNS

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Vertebrae have historically been used as the defining feature of vertebrates: they diagnose the clade and provide structural support central to the vertebrate skeleton. Despite these pivotal roles in systematics and functional anatomy, it is widely known that vertebrae vary dramatically across taxa; the phylogenetic history of this structure is complicated and probably rife with homoplasy. Here we use new methods and trees to analyze the evolutionary diversification of this fundamental structure. Gnathostome vertebrae comprise either a notochord or a series of vertebral centra, neural and hemal arches, and may include a variety of transverse processes and intercalary components. To investigate the phylogenetic and ontogenetic origins of these structures we used a combination of ancestral state reconstructions and computed tomography (CT). Hypotheses of early gnathostome relationships are currently undergoing large-scale revision: placoderms are now considered to be successive grades of stem gnathostomes, and acanthodians have been recovered as paraphyletic stem chondrichthyans. We combined these new phylogenies with trees representing gnathostome crown clades to create a supertree, onto which we used parsimony methods to estimate ancestral states for a set of axial characters, including presence of centra and ribs, polyspondyly, and fusion of neural and hemal arches and spines. Our analyses indicate that centra have evolved independently as many as nine times, while polyspondyly and synarcuals (series of fused centra) have each evolved at least three times. To explore the developmental differences in chondrichthyan and osteichthyan vertebrae we treated seven little skate embryos (*Leucoraja erinacea*) with iodine solutions and obtained microCT scans of the axial column at the transition between the trunk and caudal regions. The scans reveal new levels of complexity in chondrichthyan centra: an inner calcification constricts the notochord and an exterior calcification surrounds the notochord and the inner centrum. This dual embryological origin of chondrichthyan centra differs from the solely notochordal origin of many teleost centra, and the exclusively somitic origin of tetrapod centra, indicating that gnathostomes have invented multiple mechanisms to evolve similar vertebral morphologies. Such diversity of vertebral components and homoplasy in this system signals levels of structural complexity and nested axial patterning that have yet to be explored in the fundamental divisions of the vertebrate clade.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

FUNCTIONAL MORPHOLOGY OF HARD-PREY CRUSHING TEETH

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Predation on hard-shelled organisms has helped shape both modern and fossil ecologies. While much work has been done on the evolution and diversification of prey defenses, less work has been done on the teeth of hard-prey predators, despite their prevalence in the fossil record. Tooth morphology is often used to infer diet of extinct animals, and low-crowned, robust, or molariform teeth are often interpreted as indicators of durophagy. However, there is much variation in durophagous tooth morphologies, in both extant and extinct organisms. This diversity begs the question: what are the parameters that direct evolution of crushing tooth morphologies? From a functional perspective, one can ask two questions: (1) is there an ideal tooth shape for crushing hard-shelled prey, and (2) how do these different shapes withstand the high forces required to process prey? Additional constraints on tooth morphology may be rooted in the evolutionary history of different lineages. To determine if there is an ideal shape for crushing prey, I constructed physical models of idealized tooth shapes and tested them on rapid-prototype models of shells. To test which of these same tooth shapes would be most likely to fail, I tested them using Finite Element Analysis (FEA). Comparing these two studies sheds light on the functional trade-offs that limit crushing tooth morphology. I found that convex teeth, especially those with tall skinny cusps, require less force to break shells, but shapes with tall skinny cusps are also the most likely to deform and break. To determine the impact of lineage on tooth morphology, I quantified tooth morphologies of members of the group Placodontia, a clade of extinct marine reptiles generally believed to have been hard-prey consumers. Tooth morphology changes across the placodont phylogeny, as well as tooth location. By comparing model morphologies to placodont tooth data, I can predict the functional limitations of different teeth.

Technical Session II (Wednesday, November 5, 2014, 9:45 AM)

ORIGIN OF MAMMALIAN PHARYNGEAL MUSCULATURE

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The mammalian pharynx plays a significant role in two of the characteristic features that define mammals: 1) a palatopharyngeal muscle that can hold the larynx in an intranarial position (essential for the respiratory turbinates to function as a temporal countercurrent exchange mechanism for heat and water conservation) and also seals the nasopharynx from the oropharynx when the larynx is withdrawn from the palatopharyngeal sphincter during swallowing and panting; 2) tensor veli palatini and palatoglossal muscles which, together with the tongue, help control the ordered transport of solid foods or liquids from the oral cavity to the valleculae (oropharynx) during eating, drinking, and suckling. Based partially on histological sections of the heads of mammals and reptiles and CT scans of the palatal region of non-mammalian cynodonts, mammaliformes, and two bulk-stained extant mammals (*Didelphis* and *Ornithorhynchus*), we speculate on progressive changes in the bones forming the palate in a phylogenetic line leading from pelycosaurs to mammals. We conclude that low pterygopalatine ridges of non-mammalian cynodonts supported a soft palate that included a palatopharyngeal muscle that extended from the hard palate and pterygopalatine ridges to the esophagus. In the transition from advanced non-mammalian cynodonts (ictidosaurs) to mammals, the pterygoid bones are considerably reduced in size and a major reorganization of the internal adductor muscles resulted in the origin of tensor veli palatini and medial pterygoid muscles. In mammals, the transverse processes that restricted movements of the lower jaw to a single plane in non-mammalian cynodonts and mammaliaformes are lost, and all that remains of the pterygoid bone are tall pterygopalatine ridges which form part of the lateral wall to the nasopharynx, provide an attachment area for the palatopharyngeus, and support, along their ventral edges, a soft palate that includes fibers of the tensor veli palatini and palatoglossal muscles.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

PHYLOGENETIC IMPLICATIONS OF THE BIRD-LIKE PODOTHECA OF *CONCAVENATOR CORCOVATUS* (THEROPODA, CARCHARODONTOSAURIDAE)

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The evidence on the morphology of the soft-tissues belonging to the autopod of non-avian dinosaur is restricted to some examples of exceptional preservation of integumentary structures and some well-preserved tracks. The holotype of *Concavenator corcovatus* (MCCM-LH 6666) is a complete and well-preserved carcharodontosaurid individual from Las Hoyas (Lower Cretaceous, Cuenca, Spain). The exquisite preservation of *Concavenator* is typical from this fossil site, and is related to burial by development of microbial mats. In this context, the *Concavenator* specimen shows replicas of soft-tissues associated with several areas of the skeleton, such as around the pedal digit, the metatarsal area and the vertebral series.

The autopodial soft-tissues of *Concavenator* have been analyzed in order to reconstruct the morphology of a complete foot of a non-avian theropod. The analysis has been carried out based on descriptions under visible and UV light. A previous taphonomic analysis has been taken into account regarding the correct interpretation of the state of preservation of the replicas of soft-tissues. Finally, a comparative analysis with the pedal anatomy of extant birds allowed us to establish a structural and functional interpretation of some morphological aspects of the foot.

The results suggest that the impressions around the foot bones represent the skin of a podothecal structure with plantar toepads and sheaths of claws. The arrangement of the scales on the podotheca resembles those observed in extant birds and primitive avian dinosaurs. The toepad distribution shows an arthral condition, as in primitive extant birds. The curvature angle of the cornified sheath falls within the range of those of terrestrial birds. Hence, the description of a bird-like podotheca in *Concavenator* supports the early occurrence of this feature in the ancestor of birds, already apparent in the clade Allosauroidea.

In conclusion, the *Concavenator* holotype has one of the most complete and best-preserved examples of a foot of a non-coelurosaurian theropod. The replicas of the soft structures of this foot provide information that allows to describe the aspects of the podotheca of an allosauroid theropod. Moreover, the distribution of the toepads and the morphology of the claws show similarities with those of the extant birds, providing a better understanding of the pedal anatomy along the theropod lineage. This evidence also allows the testing of hypotheses about the relationship between theropod's foot bones and its soft tissues based on the ichnological evidence.

Romer Prize Session (Thursday, November 6, 2014, 10:30 AM)

THE FUNCTIONAL MECHANICS OF ORNITHOMIMOSAUR AND THEROPOD CRANIA

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Ornithomimosaurs have garnered a great deal of interest in studies of theropod evolution due to the edentulous nature of derived members. Understanding the evolution of this group has implications for theropod evolution and putative dietary shifts from carnivory to herbivory.

The skulls of three ornithomimosaurs (*Garudimimus brevipes*, and the ornithomimids *Struthiomimus altus* and *Ornithomimus edmontonicus*) were digitally reconstructed and retrodeformed using computed tomography (CT) scan data. Virtual muscles were recreated using phylogenetic bracketing and osteological correlates. From these virtual muscles, bite forces were calculated. To study the influence of beaks on skull mechanics, hypothetical keratinous beaks were created using evidence from fossils and extant taxa. Finite element (FE) analysis was used to compare the biomechanical performance of the more primitive *Garudimimus* to the derived ornithomimids under pecking and biting loads and with different hypothetical beak morphologies. Feeding induced stress, strain and deformation in the ornithomimosaur FE-models was compared to the performance of a large theropod (*Allosaurus fragilis*), and a skull of an ostrich under reconstructed biting loads. These models were all scaled to the same surface area and total applied muscle loads to assess comparative strain patterns. The skulls were also divided into two modules to assess modularity and further understand functional changes: an anterior, rostral module, and a posterior, neurocranial module.

Results show that beaks reduce strain in the underlying bone in ornithomimosaur skulls. In *Garudimimus* and *Struthiomimus* higher stresses are experienced under biting loading regimes than under pecking loads, whilst the opposite is true in *Ornithomimus,* which may be linked to different food procurement methods. Tests on all of the theropod skulls shows the evolution of functional modules using FE for the first time. In *Allosaurus* and *Garudimimus* the skulls possess higher strains in the neurocranial module, whilst in the ornithomimids and the ostrich the strains are higher in the rostral module. The shift in strain location within ornithomimosaurs and theropods in general is likely linked to an increase in brain size, which causes an increase in bone volume protecting the endocranium and also shifts musculature from the temporal fenestra towards the palate and orbital regions.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

VARIATION IN INTRA- AND INTER-INDIVIDUAL OSTEOCYTE LACUNAR DENSITY IN A THEROPOD DINOSAUR (COELUROSAURIA: ORNITHOMIMIDAE)

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Studies of bone microstructure have yielded numerous insights into the growth rates of extinct organisms. Osteocyte lacunar density (OLD) in the bone cortex of extant and extinct vertebrates has been shown to be correlated to body size and relative growth rates. Other variation in OLD may be related to ontogeny and sampling location. However, previous work on OLD relies on comparisons of individual, non-consistent, long bone elements. This study seeks to quantify the range of variation in OLD present within an individual (through sampling of different sites within a bone, and in comparing results between bones of the same individual) and between individuals (through comparisons of average values for each individual, and values between individuals of different age) in a series (n=6) of ornithomimid dinosaurs from the Upper Cretaceous Horseshoe Canyon Formation of Alberta. Elements including the femur, tibia, fibula, metatarsals, and pedal phalanges were thin-sectioned and compared to assess OLD variation within a single species of ornithomimid dinosaur.

OLD ranged from ~29800 to ~42800 osteocyte lacunae per mm^3, with an average ornithomimid OLD of ~35000 lacunae/mm^3. For an estimated ornithomimid body size range of 60-100 kg, this yields an OLD-mass relationship relatively similar to mammals and theropods, and slightly lower than that of ostriches. The effect of ontogenetic stage on OLD, in which sampling of OLD in the outer cortex of mature animals is recommended to control for changing OLD throughout ontogeny, appears negligible; there is considerably more variation in OLD between elements of an individual than in different positions within a single element, or in the average OLD between different individuals. Therefore localized factors relating to differential limb growth may play a larger role in the distribution and density of osteocyte lacunae than previously thought. Indeed, variation between elements of single individuals suggests that estimating growth rates of extinct species may be more complex than previously considered, and may be significantly affected by individual variation and allometry of different skeletal elements.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

ESTIMATING RESPIRATORY TURBINAL SURFACE AREA FROM SNOUT DIMENSIONS IN ARCTOID CARNIVORANS.

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A mammal's nose, or more precisely, its shape, size, and the turbinal bones within, can reveal clues about an animal's ecology, its water and heat demands, as well as its relative reliance on olfaction. Within the anterior snout lie the maxillary turbinals, a set of complex, scroll shaped bones carrying the respiratory epithelium that function to condition incoming air and minimize heat and water loss from exhaled air. Posterior to these are turbinals that support a receptor field of olfactory sensory neurons. The advent of high resolution CT scans and 3-D imaging software has made clear, non-destructive quantification of nasal chamber volume and turbinal surface area possible. However, CT scanning rare specimens can be costly and/or risky, and fossils can be filled with matrix, and so we have aimed here to identify a set of external landmarks and linear skull metrics that together can be used to estimate nasal chamber size as well as relative turbinal surface area. Previous comparative studies using digital methods have revealed that, among arctoid carnivorans, aquatic species have significantly more respiratory turbinal surface area than their terrestrial counterparts. In our current study, we focus on a set of specimens for which snout volume and turbinal surface area data already exists. The targeted skulls represent 20 species from six families of arctoid carnivorans and cover aquatic, terrestrial and semi-terrestrial ecologies. As a proxy for nasal chamber volume, we used a series of 8 landmarks that best capture the dimensions of the nasal chamber. We used reduced major axis regression (both traditional and phylogenetic to account for non-independence among species) and partial correlation analyses to examine the relationship between rostral size and turbinal surface area. Results showed that the centroid size of the rostrum is positively correlated with maxilloturbinal surface area, and was able to distinguish semi-aquatic species with expansive respiratory turbinals from terrestrial species.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A RE-EVALUATION OF THE PURPORTED DINOSAUR FINDS FROM THE MIDDLE-LATE TRIASSIC OF POLAND

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The alleged historical Polish Triassic dinosaur discoveries (e.g., *Thecodontosaurus primus*, *Zanclodon silesiacus*) have been repeatedly cited in articles about paleobiogeography of the Middle-Late Triassic archosaurs and in taxonomical reviews of the Triassic dinosaur taxa. Here, we re-evaluate each purported Triassic dinosaur discovery from Poland using an apomorphy-based approach. Additionally, we describe some supposed dinosaur specimens collected from the Triassic deposits of Poland, but only briefly mentioned in Polish-language geological journals, field notes or museum labels. We attempt to assign all described specimens to the least inclusive tetrapod clade possible. Revision indicates that some remains represent non-dinosaurian archosaurs or prolacertiform taxa. Most of the analyzed dinosaurian specimens are fragmentary and indistinguishable from skeletal elements described from well-known Late Triassic taxa of Europe. This re-evaluation concludes that basal dinosauriform and dinosaur fossils are present in the Late Triassic of Silesia and the Holy Cross Mountains, but dinosaur remains described from the Middle Triassic sites are not diagnostic at the level of Dinosauria or even Dinosauromorpha. New analysis of the *Velocipes guerichi* holotype from Kocury site (Silesia) suggests that it is probably the proximal part of an elongated and flattened fibula of a neotheropod dinosaur. This probable non-tetanuran neotheropod and possible basal dinosauriforms are the only identifiable dinosauriform skeletal remains from the Polish Triassic discovered prior to the description of *Silesaurus opolensis* from the Late Carnian of Silesia.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

AN OVERVIEW OF THE GENUS *COELACANTHUS* (SARCOPTERYGII: ACTINISTIA) WITH EMPHASIS ON SOUTH AMERICAN OCCURRENCES

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Coelacanthus was one of the first sarcopterygian fish described in the first half of the 19th century. The genus is monotypic (*C. granulatus*) and occurs in marine strata in the Permian of England, Germany, and Poland. Historically, several species have been referred to this genus, although many of them have been later transferred to other genera. Here, we corroborate the occurrence of *Coelacanthus* in South America based on a single well-preserved angular previously described from the Permian Vitiacua Formation, Bolivia. Beyond this occurrence, there are other records of coelacanths in the Paleozoic of South America that might belong to the genus *Coelacanthus* (e.g., several fragments and scales, as well as an isolated pterygoid assigned uncertainly to the Carboniferous genus *Rhabdoderma*, reported from the Pedra do Fogo Formation; a few isolated teeth from the Corumbataí Formation; and indeterminate fragment of an undetermined coelacanth in the Mangrullo Formation). These occurrences indicate the possible distribution of *Coelacanthus* in the southern portion of Pangea, contrasting with what is currently known and emphasizing the worldwide distribution of genus in Pangea. Furthermore, considering its strict occurrence in the Late Permian, taxa attributed to *Coelacanthus* in the Devonian and Triassic (e.g., *C. welleri*, *C. luzensis*, respectively) need to be revised.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

NEW CRANIAL REMAINS OF THE ENIGMATIC ARCHOSAUR *RAZANANDRONGOBE SAKALAVAE* FROM THE MIDDLE JURASSIC OF MADAGASCAR CLARIFY ITS PHYLOGENETIC RELATIONSHIPS

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Razanandrongobe sakalavae is a large predatory archosaur of uncertain affinities that was diagnosed on the basis of fragmentary maxilla and teeth, from the Middle Jurassic

(Bathonian) of the Mahajanga basin, NW Madagascar. Here we describe two new cranial elements which greatly improve our knowledge of this enigmatic species. The almost complete right premaxilla indicates that the rostrum is deep, wide and not pointed, with four alveoli that are sub-vertical, just slightly curved lingually. The external nares are confluent and face rostrally. The premaxilla lacks any lateral groove at premaxillomaxillary suture for reception of mandibular fangs. The left dentary is incomplete caudally. The preserved portion bears eight large mandibular teeth of similar size, none of which is an hypertrophied fang. The mandibular symphysis extends posteriorly to level of the eight tooth. The splenial itself is not preserved, but its sutural marks on the dentary indicate that the splenial contribution to the mandibular symphysis is approximately one fifth of the symphyseal length in dorsal aspect.

On the basis of the new data, some previously uncertain features of the holotypic maxilla, such as the margin of the suborbital fenestra and the contact surfaces for the palatine, the ectopterygoid and the jugal, are now apparent. The phylogenetic relationships of the species within Archosauriformes are tested. The results confirm that *R. sakalavae* is a valid species, nested at the base of Mesoeucrocodylia and is distinct from any currently known member of the taxon. A cranial reconstruction is attempted, informed by the results of the phylogenetic analysis.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

CLAW MORPHOMETRICS IN WESTERN AUSTRALIAN MONITOR LIZARDS: FUNCTIONAL MORPHOLOGY AND NICHE SEPARATION WITHIN A TOP PREDATOR GUILD.

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Many studies have investigated the morphology of claws. This includes modern bird talons, which are often used as analogues for non-avian theropods. Less common are studies of quadrupedal reptile claws, and virtually no studies look at claws as an indicator of niche partitioning among co-occurring species within an ecosystem. The purpose of this study is to quantitatively analyze the claw morphology of the 10 co-occurring monitor lizard species (family: Varanidae) from top predator guild in the Kimberley of Western Australia. This study will determine 1) if there are significant differences in claw form and 2) if ecological niche characters may be linked to said differences. Photographs of the varanid claws were taken from a combination of both field-caught and preserved museum specimens. A geometric morphometric approach was used; two semilandmark curves were plotted along each claw. Claw centroid size (CS) and snout-vent length (SVL) were included as size metrics, and two ordination methods compared claw shape. A priori ecological groups were selected based on habitat preferences for each species and compared. Claw form was also compared to previously constructed molecular phylogenies. MANOVA indicates a significant difference in claw shape between the co-occurring species, as well as between a priori groups. Claw CS increases isometrically relative to SVL, although the open-woodland taxa tend to have noticeably larger claws than their congeners. Shape does not change allometrically. Open-woodland taxa possess elongate, straight claws potentially for digging, whereas rocky-escarpment taxa have stout, straight claws for maneuvering in rocky crevasses. Open-rocky grassland taxa occur in between the aforementioned groups. Arboreal species possess stout, hooked claws for woody substrate. Semiaquatic monitors all have hooked claws that are moderately elongate, but *Varanus mertensi* has noticeably more elongate claws than *V. mitchelli*. This separation, as well as overlap seen between certain ecological groups, may be attributed to phylogeny. *V. mitchelli* and all the arboreal, open-rocky-grassland, and rocky-escarpment taxa fall within the *Odatria* clade, and show distinct overlap. *V. mertensi* falls closer to other members of its own *gouldii* clade. Studies such as these of claws and other functionally significant characters will allow for the extrapolation of ecological data in analogous extinct taxa, as well as give insight into niche partitioning within co-occurring species within extinct ecosystems.

Symposium 5 (Saturday, November 8, 2014, 2:15 PM)

ECOMETRICS DOWN UNDER: CORRELATION OF MORPHOLOGY WITH PALEOHABITAT IN KANGAROOS

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Both craniodental and postcranial data of mammals have the potential to reveal information about habitat structure. A particular issue in the Oligo-Miocene of Australia is whether the known fossil mammal faunas derive from tropical forest (as indicated by the faunas) or drier environments (as could be interpreted from the sediments). In addition, were all of the Miocene areas of a similar habitat type? Specifically, were the Queensland Riversleigh localities the same as the South Australian Etadunna localities?

We compared data from fossil macropodoids (kangaroos and rat-kangaroos) with that of extant species to determine how morphological data correlated with diet and locomotion. Multivariate analyses of 14 craniodental measurements of 43 species of extant macropodoids showed good discrimination (88% correct classification) between dietary categories (omnivore, browser, mixed feeder, and grazer). Tropical forest browsers always clustered separately from the other browsers. Because fossils with complete skulls are rare, the analyses were also performed with only five measurements (four dental and one mandibular), providing similar results.

Sixteen fossils from Etadunna and nine from Riversleigh were then entered as unknowns. Almost all of the fossil taxa fell within the areas of browsers or omnivores: two Oligocene taxa clustered with the mixed feeders. Fewer taxa clustered with the extant tropical forest browsers at Etadunna, especially during the late Oligocene.

Similar analyses were performed on the calcaneum (25 variables) of 49 extant macropodoids (41 species). Good separation (93% correct classification) was achieved between the locomotor habits of "non-hopping or rare hoppers" (mainly tree kangaroos, *Dendrolagus* spp.), "specialized hoppers" (*Macropus* spp.), and "regular hoppers" (other species). Nine Miocene kangaroos (7 Etadunna, 2 Riversleigh) grouped mainly with the non-hoppers: two species grouped with the regular hoppers, and one late Miocene species grouped with the *Macropus* species. Several species of the primitive extinct family Balbaridae specifically clustered with the tree kangaroos.

These results show that Miocene kangaroos were predominantly browsers, without specialized hopping abilities, and some primitive forms (species of *Balbaroo*) may have been arboreal. This supports the hypothesis of a closed forested environment for these regions in Oligo-Miocene of Australia, and the craniodental data suggest that the Etadunna region was somewhat drier than Riversleigh.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

CRANIAL MORPHOLOGY AND PHYLOGENY OF CARETTOCHELYID TURTLES

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We studied the cranial morphology of the carettochelyids *Kizylkumemys schultzi*, Early Cretaceous, Uzbekistan; *Anosteira maomingensis*, early Eocene, China; *Carettochelys insculpta*, recent. These taxa share the following cranial synapomorphies: fossa behind quadrate; reduced antrum postoticum, foramen nervi trigemini divided into two parts by prootic; pterygoid trough; foramen posterius canalis caroticus interni (fpcci) placed in pterygoid and connected with basisphenoid by suture. Other cranial characters: *K. schultzi*: 1(0) wide upper temporal emarginations; 2(0) small parietals; 3(0) pterygoid trough opened ventrally; 4(0) position of fpcci anterior to quadrate condyle, near middle part of basisphenoid; 5(0), pear-shaped basisphenoid; 6(0) oval-shaped cavum tympani; 7(0) reduced antrum postoticum; 8(0), shallow fossa behind quadrate; *A. maomingensis*: 1(0); 2(0); 3(0); 4(1), position of fpcci at level of quadrate condyle, near posterior border of basisphenoid; 5(1), arrow-shaped basisphenoid; 6(0); 7(1), complete loss of antrum postoticum; 8(0); 9(0) long and narrow supraoccipital crest; 10(0) large lower temporal emarginations; 11(0) split posterior margin of maxilla; 12(0), no maxilla/quadratojugal contact; 13(0) large jugal with contribution to lower temporal emargination; 14(0) alveolar surface of maxilla sharply widens posteriorly; *C. insculpta*: 1(1), narrow upper temporal emarginations; 2(1) large parietals; 3(1) pterygoid trough closed ventrally; 4(2) position of fpcci posterior to level of quadrate condyle, distant from posterior border of basisphenoid; 5(1); 6(1), subcircular cavum tympani; 7(1); 8(1), deep fossa behind quadrate; 9(1), short and wide supraoccipital crest; 10(1), small lower temporal emarginations; 11(1), straight posterior margin of maxilla; 12(1), maxilla/quadratojugal contact; 13(1), small jugal without contribution to the lower temporal emargination; 14(1) alveolar surface of maxilla gradually widens posteriorly. The inclusion of the cranial characters in the phylogenetic analysis of Carettochelyidae resulted in sister relationships of *K. schultzi* to the clade including *A. maomingensis* and *C. insculpta*. This result contradicts previous studies, which united *Kizylkumemys* and *Anosteira* in the clade Anosteirinae, and agrees with most recent phylogenetic analyses. This study was supported by grants NSFC 41210001 and RFBR.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

SECONDARY BONE GROWTH (EPIKOURON) AND EXPOSED OSSICONES: TWO NEW CHARACTERS UNITING PALAEOTRAGINAE (GIRAFFIDAE, MAMMALIA)

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There are seven subfamilies of giraffidae, which are Canthumerycinae, Giraffokerycinae, Sivatheriinae, Okapiinae, Palaeotraginae, Bohliniae, and Giraffinae. The relationships are not fully resolved with cladistics. We are presently investigating two new characters that unify Palaeotraginae and can be used to differentiate between the other giraffid subfamilies. Secondary bone growth is small projections of bone that form on the surface of ossicones. In the giraffe, the secondary bone growth starts on the ossicone, and often spreads and covers the calvaria. We name these bone growths “epikouron.” All of the subfamilies besides Okapiinae and Palaeotraginae have secondary bone growth, or epikouron, on the surface of the ossicones. In Canthumerycinae, epikouron is irregularly distributed on the ossicone, as is seen in the giraffe. In Bohliniae, the epikouron is confined to the apex of the ossicone. In Giraffokerycinae and Sivatheriinae, it forms elongated streaks on the surface of the ossicones**.** Fossil specimens of adult male Palaeotraginae suggest that the ossicones were exposed to the air without overlying integument. This is supported by the presence of a beveled surface at the tip of the ossicone with wear facets. These facets are not found in younger specimens, and are found on the lateral surface of ossicones of older individuals. These planar facets would not have formed had there been integument covering the entire surface of the ossicone. We know from the okapi that having exposed bone without overlying integument is possible. In the okapi, however, the exposed surface is polished circumferentially. In other words, the polish is found in all directions, as opposed to Palaeotraginae, where the wear is concentrated on the lateral surface and on a single facet. In both Palaeotraginae and Okapiinae, the exposed ossicones do not have epikouron on the surface. We hypothesize that the overlying integument contributes to the formation of epikouron, and having exposed ossicones is not conducive to the formation of these secondary bone growths. The lack of epikouron combined with the exposed ossicones are characters shared by all members of Palaeotraginae.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

ISOTOPIC SIGNATURE ($\Delta^{13}C$, $\Delta^{18}O$) OF THE PALEOECOLOGY AND NICHE PARTITIONING OF THE PLEISTOCENE MEGAFAUNA FROM BRAZILIAN INTERTROPICAL REGION, NORTHEASTERN BRAZIL

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The extinct mammals *Eremotherium laurillardi*, *Notiomastodon platensis*, and *Toxodon platensis* are recorded for the Late Pleistocene of the Brazilian Intertropical Region (BIR). In order to evaluate the paleoecology of these species, $\delta^{13}C$ and $\delta^{18}O$ analyses were performed and compared with previously published stable isotope data for these species, *Valgipes bucklandi*, and *Equus* (*Amerhippus*) *neogeus*. A standard pretreatment was performed to eliminate organic material and secondary carbonates. However, there are some doubts about the reliability of sloth dentine even after pretreatment. Thus, these results may be biased, and shall be confirmed with future bone analyses. The $\delta^{13}C$ and $\delta^{18}O$ data suggest that *E. laurillardi* was a mixed feeder (n = 14, μ $\delta^{13}C$ = -4.35‰; $\delta^{18}O$ = -1.45‰), with high consumption of C_3 plants by exploiting dry forest borders, feeding on fruits and forest floor C_3 plants in all BIR. In latitudes 10° 21'—14° 46' S, *E. neogeus* was a C_4 grazer (n = 3, μ $\delta^{13}C$ = 0.73‰; $\delta^{18}O$ = 0.67‰), and the high values of $\delta^{18}O$ can also indicate the enrichment of ^{18}O in C_4 grass. Isotopic values of *T. platensis* (n = 4, μ $\delta^{13}C$ = -9.51; μ $\delta^{18}O$ = -2.20‰) and *N. platensis* (n = 2, μ $\delta^{13}C$ = -6.60; μ $\delta^{18}O$ = -1.00‰) show that they were mixed-feeders, tending to consume almost exclusively forest floor C_3 plants at dry forest borders. Possibly, *N. platensis* could feed on fruits as well. In latitudes 9° 22'—10° 17' S there is a change in dietary items, and *N. platensis* shows an exclusively C_4 grass diet (n = 9, μ $\delta^{13}C$ = -0.21; μ $\delta^{18}O$ = 1.26‰), while *T. platensis* (n = 3, μ $\delta^{13}C$ = -2.65; μ $\delta^{18}O$ = 0.19‰) has a mixed-feeding diet with high consumption of C_4 plants, but still continuing to explore dry forests borders. Lastly, in latitudes 5° 49'—6° 15' S, *N. platensis* (n = 1, $\delta^{13}C$ = 1.04‰; $\delta^{18}O$ = -0.25‰) and *T. platensis* (n = 1, $\delta^{13}C$ = 0.12‰; $\delta^{18}O$ = -2.22‰) were grazers, while *V. bucklandi* (n = 1, $\delta^{13}C$ = -10.17‰; $\delta^{18}O$ = -1.74‰) inhabited the dry forest border, feeding on C_3 plants. The results suggest that during the Late Pleistocene of BIR, the environment changed from canopy dry forests to more open habitats between latitudes 14° S and 5°S. Furthermore, species like *T. platensis* and *N. platensis* had a generalist diet, indicating a good environmental plasticity. With such capacity to adapt to environmental changes, the cause of extinction of these species remains unclear.

Symposium 4 (Friday, November 7, 2014, 10:15 AM)

THE DEVELOPMENT OF THE MULTIPARTITE AND MONOSPONDYLOUS VERTEBRAL CENTRA OF BASAL TETRAPODS BASED ON PALEOHISTOLOGICAL DATA

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It was often thought that the multipartite vertebral centra (i.e., rhachitomous and embolomerous) of many basal tetrapods like temnospondyls and "anthracosaurs" were preformed in cartilage and ossified endochondrally and later perichondrally in further ontogeny, whereas the mainly monospondylous lepospondyl centra developed by direct ossification and consist mainly of membranous bone. To test this hypothesis, we have investigated the paleohistology of the vertebral centra of different groups of basal tetrapods to reveal similarities and differences in their developmental origin and mode of ossification. The intercentra of the studied temnospondyls, such as *Eryops,* and some stereospondyls are characterized by both endochondral and periosteal bone. The endochondral bone in the dorsal and central regions of the centra forms a rather unorganized trabecular network with remains of calcified cartilage. The parallel-fibred periosteal bone forms the ventrolateral border. The vertebral centra of different "anthracosaur" groups consist of a network of endochondral trabeculae and a thin ventrolateral border of periosteal bone. In the chroniosuchian *Bystrowiella*, the trabecular network is less dense in the pleuro- than in the intercentrum. In the pleurocentrum of the embolomere *Archeria*, the bone density decreases along the dorsoventral axis. The notochordal canal is surrounded by circular arranged parallel-fibered bone. Calcified cartilage is absent. The monospondylous, notochordal centra of the lepospondyls examined show a high variability. In microsaurs, the centra are characterized by rather compact bone with parallel fibered bone matrix. Small erosion rooms as well as primary and secondary osteons are present around the notochordal canal and a chondroid-like tissue is observable. The nectridean vertebral centrum is characterized by areas of compact bone around the notochordal canal, the neural canal and the ventrolateral border of the centrum. The rest is filled by a network of thin, parallel fibered trabeculae. The histological framework of the vertebral centra shows a taxon-dependent and ontogenetic variability, among others, in the extent of the periosteal region, the vascularization and the amount of calcified cartilage. The presence of endochondral bone indicates a cartilaginous preformation of the centra in all studied temnospondyls, "anthracosaurs", and lepospondyls. Higher amounts of calcified cartilage, mainly observable in aquatic stereospondyls, indicate a slow rate of ossification of the vertebral centra.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

OVERVIEW AND NEW FINDS OF *AMBYSTOMA* (AMPHIBIA; CAUDATA) FROM THE PLIO-PLEISTOCENE OF ARIZONA AND NEW MEXICO, USA

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The present study combines an overview of the literature on fossil salamanders (Amphibia; Caudata) from the Pliocene and Pleistocene with previously unreported specimens from the Pleistocene (Rancholabrean Land Mammal Age) of New Mexico to determine what genera inhabited the American Southwest during this time period. The American Southwest is particularly arid, consisting of valleys, mountains, plateaus, and uplands, that seems unlikely to support salamanders within any of its faunal communities. Nonetheless, three species of salamanders have distributions within select habitats in the region today: *Ambystoma tigrinum* (Ambystomatidae), *Plethodon neomexicanus* (Plethodontidae), and *Aneides hardii* (Plethodontidae). The distribution of *A. tigrinum* encompasses most of the region except for the most arid valleys and mountains of the Gran Desierto in southwestern-most Arizona and along the lower Colorado River valley. *Ambystoma tigrinum* is found in a wide array of habitats from deciduous and riparian forests to woodlands and alpine meadows, and requires standing water only for reproduction. In contrast, the two plethodontids are highly restricted to two mountains ranges along the central axis of New Mexico. These plethodontids require year-round moisture and are confined to high-elevation, predominantly montane coniferous forests. Within Arizona and New Mexico, the Pliocene and Pleistocene records vary from imperfect to impressive (respectively), yet both time periods have a sampling bias in favor of valley bottom localities and low-elevation cave sites. Because of this, the fossil documentation of salamanders from the region is apparently predisposed towards recording *A. tigrinum*, but not the plethodontid species. There are no fossil reports of either *Plethodon neomexicanus* or *Aneides hardii* from the Southwest, hence their dispersal into the region is not understood. Collections have been viewed with the hope of locating fossils of the plethodontids. In the process, new fossils from the high-elevation (2115 m) lake basin of San Agustin (west-central New Mexico) have come to light and are presented here. These are presented in relation to the existing literature of fossil salamanders as well as the reconstructed paleoclimates of the region from the Pliocene to present.

Technical Session XVI (Saturday, November 8, 2014, 9:30 AM)

THE EARLY RADIATION OF ACANTHOMORPH TELEOSTS: WHEN FOSSILS HELP TO RESOLVE DEEP PHYLOGENETIC RELATIONSHIPS IN A MAJOR EXTANT CLADE

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With over 17 000 extant species (one third of the extant vertebrates), Acanthomorpha is a highly diverse marine teleost clade characterized by spines on the unpaired fins. In the last decade, large-scale molecular analyses helped to shape the acanthomorph tree, overturning some older views on their intrarelationships. However, major uncertainties remain on the pattern and timing of the early diversification of this clade in the Late Cretaceous. The Acanthomorph fossil record starts in the Cenomanian and is rather well documented in many Tethyan outcrops. Some of the Cretaceous fossils are tentatively included in modern orders but other taxa are completely extinct, including Pharmacichthyidae, Pycnosteroididae, Aipichthyoidea and Sphenocephalidae. In our presentation, we show how cladistic analyses realized in a renewed large-scale phylogenetic frame, based on skeletal characters and including Cretaceous fossils alongside modern representatives of the major acanthomorph subgroups, resolve some of these subgroups position and/or definitions.

The main results concern the Lampridiformes, an enigmatic order comprising the opah and oarfish, and the Paracanthopterygii, an acanthomorph subclade whose boundaries have been completely remodeled by molecular phylogenies. Lampridiformes are placed as the sister group of Euacanthomorpha and their early fossil record is now documented since Pharmacichthyidae, Pycnosteroididae and Aipichthyoidea are recovered as part of their stem-group. The topology recovered for Paracanthopterygii is highly congruent with recent molecular results: Paracanthopterygii is defined as the clade comprising extinct Sphenocephalidae and extant Percopsiformes (trout perches), Gadiformes (cods and allies), the enigmatic genus *Stylephorus* and Zeiformes (dories).

In each case, the inclusion of fossils has proven to be crucial to resolve topologies. Fossils provide plesiomorphic character state combinations that help detect sequentially homoplastic characters, otherwise undistinguishable from homologies in extant taxa only. Such analyses are particularly relevant groups whose large-scale phylogenies are mainly supported by molecular data. They provide morphological synapomorphies that support clades objectively. Fossils are directly placed in the trees, allowing a more precise dating of the early diversification events. Our data support an explosive diversification of acanthomorphs in the Cenomanian, characterized by the nearly simultaneous appearance of all major clades.

Preparators' Symposium (Saturday, November 8, 2014, 3:45 PM)

BREAKS, REPAIRS, AND ESSENTIAL COMPETENCIES FOR VERTEBRATE FOSSIL PREPARATORS

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Repair of specimens is one of the most common tasks for fossil preparators and is often viewed as mindless glue jobs or just sticking pieces back together. Good, long-lasting repairs address the root cause of damage and require thought and considerable competency. In fact, all of the 14 Essential Competencies for the Professional Vertebrate Fossil Preparator, proposed by the 2012 Austin Workshop, are involved in repairs. Every year at the American Museum of Natural History, hundreds of specimens are delivered

broken to the lab with requests for repair. A close look at many of these specimens reveals previous repairs in a typical pattern of multiple parallel joins made with different materials. This pattern is evidence of a cyclical history of breaks and repairs. Competent repairs can overcome this cycle.

Examples are discussed within the framework of the Essential Competencies. Prior to any treatment, the physical nature of the specimen and the task at hand are assessed and an end goal determined (Critical Thinking). Vertebrate fossils must be appreciated as brittle, complex composites of natural bone and matrix minerals (Understanding of Fossils as Biological and Geological Materials) combined with aging adhesives, coatings, consolidants and fillers (Understanding of Adhesives). The root cause of most damage is the inability of the specimen to resist flexing. Competent repairs require an intuitive feeling for inflexibility, vulnerable shapes and self-destructive weight (Aptitude for Fossils as Materials). Repairs may employ techniques to increase resistance to flexing (Use of Preparation Techniques) or reduce the chance of flexing by means of external supports, which are often a key component of competent repairs (Use of Archival Housings). Alternatives to joining should be considered (Ethics of the Use of Specimens). If a repair involves joining, the reconstructed specimen must resist deterioration for as long as possible (Understanding of Conservation Principles and Ethics), but remain usable for research (Participation in the Science of Paleontology). Materials and techniques used for repairs should always be recorded in laboratory records for future reference (Documentation and Record Keeping).

Technical Session XI (Friday, November 7, 2014, 4:00 PM)

THE TEMPORAL SCALE OF DIET AND DIETARY PROXIES

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Dietary reconstructions estimated from different proxies such as dental microwear, jaw morphometrics, and stable isotopes often don't match, especially for extinct species suspected of being generalists. These mismatched diet reconstructions are only incongruent if one assumes an idealized situation where diet is constant and scale invariant. Because diet can change greatly over ontogenetic, ecological, and evolutionary time, what appear to be incongruences in diet reconstructions might actually reflect the normal range of dietary variation time averaged by differently scaled proxies. We used statistically rigorous multiyear diet classifications of 139 mammals and several high temporal resolution mammal datasets to simulate the range of values that could be obtained from frequently used dietary proxies. We show that natural variation in diet can lead to highly disparate dietary reconstructions if proxies record diet at different temporal scales.

For example, a single African elephant (*Loxodonta africana*) can be classified as a strict browser, mixed feeder, or a grazer depending on whether tusk or hair samples are used for isotopic analysis as each proxy averages diet over a different length of time. Grizzly bears (*Ursus arctos horribilis*) can be classified as carnivores, herbivores, omnivores, insectivores, or granivores depending on when and for how long their diets are measured. With the wide range of dietary proxies available to both paleontologists and neontologists, diet can be roughly inferred from seconds of an animal's life to many millions of years of evolutionary history, almost 16 temporal orders of magnitude. These differing dietary reconstructions are not a nuisance but a desirable tool that allows us to create multi scale reconstructions that represent a species' diet over time and that are much more informative than any single proxy.

The utility of different proxies depends on the nature of the research question and the temporal scale examined. The exact time that proxies average diet over can vary by tissue, age, and taxa and few species have had these parameters experimentally measured. Still, care should be taken to avoid 'scale jumping' by grossly mismatching the extent of the ecological or evolutionary question with the extent of the data. When one population of generalists, like grizzly bears, can show more variation in diet in just four months than is found among hundreds of species in one year, any scale-blind dietary reconstructions or comparisons should be made cautiously.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

INTERCONTINENTAL DISPERSAL OF MAMMALS DURING THE PALEOCENE: NEW DATA FROM EUROPE

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The Paleocene in general and in Europe in particular, is generally considered as an epoch with high endemism and few intercontinental dispersals of mammals, although some faunal interchange is known between Asia and North America, mainly from the Tiffanian-Clarkforkian boundary. Up to now, however, faunal interchange between Europe and North America during the Paleocene has almost never been demonstrated.

The study of the early Paleocene fauna of Hainin (Belgium) reveals high endemism in European mammals at the end of the Danian (early Paleocene). The age of the fauna of Walbeck (Germany) is reevaluated and is likely to be Selandian (middle Paleocene), significantly older than previously suggested. Therefore, Walbeck is closer in age to Hainin than to the typical late Paleocene fauna of Cernay (France). However, the faunas from Walbeck and Cernay share many common genera that are not present in Hainin, showing a faunal turnover around the Danian-Selandian boundary in Europe, marked by the first occurrence of *Plesiadapis*, *Arctocyon* and *Adunator* in Walbeck, and of neoplagiaulacid multituberculates and *Dissacus* in Cernay.

The three genera present in Walbeck are abundant and diversified in North America from the beginning of the Tiffanian, i.e., older than the expected age of Walbeck. Therefore, it is inferred that these genera dispersed from North America to Europe around the Danian–Selandian boundary, corresponding roughly to the Torrejonian–Tiffanian boundary. The absence of multituberculates in the fauna of Walbeck does not allow the drawing of definite conclusions about the moment of their dispersal, but it is likely that it happened at the same time as *Plesiadapis* and *Arctocyon*, because neoplagiaulacids are abundant and diversified during the whole Paleocene in North America. Similarly, *Dissacus* is very rare in Cernay, and could also have dispersed at the same time as others, but remained unnoticed because of its rarity.

The Clarkforkian in North America is marked by massive arrival of taxa from Asia, among which are rodents, carnivorans, and tillodonts. The recent discovery of the latest Paleocene fauna of Rivecourt (France), where typical Paleocene taxa cohabit with rodents and a carnivoran, indicates that the large-scale dispersal event marking the Paleocene–Eocene boundary began in Europe about at the same time as in North America, with the arrival of rodents and carnivorans. The morphology of the new carnivoran species suggests that this group dispersed separately from Asia to Europe and from Asia to North America.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

SYSTEMATIC IMPLICATIONS OF A SAUROPTERYGIAN SKULL FROM THE UPPER TRIASSIC OF GUADALAJARA (SPAIN)

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The Spanish record of Triassic sauropterygians is relatively little-known. However, several fossil sites (located in Aragon, Catalonia, Castilla-La Mancha, Andalusia and the Balearic Islands) have provided remains of the nothosaurids *Lariosaurus*, *Nothosaurus* and *Ceresiosaurus*, and also of pachypleurosaurs, pistosaurs and placodonts. In addition, well preserved remains of eusauropterygians, some of them corresponding to relatively complete skeletons, were discovered in 2008 in the new site of El Atance (Guadalajara, Castilla-La Mancha), located in the Keuper facies (Late Triassic). These remains were tentatively identified as belonging to the genus *Simosaurus*.

One of the sauropterygian partial skeletons from El Atance shares with *Simosaurus gallairdoti* (the only known member of this genus and of the clade Simosauridae) the presence of vertebral infrazygapophysis in addition to the zygosphene-zygantrum articulation, a postcranial character so far recognized as autapomorphic for *Simosaurus*. This specimen also includes a nearly complete skull presenting a series of characters historically associated with *Simosaurus*: brevirostrine skull, snout not constricted and large upper temporal fossae (much larger than the orbits).

A more detailed study of the taxon from El Atance allows us to recognize some relevant features not shared with *Simosaurus*. The postorbital region of *Simosaurus* is much larger than the preorbital region; however, both regions have a subequal length in the sauropterygian from El Atance. The choanae in the latter are proportionately larger, and are situated further back than in *Simosaurus*. The mandibular articulation of the taxon from El Atance is situated almost at the same level that the occipital condyle, whereas the mandibular articulation is displaced to a level well behind the occipital condyle in *Simosaurus*. In addition, the sauropterygian from El Atance presents many small dental alveoli, not consistent with the wide and much less numerous teeth of *Simosaurus*. These and other characters suggest that the sauropterygian of the El Atance site is not a member of *Simosaurus gallairdoti*, but a new taxon related to it.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

MAMMALIAN CAVE FAUNA FROM THE LATE PLEISTOCENE OF THE WESTERN OZARK PLATEAU, OKLAHOMA

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The Ozarks are a highland system riddled with caves across multiple states within the South-Central United States. During the Late Pleistocene retreat of the North American Laurentide ice sheet, habitat and species composition of this region was indicative of a more temperate climate. Many studies have ascertained a strong boreal influence on Late Pleistocene mammalian faunas in the central Ozarks, but less is known of this period in the highland region of eastern Oklahoma. This study focuses on a site designated as AD-14 located within the Duncan Field Cave Complex of Adair County, Oklahoma which straddles the border of Oklahoma and Missouri and represents the westernmost edge of the Ozark Plateau. Material was collected from muddy deposits in the cave floor where bones were visibly accumulating as a lag deposit. Preliminary dating yielded a conventional radiocarbon age of 12,304 ± 50 years for this site. Further radiocarbon analysis is needed to determine if this is a temporally mixed or contemporaneous deposit. Here, we introduce the mammalian fauna found in this Late Pleistocene accumulation, which is dominated by bat (Chiroptera) remains. As the Duncan Cave Complex is currently regarded one of the most biologically rich cave system in the state, a comparative analysis of relative species abundance may indicate key differences between current and Late Pleistocene environments with possible implications for conservation.

Technical Session VII (Thursday, November 6, 2014, 12:00 PM)

THE COMPLETENESS OF THE FOSSIL RECORD OF PTEROSAURS: IMPLICATIONS FOR THEIR DIVERSITY AND EVOLUTION THROUGH THE MESOZOIC

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Pterosaurs, a Mesozoic group of flying archosaurs, have recently become a focal point of ongoing discussions into the effect of sampling biases on the fossil record and their influence on observed diversity patterns. Numerous attempts to mitigate the effects of geological and anthropogenic sampling biases have been made through the use of sampling proxies to more finely resolve their evolutionary history. However, the completeness of specimens as an additional sampling metric has thus far been overlooked for the group, despite its capacity to capture previously neglected aspects of sampling.

Here we assess the quality of the fossil record of Pterosauria using a character completeness metric based on the number of phylogenetic characters from a recent, well-sampled data matrix that can be scored for all known skeletons of each valid species (171). Averaged completeness values for each geological stage were calculated through time, with non-parametric and parametric comparisons made with equivalent time series

data representing pterosaur observed diversity and model-based residual diversity, avian and sauropodomorph completeness, sea level, as well as a number of sampling proxies, including pterosaur-bearing, dinosaur-bearing and tetrapod-bearing collections and formations.

Pterosaur completeness is observed to fluctuate substantially, showing peaks during the Early and latest Jurassic (Toarcian and Tithonian) and middle Cretaceous (Aptian). Evidence is recovered for troughs within the Cenomanian-Turonian and the Maastrichtian, stages that have been regarded as extinction intervals. Correlation with 'sampling-corrected' diversity indicates that species-richness and abundance is likely to have impacted the chance of preserving pterosaur remains. Pterosaur completeness is demonstrated to be heavily influenced by Lagerstätten: peaks of completeness are shown to correlate to major Lagerstätten deposits, and correlation with observed diversity is lost when species known from these deposits are removed. A statistically significant, positive correlation with Mesozoic avian completeness supports the hypothesis that Lagerstätten deposits have an increased influence on smaller bodied organisms, contrasting with a lack of correlation with large bodied Cretaceous sauropods.

This study highlights the importance of understanding the relationship between various taphonomic controls when correcting for sampling bias, and is further evidence for the dominant role of sampling on observed patterns in pterosaur diversity.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

NEUROANATOMY OF THE CRETACEOUS BOTHREMYDIDS *GALIANEMYS EMRINGERI* AND *G. WHITEI* (TESTUDINES, PLEURODIRA) BASED ON CT SCAN DATA

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The use of Computed Tomography (CT) scans is a powerful tool for paleoneurology, allowing a non-invasive exposure of new morphological data. Although new studies are assessing the neuroanatomy of several groups of vertebrates, turtles still are neglected in this area. The aim of the present work is to provide new morphological information on the neuroanatomy of the Cretaceous bothremydids *Galianemys emringeri* and *G. whitei* based on CT scan-generated endocasts. The endocasts of both species share the same overall shape and proportions. The hypoglossal nerve has two rami, as is usually the case in pleurodires. The canalis caroticus laterale is absent, as in *Chelus*, Pelomedusidae and several other bothremydids. The bony labyrinth is similar, although the semicircular canals and anterior ampulla are larger in *G. emringeri*. The short abducens nerve leaves the basisphenoid and enters the inner lateral side of the sulcus cavernosus; the nerve canal is rectilinear in *G. whitei,* and is convex and handle-shaped in *G. emringeri*. In *G. emringeri*, the facial nerve canal is shorter and thinner than in *G. whitei* and, as in other pleurodires, joins the canalis caroticus internus; in *G. emringeri*, the canal is much longer and conspicuous, and joins the canalis cavernosus, more similar to the condition seen in cryptodires. The canalis caroticus internus of *G. emringeri* is shorter and thinner, opening in a deep fossa pterygoidei, while in *G. whitei* the longer and thicker canalis caroticus internus opens in a shallow fossa pterygoidei. For both specimens there is one paired foramen for the statoacoustic nerve, slightly posterior and dorsal to the facial nerve, entering the cavum labyrinthicum in its anterior portion. The foramina for the glossopharyngeal nerve are not visible, and there is no indication of a specific foramen for the accessory nerve. Further studies are being conducted to help elucidate the neuroanatomy of pleurodires.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

COLOMBIA'S FIRST PTEROSAUR: A NEW GENUS OF DSUNGARIPTERID DOCUMENTS A NOVEL DENTAL MORPHOLOGY IN PTEROSAURS

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The Mesozoic non-marine fauna of northern South America is depauperate relative to the southern portion of the continent, with much of our knowledge coming from a few fragmentary and non-diagnostic specimens. This trend is also seen in pterosaur diversity, which in South America is primarily based on lagerstätte deposits such as Crato or Santana Formations from the southern region, with little known about northern taxa. Here we report a new pterosaur from the Early Cretaceous Rosablanca Formation of Colombia, which represents the first pterosaur described from Colombia and the only named pterosaur from the northern part of the continent. It is a dsungaripterid, the second known from South America, and at an estimated wingspan of 3-3.5 m is similar in size to *Noripterus* from China. The new taxon documents a unique combination of morphological characters in the lower jaw including tooth placement along the midline of the jaw and extremely reduced tooth sockets not seen in any other pterosaur. The unusual dentition combined with paleoecological evidence suggest a durophagus diet. This pterosaur helps document the evolution of dsungaripterids and suggests a radiation of the clade in South America during the late Jurassic-Early Cretaceous. This taxon sheds light of the evolution of tooth reduction in pterosaurs, and parallels the evolution of tooth loss in Mesozoic birds that has previously been linked to weight reduction for flight.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

CRANIAL ANATOMY OF *AULOLEPIS* (CTENOTHRISSIFORMES: AULOLEPIDAE): IMPLICATIONS FOR DEEP DIVERGENCES WITHIN EURYPTERYGIAN FISHES

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Spiny-rayed teleosts (Acanthomorpha) first appeared in the Late Cretaceous, undergoing an extensive radiation in the early Cenozoic to form a major part of the modern aquatic vertebrate fauna, with approximately 16 000 extant species. The closest living relatives of Acanthomorpha are the Myctophiformes (lanternfishes). Ctenothrissiformes, a Cenomanian-Turonian group of fishes, have been regarded as stem acanthomorphs. Comprising the families Ctenothrissidae and Aulolepidae, ctenothrissiforms exhibit a number of primitive teleost traits with some more derived features typical of acanthomorphs.

Ctenothrissiforms were last studied in depth over three decades ago, but since then our understanding of the morphological features that unite myctophiforms and acanthomorphs as the clade Ctenosquamata has been greatly refined. Many of the characters utilized in classifying this group concern internal skeletal anatomy that would usually require destructive preparation methods to expose in fossils. We utilised non-destructive computed tomography (CT) to examine the aulolepid *Aulolepis* in order to test its proposed affinities with acanthomorphs.

Known exclusively from Cenomanian horizons in the English Chalk, *Aulolepis* possesses traits that suggest a relationship with acanthomorphs (e.g., modified premaxilla), but it lacks a number of ctenosquamate synapomorphies by retaining a supraorbital, having more than two branchiostegals articulating with the posterior ceratohyal and showing no reduction in the size of the dorsal hypohyal. However, the second epibranchial bears an enlarged uncinate process, which represents a synapomorphy of Aulopiformes (lizardfishes and allies), the living sister group of Ctenosquamata. It is therefore probable that *Aulolepis* branches from a deeper position in the teleost tree than previously thought. Although we reject placement of *Aulolepis* as a stem acanthomorph, this genus could represent a stem ctenosquamate or an aulopiform, depending on whether the elongated uncinate process is a homoplasious trait.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

REAPPRAISAL OF THE MORPHOLOGY AND PHYLOGENETIC RELATIONSHIPS OF THE ALLIGATOROID CROCODILIAN *DIPLOCYNODON HANTONIENSIS* FROM THE EOCENE OF HORDWELL, UNITED KINGDOM

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The alligatoroid *Diplocynodon* is by far the most common European eusuchian, being described or mentioned from more than 200 localities and including several species, nine of which are considered valid and their phylogenetic relationships known. Despite being among the first *Diplocynodon* species to be named, *Diplocynodon hantoniensis* from the late Eocene of England was never described and figured with a modern approach. Most of the updated information on the morphology of *D. hantoniensis* derives indirectly from the character codings used for the cladistic analyses, which are available in the literature since the early 1990s. Subsequent studies largely relied on a single data matrix produced more than a decade ago, the analysis of which results in different topologies according to the number of taxa included in the analysis and their degree of completeness. Here we present the result of the revision of the whole Hordwell Cliff collection hosted at the Natural History Museum in London. The study of several nearly complete, well-preserved skulls and lower jaws, as well as dozens of other cranial and postcranial remains, allowed us to re-evaluate the codings of a few characters: in *D. hantoniensis*, the dentary symphysis extends from the posterior half of the fourth alveolus (BMNH 30397) to the center of the fifth alveolus (BMNH 30396, R 1043); the surangular-articular suture is strongly bowed laterally within the glenoid fossa; the lateral edges of the palatines are parallel posteriorly; the ectopterygoid-pterygoid flexure does not disappear during ontogeny; and the quadratojugal-jugal suture lies at the posterior angle of the infratemporal fenestra. The result of these changes produced, however, a general polytomy of all the *Diplocynodon* species included in the analysis, indicating that further morphological data is needed to resolve the phylogenetic relationships of the species of this clade. MD supported by Synthesys (FR-TAF 967, BE-TAF 4907, GB-3097) and by the Spanish Ministerio de Economia y Competitividad (CGL2011-28681).

Technical Session XI (Friday, November 7, 2014, 3:15 PM)

DRAMATIC DIETARY MODIFICATIONS OF CARNIVOROUS MARSUPIALS IN AUSTRALIA AS REVEALED BY DENTAL MICROWEAR TEXTURE ANALYSIS: POTENTIAL CONSEQUENCES OF INCREASED COMPETITION WITH NOVEL PREDATORS DURING THE HOLOCENE

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Carnivorous marsupials including the marsupial lion *Thylacoleo*, marsupial wolf *Thylacinus,* and Tasmanian devil *Sarcophilus*, inhabited mainland Australia during the Pleistocene. While *Thylacoleo* went extinct during the Late Pleistocene megafaunal extinction, *Thylacinus* and *Sarcophilus* instead became restricted to the island of Tasmania where *Thylacinus* went extinct during the 20th century and *Sarcophilus* is currently listed as endangered. While both the arrival of the dingo and intensification of human settlement on mainland Australia have been attributed as potential causes for the decline and/or extinction of *Thylacinus* and *Sarcophilus*, understanding their paleobiology across space and time can help assess if and how their diets changed in response to their recent geographic restriction. Here, dental microwear texture analysis was used to assess if the textural attributes of food consumed by *Thylacinus* and *Sarcophilus* varied throughout mainland Australia and as compared to their most recent occurrence on Tasmania, in addition to comparing the degree to which these taxa processed bone (i.e., durophagy).

At Wellington Caves (Pleistocene deposits in New South Wales) and on Tasmania over the past century, *Sarcophilus* and *Thylacinus* are indistinguishable in complexity and anisotropy; however, *Thylacinus* has significantly greater variance in complexity than *Sarcophilus* during historic times ($p = 0.039$). *Sarcophilus* has significantly different complexity between all times and locations examined, with the lowest complexity at Wellington Caves, the highest complexity in Victoria, and intermediate values on Tasmania. Most notably, *Thylacinus* has complexity values that suggest minimal to moderate durophagy on mainland Australia during the Pleistocene and Holocene and are not significantly different between western Australia and southeastern Australia. However, complexity values from historic specimens on Tasmania are significantly higher ($p = 0.003$) and have greater variance ($p = 0.007$) than mainland populations and

indicate extreme durophagy (equivalent to or potentially more so than *Sarcophilus*), suggestive of increased scavenging behavior and/or greater carcass utilization. Despite the absence of dingos on Tasmania, these data suggest that times were still challenging for the marsupial wolf prior to its extinction and suggest that humans significantly impacted thylacine diets during the 20th century.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

CRANIAL ANATOMY OF THE LARGE AETOSAUR *PARATYPOTHORAX ANDRESSORUM* FROM THE UPPER TRIASSIC OF GERMANY

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The large aetosaur *Paratypothorax andressorum* has so far been known only by its osteoderms. Here we describe the skull of a complete, articulated specimen of this taxon that was found in the type horizon at Murrhardt, southwestern Germany. *P. andressorum* has the following cranial autapomorphies: (1) upper jaw margin with deep notch between premaxilla and maxilla, (2) maxilla-lacrimal suture with finger-like projection, (3) upper temporal fenestra triangular, and (4) first paramedian cervical plates narrow and oval, much smaller than second row. Apart from these features, the skull of *P. andressorum*. closely resembles that of the small aetosaur *Aetosaurus ferratus* known from the same horizons, despite major differences in the morphology of the osteoderms. Both taxa share (1) the pointed, beak-shaped premaxilla which expands only gently anterior to the nasal, (2) maxilla and lacrimal excluding jugal from margin of antorbital fenestra, (3) exclusion of squamosal from margin of infratemporal fenestra, and (4) posterior part of jugal not downturned.

Phylogenetic analysis performed recovered *Paratypothorax* as the sister taxon of *Rioarribasuchus*, supported by two osteoderm characters, as a Paratypothoracisini in agreement with previous studies. The close resemblance of *Paratypothorax* and *Aetosaurus* and the immature state of all available *Aetosaurus* specimens suggest two alternative hypotheses: either (1) *Aetosaurus* is the juvenile of a close relative of *Paratypothorax* or (2) it is itself the juvenile form of *Paratypothorax.*

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

FIRST MENTION OF SIRENIANS (MAMMALIA) WITH FUNCTIONAL HIND LIMBS IN EUROPE (LUTETIAN, SOUTHERN PYRENEES, SPAIN)

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Since the first appearance of sirenians at the end of the lower Eocene (Ypresian) and the beginning of the middle Eocene (Lutetian), the fossil record illustrates the evolutionary transition between quadruped semi-aquatic forms (prorastomids), with a multivertebral sacrum, and aquatic forms, though with still well developed hind limbs in some (protosirenids) and an advanced stage of hind limb reduction in others (dugongids). Lutetian fossils are scarce—particularly in Western Europe, where the age of the deposits and/or the taxonomic determination are uncertain. The sirenian fossil remains found in the Castejón de Sobrarbe site (Huesca, northeastern Spain) correspond to the most complete fossil collection of the oldest sea cow known in Europe. The fossil-bearing bed is located in the deltaic deposits of the Sobrarbe Formation (Ainsa Basin, southern Pyrenees), which is dated as middle Lutetian with magnetostratographic and paleontologic (nummulites) data. We have recovered three skulls, four scapulae, one pelvis, and several fore- and hind limbs and vertebrae and ribs from different parts of the skeleton of juvenile and adult individuals so far. We present here the study of the pelvis, femur, and fibula. The size of the acetabulum and obturator foramen of the pelvis is similar to those of protosirenids, but the position of the foramen obturator with respect to the acetabulum and the overall morphology of the pelvis are closer to the prorastomid *Pezosiren portelli* from the lower Lutetian deposits of Jamaica. The femur shares some characters with the only protosirenid femur known, *Protosiren smithae* from the Bartonian–Priabonian of Egypt, including well developed greater and lesser trochanters, an anteroposteriorly flattened shaft, and an articulation surface for the patella. These characters are less developed than in *P. portelli*. The studied femur differs from that of *P. smithae* in having a gluteal tuberosity, probably as a relict of the third trochanter described in *P. portelli*. The only known fibula is described in *P. smithae,* so that from the Castejón de Sobrarbe site is the oldest one, which shows, unlike *P. smithae*, a distal triangular articular surface instead of rounded. The Lutetian sirenian of the Castejón de Sobrarbe site, then, retains a well developed pelvis, femur and fibula, so they were functional and would be in an intermediate development stage between those of *P. portelli* and *P. smithae*.

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Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A NEW TITANOSAURIAN DINOSAUR FROM THE UPPER CRETACOUS OF THE IBERIAN PENINSULA

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The Ibero-Armorican Island (southwestern Europe, Late Cretaceous) is important in the assessment of the diversity of non-avian dinosaurs preceding the end of the Mesozoic. Currently, three titanosaurian taxa in the Campanian-Maastrichtian of this Ibero-Armorican Island are known to have been present, although a higher diversity for titanosaurs has been hypothesized. Several titanosaurian fossil sites are known from the Iberian Peninsula, but so far just one taxon has been described: the putative basal saltasaurid *Lirainosaurus astibiae* from the Laño site (Treviño County).

The Konzentrat-Lagerstätte of 'Lo Hueco' (Campanian-Maastrichtian, Cuenca, Spain) has provided several partial titanosaurian skeletons in articulation or with a low dispersion, producing a unique record in Europe. One of these titanosaurian specimens (EC1) is here discussed. The EC1 skeleton was found partially articulated including cervical, dorsal, sacral, and caudal vertebrae, and several appendicular elements. This specimen is characterized by several titanosaurian features such as the presence of deep eye-shaped dorsal pleurocoels, procoelous caudals up to the most posterior middle ones, a pneumatized ilium, subhorizontal and perpendicularly directed pre-acetabular process to the sagittal plane, the general morphology of the ischium, and pronounced femoral trochanteric shelf. EC1 also presents some uncommon features within titanosaurs, such as the presence of a dorsally and ventrally bifurcated posterior centrodiapophyseal lamina in the dorsals, some features in the lamination of the proximal caudals, chevrons with double articular heads, and an accessory trochanter of the fibula.

Several features suggest a phylogenetically basal position within Lithostrotia (e.g., shallow lateral depressions in the cervical centra, a ridge-like hyposphene in the dorsals, procoelous mid-caudals, or a subhorizontal preacetabular process). Its scoring, together with the Ibero-Armorican titanosaurs (*Lirainosaurus*, *Ampelosaurus*, *Atsinganosaurus*), will improve phylogenetic resolution for this particular set of titanosaurs, although greater morphological similarity with *Ampelosaurus* (particularly in the appendicular skeleton) can be advanced.

The relatively complete skeletons found in the 'Lo Hueco' quarry will shed light on the systematics and diversity of the titanosaurs from the European Upper Cretaceous, testing the hypothesis that at least four different titanosaurian taxa were present in southwestern Europe at the end of the Cretaceous.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

FLUVIAL ICHTHYOFAUNAS OF THE WASATCH AND BRIDGER FORMATIONS (EARLY AND EARLY-MIDDLE EOCENE), SWEETWATER COUNTY, SOUTHEASTERN WYOMING, U.S.A.

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Fish faunas of the Eocene river systems of Wyoming are poorly known in comparison to the lake ichthyofaunas of the Green River Formation. We describe two river faunas recovered at two localities from the early Eocene Wasatch and early-middle Eocene Bridger Formations. The Wasatch and Bridger localities have drastically different faunas, only sharing a single taxon, although the fishes found in both localities are also present in Green River Formation lake deposits. The ichthyofauna of the Wasatch locality includes a lepisosteid (gar), an amiid (bowfin), *Diplomystus* (extinct herring relative), *Notogoneus* (extinct beaked sandfish), at least two amblyopsid-like percopsiforms (cave and troutperches), and at least two centrarchids (sunfishes) along with '*Priscacara*' (perciform of uncertain affinity). The material is notable in only including very small elements, most of which represent young juveniles. Furthermore, the percopsiform material is similar to that found in the more recent Cypress Hills Formation of Saskatchewan, Canada, and may therefore represent the earliest evidence of the Amblyopsidae. The material attributed to '*Priscacara*' is also similar to centrarchid material, suggesting that at least some of the fishes included in *'Priscacara*' may have affinities with sunfishes. In comparison, the Bridger assemblage only comprises a lepisosteid (gar), *Phareodus* (extinct bonytongue), and *Astephus* (extinct catfish). The growth characteristics of the Bridger *Astephus* material suggest the presence of a single species, and are more similar to those of the smaller *Astephus* taxon B than to those of the large *Astephus* taxon A from the Cypress Hills Formation. Although the material identified here is mostly disarticulated, it is three-dimensionally preserved, showing anatomical details not visible in articulated specimens, and allowing for comparisons with other microvertebrate fish material from the Late Cretaceous and Cenozoic. Additionally, the different taxonomic diversities of the Wasatch and Bridger localities indicate different paleoenvironments. The Wasatch assemblage indicates a very shallow, well-oxygenated environment with abundant aquatic vegetation and sluggish flow strengths, such as found in lateral floodplain waters that remain connected to active river channels. Contrastingly, the Bridger assemblage represents poorly oxygenated backwaters, susceptible to being isolated and slowly infilled, only preserving a low diversity of fishes capable of sustaining hypoxic conditions.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

SYSTEMATIC REVIEW OF THE SHREWS (SORICIDAE) FROM THE GRAY FOSSIL SITE, TENNESSEE, USA

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Little research has been done on North American fossil shrews in the last three decades and no work has been conducted on remains from eastern North America. Ten soricid taxa have been recovered from the Gray Fossil Site (late Miocene/early Pliocene) in the Southern Appalachians, Washington County, Tennessee. At least three of these taxa are new and several remain to be identified. *Crusafontina* sp. nov. is one of the youngest of the genus and substantially the largest. *Blarinella* sp. nov. is the first occurrence of the genus in the western hemisphere and thus has implications about the divergence of the tribe Blarinellini. The third is likely to also represent a new genus. In addition to the new taxa, the *Sorex* spp. found provides evidence for a late Miocene radiation of the genus. The overall high diversity of shrews at the GFS is unusual, but evidence from acid etching suggests that a few of the smaller taxa were brought to the site by carnivores (mammalian, avian, etc.); these shrew taxa provide insight to nearby ecosystems that would not otherwise be captured at the locality. Local flora and fauna from the GFS provide the first nearly complete record of an ecosystem in the Southern Appalachian Mountains, an area now recognized for its role as a refugium for both northern and southern taxa.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

DIETARY ADAPTATIONS IN GIRAFFID SPECIES: A DEEP TIME ANALYSIS

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The ruminant premaxillary shape corresponds to diet. Species that browse tend to have pointed premaxillae, which enable them to be selective. Grazers exhibit premaxillae resembling a square shape, allowing them to consume larger quantities of food at one time. Mixed feeders have premaxillae intermediate in form, permitting them to perform both functions. In giraffids only one premaxilla is preserved in Europe; that of *Samotherium boissieri*. In addition to others, we have discovered and studied several premaxillary specimens from the late Miocene of Gansu in China. We utilized three metric methods to attain the premaxillary shapes for comparison. *Giraffa camelopardalis* is known to be a browser. Our preliminary data show that most extinct giraffid species were mixed feeders, such as *Schansitherium tafeli* from Gansu, China and *Honanotherium schlosseri* from Gansu, China. Browsers were rare, and included, for example, *Afrikanokeryx leakeyi* from Baringo, Kenya. We find inconsistencies in the premaxillae. For example, a premaxilla of *Samotherium boissieri* from Samos, Greece was found to be a grazer whereas a premaxilla of *Samotherium boissieri* from Gansu, China was found to be a browser. This could be explained by: (1) time depth, (species could differ in time by as much as 3 million years); (2) geographical location; (3) unrecognized new species; or (4) diet variation within each species. These four explanations are not mutually exclusive. We conclude that a single giraffid species can vary its dietary anatomy and diet in deep time. This cannot be tested with extant ruminant species. This variation shows adaptational variation that has not been observed before.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

CHARACTERIZATION OF PREDATOR-PREY INTERACTIONS IN THE CONTEXT OF A LATE MIOCENE ENVIRONMENTAL PERTURBATION

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The investigation of mammalian predator-prey relationships has mainly focused on modern communities. This prevents characterization of how trophic interactions may change in the face of environmental and/or climatic perturbations, since these responses may require decades to be fully appreciated. The study of ancient mammalian communities can shed light on this subject. Here we explored resource use by apex predators applying a Bayesian stable isotope mixing model (SIAR) for the first time to two Spanish late Miocene localities: Los Valles de Fuentiduena (~9.62 Ma, LVF) and Cerro de los Batallones (~9.08 Ma, BAT). These sites span the onset of a regional environmental change, including an increase in the seasonality of precipitation and in aridification that occurred at ~9.5-9.0 Ma. The model reveals substantial resource overlap among the LVF carnivoran guild (felids, barbourofelids, amphicyonids and hyaenids), even though most of taxa belonged to the same functional group (solitary active hunters). Low seasonality of precipitation at the time when LVF accumulated may have promoted high levels of primary productivity with abundant biomass at different trophic levels, facilitating resource overlap among sympatric carnivorans. The model reveals significant differences in prey contribution for BAT carnivores pointing to resource partitioning between two sabre-toothed cats and an amphicyonid. We hypothesize that limited resources resulting from environmental change led to greater competition among BAT apex predators, whose coexistence was likely facilitated by resource partitioning. In addition to differences in resource utilization, mammalian taxonomic structure and diversity pattern also differed between the localities, likely driven by regional environmental change, which resulted in a protracted mammalian turnover event with high extinction occurring between 9.5 and 8.5 Ma.

The investigation of ancient predator-prey relationships may contribute to characterization of how trophic systems respond in the event of protracted environmental perturbations. This may be relevant to understanding the impact of current perturbations to the predator-prey interactions.

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Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

COMPARISON OF TWO LATE MIOCENE CARNIVORAN-DOMINATED FOSSIL ASSEMBLAGES FROM SPAIN WITH SPECIAL EMPHASIS ON THEIR CARBON STABLE ISOTOPE PALEOECOLOGY

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Mammalian fossil assemblages reflect the herbivore:carnivoran ratio of living communities (estimated as 10:1), and this is why sites dominated by carnivoran remains are highly uncommon in the fossil record. In Cerro de los Batallones Miocene paleontological complex (Madrid Basin, Spain), two sites, Batallones-1 (BAT-1) and Batallones-3 (BAT-3), are primarily composed of carnivoran remains (> 98% of the large mammal remains) and are providing precious information about taxa that were previously unknown or poorly known. In the late Miocene, these sites acted as natural traps for the fauna. The two sites are diverse in their carnivoran faunal composition with BAT-1 recording a total of 10 species and BAT-3 recording a total of 13 species. Although both sites are dated as Vallesian (late Miocene; 10-9 Ma), differences in their carnivoran compositions are attributed to temporal differences. with BAT-3 being slightly younger than BAT-1 (based on small mammal biochronology).

In BAT-1, we already conducted C stable isotope analyses on tooth enamel of three sympatric hypercarnivores (the sabertoothed cats *Promegantereon ogygia* and *Machairodus aphanistus* and the amphicyonid *Magericyon anceps*) to infer diet, resource partitioning, and habitat. Here, we expand stable isotope analyses to selected BAT-3 carnivores (including *Promegantereon ogygia* and *Machairodus aphanistus*) to evaluate possible environmental shifts that would explain the changes in the BAT-3 carnivoran guild compared to BAT-1.

Carnivore C isotope values ($\delta^{13}C$) imply the presence of a C_3 woodland ecosystem both in BAT-1 and BAT-3. In BAT-3, as observed in BAT-1, the two sabertoothed cats are indistinguishable in terms of their $\delta^{13}C$ values, which implies that they consumed prey with similar $\delta^{13}C$ values (but not necessarily the same prey). $\delta^{13}C$ values of *Promegantereon ogygia* from BAT-1 and BAT-3 show a marginally significant difference ($p = 0.57$) that might be pointing to the use of prey from more open woodland by the BAT-3 individuals compared to the BAT-1 individuals. *Machairodus aphanistus* individuals from BAT-1 and BAT-3 show no significant differences. Although more stable isotope analyses are being performed on carnivorans from BAT-3, results obtained so far point to stable environmental conditions with the predominance of a woodland habitat throughout the time elapsed between BAT-1 and BAT-3.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

FOSSIL SEA COWS (MAMMALIA: SIRENIA) OF EUROPE AND THE MEDITERRANEAN: WHY SO DEPAUPERATE?

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Vertebrate paleontology began in Europe over two centuries ago, making Europe the longest-studied region of the globe for VP—hence presumably the most thoroughly sampled and best understood. Sirenians were among the mammals first studied by early paleontologists. Why, then, are so few valid sirenian taxa known from this region? North Africa, Asia, and the Americas have commonly yielded sirenian faunas comprising three or more sympatric genus-level lineages. Four, and possibly several more, sympatric genera are recorded near Charleston, South Carolina during the Chattian. But no European/Mediterranean site after the Eocene has demonstrates more than two taxa, and most collecting areas have only one. After the Serravallian (and until the Piacenzian), only a single, anagenetically-evolving, ecologically-generalist sirenian lineage persisted in the region. Its subfamily (Halitheriinae), moreover, had been present there since the Eocene, through 10 post-Priabonian stages, while two other, more specialized subfamilies (Miosireninae, Dugonginae) had existed there for only three and five stages, respectively.

Possible reasons for this low diversity of herbivorous marine mammals include low diversity of food plants (seagrasses) and relatively high-latitude, less than fully tropical conditions in the European/Mediterranean realm for at least some of post-Eocene time. On the other hand, the complex history of Tethyan/Paratethyan paleogeography (involving frequent tectonic creation and elimination of connections between basins, with the Indian Ocean, and with North America) should have been favorable for generating biodiversity by allopatric speciation and immigration (e.g., numerous transatlantic faunal exchanges of Tertiary molluscs are well documented). Although several transatlantic dispersals of sirenians are also indicated, and three dugongine genera were present in India during the Aquitanian (while the Proto-Mediterranean and Indian seas were still broadly connected) but are not known farther west, the low diversity of European/Mediterranean sirenians remains a mystery.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

MICROTECTONIC EFFECTS OF QUADRUPEDAL FOOTPRINTS ON THE LEE FACE OF SAND DUNES FROM THE BOTUCATU FORMATION (LOWER JURASSIC TO LOWER CRETACEOUS, BRAZIL): POSSIBLE INTERPRETATIONS

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The Brazilian Botucatu Formation is renowned for its ichnofossil content, mostly tracks of bipedal and quadrupedal vertebrates. Dinosaur footprints as well as quadrupedal tracks and trackways of synapsid origin are found in this aeolian sandstone, impressed on the lee faces of sand dunes in a hyperarid paleoenvironmental setting. Several specimens, housed at the Museu de Paleontologia e Estratigrafia of the Rio Claro Campus, Sao Paulo State University (UNESP), have been investigated in order to examine foot/sediment interaction. Most of the examined slabs come from a single quarry (the so-called Ouro Site) in the Araraquara Municipality (São Paulo State). The inclination of the original slope was around 30 degrees, and the selected slabs show quadrupedal animals walking mainly uphill. The interaction between the animal and the sediment is revealed in several manus-pes sets, or pes only sequences. The effects of the forces applied by the foot on the sand are clearly preserved posteriorly to the footmark as extra-morphological perturbation of the sediment. These extra-morphological features registered ground deformation in the form of thrust faults oriented transversely with respect to the trackway midline. We infer therefore that a rotational component in the movement of the animal foot was involved in order to produce this deformational pattern. This rotational movement of the foot is symmetrical and constantly oriented toward the midline of the trackway. From a sedimentologic point of view, the presence of thrust-like deformation implies an early consolidation (or cementation) of the sediment as the rheological properties necessary for development of the observed structures are not compatible with unconsolidated, loose sand. This early cementation may probably have occurred superficially on the surface through humidity from night and morning mist, as the animal leg could have sunk no more than a tenth of a centimeter below the surface. This specific feature has been so far observed on a single morphotype among the Botucatu traces, but further analysis is needed to understand if association with other quadrupedal and bipedal traces occurred.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

FOSSIL COMPLETENESS IN MOSASAURS

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Understanding the quality of the fossil record is an essential prerequisite for interpreting the significance of macroevolutionary patterns. Measured palaeodiversity has been filtered through geological processes, and attempts to correct for sampling bias have resulted in a debate concerning the role of sampling proxies in models of biodiversity. Fossil quality could play an important role in the understanding of biodiversity through deep time. Here, we assess the completeness of mosasaur fossil specimens as a proxy for the quality of the mosasaur fossil record. Mosasaurs arose, diversified, and evolved to become the apex predators of the Cretaceous seas prior to their demise at the K/Pg boundary. Fossil quality of mosasaur fossils was investigated and the completeness of these specimens were scored using skeletal and phylogenetic completeness metrics. Results indicate that thousands of mosasaur fossils represent a worldwide presence and a rising diversity in the Upper Cretaceous. Mosasaur material has been assigned appropriately to species, and completeness scores can be used to make useful comparisons between specimens. Lithology has a measureable effect on mosasaur fossil completeness with scores varying significantly between formations. Mosasaur diversity is not correlated with completeness and there is no evidence for sampling bias limiting the mosasaur diversity signal.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

ARCTIC HADROSAURID DIVERSITY IN THE MAASTRICHTIAN: NEW DATA FROM THE PRINCE CREEK FORMATION OF NORTHERN ALASKA

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Recently, the faunal composition of the Upper Cretaceous Prince Creek Formation of northern Alaska has expanded with the recognition of new species of ornithischian and theropod taxa. These are unique to the Arctic and provide important new data to test hypotheses of dinosaur biogeography in North America. Here, we report on the diversity of hadrosaurids from the northern-most end of Laramidia, including the description of a new saurolophine and the first record of a lambeosaurine for the formation. The saurolophine taxon is represented by abundant material from the Liscomb Bonebed, which consists primarily of juvenile remains from three different size classes and rare adult-sized material. Three semi-independent methods were employed to test the taxonomic identity of this material, including geometric morphometrics, and comparative morphological and cladistic analyses. The results indicate a sister taxon relationship with *Edmontosaurus*; however, the Alaskan taxon possesses a unique suite of cranial characters that distinguishes from either *E. regalis* or *E. annectens*. The lambeosaurine is represented by a fragmentary skull. Its referral to Lambeosaurinae is based on the combination of a relatively short and deep maxilla that possesses a dorsal process that is taller than wide and dentary teeth with accessory carinae. The less extreme height to width ratio of the dorsal process and the presence of marginal papillae on the dentary teeth indicates it is not congeneric with the only coeval Maastrichtian lambeosaur, *Hypacrosaurus altispinus* from the Horseshoe Canyon Formation of Alberta. The new material represents one of the stratigraphically youngest lambeosaurines known in North America, is the first unequivocal occurrence of this clade in the Arctic, and expands the known diversity and geographic range of lambeosaurines in Laramidia. Collectively, the two new hadrosaurids from the formation provide further support for the existence of a unique, early Maastrichtian polar dinosaurian community known as the Paanaqtat Province.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

DIRECT EVIDENCE OF TROPHIC INTERACTIONS BETWEEN 'APEX' PREDATORS IN THE UPPER TRIASSIC CHINLE FORMATION

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Reconstructing the trophic structure of extinct faunas requires evidence of behavioral interactions among individuals. Hypotheses of feeding behaviors and community structure can only be evaluated using rare direct evidence of trophic interactions in the fossil record, such as bite marks. We present evidence of feeding interactions and/or interspecific fighting recorded on two large bodied, carnivorous 'apex' predators from the Upper Triassic Chinle Formation (~210 Ma). Each interaction was recorded on the femora of two large paracrocodylomorphs in the form of multiple sets of bite marks. Direct evidence of a survived attack is recorded in the larger femur (estimated element length = 625 mm; estimated total body length = 8-10 m) by both healed punctures and a large embedded tooth crown (32.8 mm in length based on computed tomographic data). Two other sets of bite marks on this specimen exhibit no evidence of reaction tissue, and therefore are interpreted as peri- or postmortem in origin. The second paracrocodylomorph femur exhibits four large unhealed punctures indicating that the animal did not survive the attack or that the bite marks were the result of scavenging soon after death. The combination of character states observed from both specimens (e.g. morphology of the embedded tooth, 'D'-shaped profile of the large punctures, evidence of bicarination of the marking teeth, spacing of potentially serial marks) indicates that large phytosaurs (at least 3-4 meters long) were actors in both cases. Our analysis of these specimens demonstrates that 'apex' predators (i.e. paracrocodylomorphs) were targeted by phytosaurs in these Late Triassic ecosystems. Previous interpretations separating 'aquatic' and 'terrestrial' Late Triassic trophic structures are demonstrated to have been overly simplistic; we show they were intimately connected even at the highest trophic levels. Our data support that size alone cannot be the deciding factor in determining trophic status, and that related interpretations of feeding behavior and trophic structure for the Late Triassic of western North America were built upon mistaken paleoecological assumptions. Furthermore, these marks provide an opportunity to start exploring the seemingly unbalanced terrestrial ecosystems from the Late Triassic of North America, in which large carnivores far out-number herbivores in terms of both abundance and diversity.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

NEW DISCOVERIES AND REEVALUATION OF LARGE-BODIED EARLY CROCODYLOMORPHS: IMPROVING RESOLUTION AT THE BASE OF CROCODYLOMORPHA AND THE EVOLUTIONARY ROLE OF PARAPHYLETIC GRADES

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Recent comprehensive phylogenetic analyses have improved taxonomic and character sampling within early archosaurs, clarifying the sister group relationships of Crocodylomorpha, yet resolution amongst basal members is still lacking. Previously, the basal-most members of Crocodylomorpha have included small-bodied, relatively fleet-footed and gracile forms, while their sister-taxon has been hypothesized to be the robust, large-bodied Rauisuchidae (e.g., *Postosuchus*). This implies a large gap in the fossil record of body size, as well as other aspects of morphology including limb proportion.

Newly discovered specimens and reevaluation of previously described specimens are helping to clarify evolutionary trends and relationships among these early crocodylomorph taxa. Our analyses recover a number of large-bodied taxa, including a new taxon from the Carnian (early Late Triassic) of North Carolina (NCSM 21588), CM 73372 (formerly considered a juvenile *Postosuchus*), and *Redondavenator*, as the most basal members of Crocodylomorpha. These specimens embody the transition from 'rauisuchian' to 'sphenosuchian' morphology and bridge the body size gap between basal crocodylomorphs and their sister taxa. However, limited overlap in preserved elements between the three large-bodied basal crocodylomorphs (e.g., comparative premaxillae in NCSM 21588 and *Redondavenator*, and a few vertebrae in CM 73372 and NCSM 21588) remains a persistent problem and additional materials are needed to improve support.

With these additions, a clearer picture of the transition between 'rauisuchians' (basal Loricata) and 'sphenosuchians' (basal Crocodylomorpha) begins to emerge, in which morphology typifying Crocodylomorpha appears before a shift in body size. Paraphyletic 'rauisuchian' and 'sphenosuchian' grade animals represent an evolutionary period of reduction in body size and gradual, accumulative shifts in character states in stem paracrocodylomorphs leading up to the diversification and radiation of Crocodyliformes in the Jurassic and beyond.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

NEW PANTOLESTIDS FROM THE UINTA FORMATION, UINTA BASIN, UTAH

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Pantolestids were semi-aquatic mammals of with a colorful taxonomic history that were initially recognized from the North American early middle Eocene (Bridgerian North American Land Mammal Age, NALMA). They have also been recovered in similarly aged Eocene deposits in Europe and Asia as well as from earlier Eocene (Wasatchian NALMA) deposits in North America. Pantolestids have been reported in faunal lists from the Uintan NALMA, but none has ever formally been described. Expeditions to the Uinta Formation, Uinta Basin, Utah, have recovered new specimens of the genus *Pantolestes* from stratigraphically controlled localities. These new specimens in combination with those few held in museums allow us to garner some understanding of pantolestid diversity during the late middle Eocene, specifically from the Uinta Formation.

Previous scholars have noted five species of Bridgerian NALMA *Pantolestes* that can only be differentiated based on size: two smaller forms (*P. longicaudus* and *P. elegans*), two larger forms (*P. natans* and *P. phocipes*), and an ‘intermediate’ form (*P. intermedius*), whose type specimen is only a humerus. None of the species can be separated by dental morphology alone. We have evaluated the dental metrics of these Bridgerian NALMA forms and our analyses indicate that the two smaller forms are statistically identical in terms of size. This is also true for the larger forms, *P. natans* and *P. phocipes*. Based on both dental metrics and morphological comparisons, it is evident that a small form (*P. longicaudus*) and a larger form (*P. phocipes*) are present in the Uinta Formation. Both taxa are found in localities that correlate with both the Ui2 and Ui3 biochrons, formally extending their temporal ranges.

Dental morphology of Uintan pantolestids is essentially identical to that of Bridgerian *Pantolestes* suggesting a similar dietary ecology in taxa from both time periods. Postcranial remains from the Uinta Formation, including several isolated elements and one dentally associated partial skeleton, are morphologically very similar to those known from earlier in the Eocene. Like earlier Wasatchian and Bridgerian taxa, these remains suggest that Uintan pantolestids retain a semi-aquatic and semi-fossorial lifestyle. Interestingly, pantolestids are found in equal abundance in the lower and upper members of the Uinta Formation although the late Uintan has long been seen as a time of increasing drought and aridity, and thus presumably increasingly limited access to aquatic resources.

Romer Prize Session (Thursday, November 6, 2014, 10:15 AM)

HOW OPEN IS “OPEN HABITAT”? QUANTIFYING AND RECONSTRUCTING THE ENVIRONMENTAL CONTEXT FOR VERTEBRATE EVOLUTION DURING THE CENOZOIC USING THE LEAF AREA INDEX

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Vertebrate diversity and morphological disparity are strongly correlated with the allocation of primary productivity in space, or vegetation structure. Therefore, the

evolution of diet and community structure is best understood in an ecological context that includes vegetation. How can vegetation structure be quantified in the fossil record? This study presents a new, ataxonomic method to quantify habitat using the Leaf Area Index (LAI-the area of leaves in the canopy per area of ground) based on the functional morphology of light response preserved in silicified plant cells (phytoliths). The reconstruction of LAI is applied to the middle Cenozoic of Patagonia to test the ″open habitat hypothesis″ as an alternative to the ″early grassland hypothesis″ for the evolution of precocious hypsodonty in South American herbivores.

The LAI proxy is based on the known relationship between leaf epidermal cell shape (undulation) and cell size (surface area) to the light environment, whereby shade leaves have larger and more undulated cells than sun leaves. These cells are often preserved as phytoliths in paleosols that also preserve vertebrate fossils. To establish the relationship between LAI and silicified cell morphology I sampled modern soils across an LAI gradient in Costa Rica hypothesizing that phytoliths from soils of closed-forest habitats would be larger and more undulated due to diffused light under a forest canopy compared to more open habitats. At each site LAI was measured with hemispherical photography. Epidermal phytoliths from dicots, ferns, and non-herbaceous monocots were isolated from soil, photographed, and measured. Cell undulation was quantified using an Undulation Index (UI). Consistent with expectations from botanical ecomorphology, LAI was significantly correlated with mean phytolith UI and surface area in a robust linear model (r^2=0.63, p<0.0001).

Applying the model from this calibration dataset, I reconstructed a record of LAI from 43 vertebrate sites in Patagonia spanning 50-12 Ma and compared it to well-known records of Southern Ocean climate and faunal hypsodonty. The reconstructed LAI values track isotope records of sea-surface temperature and diverse estimates of precipitation. Also, pulses of faunal hypsodonty correspond to intervals of low LAI (<1), similar to shrubland values. Conventional phytolith studies show low abundances of grasses and the new LAI record strongly supports a scenario where the ingestion of exogenous grit in open, grass-free habitats drove the evolution of hypsodonty in Patagonian faunas.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

ANISIAN (~ 245 MA) REPTILIAN TRACKS FROM WINTERSWIJK; WHAT HAS LED TO THEIR PRESERVATION, AND WHO LEFT THEM?

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The Anisian quarry of Winterswijk (the Netherlands) has yielded skeletal remains of euryapsids (such as *Nothosaurus* and *Anarosaurus*), fishes, as well as numerous reptile tracks. At least 13 individual trackways were uncovered in a 6 x 3 m plane from so-called layer V. These tracks may not necessarily belong to the well-known ichnospecies *Rhynchosauroides peabodyi* or *Rhynchosauroides haarmuehlensis*, for these ichnotaxa appear to concern larger tracks than any of the countless tracks in layer V. Yet the tracks do have a similar structure, therefore nothing can be excluded at this point. Cluster analysis demonstrated that reptiles of at least three different size classes, but belonging to the same species, have walked these tidal flats. Actuopaleontological research using living reptiles has allowed for a reconstruction of the dimensions of these reptiles. In order to estimate how these tracks were created and preserved, a substrate analysis was performed. The prevailing theory prior to the present study was that microbial mats on the tidal flats were responsible for the fine preservation of the tracks. Although our research did not falsify this hypothesis, it has provided a possible alternative theory. We have thus far been unable to find microscopic evidence of algal/microbial remains in the micritic limestone rock. Therefore, two questions remain: a sedimentological question about the exact origin of the micritic limestone, and an ichnological question about the reptile that left the *Rhynchosauroides*-like trackways.

Symposium 1 (Wednesday, November 5, 2014, 8:15 AM)

ARCHAEOPTERYX* AND PARAVIAN PHYLOGENY: THE ENIGMA OF *BALAUR

DYKE, Gareth, University of Southampton, Southampton, United Kingdom; CAU, Andrea, Museo Geologico e Paleontologico 'Giovanni Capellini', Bologna, Italy; NAISH, Darren, University of Southampton, Southampton, United Kingdom; BROUGHAM, Thomas, University of Southampton, Southampton, United Kingdom; GODEFROIT, Pascal, Royal Belgian Institute of Natural Sciences, Brussels, Belgium

Reminiscent of the debate over the phylogenetic placement of the alvarezsaurids *Mononykus* and *Shuvuuia* more than a decade ago, recent fossil discoveries, especially from China, have re-focused attention on the definition of Avialae and the critical importance of *Archaeopteryx*-like paravians. Phylogenetic hypotheses including the Late Jurassic *Xiaotingia* and *Aurornis* have questioned the placement of *Archaeopteryx* in the avian stem and led to suggestions that some 'bird-like' taxa might be more robustly placed in other early-diverging regions of Maniraptora. Indeed, recent character and taxon-rich studies have diverged on the placement of other superficially 'dromaeosaur-bird-like' animals, in particular the enigmatic Late Cretaceous *Balaur bondoc* from Transylvania (Romania).

Balaur, from the Maastrichtian Sebes Formation, is the most complete theropod known from the European Late Cretaceous. Initial descriptions of this remarkable specimen included its phylogenetic interpretation as an aberrant dromaeosaurid with velociraptorine affinities. Our re-interpretation of this specimen, however, indicates that *Balaur* displays a combination of apparent plesiomorphies and several derived bird-like features that we highlight in a new phylogenetic analysis (incorporating all previously employed characters and taxa). Analyses focusing on basal paravians supports our reinterpretation of *Balaur* as an avialan more derived than *Archaeopteryx*. The placement of *Balaur* among Avialae was not biased by assumptions of character weighting, with the Romanian theropod consistently recovered among basal (non-pygostylian) birds. Indeed, we hypothesize that *Balaur* may represent a flightless taxon within the basal grade of long-tailed birds, consistent with additional skeletal evidence from the Sebes Formation. Omnivorous ecology, inferred by phylogenetic bracketing among avialans, fits the unusual morphology of *Balaur* in the context of the 'island effect' phenomenon.

Technical Session VII (Thursday, November 6, 2014, 9:00 AM)

ONTOGENY AND GROWTH IN BASAL CROCODYLOMORPHS AND THEIR CLOSE RELATIVES

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Paracrocodylomorpha (crocodile-line archosaurs) is a clade of predominantly terrestrial carnivores that first arose in the Triassic and diversified into a wide variety of bauplans. These include species filling top predator niches in the Late Triassic that exhibit convergent morphology and ecological similarities with theropod dinosaurs. Although a great deal of paleohistological research has been conducted on their theropod competitors, few paracrocodylomorph taxa (e.g., *Postosuchus*, *Terrestrisuchus*, and *Effigia*) have been examined previously and these studies have been limited in scope and comparative data and several of these taxonomic identities have been subsequently questioned.

Here we present the first comprehensive multi-taxon, multi-element histological analysis of Paracrocodylomorpha. We examined the paleohistology of multiple skeletal elements including the humerus, femur, tibia, fibula, and osteoderms, spanning a range of body sizes across basal Crocodylomorpha and their immediate outgroup, Rauisuchidae (typified by *Postosuchus alisonae*). Sampled crocodylomorphs include *Dromicosuchus grallator* and two yet unnamed taxa, a large-bodied basal crocodylomorph (NCSM 21588), and a 'sphenosuchian'-grade crocodylomorph (NCSM 21722).

We find a lack of trabecular bone in the long bones of several specimens, implying that these bones are under less mechanical stress than analogous bones in modern crocodylians. In addition, the taxa sampled suggest complex heterochronic change during the evolution of this lineage in association with body mass trends. NCSM 21588 is a large (skull length >50 cm) yet skeletally immature individual, based on absence of fusion in preserved vertebrae. Paleohistological analysis of the specimen confirms a juvenile growth stage based on the predominance of primary osteonal pseudo-lamellar bone. Several lines of arrested growth (LAGs) are present in the specimen. The dramatically smaller 'sphenosuchians' sampled appear to be more skeletally mature, suggesting a shift in growth strategy early on in crocodylomorph evolution.

Only small-bodied, gracile 'sphenosuchians' survived the end-Triassic extinction, radiating into a number of ecological niches and eventually giving rise to modern crocodylians. These data suggest the higher growth rates and metabolism exhibited by basal crocodylomorphs compared to extant crocodilian relatives may have contributed to their early ecological success and shed light on the growth patterns, metabolism, and ontogeny of Paracrocodylomorpha.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

NEW FINDINGS ON THE BRAIN AND SKULL STRUCTURE OF THE RECENTLY EXTINCT FLIGHTLESS GIANT MOA (AVES: *DINORNIS*), WITH IMPLICATIONS FOR ITS BEHAVIOR

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Moa comprise a group of extinct flightless birds known only from New Zealand. They have been a charismatic group since their description, but much about their phylogeny, anatomy, and life history remains unknown. The phylogeny of Palaeognathae, the group to which moa belong, also remains controversial, particularly with inclusion of its extinct members. Palaeognaths are a basal group of neornithine (crown) birds that include flighted members such as tinamous and lithornithids and flightless ratites such as ostriches, rheas, emus, cassowaries, kiwi, and moa. Studies on the external brain morphology of palaeognaths are relatively recent, and thus their neuroanatomy could provide insight into not only phylogeny but also avian brain evolution in general. The skull structure and endocranial anatomy of a specimen of South Island giant moa (*Dinornis robustus*, FMNH PA 35) were studied using computed tomography (CT scanning), and aspects of the cranial anatomy of the specimen, such as the cranial endocast and inner-ear labyrinth, were virtually reconstructed in Avizo and modeled in Maya. Similar analyses were done for all extant palaeognath clades, as well as for *Lithornis*. Many soft-tissue structures that have never been studied previously in *Dinornis* could be compared to the same structures in other palaeognaths. Many aspects of brain and neurovascular structure are conservative in *D. robustus* compared to other palaeognaths. The optic tectum, however, shows marked reduction compared to that of other palaeognaths, and also has an apomorphic position, being located rostral to the trigeminal nerve trunk as opposed to dorsal to this structure as in other palaeognaths. The smaller size of the optic tectum has been noted for other moa species by other authors and has been hypothesized to correlate with the relatively small orbit, but the significance of the unique position of this lobe has not been explored. A surprising finding is that the floccular lobe (auricle) of the cerebellum was absent, despite being present and moderately well developed in all other palaeognaths examined in this study. The apparently highly reduced flocculus in this group and in other members of Dinornithiformes has not received much attention from previous workers and could have implications for the behavior of these extinct birds. In fact, reduction of the optic tectum and flocculus in moa could be linked in that the flocculus is intimately connected to the visual apparatus via the vestibulo-ocular reflex, perhaps suggesting reduced reliance on sophisticated vision-based behaviors.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

PHYLOGENY OF A NEW EARLIEST PALEOCENE (PUERCAN) ARCTOCYONID "CONDYLARTH" FROM THE GREAT DIVIDE BASIN, WYOMING, AND IMPLICATIONS FOR UNDERSTANDING RELATIONSHIPS AMONG THE EARLIEST "CONDYLARTHS"

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Recent studies suggest that the radiation of placental mammals after the Cretaceous–Paleogene (K–Pg) extinction was explosive and occurred within a few hundred thousand years of the boundary. Earliest Paleocene (Puercan) faunas are vital for testing this hypothesis. A new early Puercan (Pu1) fauna has been discovered from the China Butte Member of the Fort Union Formation in the Great Divide Basin, southern Wyoming. The fauna includes a new arctocyonid "condylarth" genus and species, described here. Based on a sample of 14 partial dentaries whose combined dentitions represent the p2, p4, and m1–3, the new taxon appears most similar in size and molar morphology to early Puercan arctocyonid *Oxyprimus erikseni*, but differs primarily in its p4 morphology. To examine the relationships between the new taxon and other Puercan arctocyonids and periptychids from the Western Interior of North America, a phylogenetic analysis utilizing 18 taxa (including 16 "condylarth" species, the plesiadapiform *Purgatorius*, and outgroup taxon *Cimolestes*) and 52 dental characters was performed. Characters were aggregated from a number of previous phylogenetic analyses of "condylarth" taxa, and scored based on direct comparative study of specimens and casts from several museum collections, as well as descriptions of dental morphology in the literature. The resulting strict consensus tree of 190 steps shows that the new arctocyonid from the Great Divide Basin is closely related to *Oxyprimus* spp. and *Protungulatum donnae*. Further, our analysis suggests that *Purgatorius* is the sister group to the monophyletic Puercan arctocyonids, a result that is consistent with other recent phylogenetic analyses that utilize dental as well as cranial and postcranial characters. The Puercan Periptychidae appear to be paraphyletic, and the early Puercan periptychids *Mimatuta morgoth*, *Mimatuta minuial*, and *Maiorana noctiluca* appear in a tritomy as the sister clade to *Purgatorius* + Arctocyonidae, while the remaining Puercan periptychid taxa (*Conacodon* spp., *Ampliconus browni*, *Oxyacodon priscilla*, and *Mithrandir gillianus*) form a monophyletic clade. This analysis is the first to focus on a large set of Puercan arctocyonid and periptychid taxa across geographically-widespread localities, and, with the addition of the new species from the Great Divide Basin, suggests that diversity among early Puercan "condylarths" was higher than previously thought.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

THE SPECIES OF THE GENUS *BELONOSTOMUS* (NEOPTERYGII, ASPIDORHYNCHIFORMES) IN THE LATE JURASSIC OF THE SOLNHOFEN ARCHIPELAGO

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Belonostomus is one of four genera in the extinct neopterygian family Aspidorhynchidae, which ranged from the Late Jurassic (Kimmeridgian to Tithonian of England, France, and Germany) to the Late Cretaceous (England, Germany, Italy, Lebanon, North and South America). The genus is poorly known because its type species, *B. tenuirostris*, lacks a type specimen.

Our present study recognizes four species of *Belonostomus* within the Plattenkalk basins of the late Jurassic Solnhofen Archipelago (spanning some twenty ammonite horizons from late Kimmeridgian to early Tithonian): *B. kochi, B. tenuirostris, B. muensteri*, and *B. sphyraenoides*. Of these, *B. kochi* is restricted to the Plattenkalk of Kelheim (late Kimmeridgian), including Kelheim-Kapfelberg (the holotype locality) and Ettling (possibly late Kimmeridgian). The holotype of *B. tenuirostris* is from the Plattenkalk of Solnhofen (*rueppelianus* horizon of the Tithonian), but this species also occurs in the basins of Zandt (Zandt, Oechselberg, and Schamhaupten) and Painten (*rebouletianum* to *eigeltingense alpha* horizon). *Belonostomus muensteri* occurs in the Moernsheim Formation (*moernsheimensis* horizon) of Daiting and the Solnhofen area (the holotype locality). *Belonostomus sphyraenoides* (closely related to *B. muensteri*) is found in the Eichstätt basin (*eigeltingense beta* horizon of the Tithonian), where its genus is very rare.

The species are easily distinguished by the following features: *Belonostomus kochi*, *B. sphyraenoides*, and *B. muensteri* have two rows of teeth in the premaxilla, whereas *B. tenuirostris* has only one; the ratio of upper to lower jaw length (measured from anterior rim of orbit to anterior tip of jaw) is 28-44% in *B. tenuirostris*, but 0-20% in the other species; *B. tenuirostris* has 77-78 vertebrae and approximately 77-78 lateral line scales, whereas *B. kochi* and *B. sphyraenoides* have only 68-71 vertebrae and 70-72 lateral line scales; and *B. muensteri* has granulated scales and posterior cranial bones, whereas in the other three species these structures are smooth.

This combination of morphological features strongly suggests that two separate lineages of *Belonostomus* were present in the late Jurassic: one including *Belonostomus tenuirostris*, appearing in the late Kimmeridgian and continuing to the *rueppelianus* horizon of the Tithonian; and a second lineage appearing in the late Kimmeridgian and including *B. kochi*, *B. sphyraenoides*, and finally *B. muensteri* in the *moernsheimensis* horizon of the Tithonian.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

CURATIONAL CHEMICAL SECRETS OF *ARCHAEOPTERYX*

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Archaeopteryx is one of the most iconic fossil vertebrates. The conservation of such specimens is essential so that future studies can further unlock the geological, biological, and chemical histories as new technologies become available. The first of these specimens, a single feather (BSP-1869-VIII-1 and MB.Av.100), was described more than 150 years ago, with an additional twelve fossils that have since been excavated, prepared, and conserved. Three *Archaeopteryx* specimens, the single feather (MB.Av.100), the Berlin counterpart (HMN1880), and the Thermopolis specimen (WDC-CSG-100) have undergone non-destructive chemical analysis using Synchrotron Rapid Scanning X-Ray Florescence (SRS-XRF). The results of this work have mapped endogenous chemistry attributable to this organism after 150 million years.

SRS-XRF analysis has also shone new light on the preparation and curatorial history of these three *Archaeopteryx* specimens. This technique chemically maps the entire fossil, including the matrix, thus enabling curatorial artifacts to be mapped and unambiguously identified as such (fingerprints, fillers, etc.). Another key aspect of this approach is that quantitative point analyses can be made which allow contaminant amounts to be constrained.

Fingerprints can be identified on all specimens, in both chlorine and bromine, with the most abundant fingerprints occurring along the perimeter of HMN1880. Additionally, both MB.Av.100 and HMN1880 show elevated copper and nickel along the periphery of the blocks, possibly due to the brass collection drawer handles from their storage cabinets. MB.Av.100 displays writing along the top and bottom of the block that is rich in iron due to the use of gall ink. Additionally, a zinc square surrounds the feather from where a masking window was mounted with adhesive. Glue and brush strokes can be clearly mapped in chlorine, silicon, and bromine on HMN1880. Filler made of arsenic, barium, and zinc is also present. The most recently discovered of the three specimens, WDC-CSG-100, also shows significant preparation. The distal three quarters of the right humerus, sections of several caudal vertebrae, the distal left femur, and the proximal tibia have all been restored and can be clearly seen in bromine and the absence of key elements expected for bone, such as phosphorus. The application of SRS-XRF provides important insight to the post-taphonomic history of a fossil but also allows the assessment of curation impact due to preparation, conservation, storage, and handling on these and other fossils.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

TAXONOMIC DIVERSITY AND GEOGRAPHICAL DISTRIBUTION PATTERN IN HYAENODONTIDS (MAMMALIA) FROM THE PALEOGENE OF ASIA

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At least 13 hyaenodontid genera (Mammalia, Creodonta) have been reported from the Paleogene of Asia. This study summarizes geographical and temporal distributions of Asian hyaenodontid subfamilies and discusses their relationships to mammalian dispersal events.

The earliest occurrences include North American genera, *Prolimnocyon* (Limnocyoninae) from the latest Paleocene of Inner Mongolia and *Arfia* (Arfianinae) from the early Eocene of Mongolia. *Arfia* is also known from the basal Eocene of Europe. It has been suggested that some mammals (e.g., the primate *Teilhardina*) migrated from Asia to Europe, then to North America during the Paleocene-Eocene Thermal Maximum. *Prolimnocyon* is unique in occurring only in North America and Asia. *Sinopa* (Sinopinae) and *Limnocyon* (Limnocyoninae) have been reported from the middle Eocene of central and northern China; they first appeared in the late early Eocene of North America and have their sister genera in the early early Eocene of the Great Plains, suggesting that they migrated to East Asia later than the late early Eocene. This migration coincides with that of other mammals (e.g., *Hyrachyus*, *Harpagolestes*, *Mesonyx*, *Palaeosyops*, *Uintatherium*).

Indohyaenodon (Indohyaenodontinae) from India is the other earliest Eocene genus. Co-occurring adapoid primates and diacodexid artiodactyls have indicated biogeographic connections to Europe, supporting a hypothesis of indohyaenodontine-*Arfia* affinity. This Asian subfamily includes *Paratritemnodon* from the middle Eocene of Indo-Pakistan and *Kyawdawia* and *Yarshea* from the late middle Eocene of Myanmar. The similarity in distribution pattern between anomaluroid rodents and indohyaenodontines favors an African origin of the Indohyaenodontinae. *Orienspterodon* is known from the late middle Eocene of central China and Myanmar, and it is treated as a hyaenailourine or a derived form of indohyaenodontine. The former classification assumes a migration to Europe and Africa of the subfamily, and this event agrees with the migration of anthracotheriid artiodactyls.

The fossil records of the Hyaenodontinae began in the late early Eocene of Kyrgystan (*Isphanatherium*, *Neoparapterodon*). Although *Hyaenodon* distributed widely in the northern hemisphere, corresponding mammalian dispersal events are not clear. The geographical range of the hyaenodontines are limited to the middle-to-high latitude area in Asia. In sum, geographical distributions and dispersal events differ among subfamilies (e.g., indohyaenodontines, hyaenodontines, and sinopines).

Preparators' Symposium (Saturday, November 8, 2014, 4:00 PM)

SIMPLE FORENSIC METHODS FOR PALEONTOLOGICAL DIAGNOSIS

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Paleontological research is faced with a challenge on a regular basis; namely, determination of 'real' data in specimens under study. Fossils are frequently modified during the processes of collection and preparation. This modification includes addition of adhesives and gap fillers, removal of matrix, bone, or other fossilized materials, and in some cases composite elements that represent different individuals or even different taxa. These additions can misrepresent or obscure anatomical features. Sometimes this is inadvertent, the result of structural or aesthetic treatments, but sometimes the intent is fraudulent misrepresentation of the fossil remains. Whatever the motivation, this issue applies whether interpreting modern or historic specimens. Fossil preparation, collection management, and research based on those specimens all face the same observation and evaluation issues. Many diagnostic tools, like traditional X-ray, High Resolution X-ray computed tomography, Synchrotron X-ray tomographic microscopy, Scanning electron microscopy, and Energy-dispersive X-ray spectroscopy are available to researchers, but can be costly or not available on a widespread and regular basis. Low-tech alternatives abound, in some cases wetting a specimen with water often reveals evidence of

introduced material. It has long been known that ultraviolet light (UV) has usefulness as an effective diagnostic tool. Differing material components may fluoresce at wavelengths distinct from surrounding materials, highlighting areas that bear closer microscopic or chemical investigation to determine whether the element in question is original to the organism. UV imaging equipment is universally available and affordable, making it a logical choice as a standard practice in helping to evaluate and document specimens. The process of creating a specimen requires manipulation of natural objects, therefore diagnostic methods like UV analysis should be integrated into the regular laboratory documentation and investigation workflows.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE FIRST NEARLY COMPLETE NEUROCRANIUM OF A SILURIFORM (CATFISH) FROM THE UPPER EOCENE BIRKET QARUN FORMATION, WADI EL-HITAN, EGYPT

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The UNESCO World Heritage site, Wadi El-Hitan, located north of the Western Desert of Egypt, has produced a remarkable collection of Eocene vertebrates. The geology of the Wadi El-Hitan area is uncomplicated, consisting of three rock units of middle to late Eocene age. Recent field studies on the marine deposits of the upper Eocene Birket Qarun Formation have led to the discovery of a well preserved skull fragment of a large siluriform (catfish). The collected material comprises a complete left neurocranium, two operculars, left suspensorium, pectoral girdle and spine, and a disassociated series of vertebrae. The new catfish specimens are the oldest and the most complete materials collected so far from the Birket Qarun Formation and provide much anatomical and paleontological data. It is fairly a large specimen, with a predicted body length of about 2 m, based on cranial to postcranial proportions. Preliminarily comparisons of the new fossil indicate similarities to the Paleogene Fayum catfish *Socnopaea*. The dorsal skull roof bones are ornate and are streamlined in shape anteriorly; in the posterior region they are slightly expanded laterally. The new fossil exhibits three nuchal plates, the median of which is narrow and elongate bearing teardrop-shaped ornamentation and a wide convex junction with the lateral nuchal plate. This differs from the two median nuchal plates of *Socnopaea*, that are broader, granulose in texture, and articulate via a V-shaped junction. Moreover, the opercule of the new fossil has a strut-like radiating pattern from the proximal articulation to the margins, whereas *Socnopaea* exhibits small bumps and ridges ornamenting its surface. In addition, the dorsal spine of the new specimen has two rows of tubercles along the length of its anterior surface compared to three on the *Socnopaea* dorsal spine. Additional comparison with the living *Chrysichthys* reveals that they share nuchal plate ornamentation and the slightly convex junction with the lateral nuchal plate, but that they differ in exhibiting a smooth anterior surface for the dorsal spine. Details of the articulated neurocranium may shed further insight into the taxonomy of this specimen.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

PALEOGENE TEMPERATURE ESTIMATES FROM BODY SIZE IN GLYPTOSAURINE LIZARDS (SQUAMATA: ANGUIDAE) FOR THE INTERIOR OF NORTH AMERICA

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Poikilothermic vertebrates such as lizards can offer viable proxies for terrestrial climate based on measurable relationships between environment and body size. Ambient temperature constrains body size in extant lizards, but this relationship remains to be tested thoroughly in extinct forms. In this study, we show that mean annual paleotemperature (MAPT) estimates based on body size in glyptosaurines (Squamata: Anguidae) correspond to known histories of continental climate change through the Middle Paleogene of the Great Plains and the Western Interior, but differ from existing proxies for the Late Paleogene. We modeled the relationship between skull length and snout-vent length (SVL) for extant anguimorphs and used these models to estimate SVL in glyptosaurines based on fossil cranial material. We then applied the model relationship between mass-specific metabolic rate, maximum SVL and minimum mean annual temperature for extant *Heloderma*, the largest North American anguimorph, to body size estimates of glyptosaurines to estimate paleotemperatures through the North American Paleogene. We find that maximum body size remained approximately constant among the largest glyptosaurines from the early Eocene to the early Oligocene, with estimated MAPT of about 19-20°C in the Great Plains and Western Interior during this interval. Our results are consistent with other local proxies for the early Eocene, but indicate warmer early Oligocene temperatures than estimated from other proxies. Our results imply that either MAPT remained above critical minimum temperatures for efficient metabolism in large lizards, or that large glyptosaurines behaviorally maintained body temperatures above ambient levels when temperatures were cooler in the late Paleogene.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

REVISION OF CRANIAL ANATOMY AND PHYLOGENETIC RELATIONSHIPS OF *AUSTRALERPETON COSGRIFFI* (TETRAPODA: TEMNOSPONDYLI)

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Australerpeton cosgriffi is the best known Paleozoic 'amphibian' (Tetrapoda: Temnosponondyli) from Brazil. Known specimens were collected in the Serra do Cadeado area, from the upper levels of the Rio do Rasto Formation (Late Permian, Parana Basin). Previously published works focusing on the scales and postcranial anatomy provided useful information on the morphology of the taxon, but its skull has never been described in detail. A comprehensive description of the skull material allowed comparisons to other temnosponondyls, and the reassessment of its phylogenetic position, which is currently unclear. *Australerpeton cosgriffi* has been alternatively associated with Archegosauridae (Platyoposaurinae) or Rhinesuchidae. The first group includes 'stem-stereospondyls' typical from the Late Permian of Eastern Europe, whereas the second group encompasses basal Gondwanan stereospondyls from the Permian of the Karoo Basin, South-Africa. To access the phylogenetic placement of *Australerpeton cosgriffi*, a broad revision was performed, which resulted in a 36-taxon/221-character matrix. A parsimony analysis conducted in TNT (10 000 replicates, TBR, Hold 10) resulted in four most parsimonious trees (MPTs) with 706 steps. The strict consensus depicts a grade of basal Stereospondylomorpha including conventional Archegosauridae. The Stereospondyli clade includes *Australerpeton cosgriffi* as an apical Rhinesuchidae, a clade further divided in three subgroups: Uranocentrodontinae (including *Uranocentrodon senekalensis*), Rhinesuchinae (including *Rhinesuchus whaitsi*, *Rhineceps nyasaensis* and *Rhinesuchus broomianus*) and Australerpetinae (including *Australerpeton cosgriffi*, *Laccosaurus watsoni*, *Broomistega putterelli*, *Rhinesuchus capensis* and *Rhinesuchoides tenuiceps*). The nesting of the long-snouted *Australerpeton cosgriffi* within Rhinesuchidae implies an evolutionary convergence with the also long-snouted Platyoposaurinae. Indeed, the rhinesuchid synapomorphies seen in *Australerpeton cosgriffi* are concentrated in the occiput and posterior palatal regions. *Australerpeton cosgriffi* is the first long-snouted stereospondyl, expanding the record of Rhinesuchidae to non-African areas, and corroborating a Gondwanan origin of Stereospondyli. Finally, the more recent temporal distribution of Rhinesuchidae, in comparison with Platyoposaurinae, corroborates a Lopingian-Wuchiapingian age for the Serra do Cadeado fauna, as already hinted by the presence of the dicynodont *Endothiodon*.

Technical Session VIII (Thursday, November 6, 2014, 4:00 PM)

A MULTI-SCALE, GEOSPATIAL MODEL FOR IDENTIFYING PRODUCTIVE FOSSIL LOCALITIES IN THE GREAT DIVIDE BASIN, WYOMING

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Although paleontologists and paleoanthropologists use geological maps and expert knowledge of their field study areas to identify potential fossil-bearing deposits, finding fossiliferous localities in a traditional ground-based search still involves a good deal of serendipity. Advances in geospatial science now allow investigators to determine rock types, characterize depositional environments, and identify known geological units (e.g., formations and members) through analysis of geographical data and images from a variety of remote sensing instruments. Supervised classifications of Landsat satellite images using maximum likelihood and artificial neural network methodologies were used to identify potentially productive Eocene mammalian fossil localities in the Great Divide Basin, Wyoming. While these methods worked well in a general reconnaissance of this 10,000 square kilometer basin, false positive indications resulted from uncertainties associated with the available geological maps. To improve this result, high resolution Worldview 2 satellite images of selected areas with concentrations of potential localities from the Landsat analysis were analyzed using GEographic Object-Based Image Analysis (GEOBIA) techniques, which segment digital images into spectrally homogeneous image objects. In addition to allowing statistical analysis of the spectral characteristics of the image objects, GEOBIA techniques also let analysts incorporate expert knowledge and contextual information to improve classification accuracy. The spectral and spatial characteristics of the image objects that represent a highly productive locality (Tim's Confession, WMU-VP-220) were used to build a signature that in turn identified similar image objects throughout the areas covered by the high resolution images. During the summer field season of 2013, thirty one locations that would not have been spotted from the road in a traditional ground survey were visited. At thirteen of these locations, vertebrate fossils were recovered, leading to the documentation of twenty five new fossil localities. Supported by NSF-BCS 1227329 to RL Anemone and CW Emerson.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

DIVERSITY OF EOCENE ANTARCTIC SAND TIGER SHARKS (CHONDRICHTHYES, ODONTASPIDIDAE): CLIMATIC CONTROLS OR IMPLICATIONS FOR NURSERY AREAS?

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The Palaeogene was one of the most important time intervals for global climatic changes. It was characterized by extensive greenhouse conditions during the Early Eocene climatic optimum resulting in an important interval of global warming, which lasted until the end of the middle Eocene (ca. 37 Ma) and which can be used for inferring consequences of future global warming. One of the general assumptions is that marine fishes were affected. Nevertheless, the impact of greenhouse conditions on marine fishes has not yet been analyzed in detail. Eocene marine deposits of Antarctica yielded the most diverse Palaeogene cartilaginous and bony ichthyofaunas from the Southern Hemisphere to date, which have helped to understand the impacts of climate fluctuations on marine fishes in deep time. Eocene marine vertebrate remains are very common in sediments of the La Meseta and Submeseta Formations on Seymour Island (Antarctic Peninsula), which are generally subdivided either into three transgressive-regressive cycles (Units I-III) or seven major lithofacies (TELMs 1-7). Remains of diverse fish assemblages are very common throughout the Antarctic Eocene with isolated chondrichthyan teeth and rare placoid scales being the most abundant vertebrate remains. So far, members of 24 genera have been described. Odontaspidid sandtiger sharks (e.g., *Carcharias*, *Palaeohypotodus*, *Striatolamia*) seemingly dominate the chondrichthyan associations, while other groups are less numerous. All available data imply an increase in species richness from TELM 1-5 (late Palaeogene-middle Eocene) with *Striatolamia macrota*, a rather large predator with bipolar distribution in the Eocene being the dominant element. A cold-water adapted chondrichthyan fauna obviously becomes

established from TELM 4 onwards. The overwhelming dominance of the sand tiger shark, *Striatolamia macrota*, in the fossil assemblages of TELMs 3-5 representing abundant juveniles and adults as inferred from tooth height indicates that the coastal waters of Antarctica might have served as a nursery area for these sharks. A similar pattern is found in the extant sand tiger shark, *Carcharias taurus*, which uses nursery areas to give birth to its young. Neonates and juveniles spend their first few weeks, months or even years in these nursery areas as they provide shelter and protection from larger predators. Here, we present detailed analyses of Eocene Antarctic sand tiger sharks for understanding their abundance fluctuations and for identifying potential Eocene Antarctic nursery areas.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

NEW RODENTS FROM THE LATE OLIGOCENE FOSSIL LAGERSTÄTTE ENSPEL, GERMANY

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Articulated skeletons of eomyids, a biostratigraphically important family of fossil rodents, are solely known from the late Oligocene Fossil Lagerstätte Enspel in the Westerwald (Germany). So far only one eomyid taxon, *Eomys quercyi,* had been represented by one incomplete and one complete skeleton. The complete skeleton is most remarkable for its soft part preservation because it provides the oldest evidence for gliding in rodents. Here we report the first skeletal find of *Eomyodon,* which in Enspel was previously known only from isolated teeth found in bird pellets. This partial skeleton preserves most of the skull and extremities, and also includes the soft tissue body outline. By x-ray investigation almost dissolved bones and cartilaginous structures could be detected that are not visible under the light microscope. The skeleton was reconstructed three-dimensionally based on µCT data, enabling the identification of teeth completely covered by bone. It shows a generalized rodent bauplan with an estimated body mass by means of femur length of about 10 g. While smaller than *Eomys quercyi*, the fused epiphyses as well as the absence of deciduous dentition argue for a fully grown adult. The lengths and proportions of the phalanges indicate a terrestrial lifestyle, and the preserved soft parts do not provide any adaptations for gliding. Eomyids represent the predominant mammalian remains in bird pellets from Enspel. By a detailed study of the pellets, besides teeth of eomyids, teeth of glirids and cricetids were found, indicating the presence of two rodent families previously not known from Enspel.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

RESOLUTION AND ACCURACY OF 3-DIMENSIONAL MODELS OF SPECIMENS USING PHOTOGRAMMETRY AND IMAGE STACKING SOFTWARE

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Photogrammetry is a relatively inexpensive and more portable method of digitizing the three-dimensional surface morphology of specimens through the use of digital images from a camera instead of a laser surface scanner. However, when photographing specimens that have considerable depth it can be difficult or impossible to keep the entire specimen in focus in each image, which has the potential to influence how photogrammetry software pieces together the images to build the 3D model. This is particularly challenging in the case of very small specimens, because in order to capture more detail, the specimen must fill the frame of the camera, which requires the camera to be relatively close to the specimen and the closer an object is to the camera, the more narrow the region in focus will be.

Image stacking is a technique whereby multiple images in the same field of view, but at different focal distances, are digitally combined to create a single image with most or all of the object of interest in focus. This technique in conjunction with traditional photogrammetry has the potential to generate three-dimensional models with high levels of detail without sacrificing accuracy or requiring large numbers of photographs taken at slightly different angles. However, there is also potential for details to be lost or image misalignments to occur and be amplified when processing images through these additional steps.

To determine how combining image stacking with photogrammetry influences precision and accuracy, models of several objects of known dimensions and varying surface complexity were generated using the same sets of images from the same camera. Two models were created of each object, the first with photogrammetry software alone and the second by processing the original images with image stacking software before imputing the files into the photogrammetry software. The dimensions of these models were then compared to each other and to the dimensions of the original objects. The effects of incorporating image stacking on the precision and accuracy of these models will be discussed for each object and recommendations made for which types of specimens should be digitally modeled in this way.

Symposium 1 (Wednesday, November 5, 2014, 9:00 AM)

LONG BONE HISTOLOGY, GROWTH, AND THE 'BLOOD' OF *ARCHAEOPTERYX*

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Archaeopteryx is the oldest and most primitive known bird (Avialae). It is believed that growth and energetic physiology in basalmost birds such as *Archaeopteryx* were inherited in their entirety from non-avialan dinosaurs. We report that long bones sampled from the Eichstätt, Munich and Solnhofen *Archaeopteryx* specimens are composed of sparsely vascularized, parallel-fibered bone. This bone type is uncharacteristic of non-avialan dinosaurs, whose bones are typically woven fibered and highly vascularized. Our previous discovery of a scale-dependent maniraptoran histological continuum explains these findings. *Archaeopteryx* and other small basalmost birds show retention of the phylogenetically earlier paravian dinosaur condition. Growth analysis for *Archaeopteryx* suggests these animals showed maximal growth rates like non-avialan dinosaurs, considerably slower than living precocial birds, but still within the lowermost range for endothermic vertebrates. The first birds were simply feathered dinosaurs with respect to growth and energetic physiology. In addition our data suggest that all known *Archaeopteryx* specimens represent immature individuals. During analysis of the Munich specimen we discovered red, spheroid objects, similar to those described in non-avialan dinosaurs, and hypothesized to be blood cells. The diameters and range of sizes for the structures are biologically inconsistent with erythrocytes. Elemental maps of the inclusion regions using X-ray spectroscopy (EDS) suggest they are phyllosilicate minerals.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

PALEOGENE SURFACE UPLIFT AND ITS IMPACT ON TERRESTRIAL PALEOENVIRONMENTS AND MAMMALIAN COMMUNITIES IN WESTERN NORTH AMERICA

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The apparent lack of change in the mammalian faunas across the Eocene–Oligocene boundary (about 33 Ma) in North America is strongly debated in the paleontological community. Here we document the existence of a consistent pattern between precipitation estimates, faunal structure, and response to changing topographic boundary conditions throughout the Paleogene. Topographic reorganization of large parts of western North America impacted mammalian dispersal and community structure during the Eocene. This interval of tectonically-driven surface uplift in North America took place between 50 and 37 Ma ago. Regional surface uplift caused large-scale reorganization of precipitation patterns, and according to our data, the mammalian faunas adapted to these changes and high elevation paleoenvironments. We see large changes in mammalian community dynamics that reflect changes in precipitation regime during the Eocene, especially at the transition between the North American Land Mammal Ages (NALMAs) Wasatchian–Bridgerian (50 Ma), Bridgerian–Uintan (46 Ma), and Duchesnean–Chadronian (37 Ma). These changes correspond to the radiation of artiodactyls, matched by the terminal decline of primates. Among the ungulates, extinctions occurred in lineages that retained bunodont or semi-lophed teeth indicative of a diet of softer browse. Despite a temporal resolution based on land mammal ages, it is obvious that most of the changes in our records occur between 50–37 Ma, suggesting that these were not contemporaneous with the Paleocene–Eocene Thermal Maximum (55 Ma), the Early Eocene Climatic Optimum (52–50 Ma), or the Eocene–Oligocene boundary (34–33 Ma), but rather developed in concert with surface topography in western North America. We suggest that the relative lack of change around the Eocene–Oligocene boundary reflects the fact that mammalian faunas were already pre-adapted to cooler and drier conditions before this transition, resulting from the effects of earlier surface uplift

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

THE INHIBITORY CASCADE AS A GENERAL MECHANISM FOR INTEGRATION IN THE MAMMALIAN PRIMARY DENTITION

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Molar teeth are a defining feature of mammals, not being present in other vertebrates. Two characteristics of molar teeth are responsible for their importance to mammalian ecology and evolution: precise alignment and high complexity. Both of these features enable efficient mechanical breakdown of food to fuel the high metabolic rate of mammals. The precise occlusion of molars is enabled by the very high degree of integration both along the tooth row and between occluding teeth. Earlier work has shown that molar teeth in most mammals develop and evolve according to a strict pattern that controls the relative sizes of the molars, termed the inhibitory cascade (IC). This macroevolutionary pattern extends from early mammals through to modern mammal groups.

Here, this work is extended to show that the IC pattern in molars is part of a more general system of patterning in mammalian teeth. I develop and show support for a number of hypotheses regarding tooth patterning in recent and fossil mammals, namely: (1) deciduous premolars also follow the IC pattern, but often in the reverse direction compared to the molars; (2) the IC pattern in upper and lower tooth rows is integrated and varies together in individuals and throughout evolution; (3) postcanines in pinnipeds and polydont odontocetes, and the continuously-replaced molars in the nabarlek (*Petrogale concinna*), follow the IC pattern; (4) the IC mechanism has greatest influence on the primary dentition, and is reduced in the secondary dentition; (5) there are common developmental controls for the IC pattern and dental complexity; and (6) many reptile dentitions lack the IC pattern. Confirmation of these hypotheses will clarify the organizing principles of the sophisticated developmental mechanisms responsible for the highly integrated mammalian dentition, but also add to the limitations on evolutionary potential in mammalian dentitions.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A NEW, LARGE-BODIED TERRESTRIAL CROCODYLIFORM FROM THE LATE CRETACEOUS OF SUDAN

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Peirosauridae is a clade of tall-snouted, presumably terrestrial crocodyliforms that had a Gondwanan distribution in the Cretaceous. Although several complete peirosaurid skulls are known, their fossil record is generally poor. The Upper Cretaceous Wadi Milk

Formation of northern Sudan has yielded a rich assemblage of fossil vertebrates, and new fieldwork in this unit has uncovered a high diversity of crocodyliforms. Here we describe a new peirosaurid from this unit, which is a rare record of this clade from the Cretaceous of eastern Africa and is notable for its large size relative to previously described taxa. The material consists of articulated right and left anterior dentary and splenial segments, with two complete teeth and multiple broken tooth bases, and an almost complete fused frontal complex. Both specimens were recovered in situ from a coarse-grained conglomerate at the base of a small channel. The new material differs from other members of Peirosauridae in that the maximum diameter of the enlarged first dentary alveolus exceeds that at the fourth position and hosted an anteriorly directed tooth, and the anterior margin of the dentary symphysis distinctly squared-off in dorsal view.

In order to assess the systematic position of the Wadi Milk peirosaurid, both specimens were coded into the data matrices of two recent crocodyliform analyses focused on Mesozoic Crocodyliformes. The new Sudanese taxon is a peirosaurid and forms a close relationship to *Hamadasuchus* and *Lomasuchus* in all analyses.

The new Sudanese taxon is notable for its large size compared to most Cretaceous peirosaurids. The estimated size of the skull, based on comparison with a complete skull of *Hamadasuchus* (ROM 52620), is approximately 70 cm, with an estimated total body length of approximately 5 m. This is about twice as large as other taxa. Peirosaurids are presumed to be terrestrial predators due to their tall snouts, forwardly directed nares and laterally directed orbits. Theropod dinosaur material from the Wadi Milk Formation is rare, and is typically from modestly sized taxa. The large size of the Sudan peirosaurid suggests that it may have competed with theropod dinosaurs as a top terrestrial predator.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

THE POWER OF THE POSTCRANIUM: A REAPPRAISAL OF THE IMPORTANCE OF CAREFUL CONSIDERATION OF 'UNSEXY' BONES FOR PHYLOGENETIC INFERENCE IN CROCODYLIFORMES

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Crocodyliformes represents the most successful clade among the pseudosuchian line of Archosauria. They first appeared during the Late Triassic, and in contrast to the semi-aquatic lineages of the living forms, fossil representatives developed large ecologic diversity, ranging from terrestrial to marine environments. Modifications of the postcranium played a major role in the adaptation to these distinct habitats. However, the postcranial part of the skeleton is poorly represented in phylogenetic hypotheses of the group, and postcranial data commonly accounts for only 8.5-20 % of the matrix size. As many fossil crocodyliforms are found with substantial postcranial remains, an increase of character coding for this region is generally possible.

A caudal vertebra from the Kem Kem assemblage from the Cenomanian deposits of Morocco was the starting point for new research on morphological characters of this part of the skeleton. Here, we propose several morphological characters for caudal vertebrae. These elements are, although commonly found and occasionally used as type material for crocodyliform taxa, often insufficiently described and figured even in otherwise detailed osteological descriptions of more completely preserved taxa. Also, caudal vertebrae are largely ignored in phylogenetic analyses (commonly 0.3-1 % of characters). While caudal characters in most existing phylogenetic matrices are limited to the form of the intercentral articulations, we recognize several phylogenetically informative traits in the position and orientation of vertebral landmarks, such as the relative position of the transverse processes to the level of the neural canal.

We show that a) the morphology of caudal vertebrae varies systematically between crocodyliform taxa, that b) these variations can be translated into meaningful characters for cladistic analysis, and that c) main patterns of crocodyliform phylogeny can be recovered from caudal vertebrae. Based on our results, we propose that postcranial remains should receive more attention in both the original description of fossil material and phylogenetic analyses, as they can help reveal phylogenetic information for Crocodyliformes. Future work should aim to integrate more characters from the postcranium in existing, cranial-skewed datasets in order to further refine the resolution of crocodyliform phylogenetic hypotheses.

Technical Session VII (Thursday, November 6, 2014, 8:15 AM)

TAXONOMY AND ONTOGENY OF PROTEROSUCHIDAE (DIAPSIDA: ARCHOSAUROMORPHA): IMPLICATIONS FOR THE TEMPO AND MODE OF EARLY ARCHOSAURIFORM EVOLUTION

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Archosauriforms include archosaurs and several Permo-Triassic diapsid groups, such as proterosuchids, erythrosuchids, proterochampsids, euparkeriids and doswelliids. The phylogenetic position of Proterosuchidae as the earliest-branching group of archosauriforms means that it is a critically important clade for understanding the successful evolutionary radiation of this group during the Mesozoic. Proterosuchids are best sampled from the earliest Triassic of South Africa, with more than 20 specimens known. These specimens form the basis for four nominal species: *Proterosuchus fergusi*, *Chasmatosaurus vanhoepeni*, *Chasmatosaurus alexanderi* and *Elaphrosuchus rubidgei*. However, interpretations of the taxonomy of the South African proterosuchids have been complex and widely divergent, and *P. fergusi* is currently considered the only valid species. Ongoing discovery of well-preserved specimens continues to improve sampling of South African proterosuchids and provides an impetus to revisit their taxonomy. Based upon a comprehensive re-examination of proterosuchid specimens in collections worldwide we conclude that the holotype of *'P. fergusi'* is undiagnostic. Qualitative and quantitative analyses indicate that *C. vanhoepeni* and *C. alexanderi* are valid species, and we recognize a third new species of *Chasmatosaurus* based on a single, previously described specimen (NMQR 880). Using this new taxonomy we qualitatively and quantitatively analyzed the cranial ontogenetic development of *C. vanhoepeni* based on 13 specimens. Through ontogeny, the skull of *C. vanhoepeni* became proportionally taller, the infratemporal fenestra larger, and the teeth more numerous with apicobasally shorter crowns. The elongated snout and enlarged premaxilla that are characteristic of proterosuchids underwent isometric growth. Our results indicate that the species richness of earliest Triassic archosauriforms is greater than previously appreciated, but archosauriform morphological disparity remained low and did not expand until the late Olenekian-early Anisian. The overall cranial morphology of juvenile proterosuchids resembles that of the non-archosauriform archosauromorph *Prolacerta*, and adult specimens acquire a more erythrosuchid-like morphology. Accordingly, peramorphic events may have driven the early evolution of the archosauriform skull. This new information provides a basis for the future identification of more punctual heterochronic events during the early evolution of Archosauriformes.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

EVOLUTION OF SAURISCHIAN DENTITION

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Saurischian dinosaurs originated as carnivores, but several taxa evolved herbivorous and omnivorous diets. Through the Mesozoic, different ecomorphological groups came and went, defined by their jaws and teeth. In order to characterize how many times and when diets evolved in Saurischia, we used morphometric, disparity and evolutionary rates analyses on 150 taxa belonging to the main clades of Theropoda and Sauropodomorpha. These methods are used to explore the diversity of form through time and between subclades, and they identify times when evolution was unusually fast or slow. The calculations are based on 30 characters, including aspects of tooth shape, tooth count, presence or absence of a rhamphotheca, and shape of the jaws. The aim of this study is to quantify volumes of morphospace occupied by the different clades and the disparity in their tooth morphologies. In addition, the overlap of different morphospace clusters gives important information about convergent events through time or between taxa of the same age. With disparity analysis, the amount of diversity in tooth shape is quantified among genera and subclades through time and mass extinctions. Evolutionary rates are calculated to determine how fast a clade evolved related to changes in dentition and dietary shifts, testing if a particular diet favored radiation in a clade or if the radiation and diversification of taxa are not related to feeding innovations. Various evolutionary models (Brownian, Early Burst, Trend and Ornstein-Uhlenbeck) allow for the reconstruction of a realistic model of evolution. Moreover, this study tests correlations between dietary shifts, innovation in dentition and variation in body size in order to quantify potential relationships. Within Theropoda, while convergent dentition is found in the biggest theropods that appeared at different times, changes in tooth morphology and the tooth reduction characterizing the dentition of smaller theropods are more dramatic, implying high evolutionary rates. Moreover, high diversification of diets is found in Avialae. Within Sauropodomorpha, the three main clades (Prosauropoda, Macronaria and Diplodocoidea) are distinguished and separated in the resulting morphospace, showing different dentitions for different specialized dietary preferences.

Technical Session I (Wednesday, November 5, 2014, 9:15 AM)

EXTREME NASAL DOMING IN NEW MATERIAL OF THE PLEISTOCENE ALCELAPHINE *RUSINGORYX ATOPOCRANION* (ARTIODACTYLA, BOVIDAE) FROM RUSINGA ISLAND, KENYA: RE-DESCRIPTION AND FUNCTIONAL ANALYSIS

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Originally described from a partial basicranium, the taxonomic validity of the extinct alcelaphine bovid *Rusingoryx atopocranion* has been the subject of debate since its discovery in 1984. Here we present a revised diagnosis based on novel and complete cranial material recovered from recent excavations of the Pleistocene Wasiriya Beds of Rusinga Island, Kenya. These excavations uncovered a mass death assemblage with a minimum of 11 individuals, including well-preserved skulls of 6 adults and 1 juvenile. Adult skulls reveal an extreme degree of ossified nasal doming that distinguishes *R. atopocranion* from all other alcelaphines. The addition of new morphology to an alcelaphine character matrix was analyzed using parsimony and Bayesian phylogenetic analyses. Results show 95% support at the node separating *Rusingoryx* from its sister taxon, *Megalotragus*, and further validates *R. atopocranion* as a taxonomic entity.

We explored three hypothetical functions for the bony crest. Thermoregulation, visual display, and sound production were examined by combining archosaur analogs (e.g., hornbills and lambeosaurine hadrosaurs), computed tomographic (CT) scanning, 3-D model building (Avizo v. 7.0), demographic statistics, and physical models of sound production and propagation through airways. In the CT-scans, evidence for expanded cranial thermoregulatory structures (turbinates and open-ended sinuses) was not observed. Age profiles generated from dental eruption and wear patterns show a mixed juvenile/prime dominated assemblage that likely contains males and females. Within this sample, sexual dimorphism may be captured; however, all adult skulls show similar degrees of doming. The vocal apparatus was partially reconstructed from internal and external cranial morphology, and the potential for phonic modification was tested using bioacoustic models. The internal morphology, reconstructed from CT scans, reveals an elongate nasal tract that terminates ventrally in a sinusoidal trajectory toward the oropharynx. When length and width measurements are incorporated into physical models for harmonic wave production, the capacity for sound modification within this structure is between 248 and 746 hertz. Enlarged maxillary and palatine sinuses underlying the nasal tract may have further functioned as resonating chambers. Low-frequency nasal vocalization is currently the best supported hypothesis for the function of the *Rusingoryx* ossified dome.

Symposium 2 (Thursday, November 6, 2014, 4:00 PM)

THE BIRTH OF A DINOSAUR TRACK: SUB-SURFACE 3-D MOTION RECONSTRUCTION AND DISCRETE ELEMENT SIMULATION REVEAL FOOTPRINT 'ONTOGENY'

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Footprints, both modern and fossil, represent sedimentary distortions that provide anatomical, functional, and behavioral insight into trackmaker biology. Such interpretations can benefit from understanding the mechanisms of footprint formation. Yet the development of track morphology is obscured by both foot and sediment opacity, which conceals animal-substrate and substrate-substrate interactions. We used X-ray Reconstruction of Moving Morphology (XROMM) to image and animate the hind limb skeleton of guineafowl traversing a dry, granular material. The reconstructed 3-D foot motion was integrated with a validated substrate simulation employing the Discrete Element Method (DEM), resulting in a quantitative model of limb-induced substrate deformation. By defining sedimentary layers based on initial particle position, we were able to observe the track at multiple levels throughout its formation, and thus link morphological features of tracks with the motion of the foot, both at the surface and at depth. What was initially most striking was that even in loose, granular sediment, tracks with high definition were formed throughout the track volume beneath the sediment-air interface. Transmission played only a very minor role, with most observable deformation occurring close to the path of the foot. Despite the appearance of clear tracks on multiple surfaces, which could easily be misinterpreted as shallow tracks, none accurately represented the geometry of the foot due to its oblique interaction with the sediment. Linking the DEM and XROMM techniques has allowed for a direct correlation between track features and foot motions, and serves to illustrate the complexities inherent in interpreting fossil tracks in light of track maker, behavior, or function.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE EVOLUTION OF OCCLUSAL ENAMEL COMPLEXITY IN *THEROPITHECUS OSWALDI* (PRIMATES, CERCOPITHECIDAE)

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The *Theropithecus oswaldi* lineage is among the most common mammalian genera during the African Plio–Pleistocene. Known from all regions of the continent, it is an important ecological and biochronological indicator throughout Africa. Three chrono-subspecies are typically recognized. From oldest to youngest these are *T. o. darti*, *T. o. oswaldi*, and *T. o. leakeyi*. Functional morphology, enamel carbonate isotopes, and microwear analysis suggest it was a terrestrial grazer. Over its more than 3.5 million years of evolution this lineage shows a number of evolutionary trends in morphology including: increase in body and molar size, shortening and deepening of the rostrum, and greater attachment areas for the muscles of mastication. An additional trend that has been proposed is an increase in molar enamel complexity associated with its grazing behavior.

To test the hypothesis of subspecies-level complexity differences between *T. o. darti*, *T. o. oswaldi*, and *T. o. leakeyi*, we calculated the Occlusal Enamel Index (OEI) of 19 individuals; 7 from *T. o. darti*, 7 from *T. o. oswaldi*, and 5 from *T. o. leakeyi*. We restricted our sampling to the M2 to eliminate the effect of tooth position. After calculating the OEI of these teeth, we performed an analysis of variance (ANOVA) with subspecies as the independent variable and OEI as the dependent variable. We additionally performed an analysis of co-variance (ANCOVA) with taxonomy and sex as independent factors, true occlusal area (a proxy for body size) and geologic age as continuous independent factors, and OEI as the dependent factor to account for these confounding variables. Our ANOVA suggests that subspecies ($p = 0.4253$) is not significant for OEI. The ANCOVA indicates that taxonomy ($p = 0.9953$), sex ($p = 0.9817$), true occlusal surface area ($p = 0.8339$) and geologic age ($p = 0.6036$) are not significant. Our preliminary results suggest that there is no statistical difference in OEI between the three subspecies. However, the means for each subspecies (*T. o. darti* = 5.06, *T. o. oswaldi* = 4.97, and *T. o. leakeyi* = 5.54) do show *T. o. leakeyi*, the most recent subspecies, to have a higher OEI value than the other two subspecies, suggesting that more data is needed to tease apart the relationship between the taxa. We expect subspecies-level complexity differences to be small, but these differences are not significant with our current sample size.

Education and Outreach Poster Session (Poster displayed November 5 – 8)

DIGITAL SPECIMENS IN THE HIGH SCHOOL CLASSROOM

FARKE, Andrew, Raymond M. Alf Museum of Paleontology, Claremont, CA, United States of America, 91711; GAY, Robert, Mission Heights Preparatory High School, Casa Grande, AZ, United States of America; LEPORE, Taormina, Harmony School of Science-High, Sugar Land, TX, United States of America

Relatively cheap and fast digitization of fossil specimens facilitates use of digital specimens within the classroom and offers unique learning opportunities for students. A pilot collaboration between paleontologists and educators in California, Arizona, and Texas engages students in grades 9–12 in all phases of specimen digitization and usage. High school student volunteers in California use laser scanning and photogrammetry to digitize vertebrate fossils from museum collections, which are then available to the scientific community and general public. Students worldwide can access and utilize these specimens to learn the process of scientific research and writing within the context of research projects on comparative anatomy and biomechanics. These projects have been successfully implemented in the high school environment, but could be adapted for earlier grades. Students at a Texas public charter school have used the digital specimens to conduct research projects comparing nimravids with modern felids and analyzing cranial morphology in early horses. At a public charter school in Arizona, students are creating a digital archive of specimens in the school′s collection to make them accessible to researchers. For classrooms with access to a 3D printer, physical copies of specimens can be produced for easier study away from a computer screen. Benefits to students include hands-on access to primary scientific data, the potential to contribute to the scientific process, the development of keen scientific writing and research skills, and a deeper appreciation of how technology allows advancements in our understanding of the natural world. Current obstacles hindering a broader incorporation of digital fossils into the classroom include a lack of scanned specimens available for educational use, a scarcity of prepared lesson plans, technology limitations within classrooms, knowledge of the existence of these resources, and mixed educator comfort levels with the technology.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A NEW *BAIRDEMYS* SPECIES (PLEURODIRA: PODOCNEMIDAE) FROM THE MARINE CAPADARE FORMATION, MIDDLE MIOCENE OF VENEZUELA

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The genus *Bairdemys* has recently been expanded with the addition of two new species: *Bairdemys healeyorum* and *B. miocenica*, totaling six species. The first of these new species extended the temporal range (from the Oligocene to the Miocene) and geographical range (from the Venezuelan Caribbean to the USA) of the genus. Here we present an almost complete and well preserved skull from the karstic deposits of the middle Miocene Capadare Formation, Cerro Misión, northwestern Venezuela. Based on its geology and fossil content, the depositional environment of the Capadare Formation is interpreted as an offshore shallow sea. The specimen bears all *Bairdemys* synapomorphies, such as the small and slit-like antrum postoticum, a ventral vertical flange in the squamosal, and the eustachian tube separated from the fenestra postotica. Several unique characters were identified in the specimen: the jugal/maxilla contact is above the labial ridge, and does not form its base, as in all other *Bairdemys* species; there are two crests on the dorsal surface of the quadrate, whereas *B. venezuelensis* and *B. hartsteini* have only one; the crista supraoccipitalis is not longer then the caudal margin of the squamosal; and there is an additional scale covering the parietal, postorbital, and quadratojugal, absent in other *Bairdemys* species. The specimen was coded and included in a large phylogenetic character/taxon matrix for the Pelomedusoides and a preliminary analysis confirmed its assignment to *Bairdemys*, with a close relationship to *B. venezuelensis*. The new specimen adds information on the habitats occupied by *Bairdemys* turtles. Previously known species were all found in sediments deposited in brackish or estuarine waters, suggesting that these turtles had some tolerance of salt water. This is corroborated by the present data, which hint at the capacity of these podocnemid turtles to live in exclusively marine environments.

Technical Session XV (Saturday, November 8, 2014, 12:00 PM)

THE FLOCCULAR COMPLEX: NEUROANATOMY AS A TOOL TO UNVEIL PALEOECOLOGY

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Comparative neuroanatomy in vertebrate evolution provides deep insights into how brain structures evolved through time, their functions and relative importance. A central principle in neuroanatomy is that there is a relation between relative neural tissue volume and its functional importance. The floccular complex of the cerebellum, formed by the flocculus and the ventral paraflocculus (housed in the floccular fossa), integrates visual and vestibular information and is responsible for the vestibulo-ocular reflex, smooth pursuit and gaze holding (movements of the eye to fix an object in motion). The ubiquity and universal function of this complex led us to hypothesize that the floccular complex relative volume might be a proxy to infer animals' ecology. Some authors referred to variations of the floccular complex volume and its relation with body mass with putative increased vision capacity and body agility. However, no comprehensive study has yet been performed in order to address this issue.

We analyzed brain cavity endocasts from diverse extinct and extant taxa to assess the relationship between the floccular complex volume and ecological variables. We tested the following hypotheses: 1) there is a correlation between optic lobes and floccular complex volume; 2) there is a negative allometry relation between the floccular complex volume and body mass; 3) floccular complex volume varies according to locomotion type and feeding habits. We integrated data from distinct taxa and associate floccular complex size patterns with specific ecological niches. The emydopoid dicynodont *Niassodon mfumukasi* is an interesting outlier given that the floccular complex relative volume to its brain volume is unexpectedly large. This ratio is 1.9%, comparable to that of some passerine birds well known for their agility (e.g., swallows), which might indicate that a direct relationship between floccular size and behavior is far from being well understood.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

USING A PHYLOGENETIC FRAMEWORK, PHYLOGENETIC DIVERSITY, AND GEOMETRIC MORPHOMETRICS TO COMPARE THE RELATIONSHIP BETWEEN DIVERSITY AND DISPARITY IN MONITOR LIZARDS

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In paleontological diversity studies, considerable emphasis has been placed on developing methods for counting taxa. Although these methods may be used in phylogenetic context, they rarely account for phylogenetic depth. Previously, I have used Phylogenetic Diversity (PD) to demonstrate that loss or gain of a certain number of taxa may differentially affect the higher-level diversity in a community or group depending on the taxa involved and their phylogenetic isolation from other taxa. Such methods, common in extant community studies, can be useful to paleontology because they account for the level of relatedness. Paleobiodiversity studies differ from extant

biodiversity research because the data are diachronous, so I assessed PD at multiple time bins.

This study extends that research to look at how disparity might relate to shifts in phylogenetic diversity along with taxic counts. Here, I focus primarily on monitor lizards because they are considered morphologically conservative, and their current diversity patterns vary by region. To understand their current disparity patterns, I performed geometric morphometrics on the skulls of extant and extinct taxa. Partial disparity was calculated to examine the relative contribution of major taxonomic and regional groups to overall morphological disparity through time intervals. To modify this morphospace for intervals, a time-calibrated molecular phylogeny was 'chainsawed' at time bins. A new phylogeny representative of that bin was generated, and phylogenetic diversity was measured. Based on the data collected from extant and extinct taxa, a new morphospace was generated representative of that time bin (based on the taxa the newly generated phylogeny indicated existed then). African varanids, although the lowest in diversity today, encompass a great deal of the morphospace compared to the more diverse Asian and Australian regions, and represent a set of deep lineages that affect phylogenetic diversity. Fossil varanids also fall well within the total morphospace of extant groups. Though diversity is highest today (because a molecular phylogeny was used), crown African varanids first appear fairly early phylogenetically, so varanid morphospace generated by this tree is initially more extensive than expected and fills quickly through time. Despite many assumptions, such as no change in morphology of a lineage through time and that molecular divergence dates are correct, these methods provide new insights into the diversity of lineages through time at multiple scales.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

PALAEANODONTS AND ASSOCIATED VERTEBRATES FROM THE BRIDGERIAN OF MEXICO'S CENTRAL PLATEAUS: THEIR PALEOBIOLOGICAL SIGNIFICANCE

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The southern extent, makeup, and evolution of North America′s Paleogene mammal fauna, and its relationships with South America′s fauna are poorly known. Its record in Mexico/Northern Central America is quite meager, coming from five faunas retrieved from as many morphotectonic provinces in Mexico. A major task of current vertebrate paleontology research is to significantly improve this record and database. Here, we report findings about the Bridgerian Marfil l.f., Central Plateau MP, and its bearing unit.

The area lies in Guanajuato, where a Late Mesozoic metamorphic complex crops out, unconformably overlain by the Guanajuato Conglomerate (lower member: ~700 m thick, fine clastic; it bears Marfil vertebrates; upper member: ~1,200 m thick, crasso-clastic [typically red, polymictic, syntectonic], which bears Oligocene temperate palynomorphs, a volcanic succession [37-30 Ma], a Pliocene conglomerate, and Quaternary deposits. The lower member′s Early Bridgerian biochronologic dating is confirmed by the recognition of Chrons C22 and C21 [as well as the Oligocene C18 and 17 in the upper], thus giving it a calibrated Early Bridgerian [Br2] age.

The fauna includes three classes, eight orders, nine genera, and twelve species, as follows: Reptilia [Squamata: *Paradipsosaurus mexicanus*]; Aves [Falconiformes: fam., gen. indet.]; Mammalia [Condylarthra: cf. *Hyopsodus*; Carnivora: cf. *Viverravus* sp.; Rodentia: *Floresomys guanajuatoensis*, *Floresomys* spec. complex, *Guanajuatomys hibbardi, Marfilomys aewoodi*; Perissodactyla: cf. *Helaletes* sp. order uncertain; Palaeanodonta: two new gen. and sp.; and an indeterminate mammal]. The fauna indicates a warm climate. Here, we will talk on the palaeanodonts.

The five Guanajuato specimens superficially resemble Paleogene caenolestoid marsupials, dasypodid xenarthrans, and palaeanodonts; a closer look, though, discloses greater similarity with the latter, sharing with epoicotheriids numerous teeth that reach the end of the horizontal ramus, no medial buttress, and a short, high braincase; and with metacheiromyids simple, thin enameled teeth, no enamel in the occlusal surface, and diastemata, but unlike any palaeanodont, they have appressed incisors, no caniniform teeth, and the jaw is shorter than the snout.

Parsimoniously, they are assigned to an as yet undescribed family. The five specimens are so different among themselves, that we believe they represent at least to two undescribed genera, which make up the southernmost record of Eocene palaeanodonts in North America.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

NEARCTIC ORIGINS OF THE 'ENDEMIC' AFRICAN AVIFAUNA? THE NECESSITY OF FOSSILS FOR AVIAN HISTORICAL BIOGEOGRAPHY

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Living birds are the world's most diverse and ubiquitously distributed tetrapods. However, this overwhelming diversity is not distributed evenly across the globe: Earth's lower latitudes boast the majority of extant avian species-level and higher-order diversity, and many deeply diverging clades are restricted to vestiges of Gondwanaland. This common pattern has prompted the proposal of a 'Gondwanan' origin for living birds, a hypothesis that has been used to corroborate arguments for an ancient Mesozoic diversification of the avian crown group. Such arguments tend to ignore data gained from the Paleogene fossil bird record, our knowledge of which continues to improve thanks to new discoveries and diagnoses based on rigorous phylogenetic analyses. In fact, strongly supported phylogenetic hypotheses for many Northern Hemisphere Paleogene bird fossils cast considerable doubt on the hypothesis of a Mesozoic Gondwanan origin of Neornithes; many crown-clades with restricted extant distributions appear to have stem-group relatives in very different parts of the world. Here, we present evidence for a new addition to this list: new phylogenetic analyses strongly support the hypothesis that the heretofore enigmatic fossil bird *Foro panarium*, from the Early Eocene of Wyoming, USA, represents a stem-group turaco (Pan-Musophagidae). Extant turacos comprise a clade of ~23 species, all of which are endemic to sub-Saharan Africa. *Foro panarium* offers the first strong evidence for a stem-group musophagid, and reveals surprising new information on the early biogeography of this clade. This study provides a valuable addition to the known bird diversity from the Green River Formation, and more broadly emphasizes the relictual nature of extant neornithine biogeography. An ancestral state reconstruction incorporating all Paleogene fossils definitively referred to the stems of modern neornithine clades illustrates the fundamental role played by the fossil record in accurately inferring the historical biogeography of modern birds, and serves an important cautionary purpose - namely, that ignoring fossil biogeographic data may lead to strongly supported, yet entirely spurious, conclusions.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

SYSTEMATIC AND MORPHOLOGICAL REVISION OF FOSSIL AND EXTANT *MELANOSUCHUS* (CROCODYLIA: CAIMANINAE) FROM THE AMAZON

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Living caimans are important components of the Amazon ecosystems. The fossil record shows that these reptiles have been present in the northern region of South America at least since the middle and late Miocene (Solimoes, La Venta and Urumaco). Despite the relatively large number of fossil taxa and the abundance of information on extant species, the systematics of the group is rather confusing. A good example is the controversial taxonomic history of the black caiman *Melanosuchus niger* and its fossil Venezuelan congener *Melanosuchus fisheri* from the late Miocene Urumaco Formation. Most morphological (but not molecular) analyses attest a close relationship between *M. niger* and *Caiman latirostris*, with the former taxon also being assigned to the genus *Caiman* in the past. Regarding *M. fisheri*, the original description states that most of the characters distinguishing it from *M. niger* are associated with size and robustness (thus resembling *C. latirostris*), and a redescription is needed. Here the cranial anatomy of the holotype of *M. fisheri* (MCNC 243) is reviewed and compared to juvenile, sub-adult and adult specimens of *M. niger* (MNRJ 61, 81, 82) and *C. latirostris* (MNRJ 69, 2395, 9756), in order to elucidate some of the still open questions about the systematics of the genus. *M. niger* can be differentiated from *M. fisheri* on the basis of the presence of a tubercle on the posterior margin of the infratemporal fenestra, the strong ventral convexity of the postorbital bar, a V-shaped notch at the posterior margin of the supraoccipital bone, and the overall large size of the orbits, observed even in mature specimens. All these characters are diagnostic for the former species. The Venezuelan taxon also differs from *M. niger* and *C. latirostris* in having short rostral ridges that do not reach the bumps over the fourth maxillary alveoli, and a maxillary dentition that is reduced to 12 teeth. Some traits present in *M. fisheri* are shared only with juveniles of *M. niger*, such as the straight lateral margins of the cranial table and a vomer that extends anterior to the premaxilla-maxilla suture (MCZ 4336). A important new feature is the anteorbital depressed areas that are present in both *Melanosuchus* species and also in *Purussaurus*, a gigantic caiman from the Miocene of the Amazon. Unique features of *M. fisheri* can be identified in the frontoparietal bar, which is markedly dorsoventrally high and shows a very strong anteroposterior bending. Based on the combination of such characters, *M. fisheri* can be regarded as a distinct species from *M. niger*.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

MORPHOLOGICAL INTEGRATION BETWEEN THE FORE- AND THE HIND LIMB IN SABER-TOOTHS: IS THERE ANY EVIDENCE OF DECOUPLED EVOLUTION?

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The powerfully built forelimb of saber-tooth carnivorans has been traditionally interpreted as part of their prey-killing arsenal, as it is thought to be an adaption to immobilizing their prey before performing a quick and effective killing bite with their enlarged canines, with a minimum risk of fracture. Under this interpretation, the forelimbs of saber-tooths should be stouter than their hind limbs, which were not directly involved in prey capture. In spite of this, few studies have quantitatively compared the size and morphology of the fore- and hindlimb bones in saber-tooth predators.

In this study, we investigate if the morphology of the fore- and the hindlimb is decoupled in saber-tooths (machairodontines, nimravids, and barbourofelids) compared to the living felines. We collected a series of 3D-landmarks in the scapula, humerus, radius, ulna, pelvis, femur, and tibia. Then, we compared Procrustes coordinates (a proxy for bone shape) and centroid size (a proxy for bone size) for each pair of fore- and hind limb major limb bones, following the criterion of serial homology. These comparisons were made using linear regressions for centroid size and two-block partial least squares (2B-PLS) for Procrustes coordinates.

Our data suggest that, for both bone size and robustness (recovered by the first PLS axis of long bone comparisons), saber-tooth predators follow the same trend as modern felids. Therefore, the shape and size of their forelimb bones does not differ from the shape and size of their hind limb counterparts to a greater extent than in the living felines. This is particularly striking as some saber-tooths have a degree of limb robustness that goes far beyond the range of modern felids. Our results indicate clearly that the limbs of both the living felines and the saber-tooths share the same highly integrated pattern. The reason is probably that the powerful forelimbs of saber-tooths were adaptive for their hunting style, while their stout hind limbs were the inevitable outcome of developmental constrains, as both limbs share the same developmental processes resulting from serial homology. However, another possibility is that the powerful hind limbs of saber-tooths were also adaptive in order to withstand body weight loads while the forelimbs were used for immobilizing the struggling prey. Future research will answer if the highly integrated pattern between the fore- and the hind limb in felids and saber-tooth predators is

governed internally (i.e., by developmental constrains) or externally (i.e., by natural selection).

Technical Session IV (Wednesday, November 5, 2014, 2:15 PM)

UNEXPECTED COMPLEXITY IN THE BODY SIZE EVOLUTION OF SLOTHS (XENARTHRA, PILOSA)

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Extant sloths present a problem in reconstructing patterns of character evolution, in that the two living genera, *Bradypus* and *Choloepus*, are superficially similar (small-bodied, folivorous, arboreal), and yet paleontological data suggest that they diverged from one another ~30 million years ago. These genera are phylogenetically separated by a radiation of medium-sized to massive, principally ground-dwelling sloths, and it is thought that small body size and shared adaptations to arboreality in extant sloths evolved convergently in the two genera. Indeed, the six living sloth species are among the smallest, and are perhaps the most unusual, of the more than 50 known sloth species. In order to accurately reconstruct the evolution of characters such as body size among sloths, it is critical to incorporate their extinct diversity in analyses.

In this study, we use a compiled dataset of 57 living and fossil sloth species to examine changes in body mass mean and variance through time. Our analyses select a credible set of eight models, all of which partition sloths into multiple subgroups, suggesting distinct modes of body size evolution among major sloth lineages. Model-averaged parameter estimates support trended walks for most clades, with estimated rates of mean body mass change as high as 126 kg/million years for giant ground sloths in the Megatheriidae and Nothrotheriidae. Including living sloths in the analyses potentially obscures the full extent of trends in their respective groups. Estimated rates for Megalonychidae (large to giant ground sloths that also includes extant two-toed sloths) are four times higher when excluding *Choloepus*. Thus, not only do analyses based on extant taxa have the potential to oversimplify macroevolutionary patterns, in this particular case they can misidentify tempo and mode of character evolution. This study demonstrates the impact that integration of data from the fossil record can have on reconstructions of character evolution and establishes a complexity to sloth body size evolution that is not evident among the remaining extant representatives of this clade.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

NICHE PARTITIONING BETWEEN THE TWO DINOSAURIAN MEGAHERBIVORES, *EDMONTOSAURUS* AND *PACHYRHINOSAURUS*, IN THE CRETACEOUS ARCTIC NORTH SLOPE, ALASKA (PRINCE CREEK FORMATION: EARLY MAASTRICHTIAN)

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The Prince Creek Formation of northern Alaska is the most productive source of polar dinosaur remains in the world. These well-documented dinosaur remains provide a basis for inferences of the paleoecological preferences for the two most commonly occurring dinosaurian megaherbivores, *Edmontosaurus* and *Pachyrhinosaurus*. This rock unit records high-latitude, alluvial sedimentation and soil formation on a low gradient, muddy coastal plain during a greenhouse phase in Earth history. An integrated reconstruction of pedogenic processes and biota suggests that this ancient Arctic coastal plain was influenced by seasonally fluctuating water table levels and floods, and in distal areas, a marine influence. Four of the five bonebeds in this study are from the more distal areas which represent delta plain facies while the fifth bonebed is from the more proximal part of the basin representing a somewhat better drained coastal plain.

The bonebeds in the distal areas are dominated by bones attributed to *Edmontosaurus* sp. while the more proximal bonebed is dominated by the remains of *Pachyrhinosaurus perotorum*. The distribution of these bonebeds and sedimentological facies suggests that *Pachyrhinosaurus* likely preferred upland environments while *Edmontosaurus* preferred more lowland, deltaic environments. Further suggestion of niche partitioning is derived from observations of the microwear on the teeth of these two taxa. These observations suggest consumption of a harder plant material for *Pachyrhinosaurus* and a softer plant material for *Edmontosaurus*.

The presence of *Pachyrhinosaurus perotorum* in the better drained upland areas contrasts with reports of large ceratopsian remains found in the lower latitudes. Hadrosaur remains have generally been ubiquitous in the lower latitudes but seem to be preferentially preserved in the Prince Creek Formation. This contrasting distribution may be the result of physiological adaptation to the pronounced seasonality of polar terrestrial ecosystems.

Technical Session XVI (Saturday, November 8, 2014, 8:30 AM)

AN EARLY CARBONIFEROUS MASS OCCURRENCE OF SHARK EGG CAPSULES FROM FRESHWATER DEPOSITS - THE OLDEST CHONDRICHTHYAN MULTI-TAXON NURSERY

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A mass occurrence of fossil egg capsules of the morphotypes *Fayolia* and *Palaeoxyris* in Chemnitz-Glösa, eastern Germany, in late early Carboniferous (Mississippian, late Visean) deposits demonstrates pronounced reproductive behavior of late Paleozoic oviparous sharks in nonmarine environments. With the exception of a single xenacanthiform dorsal spine, chondrichthyan skeletal remains are absent. Accompanying fauna consists of rare coelacanth scales and remains of different aquatic and terrestrial arthropods, while floral elements are represented by numerous lycophytes, calamitaleans, ferns, pteridosperms and mosses. Litho- and biofacies as well as taphonomy of the capsules imply *in situ* preservation on an inundated floodplain to floodbasin. This is in accordance with oxygen and strontium isotope freshwater signatures of the shark spine.

Altogether, 42 casts of *Fayolia* in fine-grained sediment have been found, each possessing a cylindrical screw-like body that is composed of two parallel helicoidally twisted bands, and accompanied by prominent scar-lines. Several capsules are aggregated into clusters, including the largest *Fayolia* cluster yet known with 5 capsules. Xenacanthiform sharks are regarded as its most likely producer. *Palaeoxyris* is represented by 36 fragments of variably compressed specimens, several aggregating in clusters of up to three capsules. Beaks and pedicles are mostly missing in the available material. The capsules are composed of six spirally twisted bands, with a spiral pattern also occurring on the rare pedicle fragments. This find represents the oldest yet known record of *Palaeoxyris*. Hybodontiform sharks are considered to be its most probable producer. Altogether, it is the oldest find of a chondrichthyan egg capsule mass occurrence yet discovered, and is significant due to the unique co-occurrence of both *Fayolia* and *Palaeoxyris* on single rock slabs.

The spatial and temporal distribution of both egg capsule types accompanied by sparse skeletal remains allows the interpretation of the Glösa paleoenvironment as a multi-taxon nursery for two ancient shark species by analogy with extant forms. The co-occurrence of both capsule types probably indicates use of the nursery area with some degree of temporal partitioning, as is seen in several recent species coexisting in the same geographic area. The continuous occurrence of egg capsules through the profile suggests persistent use through time.

Preparators' Symposium (Saturday, November 8, 2014, 3:15 PM)

EXCAVATION AND PREPARATION OF FOSSILS PRESERVED IN LOOSE SAND

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Methods for excavation and preparation of vertebrate fossils depend to a great extent on the nature of the surrounding matrix, which is usually composed of sedimentary rock composed of particles held together by siliceous or calcareous cement. Matrix of this sort, which varies in hardness and in resistance to fracturing and crumbling, is amenable to time-honored excavation procedures using burlap and plaster jackets. When the cement that holds the matrix together is virtually absent, however, some adjustments in protocol are necessary. Paleodune sand, for example, can be cement free, as was the case at Gobero, a vertebrate-rich early Holocene archaeological site in the Niger Republic. After taking undisturbed sediment samples for pollen and chemical analysis, we used museum-grade consolidant to function as cement. To maximize the penetration of consolidant, we concentrated first on the block perimeter, using spray bottles to maintain and then jacket an edge, leaving the top of the block open. We continued this process, extending the jacket under the block. Then we saturated the block from above with consolidant, allowing it to dry and harden over several days. Finally, the block was capped and the jacket turned. When the jacket was opened in the laboratory, the perimeter of the jacket was maintained as support until the burial was fully exposed. In this way, we preserved human skeletons and grave goods with all bones and artifacts in their original positions and exposed above and below in relief on a thin slab of hardened sand.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

BRITISH PLEISTOCENE WOLVES AND WOLF-LIKE CANIDS: ECOLOGICAL WINNERS AND LOSERS?

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In Britain, the oldest record of the early wolf-like *Canis mosbachensis* is from the early Middle Pleistocene, 781-450 ka. However, by 220 ka, this canid had seemingly disappeared, supplanted by the larger modern wolf, *Canis lupus*. This raises the question of why one canid was able to succeed whereas the other one apparently failed.

Taking an exclusively British focus, inferences on paleodiet, as well as estimates of body mass, were made for both canids based on a suite of dietary-diagnostic cranio-dental morphometric data combined with information on tooth breakage and wear in order to elucidate intra-species temporal differences in paleodiet and size, as well as inter-species differences in ecology.

A lack of temporal variability in the paleodiet and body size of *C. mosbachensis* contrasts with the greater variation found in *C. lupus* in the later Pleistocene. Comparative climatic stability in the early Middle Pleistocene prior to the Anglian Glaciation (450 ka), combined with a diverse and abundant prey base and a large and species-rich carnivore community, apparently constrained body size and prey choice in the smaller-sized *C. mosbachensis*. In contrast, greater temporal variation in the paleodiet and body size of *C. lupus* likely reflects the more dramatic climatic changes of the late Middle to Late Pleistocene, which led to changes in the openness of the environment as well as in large carnivore competition. The more flexible and adaptive ecology of *C. lupus* therefore enabled its survival through the later Pleistocene and into modern times. Funding for this research was provided by a Reid Research Scholarship (Royal Holloway University of London), the Quaternary Research Association and SYNTHESYS ([SE-TAF-1784] financed by the European Community-Research Infrastructure Action under FP7 capacities specific program).

Technical Session VI (Thursday, November 6, 2014, 8:45 AM)

THE MIDDLE MIOCENE DORMOUSE DATUM IN THE SIWALIKS OF SOUTH ASIA

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Dormice are small rodents of Eurasia and Africa, dentally distinctive, and phylogenetically isolated. Although previously considered related to muroids, molecular data associate dormice with squirrels. Their cheek teeth are unforgettable The occlusal surface is marked by distinctive, thin transverse ridges. The excellent Siwalik fossil record for the middle Miocene of the Indian Subcontinent illustrates the succession of faunas there on a precise time scale. Siwalik assemblages include squirrels, gundis, and diverse muroids, but no dormice until after 14 Ma. The earliest Siwalik dormouse record

is abrupt, at 13.8 Ma, and coincides with the appearance of the stem murid *Antemus chinjiensis*. This dormouse is a species of *Myomimus*, an extant genus of central Eurasia. The Siwalik *Myomimus* persists in successive assemblages with a number of arboreal rodent elements until about 12 Ma. Late Miocene (12 to 10 Ma) assemblages also contain dormice, but minor morphological differences indicate two species, one of which resembles European *Peridyromys*. Still later assemblages are characterized by a more derived dormouse presenting dental morphology similar to that of *Dryomys*, an extant genus living as far east as Iran. The Siwalik record of dormice shows change, but does it reflect evolution in the Indian Subcontinent, or multiple immigration events of lineages from outside that biogeographic subregion? Increasingly it appears that the Siwalik theater of evolution was moderately isolated, and a single immigration event brought dormice to the region shortly after 14 Ma. Diversification of that founding lineage increased species diversity in South Asia. While modern *Myomimus* is terrestrial, the habitat preferences of Miocene Siwalik species, in relationship to those of other faunal elements, remain uninvestigated.

Technical Session VII (Thursday, November 6, 2014, 9:15 AM)

THE CRANIAL ANATOMY AND FEEDING ECOLOGY OF *TYRANNONEUSTES LYTHRODECTIKOS* (CROCODYLOMORPHA: METRIORHYNCHIDAE) FROM THE MIDDLE JURASSIC OF EUROPE

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The Oxford Clay Formation (Callovian-early Oxfordian, Middle-Late Jurassic, ca. 164-157 Ma) boasts one of the best records of Mesozoic marine reptiles. Among these, *Tyrannoneustes lythrodectikos* is one of numerous sympatric metriorhynchid crocodylomorphs. This taxon has a mosaic of derived and plesiomorphic features relating to macrophagy (feeding on large-bodied prey items). As such, *T. lythrodectikos* is of great importance in our understanding of the early evolution of macrophagy among geosaurine metriorhynchids. This is especially important as during the Late Jurassic and Early Cretaceous, macrophagous geosaurines diversified into a range of ecomorphotypes, some of which were somewhat reminiscent of extant killer whales and barracudas.

A long known, but previously misinterpreted, museum specimen is demonstrated to pertain to *Tyrannoneustes lythrodectikos*. This specimen consists of an incomplete skull, lower jaw, four cervical vertebrae and four dorsal vertebrae. As skull material was previously unknown for *T. lythrodectikos*, this specimen allows us to investigate the feeding ecology of the species, and reveals new apomorphic characteristics. Between the holotype and this specimen, *T. lythrodectikos* had the following macrophagous characteristics: an especially large optimal gape angle (the largest among the known Oxford Clay Formation taxa), a mesiodistal tooth occlusion mechanism, enlarged supratemporal fenestrae (indicating enlarged jaw adductor musculature), apicobasally elongated teeth with denticulated carinae. However, the skull and dentition retained some symplesiomorphies not likely related to macrophagy, such as: a relatively high maxillary tooth count, a relatively long and tabular snout, and denticles that are microscopic and non-contiguous along the carinae.

This specimen also provides some interesting ontogenetic information. Based on estimated basicranial length, this individual would have been approximately 4.8 m long. However, the lack of neurocentral fusion on the cervical and dorsal vertebrae suggests that this specimen was not a skeletally fully mature individual. As such, we cannot exclude the possibility that *T. lythrodectikos* could exceed 5 m in total length, making it the largest known Middle Jurassic metriorhynchid. However, *T. lythrodectikos* was neither the only macrophagous metriorhynchid nor the largest predator in the Oxford Clay Formation. This raises an interesting question, currently under investigation, of how several such taxa could co-exist in the same ecosystem.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A NEW PALAEOBATRACHID FROG FROM THE EARLY PALEOCENE OF BELGIUM

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Palaeobatrachids are an extinct group of aquatic frogs. They occurred from the Late Cretaceous to the Pleistocene, only in Europe with the exception of one questionable species recorded in the late Maastrichtian Lance Formation of Wyoming and a second possible occurrence in the early Paleocene of Montana.Here, we describe about ninety isolated palaeobatrachid bones well-preserved in three-dimensions (maxillae, surangulars, vertebrae, urostyles, ilia and humeri) from the early Paleocene locality of Hainin (Belgium), which is the reference-level MP1-5 of the mammalian biochronological scale for the European Paleogene. These remains are clearly attributable to a single species of palaeobatrachid that presents the following typical characters: a surangular with a coronoid process bearing muscle scars on dorsal surface; a bicondylar sacro-urostylar articulation; an urostyle with a low neural crest and lacking transversal processes; a humerus with the humeral condyle in the alignment of the bone, epicondyles similar in size; an ilium presenting a large acetabular area, a short and posteriorly oriented pars ascendens, an elongate tuber superius, an horizontal depression on the inner surface of the iliac shaft and lacking the dorsal crest and the pars descendens; and procoelous vertebrae with typical crescent-like cotyle and condyle.

The four known palaeobatrachid genera have all been recently synonymized with *Palaeobatrachus* for which at least seven species are now recognized. The taxon from Hainin differs from most *Palaeobatrachus* species in the absence of cubital fossa on the humerus, the presence of diapophyses on the first vertebra, and the maxilla that presents a higher number of tooth positions. It is thus referred to a new *Palaeobatrachus* species or a new genus depending of the definition of the genus *Palaeobatrachus*.

Prior to this study, fragmentary remains of palaeobatrachids had been identified in the Campanian of France and Spain and in the Late Paleocene of France. The early Paleocene species from Hainin is therefore the earliest formally described species from Europe. This abstract is a contribution to the project BR/121/A3/PALEURAFRICA funded by the Belgian Science Policy Office.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

ANAASSOCIATED SKELETON OF JUVENILE LATE EOCENE BASILOSAURID ARCHAEOCETE (CETACEA: ARCHAEOCETI) FROM NEW ZEALAND

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A new juvenile basilosaurid helps us to understand developmental patterns in Archaeoceti (stem-Cetacea), and adds to the range of Eocene archaeocetes from New Zealand. The fossil is from the Ashley Mudstone of Hurunui, Canterbury (local Kaiatan or Runangan Stage, 34.6–39.1 Ma, mid Bartonian-later Priabonian). The slightly disarticulated skeleton is spread over 750 mm by 350 mm on a bedding plane of massive, slightly glauconitic, pyritic, calcareous mudstone. The skull is ventral up, while the postcranial skeleton presents a slightly mixed sequence of cervical and thoracic vertebrae and ribs. Some elements are bioeroded.

A juvenile age class is suggested by: disarticulated exoccipitals, basisphenoid-basioccipital, and rostrum; anteroposteriorly thin thoracic vertebral bodies that are separate from neural arches and epiphyses; and spongy extremities on the ribs. Further, tooth crowns are hollow with thin enamel; roots are thin-walled and hollow, without evidence of layered dentine or cementum. An upper P1 appears to be incompletely erupted. Cheek-teeth are both in situ and scattered around the skull and postcrania. These teeth are buccolingually compressed, with multiple subconical and non-palmate denticles (as in other Basilosauridae), smooth rather than ridged enamel, and (in upper P3) barely denticulate buccal and lingual cingula. Skull length, based on added dimensions of separated elements, is 300+ mm from the basion to the incomplete tips of premaxillae; condylobasal length (cbl) could have been 30+ mm more. The skull is clearly smaller than reported for adult Dorudontinae, including the small species of *Ocucajea* and *Saghacetus*.

The juvenile features, and/or lack of some elements, hamper taxonomic comparisons, but tooth and periotic features are similar to those reported for *Dorudon* and *Zygorhiza.* The tympanoperiotics are large relative to skull size, approaching proportions seen in adult *Dorudon* and *Zygorhiza*. As in living Neoceti, hearing may have been well-developed at a young ontogenetic age.

Symposium 4 (Friday, November 7, 2014, 10:30 AM)

3D COMPUTATIONAL MODELLING IN STEREOSPONDYLS (TEMNOSPONDYLI): SKULL MECHANICS AND ECOMORPHOLOGICAL IMPLICATIONS

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Stereospondyls were secondarily aquatic animals that mainly inhabited freshwater but were also present in brackish swamps and deltas and shallow marine environments. After the Permian mass extinction, the ecological differentiation among stereospondyls increased and they occupied a wide range of ecological niches. Most stereospondyl groups are inferred as active swimmers, ambushers and/or active predators. The ecological role of these amniote predators is debated, suggesting ecomorphological analogies with extant crocodilians from broad-headed (as alligatorids) to slender-headed (as gavialids). The ecological role was tested performing 3D Finite Element Analysis (FEA) of stereospondyl skulls using an extant phylogenetic bracket but also a comparison with extant eusuchians. These techniques allowed the evaluation of different ecological scenarios and to test different loading cases using volume scaled models that enabled the proper comparison of the results. Stereospondyls probably were able to perform a bilateral bite, with stresses mainly on maxillary and nasal bones and the interorbital region. The posterior part of the skull presents moderate levels of stress on parietal and postparietal bones and the occipital condyles, whereas on the palate the vomerine plate reveals important stresses. Interestingly, the cultriform process of the parasphenoid shows very low or no levels of stress in all the tested cases. Under a lateral loading to simulate how prey items could be grasped by using a rapid sideways sweep of the head during active swimming, the analyses show that most stereospondyls presented very high levels of stress in the region of parasphenoid and exoccipitals, but also in the complete vomerine plate. This stress pattern may have precluded this feeding behavior in most of the stereospondyl groups. In comparison with extant eusuchians, stereospondyls present a different stress pattern showing that the absence of the secondary palate increases the levels of stress, especially on the snout and vomerine plate. Stereospondyls are also characterized by a variable position and size of the orbits, but FEA results show that this does not affect the biomechanical capabilities of stereospondyl skulls. Stereospondyls were top predators in many continental ecosystems but were probably replaced by the rise of archosaurs. This fact is probably due to the development of a secondary palate and high rostral shape diversity in archosaurs, especially on the lateral profile, that may increase the biomechanical capabilities of the rostrum.

Technical Session III (Wednesday, November 5, 2014, 2:15 PM)

NEW DETAILS ON THE INTEGUMENTAL STRUCTURES IN THE JUVENILE MEGALOSAUROID *SCIURUMIMUS ALBERSDOERFERI* FROM THE LATE JURASSIC OF GERMANY USING DIFFERENT AUTO-FLUORESCENCE IMAGING TECHNIQUE

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Our knowledge of the morphology and evolution of integumental structures in dinosaurs is still limited due to the infrequent preservation of soft tissues in vertebrate fossils in general. The juvenile megalosauroid *Sciurumimus albersdoerferi* from the Upper Jurassic Painten Formation in Germany provides new insights into the evolution of the integument in non-avian dinosaurs, due to exceptional soft tissue preservation, including feathers and skin. These structures were investigated using UVA (with different

color correction filters) and cyan-red auto-fluorescence techniques and digital photo documentation. By using different wavelengths on the same object it is possible to enhance distinct structures, helping to verify morphological interpretations. In overview, *Sciurumimus* shows feathers on the dorsal side of the tail and the back, but also in the belly region and on the ventral side of the tail. Skin remains are preserved on the dorsal and ventral side of the tail, in the pectoral region and on the forelimbs, on the trunk and the hind limbs. Under UV light feathers illuminate yellow and cyan, whereas skin remains appear bright yellow. In contrast, using cyan-red fluorescence both integumental structures appear red, with the skin giving a much stronger signal. The feathers are gently curved filaments, which show no sign of distal branching. Proximally, some filaments seem to fuse to each other, but this might be a taphonomic artefact due to the dense overlap of feathers. Other feathers appear mono-filamentous over their entire length, resembling the filaments of *Psittacosaurus*, *Tianyulong*, *Dilong* or *Sinosauropteryx*. The skin remains found in *Sciurumimus* seem to be rather smooth and show no signs of scales. Along the dorsal side of the tail the skin is decayed, revealing a horizontal meshwork of thick, short, wrinkly filaments overlain by an outer skin layer. Due to their different morphology and different luminescence, we interpret these filaments as remains of collagen fibers from the dermis, covered by epidermis, rather than as feathers. In one area, the outer skin layer is associated with feathers, showing that the filaments may be anchored in the skin as it is described for *Psittacosaurus*. In sum, *Sciurumimus* shows the phylogenetically oldest record for feathers within theropods, closing the gap towards basal ornithischian dinosaurs and pterosaurs possessing filamentous integuments. Feathers in this taxon are furthermore very similar to those found in these clades, supporting the homology of these structures.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

TITANOSAUR MEETS NEXTENGINE: COAXING BIG DATA FROM AN ENTRY-LEVEL 3D LASER SCANNER

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Three-dimensional laser scanning of fossils is a versatile tool for paleontologists. Digital models of fossils are portable, can be viewed from any perspective, and can be articulated digitally for display and to examine biomechanical hypotheses. The ability of scanners and scanning services to capture high resolution data generally varies in proportion with cost. Here we present the methods we have developed using the NextEngine 3D laser scanner. We chose this scanner because of its modest price and its ability to capture the photographic texture of objects. Another advantage of this system is that it does not require post-processing of data to generate results. In our trials, the NextEngine scanner excelled at capturing high resolution 3D data for moderately sized objects, between five and one hundred centimeters. However, it performed poorly when attempting to capture surface detail of very small objects, such as the serrations on a two centimeter long theropod tooth. It also struggled when imaging very large objects, such as a two meter long titanosaur femur. Certain shapes caused particular difficulty, such as very flat and thin objects, such as an ilium, or those with deep fossae and thin processes, such as dorsal or cervical vertebrae. However, through trial and error and adaptations of the scanner's functionality, we were able to get high quality 3D models for every preserved element of a very large titanosaurian sauropod dinosaur. Some of our adapted methods included starting with a large, flat surface near the center of the object, taking scans at several vantage points along complex edges, trimming superfluous data, removing and rescanning areas that caused the model to misalign, breaking the 'fuse' process into several steps, and most importantly, carefully selecting alignment points. Despite these difficulties and limitations, with some perseverance, it was possible to produce very high resolution models, overlain with photographic textures, for a relatively small monetary investment. The NextEngine scanner may not be the best choice for capturing 3D data from very small or very large fossils. However, it does provide an affordable entry into three-dimensional research and virtual curation.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

RODENT TOOTH SHAPES AS ECOMETRIC TRAITS: PREDICTING TROPHIC CATEGORIES OF RODENTS FROM 3D TOOTH MORPHOLOGY

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In the grasslands and deserts of the Great Plains and southwestern USA, both the relative abundance of rodents in trophic categories in local ecosystems and the species richness of rodents in trophic categories have been regionally tied to both precipitation and productivity. Thus, the trophic structure of fossil rodent communities could be a powerful tool for paleoenvironmental reconstruction. Critical to developing this approach is a reliable means of inferring trophic category for fossil rodents; given the great morphological diversity of rodent dentitions, to be useful across the phylogeny of rodents, quantitative traits of dentitions should not rely solely on homologous features. To this end, we have µCT scanned skulls and mandibles of 120 species of extant North American rodents at resolutions of 5–31µm. We thresholded tooth row volumes of hemimandibles of each species to produce surfaces corresponding to enamel and dentin, then cropped dentin thresholds to the functional crown as defined by the enamel-dentin junction (EDJ). From the dentin and enamel surfaces, we extracted > 30 individual measures per tooth row to calculate variants of published metrics (orientation patch count, OPC; relief index, RFI; volumetric hypsodonty, HI; and Dirichlet normal energy, DNE) in addition to novel metrics (platonic shape extraction, PSE; occlusal relief index, ORFI; outline complexity, OC; and region count, RC). We are using combinations of these metrics, in addition to traditional linear metrics, extracted for individual lower molar positions and for whole lower tooth rows in linear discriminant function analysis (DFA) to develop models that can estimate trophic category from isolated fossil teeth and whole dentitions. In initial analyses of a subset of scans comprising small-bodied species of sciurids, heteromyids, cricetids, and geomyids, a DFA of nine metrics from m1 correctly classifies 78% of species as folivores, granivores, omnivores, or insectivores based on cross-validation and the utility of reduced models varies by species. DFAs for the same metrics on m2 and on m3 correctly classify only 65.6% of those species, with omnivores the hardest to classify and most of the same species misclassified in each model. A DFA using six metrics from a mix of tooth positions performs as well as the m1 model. These results indicate that we can predict trophic category of rodents from tooth shape, opening the possibility to use the measures of tooth shape as ecometric traits in spatially explicit, whole community analyses to infer paleoenvironmental change.

Preparators' Symposium (Saturday, November 8, 2014, 3:30 PM)

***BAROSAURUS* ON THE HALF SHELL: A TWO PIECE STORAGE JACKET DESIGN FOR LARGE OR FRAGILE SPECIMENS**

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In the course of completing the move to new compactorized storage of O.C. Marsh′s dinosaurs at the Yale Peabody Museum, an unusual challenge presented itself. A large cervical vertebra from *Barosaurus lentus* needed a new storage jacket. The old jacket, made in 1916, was heavy, awkward to move, and did not adequately protect the specimen. The Peabody has created hundreds of storage jackets for large specimens, and has adopted a standardized design. The basic design, as reported previously, consists of a one piece medium density fiberboard (MDF) and custom formed Hydrocal FGR-95 and fiberglass base to fully support the specimen. For this specimen, however, once the vertebra was removed from the old jacket and transferred to the sandbox it became apparent that the Peabody′s standard support jacket design would not suffice. Due to the specimen′s size (39″ x 21″ x 9″) and fragility, the team felt they would not be able to maneuver it out of the sandbox and into a one piece support jacket without serious risk of damage. The specimen needed to be fully supported at every moment to prevent breakage. The solution: a two piece support jacket. A lightweight Hydrocal FGR-95 and fiberglass shell was molded against the side of the specimen. This lightweight shell was intended to support the specimen while it was moved. An independent—and stronger—base was built to conform to the bottom of the shell from MDF, Hydrocal FGR-95, and fiberglass. The specimen was then placed in the lightweight shell to safely move it onto the base. Now the specimen rests in the nested shell and jacket, securely supported against breakage, yet accessible for research.

Technical Session VIII (Thursday, November 6, 2014, 2:30 PM)

A PREGNANT MARE WITH FETUS OF *EUROHIPPUS MESSELENSIS* (MAMMALIA, PERISSODACTLYA, EQUIDAE) FROM THE EARLY MIDDLE EOCENE OF MESSEL PIT (GERMANY)

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The skeleton of a pregnant mare with fetus of the European equid *Eurohippus messelensis* is described from the early middle Eocene of Messel Pit, Germany. It comes from the Messel Formation, around 47 million years of age (biochronologic unit MP 11), and was excavated in the year 2000 by the team of the Senckenberg Research Institute. As usual for Messel, but also for extant horses, the mare bore only one offspring. The accumulation of its bones indicates that the fetus was still encased within the uterus when the carcass was embedded on the bottom of Eocene Lake Messel. Relics of the utero-placental unit became visible by applying micro x-ray. The wrinkled structure of its external wall corresponds to that of the recent uterus after the fetal fluid is released. The stage of development of the fetal bones and of the deciduous dentition indicate that it was not far from birth when mare and fetus died. On the other side, the birth process had not yet begun because the vertebral column and the skull of the fetus were still in a ventral position with respect to the mare and the skull did not yet lie on outstretched fore legs. Evidently, problems due to pregnancy or to the birth process did not cause the death of mare and fetus.

Technical Session XV (Saturday, November 8, 2014, 8:15 AM)

PHYLOGENETIC OVER-DISPERSION OF LATE CENOZOIC NORTH AMERICAN UNGULATE COMMUNITIES

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Communities may be comprised of closely related species (phylogenetically clumped), distantly related species (phylogenetically over-dispersed), or a random selection of species in the region. Contemporary ecologists commonly invoke the processes of abiotic filtering and biotic interactions (i.e., competition) to explain phylogenetic community assembly at large and small spatial scales, respectively. On long time scales (> 1000 years), shifts in speciation and extinction rates are the dominant forces driving organismal diversity. Studying trends in phylogenetic community structure through time might therefore reveal the effects of macroevolutionary processes on community assembly. We studied the phylogenetic community structure of extinct North American ungulates by first creating composite phylogenies that included 142 perissodactyl and 208 artiodactyl species. Both phylogenies were time-scaled using dates of first and last occurrences. We downloaded occurrence data from major fossil databases and all data were parsed by accepted subdivisions of the North American Land Mammal Ages (NALMAs; Barstovian through Rancholabrean). We then used the Net Relatedness Index (NRI) and Nearest Taxon Index (NTI) to study temporal trends in 1) continental-scale (i.e., entire complement of species) and 2) locality-scale (i.e., average relatedness of species co-occurring at contemporary localities) ungulate phylogenetic community composition. We used an information theoretic approach to test for correlations between continental and locality-scale NRI and NTI with environmental metrics ($\delta^{18}O$ from

benthic foraminifera and mean annual precipitation (MAP) estimated from paleosols), as well as several sampling bias metrics. In general, the relatedness of temporally co-occurring species decreased significantly with $\delta^{18}O‰$ from the mid Miocene to the Pleistocene at both continental and locality scales for artiodactyls and perissodactyls. The phylogenetic distance among taxa also showed significant change with $\delta^{18}O‰$ and MAP for the Artiodactyla. The trend toward over-dispersion among North American ungulates appears to result from the extinction of numerous taxa following the mid Miocene climatic optimum. Overall, our results show the impact of ungulate extinction on the formation of comparatively depauperate, over-dispersed modern North American ungulate communities.

Symposium 3 (Friday, November 7, 2014, 10:45 AM)

MORPHOLOGICAL CLOCKS CLOSE THE GAP BETWEEN AGES OF TELEOST FISHES ESTIMATED FROM MOLECULAR CLOCKS AND THE FOSSIL RECORD

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Many iconic vertebrate clades exhibit substantial disagreement between times of evolutionary origin estimated from the fossil record and those inferred using relaxed molecular clocks. The sudden appearance in the fossil record of clades with a rich diversity of lineages, such as angiosperms and teleost fishes, is a well-documented pattern. The earliest fossils of crown teleosts date to the Late Jurassic and include three of the four earliest diverging lineages: Elopomorpha, Otocephala, and Euteleostei. Literal readings of this paleontological pattern have led to conclusions that the modern teleost radiation dates to approximately 150 Ma and was characterized by an explosive diversification of fully differentiated lineages early in its history. However, this same pattern has also been interpreted as a sampling artifact driven by rich marine Lagerstätten of Late Jurassic age (i.e., Cerin and the lithographic limestones of southern Germany) that yield abundant articulated fishes. Fossil age-calibrated relaxed molecular clock analyses suggest Paleozoic roots for modern teleost biodiversity, consistently estimating a late Carboniferous-Permian age (ca. 320-280 Ma) for the teleost crown node. We investigated the use of new relaxed morphological clocks to determine if datasets of discretely coded phenotypic characters that include a number of fossil taxa would result in age estimates for crown teleosts that were similar to either the earliest appearance in the fossil record or the ages derived from molecular clock analyses. Our analyses were performed on a morphological dataset targeting the phylogenetic relationships of stem and crown lineage teleosts that included 194 characters scored for 51 taxa, of which only 14 are extant. The Lewis Mkv model was employed in BEAST v. 1.8 and the rock ages of fossil taxa were used for non-contemporaneous sampling or tip dating. The mean posterior age estimate from the relaxed morphological clock analyses for the crown teleost lineage is 279.8 Ma with a 95% highest posterior density (244.1, 314.2 Ma) that overlaps with recent relaxed molecular clock estimates for this lineage. This morphological timescale for teleost evolution strongly contradicts classical paleontological models that posit rapid diversification in the Late Jurassic, and implies an extensive unsampled early history of this successful vertebrate radiation.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

AN ACTUALISTIC EXPERIMENT TO EXAMINE SKELETONIZATION AND DISARTICULATION IN THE LA BREA TAR SEEPS

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The still-active tar seeps of Rancho La Brea California have produced millions of fossils to date. This well-studied site is unusual in that the skeletons recovered there are often incomplete, disarticulated, and mixed together with little stratigraphic order. We have hypotheses of how the animals became trapped, how they became incomplete, and how long they remained above the surface. Additionally, previous work has shown that skeletal elements moved apart from each other at least 1-3 meters, but it is unknown whether this movement occurred before or after the elements sank into the tar. To illuminate the process of disarticulation and transport we ask: how long did it take skeletons to become completely disarticulated? Forensic literature states time to complete skeletonization and disarticulation (i.e., 'clean bone') of human cadavers varies from 1-2 weeks to 3 years, dependent on a number of factors, including water and oxygen availability, temperature, and environmental pH. We are the first to document the process of decay in the aqueous, acidic environment of asphaltic deposits. Limbs removed from thawed bobcat (*Lynx rufus*) specimens were placed in a natural, active tar seep north of Los Angeles (in Chivo Canyon) and allowed to sink in to the tar naturally, mirroring the hypothesized sequence of events in the Pleistocene. The limbs are contained in wire baskets and placed in a gated area to facilitate retrieval and ensure elements are not lost due to movement or macro-scavengers. Water was initially present in the seep, a feature documented at Pleistocene Rancho La Brea. We sampled the bacterial fauna of the seep to determine the fauna native to the Chivo Canyon seep and removed samples from the surface of limbs to document any bacterial succession on the carrion. Temperature and humidity data were collected from online weather databases. This ongoing experiment has already shown that the process of decay in the tar seeps progresses differently from previous freshwater and marine decay studies, with notable delay in the timing of sloughing skin and hair and loss of muscle tissue. These differences are likely due to the unique environmental chemistry and autochthonous bacterial fauna.

Symposium 5 (Saturday, November 8, 2014, 3:30 PM)

WHICH TRAITS CAN PROMOTE EXTINCTION IN LARGE MAMMALS? RELATING PERSPECTIVES FROM LIVING AND EXTINCT SPECIES

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Whereas the last few hundred years are often treated as a temporal base-line for understanding patterns of present-day extinction risk, the fossil record offers much deeper insight into the natural waxing and waning of clades. We contrasted global and regional comparative analyses of present-day mammalian extinction risk with two datasets from the fossil record: the spatial and phylogenetic patterns of 241 mammalian species extinctions known to have occurred globally during the Holocene up to the present day and the spatial and taxonomic patterns of extinction rates estimated from stratigraphic occurrences of large mammals throughout the Neogene across the Northern Hemisphere with a new Bayesian approach. Across the three datasets, we investigated which mammalian traits and environmental conditions are correlated with high present-day extinction risk, with Holocene extinctions, or with high clade-wide extinction rates during the Miocene and Pliocene. We show that Holocene extinctions have been concentrated in specific regions and taxa that are often not congruent with the most currently threatened regions and taxa, but that large body mass is consistently associated with extinction during the Holocene and with high present-day extinction risk. Our approach allows us to assess whether the selectivity of present-day mammalian extinction risk with respect to species traits has been caused purely by anthropogenic processes, and whether our understanding of mammalian threat processes has been affected by excluding data on past extinctions.

Technical Session XVII (Saturday, November 8, 2014, 3:00 PM)

DIVERSITY OF SMALL-BODIED DICYNODONTS (THERAPSIDA, ANOMODONTIA) FROM THE LATE PERMIAN OF SOUTH AFRICA

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Dicynodonts were the most abundant and taxonomically diverse herbivores in terrestrial vertebrate ecosystems in the Permian and spanned a wide array of body sizes. Dicynodont body size distribution is not constant through time: median body size of Triassic dicynodonts is significantly greater than for the Permian, an effect of extinction selectivity around the Permo–Triassic boundary. A similar trend has been proposed for Permian dicynodonts, with small-bodied taxa (skull length < 15 cm) being more abundant and diverse in the lower part of the Beaufort Group (middle–late Permian *Tapinocephalus–Tropidostoma* assemblage zones [AZs]) than in the later Permian. In the later Permian *Cistecephalus–Dicynodon* AZ, recognized small dicynodont diversity is reduced to a few genera found at lower abundance than in earlier zones. Here, we reevaluate the record of later Permian small dicynodonts in South Africa, recognizing significant overlooked diversity in the form of several new or revalidated taxa. A probable new taxon of endothiodont dicynodont is represented by a single specimen collected in *Cistecephalus* Assemblage Zone deposits on the farm Brak Fontein. The specimen consists of a small skull (~5.5 cm long and 6 cm wide) and lower jaws. The lower jaw is very robust and dorsoventrally deep, a morphology that is similar to that of the basal dicynodont *Endothiodon*. Autapomorphies of the new taxon include the very short intertemporal region and the posterior position of the pineal foramen. *Digalodon rubidgei* was previously considered to represent a juvenile specimen of the common cryptodont *Aulacephalodon*. However, we demonstrate that *Digalodon* is a valid taxon characterized by a flattened beak, narrow parietal processes lateral to the preparietal, and an inflated intertemporal region. We also refer new material to the poorly-known genus *Emydorhinus*, including a complete skeleton. Inclusion of the aforementioned dicynodonts in the most recent analysis of anomodont phylogeny places the Brak Fontein dicynodont within Endothiodontia, as sister-taxon to *Endothiodon*+*Niassodon*, and both *Digalodon* and *Emydorhinus* within Emydopoidea. These dicynodonts are not rare components of their fauna: *Digalodon* is known from 10 specimens and *Emydorhinus* from over 30 specimens in the Graaff-Reinet area alone. Although these are lower abundances than the *Tropidostoma* AZ heyday of *Diictodon* (with hundreds of skulls), they demonstrate that small dicynodonts remained a significant part of Karoo ecosystems in the *Cistecephalus* and *Dicynodon* AZs.

Technical Session XIV (Saturday, November 8, 2014, 11:15 AM)

CONCAVO-CONVEX INTERVERTEBRAL JOINTS IN SAUROPODS AND CROCODYLIANS: DO THEY INCREASE FLEXIBILITY OR STABILITY?

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Sauropod dinosaurs were the largest terrestrial animals, with highly elongated necks and tails held off the ground as cantilevers. The sauropod neck is composed of anteriorly convex and posteriorly concave (i.e., opisthocoelous) centra, a condition that appeared in the Late Triassic coincident with the appearance of large body size and neck elongation. This condition was retained in all members of the clade. Concavo-convex joints between centra have been proposed to either 1) enhance the range of motion of the vertebral column by permitting rotation or 2) stabilize the column against shear stress by nesting one articular surface within another and increasing their area of contact.

If concavo-convex intervertebral joints facilitated a greater range of motion, then the most strongly convex condyles should occur in the most flexible regions of the vertebral column. If these joints stabilized the column, then the converse should be true. The American alligator was chosen as the extant analog in which to test this hypothesis because crocodylians are the closest living relatives of sauropods that have comparable concavo-convex centra. Flexibility was measured in situ in an alligator using computed tomography (CT) scans taken with the body manipulated to the maximum range of motion; these measurements were compared to the articular morphology of the same specimen after dissection. Results indicate that the most strongly convex condyles correspond to the least flexible parts of the spine, such as the anterior thoracic region. Conversely, the least convex condyles occur in the most flexible parts of the spine, such

as the distal caudal region. It is therefore unlikely that concavo-convex intervertebral joints evolved to enhance flexibility. The most strongly convex condyles also have the greatest proportion of overlap by the cotylar rim, which permits less rotation and maximizes the depth of nesting and area of contact between the articular surfaces. This relationship is consistent with the hypothesis that concavo-convex joints between vertebral centra function primarily in resisting dislocation by shear stresses. It is probable that the early evolution and invariant retention of opisthocoelous cervical vertebrae in sauropods stabilized the elongate, cantilevered neck. The negative relationship between the degree of articular overlap and range of motion of intervertebral joints also suggests that the degree of overlap can provide useful insights into flexibility along the vertebral column in extinct taxa.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

THORACIC MODULE OF TALPIDS FOR CRANIOCAUDAL CONTRACTIONS OF FORELIMB MUSCLES IN HYPER-ABDUCTED POSTURE

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The positions of the shoulder joints to the sternum in sprawled animals (e.g., crocodilians, lizards, monotremes, and lissamphibians) are fixed via shoulder girdles that are united at the midline, whereas those in most quadrupedal therian mammals that employ sagittal forelimb posture are flexible. Moles and shrew moles (Talpidae, Soricomorpha) are unique among therian mammals in that their shoulder joint positions to the sternum are fixed, because the short and robust clavicle articulates both with a keeled sternum and the proximal humerus. Talpids are also unique as mammals in that they have secondarily employed hyper-abducted sprawled forelimb postures, and some fossorial talpids use the internal rotation of the humerus for powerful lateral-thrust digging. During these motions, the shoulder joint is subjected to lateral compressive force. According to static stress analyses against external forces conducted for three-dimensional models of thoracic skeletons in fossorial (*Mogera*) and semi-fossorial (*Urotrichus*) talpids, a stout rod-shaped scapular blades and sterno-clavicular complex, where the powerful retractor muscles for the humeral rotation originate, were strengthened against the lateral compression to the shoulder joints and also against the cranio–caudal contractions of the retractor muscles, and little stress was transmitted to the ribcage. The unique forms of talpid thoraxes are therefore interpreted as adaptations to the powerful shoulder muscles and also to the hyper-abducted forelimb posture.

Technical Session III (Wednesday, November 5, 2014, 3:30 PM)

NEW *ELMISAURUS* (DINOSAURIA: OVIRAPTOROSAURIA) MATERIAL FROM MONGOLIA AND ALBERTA, CANADA, AND ITS BEARING ON NORTH AMERICAN CAENAGNATHID TAXONOMY.

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New *Elmisaurus* (Dinosauria: Oviraptorosauria) material from Mongolia and Alberta, Canada, expands on our anatomical knowledge of this taxon. Two partial skeletons, three metatarsi, and associated vertebral and manual elements are described from Mongolia. The frontal, previously unknown, suggests the presence of a high crest, akin to *Anzu wyliei*. The metatarsi show caenagnathid affinities, but differ in the fusion of the distal tarsals to the arctometatarsalian metatarsus. Furthermore, the unguals lack the proximodorsal lip characteristic of caenagnathids in Alberta. From Alberta, two new complete metatarsi are described, in addition to five fragmentary elements. Similar to the Mongolian specimens, the metatarsi and distal tarsals are fused proximally. These and other features support a distinction of *Elmisaurus* material from *Chirostenotes*, another caenagnathid taxon, at the generic level. Comparisons of *Elmisaurus elegans* from Alberta and *Elmisaurus rarus* from Mongolia demonstrate that these taxa are congeneric, based on metatarsal structure. This suggests that *Leptorhynchos elegans*, a taxon recently erected to distinguish *Elmisaurus elegans* material from other Albertan caenagnathids, is invalid. The variation in length between the newly described metatarsi suggests that *Elmisaurus* cannot be distinguished solely based on size, and may have been similar in body weight to *Chirostenotes* and *'Caenagnathus'*. This size variation may indicate that many Albertan specimens, previously interpreted as different taxa, are in fact a congeneric growth series. A new subfamily of caenagnathids is proposed: the Elmisaurinae, to include *Elmisaurus elegans* from Alberta, and *Elmisaurus rarus* from Mongolia. Oviraptorosauria, then, appears to be divisible into three major clades based on metatarsal structure. Basal oviraptorosaurians have elongate arctometatarsalian feet, with an unfused astragalus and calcaneum. Caenagnathids also have elongate arctometatarsalian feet, but with a fused astragalocalcaneum, and, in at least the elmisaurines, have the distal tarsals fused to the proximal metatarsus. Oviraptorids, conversely, have short, non-arctometatarsalian feet, and retain a separate astragalus and calcaneum. The functional and paleoecological effect of these differences is not yet understood.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

FAMILY SECRETS: A TOTAL EVIDENCE ANALYSIS OF FAMILY-LEVEL RELATIONSHIPS IN PINNIPEDIA AND THE ENIGMATIC PINNIPED *ALLODESMUS*

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Allodesmus is a genus of extinct pinnipeds in the family Desmatophocidae, which inhabited the northern Pacific coasts during the middle to late Miocene. Although originally described as a member of Otariidae (fur seals and sea lions), recent morphological studies hypothesize that *Allodesmus* is likely to be more closely related to Phocidae (seals). The primary objective of this study is to determine the phylogenetic position of *Allodesmus* in relation to the extant families in Pinnipedia. This is the first total evidence analysis to be conducted that includes all extant pinniped families. Sixty-two cranial and postcranial morphological characters, including two novel to this study, were collected from seven extant and four extinct representative members of Pinnipedia. Sampled taxa included four phocids, two from each subfamily, two otariids, three odobenids, two desmatophocids (including *Allodesmus*) and *Enaliarctos* as an outgroup. Two mitochondrial genes, cytochrome b and ND2, and three nuclear genes, RAG1, SRY and IRBP, were mined from GenBank and combined with morphological characters to create a total evidence dataset. Maximum parsimony and Bayesian methods were used to infer phylogenetic trees. In both analyses, *Allodesmus* was highly supported (bootstrap value >9 0, posterior probability > 0.90) as grouping more closely with phocids than otariids, congruent with previous morphological studies. However, data partitioning generated conflicting results and will be explored further with additional taxa and characters. The results of this study will be applicable to a future discussion of the debated swimming mode of *Allodesmus*, for which both otariid-like forelimb and phocid-like hind limb propulsion have been suggested. Therefore, the phylogenetic placement of *Allodesmus* has significant implications for the evolutionary history of pinniped locomotion.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

PHYLOGENETIC STATUS OF A NEW TOMISTOMINE FROM JAPAN AND CROCODYLIAN RESPONSE TO PLEISTOCENE CLIMATE CHANGE

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A new tomistomine from a Pleistocene marine bed (0.6 Ma) of the Osaka Group in Kishiwada City, Osaka Prefecture in Japan, was reported and a comparison with another previously studied tomistomine from a younger horizon (0.4 Ma) of the same group, *Toyotamaphimeia machikanensis,* suggested that these tomistomines represent two distinct taxa.

We conducted a phylogenetic analysis with a data matrix of 79 ingroup taxa and 179 morphological characters. The strict consensus tree shows that the Kishiwada tomistomine is more derived than basal taxa (*Kentisuchus*, *Megadontosuchus*, and *Dollosuchoides*) and forms a monophyletic clade with the remaining tomistomines, sharing three unambiguous synapomorphies. Interrelationships within this clade show an unresolved polytomy including the clade of *Toyotamaphimeia* and *Gavialosuchus eggenburgensis*. Despite poor resolution within this clade, our analysis confirms that the Kishiwada tomistomine is a different taxon from *Toyotamaphimeia*. The Pleistocene of Osaka was subject to repeated glacial cycles, represented by alternation of marine and terrestrial beds in the Osaka Group. The stratigraphic positions of the Kishiwada tomistomine and *Toyotamaphimeia* show there were at least two glacial periods separating them. Because crocodylians are restricted to warm temperatures (mostly tropical to subtropical climate), this indicates an extinction of crocodylians in Japan or migration south out of Japan during glacial periods, and two different tomistomines independently may have dispersed into Japan during interglacial periods in the Pleistocene.

Technical Session V (Wednesday, November 5, 2014, 1:45 PM)

AMPHIBIANS OF THE JURASSIC DAOHUGOU BIOTA, INNER MONGOLIA AND WESTERN LIAONING, CHINA

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Amphibian fossils known from the Daohugou beds (sensu stricto), Inner Mongolia, China, are strictly cryptobranchoid salamanders. No anuran fossils are known from the Daohugou beds or any of the other localities and fossil beds of Jurassic age in China so far. A previous report of a purported tadpole fossil from the Daohugou beds has been refuted, as the fossil specimen has been re-interpreted as an incomplete insect. Salamander fossils from the Daohugou locality document the earliest known phase of urodele evolution, with superbly preserved material from the Middle Jurassic strata. The term Daohugou beds (sensu lato) has also been used by some authors to include the Middle-Late Jurassic fossil beds exposed in several other localities (Reshuitang, Guancaishan, Daxishan) in western Liaoning province. Two salamander taxa (*Chunerpeton* and *Jeholotriton*) are known from the Daohugou locality (Inner Mongolia), where the salamander fossil-bearing beds are of the Middle Jurassic (Bathonian) Haifanggou (Jiulongshan) Formation. Two other salamander taxa (*Pangerpeton* and *Liaoxitriton daohugouensis*) are known from the Reshuitang locality (western Liaoning), where the fossil beds are of the Middle Jurassic (Callovian) part of the Tiaojishan (Lanqi) Formation. *Beiyanerpeton* and some undescribed salamanders have been found from the Guancaishan locality (western Liaoning), where the fossil beds pertain to the Late Jurassic (Oxfordian-Kimmeridgian) part of the Tiaojishan Formation. In addition, there are some undescribed salamander fossils known from the Daxishan locality (western Liaoning), where the fossil beds are of the Late Jurassic (Oxfordian) part of the Tiaojishan Formation. Phylogenetically, most of the nominal taxa are affiliated with the Cryptobranchoidea, but *Beiyanerpeton* and some undescribed material pertain to the Salamandroidea. All these Jurassic salamanders are known by exceptionally preserved specimens, including not only fully articulated skeletons but also unusual preservation of soft tissue structures (eye, liver, external gills, poison glands) in both juvenile and adult forms. Hence, this important fossil record provides otherwise unavailable information on the life history, phylogenetic diversity, and ecological adaptations of early crown-group salamanders. Funded by National Natural Science Foundation of China (grant 41072007/41272016).

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

STRUCTURAL CHANGES IN LATE PLEISTOCENE CARNIVORE FAUNA FROM RANCHO LA BREA

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The effect of climate change on extant mammal faunas is a frequent topic in ecological research and the analysis of past mammalian communities and their correlated evolution with global climatic change can provide data relevant to this question. Late Pleistocene and Holocene carnivore mammal faunas from the Rancho La Brea Tar Pits (Los Angeles, CA) are highly diverse and well-preserved, and were used to analyze how past climatic shifts shaped the structure of mammalian communities from southwestern North America over the past 30,000 years. Using bibliographical data, we clustered all extant terrestrial carnivores in 11 Carnivore Functional Groups with similar ecological features (diet, locomotion, and body size), and subsequently defined the functional spectra of 26 modern localities from the Nearctic. By means of discriminant analysis, we explored how the ecological structure (functional spectrum) of these communities varies with environmental conditions (type of biome). Morphofunctional analyses of La Brea species allowed us to determine their ecological features and thereby define the functional spectra of communities at different stages (pits). The selected pits varied in age: Pit 91 (around 29 ka), Pit 3 (around 18.5 ka) and Pit 61/67 (around 11.5 ka). This allowed us to analyze how community structure changed in association with climatic shifts that occurred in North America during the Late Pleistocene and Holocene, and finally compare them with the fauna found in Los Angeles today. We successfully detected the climatic shifts associated with the Last Glacial Maximum together with the Holocene warming. While a sclerophyllous woodland-shrubland is detected for Pit 91 and in modern Los Angeles, a more humid, temperate forest (taiga type) is inferred for Pits 3 and 61/67. We also identified the ecological groups mainly affected by these climatic alterations. The main difference in our communities among different climatic stages is the absence of scansorial predators and several large omnivores in the arid periods (Pit 91 and modern Los Angeles). Finally, since all extinct giant, cursorial hypercarnivores were members of the same functional group, we were also able to detect a structural pattern in the Holocene megafaunal extinction.

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Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

EUROPE-AFRICA SMALL MAMMAL EXCHANGE DURING THE MIO-PLIOCENE TRANSITION: STATE OF THE ART

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Typical African mammals have been recorded around the Miocene-Pliocene boundary in some basins of southwestern Europe in relation with its geographic location close to the African continent. However, this faunal exchange was not only in one way, and some Iberian species have been found in North Africa. These exchanges, relatively frequent before and during the Messinian Salinity Crisis due to the emersion of land bridges, have been recognized for large and small mammals, but here we are focusing on the latter ones. The African origin of some small mammals found in the Iberian Peninsula (*Myocricetodon, Debruijnimys, Paraethomys*) is generally accepted; on the contrary, other taxa previously proposed as African immigrants (*Calomyscus, Pseudomeriones,* Lophiomyinae) are currently interpreted as Asian forms. Regarding the Mio-Pliocene European small mammal immigrants into Africa, the lagomorph *Prolagus*, the murids *Stephanomys, Castillomys, Occitanomys* and a medium-sized *Apodemus,* the glirid *Eliomys truci*, and the cricetids *Apocricetus* and *Ruscinomys* have been recognized.

Two new southern Iberian localities with evidence of African fauna have been recently discovered: Gafares, in the Níjar Basin, yielding remains of *Stephanomys dubari*, *Paraethomys meini*, *Apodemus* aff. *atavus, Occitanomys alcalai,* and *Debruijnimys almenarensis* and Fuensanta 1 in the Granada Basin, with remains of *S. dubari*, *P. meini*, *O. alcalai*, and Cricetodontinae (cf. *Ruscinomys* or cf. *Byzantinia*).

The case of the species *Ruscinomys africanus*, recorded in North Africa, deserves special attention. This species shows little-reduced third molars, as well as a labial spur in the anterocone of some M1. This latter character is also observed in the *Ruscinomys* specimens from some latest Messinian populations from the Granada Basin (Dehesa-4B and Fuensanta-1), suggesting a close relationship with *R. africanus* from Northern Africa , and therefore, a possible African origin. Moreover, these features are typical of the eastern Mediterranean genus *Byzantinia*, and not of the European *Ruscinomys*. Further analyses are required to determine if the specimens of *R. africanus* and the similar forms recognized in southern Spain are related with *Byzantinia*.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

MORPHOLOGY AND MOBILITY OF THE ALLIGATOR SHOULDER GIRDLE

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The ancestral archosaur shoulder girdle consisted of an interclavicle, cartilaginous sternum, scapulocoracoids, and clavicles. The evolutionary loss of the clavicle has been highlighted as a key feature uniting Crocodylomorpha, but the functional implications of this loss have not been thoroughly explored. Recent investigations of alligators performing high walks found a substantial amount of shoulder girdle movement. Using XROMM (X-ray Reconstruction of Moving Morphology), our current study found coracosternal movement as well as rotations of the sternum relative to the vertebral column. Here, we provide a qualitative description of the morphology underlying alligator shoulder girdle mobility. The interclavicle projects cranially from the ventral midline of the cartilaginous sternal plate. Two elongate xiphisternal processes project caudally from a ball-and-socket-like joint with the sternum. Only the two most anterior ribs articulate with the sternal plate, which permit/constrain movement of the entire shoulder girdle relative to the vertebral column and abdomen. The coracoids articulate with paired anterolaterally facing grooves on the sternal plate. The coracosternal joint is bound together with a relatively loose articular capsule that permits considerable antero-posterior sliding of the scapulocoracoid relative to the sternum. A mobile shoulder girdle can have a relatively large effect on stride length, because proximal rotation causes a greater degree of hand movement than does that of more distal joints. Clavicular loss and associated mobility of the coracosternal joint may be important features in the unique locomotor behaviors of crocodylians. As a previously unexplored aspect of forelimb kinematics, mobility of the sternum relative to the vertebral column warrants further investigation in a broader range of taxa. Funding: Rhode Island EPSCor.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

AN APPROACH TO THE DIVERSITY OF IBERIAN IGUANODONT DINOSAURS BASED ON THE EARLY BARREMIAN (EARLY CRETACEOUS) FOSSIL RECORD FROM TERUEL PROVINCE, SPAIN

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Iguanodont fossils are frequent within Spanish Early Cretaceous fossil localities, yet it is difficult to establish the true diversity of iguanodont dinosaurs. The only Iberian iguanodont taxon erected for the Barremian is the styracosternan *Delapparentia turolensis*. This is a large-sized, basal iguanodont described on the basis of a partial postcranial skeleton discovered in the 1950s near the village of Galve, Teruel province, Spain, within the Camarillas Formation. The ilium morphology differs from that of other basal iguanodonts and relates *Delapparentia* to the Valanginian *Barilium dawsoni* from England. As regards the early Barremian, other fossil material may potentially represent new taxa, as the specimens in question present synapomorphic characters that distinguish them from the other known taxa. However, a lack of overlapping material introduces uncertainty in considering whether this material represents new taxa. Within Teruel province, recent findings have ascertained the presence of remains related to *Delapparentia* in two bonebeds from the Blesa and Mirambel Formations, thus increasing the known distribution and anatomical information for this taxon. In addition, another bonebed from the Mirambel Formation has yielded a second iguanodont taxon, different from *Delapparentia* with respect to its prepubic morphology. Independently, dental morphotypes from Teruel evidence the presence of three different iguanodonts in the early Barremian of Iberia: one styracosternan which would correspond to *Delapparentia turolensis*; one styracosternan bearing dentary teeth morphologically close to those of *Iguanacolossus* and *Lanzhousaurus,* and another that is a hadrosauroid judging by the presence of a unique median ridge on the lingual side of its dentary crowns. These data suggest that during the early Barremian, the Spanish iguanodont faunas were different from, but at least as diversified as, other Early Cretaceous European iguanodont faunas.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

NON-AVIAN THEROPOD SOCIO-ECOLOGY: CAN GALLIFORM BIRDS PROVIDE INSIGHTS?

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Determining the paleobiology of long extinct organisms is difficult, especially those traits related to social ecology and habitat preference. Recent work has shown that the presence of osteological cranial ornamentation of non-avian theropod dinosaurs is positively correlated with body mass, yet no modern comparative baseline is available to provide context for these results. Our study pooled habitat, body mass, and cranial ornamentation data from 245 extant species of galliform birds in an effort to test for correlations in body mass, habitat and cranial ornamentation, with the ultimate goal of relating results to previous work on non-avian theropods. A phylogenetic t-test of natural log body mass versus osteological cranial ornaments integrated over 100 trees in BayesTraits revealed a correlation between large body mass and the presence of bony cranial ornamentation. Reversible jump MCMC analysis reveals that ornaments of either soft or hard tissue do not tend to evolve in galliforms living in open habitats. Also, an evolutionary rates test suggests that the presence of cranial ornaments in a lineage does not significantly increase speciation rates. Previous association between body mass and cranial ornaments from non-avian theropods corresponds with results from Galliformes. Extending galliform results to non-avian theropods suggests those lineages possessing ornamentation may not have speciated at faster rates than those without and, potentially, that ornaments tended to occur in large theropod species living in more closed environments. These paleobiological inferences are based on modern birds with body sizes tremendously disparate from those of many non-avian theropods with osseous cranial ornamentation. Is the evolutionary and ecological pressures that shaped modern galliform bird diversity applicable to extremely large theropod ancestors? The similarity in evolutionary correlations between body mass and osseous cranial ornaments among the two study groups underscores some homogeneity in evolutionary processes, but the possibility that closed habitat played a role in the evolution of cranial ornamentation for large theropods should be considered with care given necessary relative habitat density for a 5 m tall theropod compared to small galliforms.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

A HYPOTHESIZED VERTEBRATE FOOD WEB FOR THE EARLY JURASSIC (SINEMURIAN/PLIENSBACHIAN) KAYENTA FORMATION IN NORTHERN ARIZONA

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The Early Jurassic Kayenta Formation in northern Arizona has been well prospected since the 1940s. Despite the fragmentary nature of most discoveries and the difficulty associated with performing the required fieldwork, the Kayenta Formation has yielded a relatively complete vertebrate fauna. This is especially true within the area between Moenave, Arizona and the western edge of the Hopi Reservation. While the fossil record will always be incomplete, the wide taxonomic and trophic ranges of organisms recovered allow us to attempt a reconstruction of the food web that existed when this segment of the Kayenta Formation was being deposited.

The relevant literature was surveyed; named and valid taxa were included in this analysis. In addition this analysis included several taxa that have been mentioned without formal description if additional information was available. These taxa included the Kayenta-form protosuchid, the *Edentosuchus*-like protosuchid, and the "Shake-N-Bake" theropod. Mentions in the literature of a "heterodontosaurid" yielded no additional published information and it was not included in the analysis. The taxa were analyzed on the following criteria: size, jaw and tooth shape, number of specimens identified, preservational environment, stratigraphic relationships, comparisons with extant communities, and energetics.

Ecological analyses were primarily done using the network connectivity program Network3D. Support was found for several size classes of primary consumers and two mostly separate terrestrial and aquatic food webs. Simulations within Network3D found a rapid collapse among quaternary consumers, and a gradual decline among tertiary consumers. In contrast secondary and primary consumers were mostly stable under the simulated regimes. This indicates that the lower trophic levels are incompletely represented in the fossil record and therefore unable to support the preserved diversity of higher level consumers. This hypothesis is supported by the paucity of preserved and identified plants, the foundation of most food webs, from the Kayenta Formation.

This study provides the theoretical basis for future analyses of the Early Jurassic Kayenta Formation. While many ecological roles appear to be filled, the simulation results indicate that several unidentified taxa may still remain in collections and/or in the ground. This analysis allows testable predictions to be made regarding feeding traces and identifying unoccupied niches in order to better refine our search image in regards to unidentified taxa.

Education and Outreach Poster Session (Poster displayed November 5 – 8)

A PUBLIC HIGH SCHOOL PALEONTOLOGY PROGRAM; CREATING EMBEDDED LEARNING OPPORTUNITIES FOR STUDENTS BY FLIPPING OUTREACH ON ITS HEAD

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Traditionally, most institution-driven vertebrate paleontology programs have fallen into two categories: museums and universities. These traditional institutions have formed the bulk of vertebrate paleontology programs and paleontological jobs for at least the past half century. These traditional programs have often sought to do outreach into K–12 classrooms, which have met with mixed success. While some programs are well designed and implemented, oftentimes non-K–12 educators have little idea what makes a program truly relevant to primary and secondary students or what teachers can apply in their classroom given the constraints that they work under.

At Mission Heights Preparatory High School, a public charter high school in rural southern Arizona, a new approach for making paleontology relevant to science students has begun in the 2013–2014 school year. Instead of attempting to bring outreach into the classroom to increase science literacy and inquiry, the school has begun its own institutionally-supported paleontology program. A literature survey suggests this is the first public school paleontology program in the United States.

The program is designed to engage students in real-world science, specifically paleontology, by involving students in every aspect of collecting, housing, and studying fossils. Students in the paleontology class are required to take part in the preparation, conservation, and curation of specimens at MHP. In addition to the MHP collections, students at MHP have the opportunity to engage in fieldwork. Under BLM surface collection permit UT14-001S, students are prospecting for significant vertebrate fossil remains at Comb Ridge, Utah. Already, hybodont shark teeth and a possible metoposaur have been recovered from multiple localities within the Chinle Formation at Comb Ridge, with additional fieldwork forthcoming. Specimens collected under this permit will be housed at the Museum of Northern Arizona.

This program flips the traditional model of science outreach on its head by making the secondary educator a research scientist. This allows the students to be engaged in science in a way that most traditional outreach programs do not. Increased engagement is borne out through surveys of students as well as grades in this class compared to similarly rigorous science classes within MHP. It is hoped that this program can serve as a model for other schools looking to create authentic science experiences for their students.

Technical Session IX (Thursday, November 6, 2014, 1:45 PM)

RESOLVING THE RELATIONSHIPS OF THE SQUAMATE TREE OF LIFE: AN ASSESSMENT OF NEW APPROACHES AND PROBLEMS

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Since the division of The Deep Scaly Project into separate morphological and molecular teams, a truly integrated project of wide scope has not been attempted. Much more can be done to understand how the members of Squamata are related to one another through an approach that combines the importance of both morphological and molecular evolution. Here we have developed a novel three-step methodological approach to squamate phylogenetics that incorporates the newest phylogeny-creating techniques and data from previous morphological and genetic analyses. First, we analyze a large squamate morphological dataset using Lewis's Mkv model under both a Bayesian and maximum likelihood framework. Second, we incorporate a previously constructed squamate DNA dataset and analyze the combined data within a 'total evidence' framework. Finally, we adopt a methodology that treats genes, rather than nucleotides, as the character of interest.

We find that the separate analyses of the morphological and molecular datasets, even under Bayesian and maximum likelihood frameworks, still result in drastically different relationships between higher-order clades within Squamata. Additionally, we find that the combination of these two datasets results in a phylogeny with limited support for either topology, although it definitively leans in the direction of the molecular results. Finally, by reducing the molecular dataset to gene characters, we find significantly lower support for the higher-order relationships that are strongly supported in previous analyses. By combining these data with our morphological dataset, we discover that we have inversed the effect of the power in numbers problem.

We conclude that combining datasets, although possibly detrimental to results, should be treated as a source of understanding how the datasets may differ and how they may reflect different evolutionary histories.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

SKELETAL AND DENTAL GROWTH UNDER DOMESTICATION: THE CASE OF DOGS AND ITS RELATION TO CARNIVORAN EVOLUTION AND PALEONTOLOGICAL STUDIES

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Domestic dogs—descendants of the grey wolf (*Canis lupus*)—are the oldest domesticated animals, and their tremendous morphological variability makes them a unique system to investigate intraspecific variation, directed selection, and rapid evolution. Numerous morphological peculiarities of domesticated species can also be found in mammals which have evolved on islands, including dwarfism, with shortened limbs and muzzles. Insights into morphological diversification arising through domestication can thus help us to understand the evolution of extinct island mammals. Here, we examine postnatal ontogeny in aspects of growth and life history that can be traced in fossils. Not much is known about variation and heterochronic shifts related to these markers of growth in different dog breeds and the wolf. We investigated cranial suture closure, epiphyseal growth plate closure, and dental eruption in ontogenetic series of wolves and different dog breeds representing various limb and skull morphologies. Data for 428 domestic dog and wolf individuals were collected based on X-rays and examination of macerated bones in different museum collections and veterinary facilities.

These findings were integrated and analyzed in the context of life history data. We found that body size as well as relative limb size in domestic dogs are correlated with the timing of the closure of the growth plates in the postcranial skeleton. Differing skull morphologies in different dog breeds are related to the timing of suture closure in the skull but not to the timing of tooth eruption. Life history variables were found to be mostly not different. These results indicate that the fundamental markers of growth investigated here, as well as life history variables, do not necessarily co-vary with variable adult morphologies. We expect that island forms, which exhibit adult anatomy that is significantly different from their mainland relatives, might not show any deviations regarding the postnatal growth and life history variables studied here. However, the great diversity in island forms and their ecological context prevents major generalizations.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed November 5 – 8, judging occurs Thursday, November 6)

REDISCOVERY OF *LAOPHIS CROTALOIDES* - THE WORLD'S LARGEST VIPER?

GEORGALIS, Georgios, Aristotle University of Thessaloniki, Thessaloniki, Greece; KEAR, Benjamin, Uppsala University, Uppsala, Sweden; CAMPIONE, Nicolas, Uppsala Univ, Uppsala, Sweden; DELFINO, Massimo, Univ of Torino, Torino, Italy

The Neogene vertebrate fossil record of Greece is famous for its rich mammal assemblages, which were documented as early as the 19th century. In contrast, the equally diverse but comparatively understudied coeval reptile faunas have only recently gained research attention, both as an important source of information on palaeobiogeographical radiations, and as a potential centre for the early cladogenesis of Europe's modern herpetofauna. Snake remains have been particularly enigmatic because, despite their ubiquity, they are almost always poorly preserved. Nonetheless, these isolated specimens, consisting almost entirely of vertebrae, reveal a range of taxa including typhlopids, boids, pythonids, colubrids sensu lato, elapids and viperids. To date, only two species have been formally named: the endemic pythonid *Python euboicus* and the gigantic viperid *Laophis crotaloides*. Both of these taxa were described in the 19th century and their holotypes are now lost, yet *L. crotaloides* arguably remains one of the most mysterious snake fossils from Europe. Derived from the early Pliocene (MN 15) of Megalo Emvolon in Northern Greece, *L. crotaloides* was thought to be a gigantic viper in its initial description. The holotype comprised 13 vertebrae, which although figured only as a schematic diagram, have proven sufficient to identify more recently recovered material, including a large precloacal vertebra (centrum length 16.3 mm) from the type locality. Size estimates based on the new specimen suggest a body length possibly exceeding 3 m, and a mass range of up to 26 kg that would place it amongst the largest venomous snakes ever to have lived. The presence of a gigantic viperid within the late Neogene ecosystems of mainland Greece concurs with the distribution of other large-bodied Mio-Pliocene snakes, including the elapid *Naja* sp. and an indeterminate species of *Vipera*. Conversely, their palaeoenvironmental coincidence with cool, dry climates is puzzling and prompts speculation about the ecological and/or physiological factors that must have favoured large ectothermic predators in such an atypical setting.

Education and Outreach Poster Session (Poster displayed November 5 – 8)

A MULTI-FACETED APPROACH TO ENGAGE UNDERGRADUATE STUDENTS IN SCIENTIFIC INQUIRY USING KEY FOSSIL VERTEBRATE TAXA

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Most undergraduate institutions require students to take a broad range of general education classes, which usually include at least one natural science course. Typically those courses are expected to introduce students to scientific inquiry, foster their curiosity for the natural world, and enhance their enthusiasm for science. In order to effectively meet these goals in introductory science classes it is necessary to develop projects focused on giving the students opportunities to think like a scientist.

I developed an inquiry-based project to introduce students to paleontological research within a historical geology class. This course can fulfill part of the natural science education requirements for all students, and is required for geology majors at George Mason University. The specific goals of this project were to have students utilize the primary paleontological literature, examine specimens, and query paleontological databases. For the first assignment, students were tasked with searching for peer-reviewed journal articles on several well-known vertebrate taxa, *Bothriolepis*, *Eryops*, *Dimetrodon*, *Thrinaxodon*, *Seymouria*, and *Mesosaurus*. The students were then able to examine casts of these specimens to look for homologous structures in their skulls. The final part of the project was to search the Paleobiology Database for the taxa to examine their geographic distribution and relate the fossil localities to larger global tectonic events.

The students experienced a number of challenges (e.g., interpreting the homology of *Bothriolepis*; how to deal with missing data) and could relate their experiences to what a paleontologist would experience if starting research on one of these taxa. The students were successfully able to retrieve scientific articles, they learned basic cranial anatomy, and gained valuable insight into the strengths and limitations of paleontological databases. This project was able to keep the students, almost entirely non-science majors, engaged in learning about these taxa for several classes, and overall, it successfully met the stated goals. This kind of lesson can serve as a model for enhancing student engagement and their familiarity with scientific research. It is important to scaffold these experiences so the students gain confidence and proficiencies that they can use in upper division course work, and it can provide practical experiences in thinking like a scientist that they would otherwise miss as a non-science major.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

CHARACTERS VERSUS MORPHOMETRICS: A CASE STUDY WITH ISOLATED THEROPOD TEETH FROM THE LATE JURASSIC OF LOWER SAXONY, GERMANY, REVEALS AN ASTONISHING DIVERSITY OF THEROPOD TAXA

GERKE, Oliver, Niedersächsisches Landesmuseum Hannover, Hannover, Germany; WINGS, Oliver, Niedersächsisches Landesmuseum Hannover, Hannover, Germany

Theropod dinosaur remains from the Kimmeridgian and Tithonian of northern Germany are very rare and comprise mainly teeth and footprints. Our study is based on 21 isolated theropod teeth, previously undescribed and part of the historical Struckmann collection (19th century) at the Lower Saxon State Museum Hannover (NLMH), as well as 11 teeth from the Kimmeridgian of the Langenberg Quarry near Goslar (Harz Mountains). 20 teeth of the historical collection were found in the Kimmeridgian of Hannover ("Lindener Berg") and one specimen is from the basal Tithonian of Thueste in Lower Saxony.

All teeth were identified via a character-based study and the results were compared with a morphometric analysis, i.e. various measurements taken from the teeth and included in a discriminant function analysis (DFA). Our results indicate that the Late Jurassic islands of northern Germany provided habitats for a diverse variety of theropod taxa.

The teeth from the Langenberg locality and the NLMH collection cannot be assigned to only one specific theropod group. Due to their dental characters, they are classified as Tyrannosauroidea, Megalosauridae, Dromaeosauridae, Metriacanthosauridae, Allosauridae and *Torvosaurus* sp. Four Langenberg Quarry teeth, previously assigned to velociraptorine dinosaurs, are removed from Dromaeosauridae and regarded as belonging to Tyrannosauroidea, Neotheropoda and Megalosauridae based on their dental characters. A very large tooth tip from the Tithonian of Thueste can be assigned to *Torvosaurus* sp. based on shape, orientation of the denticles, a denticle-density of 6/5 mm, and comparison with teeth recently described from the Kimmeridgian/Tithonian of Portugal. Our study shows that sometimes even incomplete material can be positively identified based on dental characters, which would not be possible with a DFA.

The DFA results illustrate the difficulties to assign certain teeth to known taxa, especially if more complete material for direct comparison is not available, like in the Late Jurassic of northern Germany. Interpreting DFA results is also hampered by the poor reclassification rate of several taxa from published morphometric datasets.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

CHANGES IN LIMB BONE SIZE OF FLORIDA *ODOCOILEUS VIRGINIANUS* (MAMMALIA, CERVIDAE) FROM THE EARLY PLEISTOCENE TO HOLOCENE

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Abundant fossils of *Odocoileus virginianus* from Florida provide an opportunity to study bone size variation between succeeding populations of a mammal species over the past 2 million years. We test the hypothesis that adult limb bone size in *O. virginianus* changed in response to environmental shifts during the Pleistocene (PLE) and Holocene (HOL). Mid-diaphyseal circumference (MDC) of 21 [illegible] (humeri, radii, metacarpals, femora, tibiae, metatarsals) were [illegible] HOL sites of Florida, [illegible] middle PLE [illegible] [LSP], [illegible] HOL [illegible]). [illegible] to determine if [illegible] significant differences in bone size existed environmentally, chronologically, and geographically between sites. [illegible] decrease in MDC in femora (ING: n = [illegible] m = 6.6[illegible] m; [illegible]: n = 1, m = 6.45 cm; COL: n = 1, m = 6.15 cm; NH: n = 4, [illegible] cm) and radii (ING: n = 14, m = 5.82 cm; NH: n = 5, m = 4.82 cm) was observed. Significant differences in MDC exist between glacial/interglacial populations in humeri (ING: n = 18, m = 6.36 cm; NH: n = 4, m = 5.33 cm; $p < 0.01$), femora (ING vs. NH: $p = .04$), and radii (ING vs. NH: $p < 0.01$). No significant difference exist between humeri from geographically adjacent glacial/interglacial sites (ING vs. LSP: n = 3; $p = 0.47$). Geographical variation in MDC was significant between central (ING, COL, LSP) and southern (NH) populations for humeri (central: n = 23; southern: n = 4; $p = 0.04$), femora (central: n = 15; southern: n = 4; $p = 0.01$) and radii (central: n = 14; southern: n = 5; $p < 0.01$). Although some element sample sizes from LSP and COL were too low for statistical testing, the observed chronologic decrease in bone circumference supports directional selection for smaller adult size throughout the PLE–HOL. Significant differences in bone size between geographically distinct glacial/interglacial populations suggest that this shift could be climatically driven, relating to the availability and nutritional content of food resources within different environments across the PLE–HOL. Although, it remains unclear whether observed changes in bone size were influenced primarily by geography, environment, chronology, or a combination of all three, continued study of PLE–HOL paleoenvironments and paleocommunities in Florida can help to better determine the influence on the bone size variation we report.

Technical Session VIII (Thursday, November 6, 2014, 2:45 PM)

DISCOVERY OF THE SKULL OF *OCEPEIA* (MIDDLE PALEOCENE OF MOROCCO): FIRST CLUE ON THE BASAL RADIATION OF AFROTHERIA AND PAENUNGULATA (PLACENTALIA)

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The Ouled Abdoun phosphate basin (Morocco) has yielded the richest Late Cretaceous-early Paleogene marine vertebrate faunas, in a fossiliferous series extending over 22 myrs during a key period of evolution. It also yielded rare continental vertebrates, among which are the earliest African placental mammals in Paleocene and Ypresian beds. New discoveries were made in beds dated to the Selandian (60 Ma) by chemostratigraphy. They include the condylarth-like mammals *Abdounodus* and *Ocepeia*, the earliest proboscidean *Eritherium*, and the earliest hyaenodontid *Lahimia*. Here, we report discovery a new material of *Ocepeia*, including the skull of *O. daouiensis* that is the best known Paleocene mammal from Africa. Its phylogenetic significance is investigated based on detailed anatomical study, including CT scan examination.

The skull of *Ocepeia* is reconstructed with help of digital 3D modeling of tomographic data. It is characterized by a remarkable mosaic of primitive eutherian-like, insectivore-like, ungulate-like, and autapomorphic features. The cladistic analysis supports relationships with insectivore-like afrotherians (afroinsectiphilians) such as *Potamogale*, instead with ungulate-like afrotherians (paenungulates). Most ungulate-like features of *Ocepeia* are autapomorphies in the cladograms. The trees recover a sister-group relationship of Perissodactyla and Paenungulata, mostly based on the shared bilophodonty, which challenges monophyly of Afrotheria and afrotherian relationships of *Ocepeia*. Structural details, however, refute the homology of the lophodonty of Laurasian and African ungulates. The cladistic analysis is unable to identify this convergence because of fossil gaps in early evolution of lophodonty in both groups.

The original combination of primitive, afroinsectiphilian and paenungulate traits supports the basal afrotherian position of *Ocepeia.* Afroinsectiphilian synapomorphies are weak, and an alternative stem paenungulate relationship is favored by several important dental and skull characters (buno-selenodonty, lower molar with hypolophid and inflated lingual cusps, a coronoid fossa, amastoidy, and the zygomatic process of maxilla). *Ocepeia* displays several striking autapomorphies, some unexpectedly convergent with primates, that indicate a long endemic evolution of the Ocepeiidae, and the old origin of basal afrotherians and placentals in Africa, since at least the end of Cretaceous.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

WHAT IS *GOBIUS BREVIS*?

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Gobioid fishes are a highly diverse group, with a fossil record that goes back to the Eocene. The extinct species *Gobius brevis* from the Miocene of the Molasse Basin and the Upper Rhine Graben in Southern Germany is one of the rare fossil gobies that was originally described on the basis of a skeleton and that, in addition, is occasionally preserved with otoliths in situ. Nevertheless, its systematic position within the Gobioidei remains problematic, prompting us to revisit this question. Our new data are based on a re-investigation of five specimens of *G. brevis* from its type locality Oehningen (southern Germany) and 36 specimens from other locations in southern Germany. We show that *G. brevis* indeed possesses features deemed to be typical for Gobiidae, such as a T-shaped palatine. However, it also displays six branchiostegal rays, a feature that clearly conflicts with its assignment to the Gobiidae, of which one important apomorphy is the occurrence of five branchiostegal rays. This unique combination of characters, as well as aspects of otolith morphology, suggest the presence of a new genus, which may represent an extinct lineage related to the Eleotridae. Environmental data indicate that the new taxon lived in a freshwater habitat, and may have had some tolerance to unfavorable conditions in a seasonal climate. Eleotridae are not represented today in the area of the Molasse Basin or elsewhere in Europe or in the Mediterranean Sea. Moreover, a new species, based on skeletons and otoliths, has been recognized among *G. multipinnatus* material from its type locality Illerkirchberg (southern Germany). It had previously been assigned to *G. multipinnatus*, but a re-examination of five specimens shows that it is not as slender as the latter, and has a smaller second dorsal fin. The new species is similar to '*Gobius*' *brevis* but has a thinner haemal spine on the penultimate vertebra 2. Its otoliths also differ from those of '*Gobius*' *brevis* in being more trapezoidal (vs. quadrate) and having a pointed (vs. rounded) sulcus tip. The otoliths of the new species are widespread in brackish sediments, suggesting that it lived in brackish waters. The results of our study show that the current taxonomy of fossil gobioids, where almost every species is assigned to the genus *Gobius* sensu lato, does not do justice to the past diversity of this interesting group of fishes.

Technical Session VII (Thursday, November 6, 2014, 9:45 AM)

INSIGHTS INTO THE FUNCTIONAL EVOLUTION OF THE CROCODYLOMORPH TROPHIC APPARATUS GLEANED FROM THE ONTOGENY OF EXTANT CROCODYLIAN FEEDING BIOMECHANICS

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During its 200 million year diversification, the crocodylomorph feeding apparatus transformed from a configuration of slender bones with relatively gracile teeth into a highly reinforced skull, outfitted with robust dentition and capable of transmitting high bite-force capacities. Along the way, forms as varied as terrestrial hypercarnivores and herbivores with occluding, mammal-like dentitions also evolved. Accompanying these myriad transformations were in-tandem changes to key aspects of the force-generating system (e.g., retroarticular process) and to the strength of the jaws (e.g., via the bony pterygoids, ectopterygoids, and secondary palate). In this study I examined the ontogenetic feeding biomechanics of modern crocodylians (e.g., *Alligator mississippiensis*, *Crocodylus johnsoni*, *C. porosus*) for its utility as an analogue to the evolution of the crocodylomorph feeding system. First, I documented how length positive allometry of the force-amplifying retroarticular process correlates with strengthening of the jaws due to palatal growth and lateral expansion of the pterygoid and ectopterygoid bones. I then examined correlated character evolution of these traits along a crocodylomorph phylogeny. Using these data I tested the hypothesis that ontogenetic patterns of cranial anatomy, critical to crocodylian feeding shifts, also reflect patterns of cranial change laid down during crocodylomorph evolution. Two major findings emerged. Results for herbivorous notosuchians indicate reversals in relative retroarticular process length and mediolateral width of the bony pterygoids and ectopterygoids as contributors to herbivory. Patterns for predatory taxa indicate a good fit between the functional analogies of neonate crocodylians to sphenosuchian-grade crocodylomorphs, juvenile crocodylians to mesoeucrocodylian forms, and adult crocodylians to neosuchian taxa. Taken together it appears that the evolution of the crocodylomorph feeding apparatus was broadly typified by functional improvements to the force-generating and prey-capture systems, the most extreme of which may have been best represented by mahajangasuchid-grade notosuchians, such as *Kaprosuchus saharicus*.

Technical Session XIII (Friday, November 7, 2014, 3:15 PM)

A REMARKABLY PRESERVED DEVONIAN ACTINOPTERYGIAN SKULL PROVIDES A NEW MODEL FOR EARLY RAY-FINNED FISH ENDOCRANIAL ANATOMY

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Our understanding of early gnathostome cranial anatomy has changed dramatically in recent years with the discovery of taxa such as *Entelegnathus* and *Pucapampella*, and the collection of new material or restudy of old specimens of *Acanthodes*, *Doliodus*, and *Ptomacanthus*. By contrast, detailed understanding of endocranial structure in Devonian ray-finned fishes has remained largely unchanged since the publication of monographic descriptions of *Mimipiscis* and *Moythomasia* more than three decades ago. While these accounts provide a wealth of morphological information, disarticulation of the relevant specimens during acid preparation has resulted in a loss of important spatial information relating to the articulation of complex structures like the gill skeleton. Here we describe the three-dimensionally preserved skull of a new genus and species of actinopterygian from the Devonian of France using non-destructive computed tomography (CT) scanning. From the Ferques Formation, the age of the fossil can be narrowly constrained to the upper Frasnian on the basis of conodont biostratigraphy. Interpretation of this form as an actinopterygian is supported by multiple derived features: an enclosed canal for the dorsal aorta; a fenestra in the palatoquadrate marking the point of articulation with the basipterygoid process; and narrowing of the interobital septum to a single sheet of bone ventral to the olfactory tracts in the orbital region. Our scans reveal a near-complete dermal cranium, an intact braincase and articulated mandibular, hyoid and branchial arches. The three-dimensionally preserved gill skeleton in this specimen represents one of the few examples available for early bony fishes, and permits comparison with osteichthyan-like gill arches recently described in Paleozoic chondrichthyans. The new actinopterygian displays many primitive characters, such as a notched jugal, short aortic canal bearing a prominent midline notch, long lateral dorsal aortae, an open spiracular canal, and poorly developed ascending processes of the parasphenoid. When combined with endoskeletal data from the braincase of *Cheirolepis*, the new taxon helps to paint a new picture of primitive ray fin cranial anatomy. Our results suggest that many anatomical aspects of *Mimipiscis*, which is often used as a model of a primitive actinopterygian, are specialized rather than generalities of the earliest ray-finned fishes.

Technical Session I (Wednesday, November 5, 2014, 10:30 AM)

SKELETON OF A NEW PROTOCETID (CETACEA, ARCHAEOCETI) FROM THE LOWER GEHANNAM FORMATION OF WADI AL HITAN IN EGYPT: SURVIVAL OF A PROTOCETID INTO THE PRIABONIAN LATE EOCENE

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Protocetid archaeocetes are semiaquatic whales known from middle Eocene strata in Africa, Asia, North America, and South America. Most were foot-powered swimmers, with hind limbs anchored to the vertebral column through a solid sacrum. Basilosaurid archaeocetes are fully aquatic whales, tail-powered swimmers, known from the late middle and late Eocene (Bartonian and Priabonian) worldwide. We found protocetid specimens in glauconite beds deposited during the initial Priabonian sea level rise following the terminal Bartonian low sea stand. These specimens, from Wadi Al Hitan in Egypt, are the first evidence of a late Eocene protocetid.

The most complete specimen, WH-203, is represented by much of the braincase and basicranium, pieces of maxilla and dentary, and upper and lower teeth. Cranial elements compare closely in size to corresponding bones and teeth of *Georgiacetus*. Tympanic bullae are a little smaller than those of *Georgiacetus*. Thirty-nine vertebrae include 7:15:4:4:9+ cervicals, thoracics, lumbars, sacrals, and caudals, respectively, complete from cervical C1 through caudal Ca9. WH-203 has two more thoracics than a typical protocetid, and two less lumbars. Vertebrae of the distal tail are missing. The sternum is exceptionally broad and flat. Sacral centra are unfused, and auricular processes of sacral S1 provide the only contact with the innominates. A centrum length profile for WH-203 parallels that of *Maiacetus* closely through the middle of the thorax, but more posterior vertebrae show a substantial increase in relative length. The scapula of WH-203 is more fan-shaped than that of *Maiacetus*. Bones of the forelimb are shorter, while those of the manus are more robust than expected for a protocetid this size (scaled relative to average vertebral length). There is no clear auricular surface on the ilium for a normal weight-bearing sacroiliac joint, and connection of the ilium to the sacrum was more loosely ligamentous. The tibia is shorter than expected, and long bones of the pes are both shorter and less robust than expected.

All of these differences—an increase in the number of thoracic vertebrae, development of a broad flat sternum, lengthening of posterior thoracic through caudal vertebrae, loss of a weight-bearing sacroiliac joint, and reduction in the size and robustness of foot bones, suggest an animal more fully aquatic and less specialized as a foot-powered swimmer than typical protocetids. Distal caudal vertebrae are not preserved: it is not known whether WH-203 had a tail fluke. Research funded by NSF EAR 0517773 and 0920972.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

BIODIVERSITY IN THE TRIASSIC: RESULTS OF THE FIELD OPERATIONS OF THE YALE PEABODY MUSEUM IN THE PETRIFIED FOREST NATIONAL PARK.

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In 2008, the Yale Peabody Museum began fieldwork in the Upper Triassic Chinle Formation in the Painted Desert (northern) portion of Petrified Forest National Park, Arizona. This area is not as extensively studied as other parts of the Park and historically was not considered particularly fossiliferous in terms of vertebrate remains. On the second day of a preliminary survey a large accumulation of bones of the aetosaur, *Typothorax,* was discovered weathering out near the surface of a pink sandy shale and conglomeritic lens at the base of the Owl Rock Member. This site contained the remains of two at least partially-articulated, well-preserved individuals, including one disarticulated skull, with a second skull in articulation with cervical and dorsal trunk osteoderms, articulated fore- and hind limbs and associated osteoderms. The skull possesses plesiomorphic character states for Aetosauria including a tapering nasal and the lack of an anterolateral expansion of the premaxilla. The premaxilla bears five teeth contrary to previous reports describing it as edentulous. The dentary and splenial lack a pronounced ventral flexion or 'chin'. These are the most complete *Typothorax* specimens discovered in the Chinle Formation of Arizona and the most complete aetosaurian skulls known from the Late Triassic of North America. A second adjacent site at the same stratigraphic level was excavated beginning in 2009. To date, this site has yielded over 200 specimens including phytosaur and rauisuchid teeth, a rauisuchid premaxilla, large and small osteoderms, articulated vertebrae, and the partially articulated pelvis, hind limbs, and shoulder girdle of an as yet unidentified large archosauromorph. This site is notable for its high density of remains with a high quality of preservation and marks the first discovery of vertebrate fossil material in the Owl Rock Member of the Chinle Formation at Petrified Forest National Park, greatly expanding the range of a number of known taxa within that unit. In 2010 we expanded our working area to the northeast discovering numerous localities bearing aetosaur and phytosaur material including partial phytosaur skulls, and an as yet unidentified archosaur and the first complete articulated fish, most likely *Tanaocrossus,* from the Park, which would be the first occurrence of this taxon in Arizona. This fieldwork has been successful not only in documenting vertebrate diversity in the Park, but also in expanding the range of known fossil localities both geographically and stratigraphically within Petrified Forest National Park.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

HOW TO PACK FOSSILS FOR LOANS

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It is not possible for every researcher to visit every museum to see every specimen, so vertebrate paleontology collections regularly loan material to researchers in other institutions. This means that delicate, irreplaceable fossil specimens are shipped all over the world. It is easy to imagine a multitude of ways in which damage can occur; however, with a few simple steps most damage can be avoided. We describe a basic packing procedure, consisting of three main components: plastic bag, inner box, and outer box, with appropriate padding added between the plastic bag and inner box, and between the inner and outer boxes to cushion the specimen and minimize movement and breakage. The plastic bag prevents contact of the specimen with packing materials, and if any breakage occurs, keeps all fragments together. We discuss selection criteria for packing materials. Some preferable materials include Ethafoam, polyester fiberfill, and stretch wrap, while materials to be avoided include cotton batting and inadequate boxes. We also include steps that should be taken before the specimen is packed, such as archival labelling and photography, which provides documentation of the specimen and its current condition. Examples are provided of checklists that can be used to standardize and streamline the packing and unpacking process for both the lending and receiving institutions. Checklists help to ensure that the same set of procedures is followed regardless of the person processing the loan. In addition to a packing list, specimen loan forms, and other documentation, a separate sheet should also be included that contains information to help the researcher return the loan safely. This sheet includes a brief outline of the appropriate packing procedure, as well as the address and contact information of the person to whom the loan should be returned. These simple steps help to maintain the level of access required for research and yet greatly reduce the loss of information inherent in any specimen breakage.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

PRELIMINARY RESULTS OF PARASITOLOGICAL RESEARCH ON A WOOLLY MAMMOTH, *MAMMUTHUS PRIMIGENIUS* FROM TAIMYR PENINSULA, RUSSIA

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A partial carcass of a mammoth (*Mammuthus primigenius*) was found in 2012 at the Taimyr, Dolgan-Nenets Region, Krasnoyarsk Territory, Russia. The mammoth nicknamed the Sopkarga-mammoth, "Zhenya". At the moment, scientific literature provides records of mammoths' causative agents of parasitic diseases. For the analysis, samples of the following were obtained: fragments of muscle tissue, liver, and rectum contents. Muscle tissue was found to be of very dense consistency, not readily dividing into separate fibers, dim-gray in color. Liver tissue was a dry, easily crumbling structure of dark brown color. Contents of intestines were pressed and a dark green color. To detect helminths, traditional parasitological (helminthological) techniques were used: native smears, the Fulleborn method, the Kotelnikov-Khrenov method with ammonium nitrate, the formalin-ether precipitation technique, the compressor method, and digestion in artificial gastric juice. Visual detection of helminths, their larvae, and eggs in corpses of animals requires experts to have special skills and apply modified research techniques. It is known that a number of external factors have a detrimental effect on the preservation of parasitic worms. For example, a helminth being in the intestines of a corpse for a long time leads to maceration of the worm, and changes in the electrolyte balance in the tissues cause the cuticle of some nematodes to rupture. Nevertheless, we were able to detect structures morphologically similar to eggs of helminths—in particular, those of nematodes and cestodes. It is interesting that the eggs of parasites were found in the liver tissue and intestinal contents. It is doubtless that permafrost conditions do eventually affect the eggs of helminths in animal corpses due to temperature differences, so the eggs end up with partially changed morphological structure. The nematode eggs have a peculiar morphological structure by which they can be detected, but a comparative microscopic evaluation of worm eggs from extinct and extant animals alone cannot give as a decisive answer on their taxonomic identity. We believe that, when studying the phenomenon of parasitism, a complex and comprehensive use of microscopic, genetic and parasitological techniques is necessary. The conducted research has indicated the existence of helminthic eggs in the mammoth. They are referred to Plathelminthes and Nemathelminthes, classes Cestoda and Nematoda respectively.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

COMPUTER SIMULATION OF HYDRODYNAMIC PROPERTIES OF SOME DEVONIAN PSAMMOSTEIDS (AGNATHA: HETEROSTRACI)

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Psammosteids are a group of sestonophagous agnathans characterized by dorsoventrally flattened dermal skeleton formed by plates, tesserae and scales. The reconstructed locomotion of heterostracans involved vertical curvilinear trajectories. It has been proposed that the wide branchial plates developed during the evolution of psammosteid exoskeleton served as hydrofoils and significantly increased the length of these trajectories. In order to test this hypothesis, we carried out a computer simulation of the hydrodynamics of three psammosteid taxa known from the most complete skeletal material with potentially different hydrodynamic properties of dermal skeleton: *Drepanaspis gemuendenensis*, *Tartuosteus maximus* and *Pycnosteus tuberculatus*. *D. gemuendenensis*, a typical representative of the Early Devonian psammosteids, is characterized by narrow branchial plates. The Middle Devonian *T. maximus* and *P. tuberculatus* possessed substantially widened branchial plates, which even obtained negative sweep in the latter species. Three-dimensional (3D) models of these psammosteids were created with SolidWorks 2008 software, computational fluid dynamic simulation was conducted using ANSIS CFX at a zero roll angle of the models. The data generated from the CFX solver was applied to calculate the drag and lift coefficients of the psammosteids according to the following formulae: $C_D = F_D/0{,}5\rho Sv^2$; $C_L = F_L/0{,}5\rho Sv^2$, where F_D is the drag force, F_L is the lift force, ρ is the fluid density (1000 kg/m^3), S is total length of the model (30 cm) and v is the speed of the object relative to the fluid (2 m/s). The coefficients C_L and C_D (for *D. gemuendenensis*: -0.0009 and 0.0009; for *T. maximus*: 0.0059 and 0.0011 and for *P. tuberculatus*: 0.0093 and 0.0013 respectively) were used to calculate hydrodynamic quality, expressed as lift-to-drag ratio (C_L/C_D) - the parameter, which characterizes gliding capabilities of a body, being proportional to the distance which can be passed by means of gliding from a certain height above the bottom. As a result of this study, it became clear that psammosteids with wide branchial plates demonstrate substantially higher hydrodynamic quality (for *T. maximus*: 5; for *P. tuberculatus*: 7) compared to species with narrow branchial plates (*D. gemuendenensis*: -1). Thus, our study confirms that one of the tendencies in the evolution of dermal exoskeleton of psammosteids was directed towards the increase of efficiency in the gliding mode of locomotion.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

FEATHER-LIKE STRUCTURES IN ORNITHISCHIAN DINOSAURS

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Recent discoveries in Middle-Late Jurassic and Early Cretaceous deposits from northeastern China have revealed that numerous non-avian theropod dinosaurs were covered by feathers. Furthermore, filamentous integumentary structures were also described in rare Early Cretaceous ornithischian dinosaurs from Liaoning Province in China: the basal ceratopsian *Psittacosaurus* and the heterodontosaurid *Tianyulong*. Whether these filaments can be regarded as epidermal and therefore part of the evolutionary lineage towards feathers remains controversial. Both filamentous and compound integumentary structures were recently found in a new basal neornithischian dinosaur from the Middle-Late Jurassic Kulinda locality in the Transbaikal region (Russia). This represents the first report, to our knowledge, of branched integumentary structures outside theropod dinosaurs, suggesting that compound feather-like structures were potentially widespread among the whole dinosaur clade and therefore potentially present in the earliest dinosaurs. As in ornithuromorph birds, the distal hind limb of the new ornithischian was extensively scaled, without elongated feather-like structures. The complex distribution of skin appendages in dinosaurs likely reflects deep homology in Amniota.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

NEW INSIGHTS ON THE MORPHOLOGY OF *EOCAIMAN CAVERNENSIS* (CROCODYLIA, CAIMANINAE)

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The Scarritt Patagonian Expeditions to southern Argentina (1930 to 1933), led by George G. Simpson, recovered a plethora of Cenozoic vertebrate fossils. Among many sites explored during the first expedition (1930-1931), the Gran Barranca, in Chubut Province, is one of the most important and yielded *Eocaiman cavernensis* (Crocodylia, Caimaninae). The specimen comprises a fairly complete skull (missing the tip of the snout and the caudal portion) and both mandibular rami. The taxon, preliminarily described as closely related to *Caiman*, is ubiquitous to phylogenetic studies of Alligatoroidea and consensually placed outside crown-Caimaninae. To investigate the osteology of the holotype of *Eocaiman cavernensis*, we performed computed tomography imaging (CT-scan), which allowed the investigation of features not accessible by external visual observation. We reexamined some poorly preserved regions of the skull, such as the nasal-prefrontal and angular-surangular contacts, as well as the prefrontal pillars. A series of new caimanines have been recently described, greatly expanding our knowledge of the group. In this context, we revised the scoring of *E. cavernensis* (based on the holotype,AMNH 3158) in Brochu's matrix of 81 taxa and 181 morphological characters. At this point, the coding of 32 characters was modified from the original scoring, some of which (seven) simply because specimens referred to *Eocaiman* were not considered. Among the modifications we highlight the absence of the nasal-lacrimal contact (due to a rostrocaudal elongation of the prefrontal), the procumbent first dentary teeth, and the extension of the dentary symphysis until the fifth tooth. This reevaluation is important for a better supported phylogenetic placement of *E. cavernensis* and also to better understand the complex paleobiogeographic scenarios proposed for the evolution of Caimaninae during the Cenozoic. This research was funded by FAPESP (process number: 2013/06811-0).

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

***ARCHAEOBELODON* VERSUS *GOMPHOTHERIUM:* OSTEOLOGICAL INSIGHTS BASED ON A NEW PARTIAL SKELETON OF *ARCHAEOBELODON* (MAMMALIA, PROBOSCIDEA) FROM THE MIDDLE MIOCENE OF SOUTHERN GERMANY**

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Archaeobelodon filholi is a barely known proboscidean taxon of Western and Central Europe, which occurred for the first time in the Mammalian Neogene Unit MN4 only shortly after the first proboscidean taxa *Gomphotherium* and *Zygolophodon* arrived in Europe in MN3b.

Fossils of *Archaeobelodon* are only rarely found and restricted to deposits of the late early to the middle Miocene (MN4–MN7). During the middle Miocene, in the Mammalian Neogene Units MN6–MN7, the monospecific *Archaeobelodon* is a coeval of the very popular proboscidean species *Gomphotherium angustidens.* Both *A. filholi* and the contemporaneous *G. angustidens* are bunodont and trilophodont gomphotheres and have morphologically and metrically extremely similar cheek teeth, often not distinguishable. Therefore these taxa are often confused and misidentified and it must be assumed that a certain percentage of collection fossils referred to *G. angustidens* in fact belong to *A. filholi*. The most distinctive dental character in *A. filholi*, compared to *Gomphotherium*, is the flattening of the lower tusks, a typical feature for all so-called shovel tuskers, or Amebelodontinae. Only through their lower tusks can they be identified as belonging to two different subfamilies, the Amebelodontinae (*Archaeobelodon*) and the Gomphotheriinae (*Gomphotherium*). Very little is known so far about postcranial and cranial differences or similarities between *Archaeobelodon* and other gomphothere taxa as no postcranial material of *Archaeobelodon* has ever been described before.

We present a recently discovered partial skeleton of an old-aged, male individual of *A. filholi* from the middle Miocene Junkenhofen locality in Southern Germany. This well preserved specimen gives new insight in cranial and postcranial characters of this little known species and allows osteological comparisons with skeletons of different species of *Gomphotherium*, such as *G. sylvaticum*, *G. subtapiroideum*, *G. angustidens*, and *G.* aff. *steinheimense*. Aspects of functional morphology and of systematic importance as well as age-related features will be discussed.

Technical Session III (Wednesday, November 5, 2014, 2:45 PM)

ENDOCAST SHAPE DIFFERENCES IN COELUROSAURIA (DINOSAURIA: THEROPODA) REFLECT PHYLOGENY AND LOCOMOTOR MODE ACROSS THE EVOLUTION OF FLIGHT

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In the 150 million years since their first appearance, birds (Avialae) have come to occupy a wide range of ecological niches and locomotory modes. Within this vast diversity, flightlessness has evolved in 16 clades, and is accompanied each time by a known suite of anatomical transformations. Each reversal to flightlessness provides an independent system on which hypotheses of morphological change can be tested. One such potential transformation may be in the neuroprocessing system, which is presumed to undergo a release from evolutionary constraints on volant behavior. However, it is unclear if the brain of flightless birds returns to a phenotype more reminiscent of its non-volant theropod ancestry, takes on a novel configuration unique to obligatory cursorial avians, or retains a morphology similar to their nearest flying relatives. To test the hypothesis that the brain shape of flightless birds is convergent on those of non-avian theropods, digital endocasts were created for flying and flightless crown-group avians and for non-avian coelurosaurs. Geometric morphometric techniques were applied to high-resolution computerized tomography scans of endocranial shape to analyze differences in gross morphology using both discrete and sliding semilandmarks. A Principal Components Analysis (PCA) was conducted on these data to illustrate patterns of morphological similarity among endocasts. Volant species occupy a greater region of PC morphospace than non-volant species, though there is some overlap between these groups. Non-avian dinosaurs occupy a unique area, not overlapping with extant birds. PC1 describes a transition from a linear to an s-shaped brain on either end of the axis, with non-avian dinosaurs having a more linear brain, and modern birds a more s-shaped brain. Interestingly, two nocturnal, flightless birds, the Kaka (*Strigops meridionalis)* and the Kiwi (*Apteryx australis*) share a region of morphospace distinct from other members of their clades due mainly to a relative reduction in volume of the optic lobes. While allometry did not significantly account for brain shape, a test for phylogenetic influence did generate a significant signal. Our results indicate that both locomotory mode and phylogeny shaped the diversification of brain morphology in birds and non-avian dinosaurs.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

ADHESIVES USED IN 2014 BY THE VERTEBRATE PALEONTOLOGY PREPARATION LABORATORY, AMERICAN MUSEUM OF NATURAL HISTORY: AN ILLUSTRATED WALL CHART

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The decision to apply adhesives to fossil vertebrate specimens should be guided by an ability to assess the specimen and the task at hand, determine the desired end product, and choose the most appropriate adhesive. At the American Museum of Natural History, while some specimens are not treated (to avoid chemical contamination), most specimens require one or more of the following: (1) consolidants during excavation and/or preparation; (2) adhesives for joining; and (3) coatings for molding.

This chart illustrates the most widely used adhesives at the AMNH with details as to why preparators choose specific adhesives for specific tasks, based on their different properties. Some of these important properties are long-term stability, solubility, removability, penetration, strength, set-time, and glossiness. Included are seven adhesives: Aron Alpha 201 (ethyl-2-cyanoacrylate), Butvar B-76 and Butvar B-98 (both terpolymers of vinyl butyral, vinyl alcohol and vinyl acetate monomers), Devcon 2 Ton epoxy (polyoxypropylenediamine hardener), Epo-Tek 301-2 epoxy (aliphatic amine hardener), Paraloid B-72 (acrylic copolymer), and Primal/Rhoplex WS-24 (acrylic copolymer dispersion).

Symposium 3 (Friday, November 7, 2014, 11:45 AM)

RE-EVALUATION OF CRETACEOUS PALEOBIOGEOGRAPHICAL PATTERNS USING MORPHOLOGICAL CLOCK AND MODEL-BASED APPROACHES: A CASE STUDY UTILIZING TITANOSAURIAN SAUROPODS WITH EVIDENCE FOR A MORE CENTRALIZED ROLE FOR CONTINENTAL AFRICA

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Titanosaurian sauropod dinosaurs were highly successful during the Cretaceous. Yet, certain aspects of their evolutionary history remain obscure, including: (1) their phylogenetic relationships; (2) when and where they originated; and (3) how continental break-up influenced their global distribution patterns. We examined these issues using recent advances in phylogenetic and paleobiogeographic analyses that utilize a morphological clock and tip-dating of non-contemporaneous taxa. Using a modified morphological data set and explicit information on taxon ages, we tested varying phylogenetic models (parameters include character and clock rates) within a Bayesian framework to estimate the best-fit tree. Uncorrelated clock models fit better than strict clocks and, interestingly, equal-rate character models were slightly favored over variable-rate character models. Overall, model topologies are congruent with one another with slight variations in taxon placement and estimated branch lengths and nodal dates. The best-fit phylogeny estimated the mean divergence date of Titanosauria at 136.26 Ma (95% highest posterior density: 152.34-124.04 Ma), supporting a likely Early Cretaceous origination. Using the R package BioGeoBEARS, we employed two paleobiogeographical models over the best-fit phylogeny: (1) a model with range expansion and contraction parameters and (2) the same model but with an additional dispersal parameter. Both models favor an African origin for Titanosauria and Lithostrotia, and an Aptian-Albian South American origin for the younger 'aeolosaurid' and 'saltasaurid' clades.

Furthermore, several Late Cretaceous immigrant taxa diverged earlier from South American clades during the middle Cretaceous: *Alamosaurus* (North America), *Isisaurus* (India), *Rapetosaurus* (Madagascar), an Asian clade, and an European clade. Consistent with our models, recent discoveries of several caudal vertebral elements that express aeolosaurid affinities from the middle Cretaceous Galula Formation of eastern Africa support a widespread and middle Cretaceous divergence of aeolosaurid-related titanosaurians. Though too fragmentary to formally include into the present analyses, the material may potentially link both the Late Cretaceous European and eastern Gondwanan aeolosaurid-relatives with those from South America. These analyses suggest a more centralized paleobiogeographic role for Cretaceous continental Africa despite the current under-sampled and poorly-documented state of much of this critical landmass.

Technical Session X (Friday, November 7, 2014, 10:30 AM)

DEVELOPMENTAL INTEGRATION CHANNELED MORPHOLOGICAL RESPONSE TO ENVIRONMENTAL STRESS IN LATE PLEISTOCENE CARNIVORANS

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Macroevolutionary analyses of diversity typically focus on extrinsic factors, such as environmental change or mass extinctions, which affect multiple lineages over long time periods, while microevolutionary studies of diversity are usually concerned with the genetic and developmental changes that shape population-level variation, the raw material of natural selection. Comparative analysis of phenotypic integration has the capacity to unify these different scales, and foci, of evolutionary study by estimating genetic and developmental interactions through the quantitative analysis of morphology, including that of fossil organisms. Although identifying the specific intrinsic drivers of phenotypic integration is often elusive, the developmental contribution to integration, and its influence on morphological evolution, can be estimated by measuring fluctuating asymmetry. Lab experiments examining the effects of artificially-induced environmental stress have demonstrated that fluctuating asymmetry increases in stressed populations but that this variation was channelled along the same directions as variation between species, rather than being distributed randomly or in novel directions. These studies provide interesting data on short-term stress, but data from the fossil record are ideally suited to further test the effects of environmental changes and developmental interactions on phenotypic integration and variation.

We analyzed 3D morphometric data from 207 specimens of *Smilodon fatalis* and *Canis dirus* from the La Brea tar pits to quantify temporal trends in size, variance, integration, and fluctuating asymmetry in response to Late Pleistocene environmental change. Specimens were separated into four time bins spanning 37,000 to 13,000 years ago, and analyses demonstrated that *S. fatalis* and *C. dirus* responded differently to presumed environmental stress during this interval. *S. fatalis* showed a gradual decrease in overall integration and an increase in size, variance, fluctuating asymmetry, and the association between fluctuating asymmetry and overall integration through time, suggesting that developmental interactions channelled the increased variance from environmental stress, as in lab experiments. In contrast, *C. dirus* shows a more volatile pattern, with increases and decreases in all attributes through this interval. Consistent with studies of dental pitting and breakage, these results suggest that *C. dirus* may have been more sensitive to short-term environmental changes than was *S. fatalis.*

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A BARRACUDA-DOMINATED TROPICAL MARINE FAUNA FROM THE MIOCENE OF MADAGASCAR

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Current and ongoing exploration of Miocene-aged nearshore marine deposits in northwestern Madagascar has resulted in the recovery of diverse invertebrates (bivalves, gastropods, and echinoids) and vertebrates including sharks, bony fishes, as yet indeterminate turtles and crocodylians, and marine mammals (sirenians). One Miocene site of particular focus is Nosy Makamby (or Mahakamby), a small island situated close to shore ca. 50 km southwest of the city of Mahajanga. Benthic foraminifera and coral from Nosy Makamby, along with evidence from foram taxa that are characteristically epiphytic on seagrass, point to a warm shallow marine environment in the Miocene that included coral reefs and seagrass beds. The fossiliferous Miocene sediment on the island consists of medium- to fine-grained calcareous sandstone, which is capped by Pliocene continental red beds. The Miocene fish material from Nosy Makamby, which is mainly comprised of well-preserved isolated teeth, along with vertebral centra, fin spines, and occasional dermal elements, includes a few ariid? catfish, tetraodontid (pufferfish), and non-diagnostic higher percomorph specimens. The most commonly represented fish in the sample, however, are sphyraenid teleosts - barracudas - which based on the Nosy Makamby sample were very common in this tropical marine setting. To date ca. 75 labiolingually flattened and fang-like teeth have been recovered that are readily identified as sphyraenid based on their broadly triangular and blade-like acuminate outline with sharply edged but unserrated cutting margins. Many of the fossil teeth are very similar to those on extant species of *Sphyraena*, although none are large, consistent with the Nosy Makamby sample being skewed towards subadult fishes. We suggest that these young Miocene barracuda were utilizing the protected habitat of the seagrass beds as a refuge, similar to extant *Sphyraena* which commonly stay in seagrass beds as subadults, and then move into deeper and more open reef environments as active piscivores when they reach larger size.

Romer Prize Session (Thursday, November 6, 2014, 9:45 AM)

SLOTH ONTOGENETIC TRAJECTORIES AND IMPLICATIONS FOR CONVERGENCE IN *BRADYPUS* AND *CHOLOEPUS*

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The two genera of modern sloths, the three-toed *Bradypus* and the two-toed *Choloepus*, are often cited as a classic case of convergent evolution due to their unusual and relatively unique suspensory locomotor habits, and the fact that they are always recovered as diphyletic. No extinct sloths have been shown to have this same suspensory locomotion so it is unlikely that this feature is plesiomorphic for sloths. In some other mammals the shape of the scapula is highly indicative of locomotion style and substrate preference. A procrustes distance ANOVA shows that the average scapula shapes of *Bradypus* and *Choloepus* are significantly different from each other, despite their shared suspensory lifestyle. Juveniles of the two genera, however, are not significantly different. Moreover, *Bradypus* adult and juvenile shapes are also not significantly different from each other, showing that *Bradypus* may have a truncated growth trajectory compared to *Choloepus*. Comparing the paths of these ontogenetic trajectories through morphospace can elucidate possible convergent or divergent evolutionary patterns. A MANCOVA on scapula shape using genus, log centroid size, and their interaction as model effects produced a non-significant interaction term, indicating that the slopes of their growth trajectories are not significantly different. Comparisons between MANCOVA predicted shapes show that the distances between the smallest and largest specimens of each genus are nearly identical. This suggests that while modern sloths are undoubtedly functionally convergent with respect to a suspensory posture, scapular morphology reflects an ancestral growth pattern shared by all sloths and is influenced more by phylogeny than function. When the MANCOVA model is extended to species from every other sloth family, including giant ground sloths and smaller semi-arboreal Antillean sloths, the interaction term between species and log centroid size is also not significant. These trajectories show that despite the wide range of locomotion styles of extinct sloths they were able to achieve this diversity without as significant a change in scapula shape development that is seen in other mammalian groups. This should lead to caution when using only the scapula to determine behavior in an extinct taxon. While in many taxa scapular morphology does seem to be highly influenced by function, in others this morphology may simply be plesiomorphic, and should be combined with measures of other elements before firm conclusions on locomotion style are drawn.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

AN OLENEKIAN HIGH-LATITUDE VERTEBRATE ASSEMBLAGE FROM THE SYDNEY BASIN, AUSTRALIA: TESTING GONDWANAN FAUNAL SEGREGATION IN THE EARLIEST TRIASSIC.

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The earliest Triassic was marked by compositional uniformity amongst continental vertebrate assemblages, with compatible higher-level lineages occurring at palaeogeographically distant localities throughout the Pangaean landmass. This faunal cosmopolitanism is thought to have developed via the absence of physical barriers to migration, which might have contributed distributional ubiquity for many clades but cannot explain their disparity in abundance at different palaeolatitudes. Indeed, the taxonomically skewed Early Triassic high-latitude tetrapod record of Australia has been used to argue for a segregation of eastern Gondwana, whereby temnospondyl amphibians came to numerically dominate the available ecosystems at the expense of comparatively rare coeval groups such as therapsids and archosauromorphs. A proposed explanation for this perceived "imbalance" has been the presence of an aquatic barrier that preferentially screened the dispersal of obligate terrestrial tetrapods across the Antarctic polar land bridge. To test this hypothesis, a survey of a rich Olenekian vertebrate assemblage from the Bulgo Sandstone in the Sydney Basin of Australia was coupled with diversity assessments of earliest Triassic faunas from elsewhere in the world. These confirmed a prevalence of temnospondyls and aquatic proterosuchids within the Early Triassic of Australia, including new material ascribable to capitosaurids, brachyopoids, and trematosaurids, as well as novel archosauriforms in the Bulgo Sandstone. However, the Australian samples also accorded with sampling bias towards fluviatile and brackish estuarine palaeoenvironments. The apparent paucity of "inland" faunal elements such as therapsids is therefore not surprising, and suggests that such groups might be more frequently encountered in floodplain facies away from the continental margins. Conversely, the discovery of further archosauriform remains in the Bulgo Sandstone hints at cryptic diversity within deltaic settings, and advocates reinvestigation of historically productive Australian Triassic localities for previously undetected taxa.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

A FEATHER PRESERVED IN THREE DIMENSIONS FROM THE EOCENE FUR FORMATION OF DENMARK

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Molecular paleontology is an emerging geobiological discipline directed to the study of ancient organic molecules that provide information on, e.g., the biochemistry, biology and evolutionary history of both extinct and extant animals. Over the past few decades, and especially in the last couple of years, the field has taken huge leaps forward thanks to advances in analytical techniques and re-evaluation of hypotheses on taphonomy. For a long time, the preservation of integumentary structures was considered to be the result of keratinophilic bacterial activity, where original soft-tissues degraded and eventually were replaced. This view has recently been challenged through the discovery of eumelanin (a ubiquitous biochrome with a wide array of functions) biomarkers in a number of fossil tissues and taxa. Conclusive molecular evidence for melanin pigment in fossil feathers has, however, so far not been reported.

We investigated an exceptionally preserved feather from the Eocene Fur Formation of Denmark, using a broad array of sophisticated imaging and molecular techniques. The fossil is preserved in a diatomite, and consists of a part and a counterpart. Under SEM, masses of ovoid to highly elongate microbodies were observed. They are aligned and located in shallow, elongate cavities measuring about 5-10 µm in length. We reconstructed the depressions using computed synchrotron radiation-based microtomography. Furthermore, we used a combination of molecular techniques (including Time-of-Flight Secondary Ion Mass Spectrometry [ToF-SIMS], IR-microspectroscopy and Extended X-Ray Absorption Fine Structure [EXAFS]) to demonstrate the presence of eumelanin biomarkers.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

THE FEMORAL ONTOGENY AND LONG BONE HISTOLOGY OF THE MIDDLE TRIASSIC (?LATE ANISIAN) DINOSAURIFORM *ASILISAURUS KONGWE* AND IMPLICATIONS FOR THE GROWTH OF EARLY DINOSAURS

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The ontogeny of dinosaurs and their closest relatives is poorly understood because few ontogenetic series from the same species-level taxon are available and what is available (e.g., *Coelophysis bauri*) has not been extensively documented. The large numbers of skeletal elements of the silesaurid *Asilisaurus kongwe* recently recovered from the Anisian of Tanzania provides an opportunity to examine the ontogenetic trajectory of the earliest known member of Ornithodira and one of the closest relatives to Dinosauria. Our approach was two-fold: to examine the detailed ontogeny of the femur and to examine the histology of a series of long bone elements. We observed bone scars develop from a series of femora (n = 27) of different lengths (73.8-177.2 mm) which we hypothesize constitutes a partial ontogenetic series. We hypothesize that the majority of femora follow a similar developmental trajectory (e.g., the anterior trochanter and trochanteric shelf develop roughly simultaneously and fuse later in ontogeny in the most common developmental path). However, we observed sequence polymorphism in the order of appearance and shape of bone scars (e.g., there is high morphological variability in the fourth trochanter throughout most of the series, and although fusion of the trochanteric shelf and the anterior trochanter is only common in larger specimens, it is present in the second smallest specimen and conspicuously lacking in one of the largest specimens). Ontogenetic Sequence Analysis (OSA) indicates that two developmental event pathways exist in our sample of *Asilisaurus* femora, and these diverge early in our hypothesized series. Additionally, five femora, three tibiae, a fibula, and a humerus were thin-sectioned to examine osteological tissues. No annual lines of arrested growth (LAGs) are present in any of the specimens, and there is little histological information about the relative ontogenetic stage of the femora. The woven-fibered bone present in the cortex of the elements sectioned is similar to that of the earliest dinosaurs.

The ontogenetic pattern of *Asilisaurus* femora provides a baseline for understanding growth in early dinosaurs, particularly theropod dinosaurs. This sequence polymorphism provides an alternative explanation for the robust/gracile dichotomy found in early dinosaurs (e.g., *Coelophysis*, *"Syntarsus"*, *Thecodontosaurus*) that has previously been interpreted as sexual dimorphism. The shared femoral scar features found in *Asilisaurus* and early dinosaurs suggest this ontogenetic pattern is pleisiomorphic for Dinosauria.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

GIGANTIC *MOSASAURUS HOFFMANNI* (SQUAMATA, MOSASAURIDAE) FROM THE LATE CRETACEOUS (MAASTRICHTIAN) OF PENZA, RUSSIA

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A fragmentary skull of a mosasaur was found in 1927 in the Upper Cretaceous (Maastrichtian) deposits in the city of Penza (Russia). Later, this specimen was exhibited in Chernishev's Central Museum of Geological Exploration (St Petersburg) but has never been described. This is one of the most complete mosasaur finds from Russian territory. Some bones of the skull from Penza were lost and their description in my study is based on plaster casts and archival photos.

The Penza specimen can be attributed to *Mosasaurus hoffmanni* on the basis of the following characters: the posterior carina that shifts from a somewhat lateral position in the anterior teeth to a posterior position further along the tooth row, a frontal with convex lateral margins and a powerfully built dentary. Characteristic features of the Penza specimen are an enormous descensus processus parietalis and the absence of a firmly interdigitated suture between the scapula and coracoid, such as in *M. hoffmanni*. This is the first unequivocal record of this taxon from Russia.

The length of the skull is more than 1700 mm, which implies that the total length of the animal should be approximately 17 m (if we use the well-known *M. hoffmanni* head-to-body ratio of 1:10). This makes *M. hoffmanni* from Penza one of the largest mosasaurs known.

Technical Session II (Wednesday, November 5, 2014, 11:45 AM)

MORPHOLOGICAL DISPARITY PATTERNS OF CRETACEOUS AND EARLY PALEOCENE THERIANS

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The end-Cretaceous extinction of non-avian dinosaurs opened ecological niche space that was subsequently exploited by Cenozoic mammals. However, some evidence suggests mammals began to diversify prior to the Cretaceous–Paleogene (K–Pg) boundary (66 million years ago). Diversification of mammals into new ecological niches would have led to a greater variety of diets, and, consequently, an increase in morphological disparity of molars. To assess the possibility that mammals began to diversify prior to the K–Pg boundary, we examined morphological disparity patterns of Cretaceous and early Paleocene therians, the mammal group that gave rise to diverse placentals and marsupials. Two-dimensional landmark data from occlusal surfaces of individual lower molars belonging to 105 crown therian and stem tribosphenidan genera were studied using geometric morphometric techniques, including a Procrustes analysis and principal components analysis. Therian genera were assigned to time bins based on the temporal range of their fossil occurrences, and morphological disparity of molar shape was calculated for each time bin. To explore evolutionary trends on a regional scale, taxa from North America and Asia were separated and results were considered

independently for the two continents. To account for morphological features not captured by two-dimensional geometric morphometrics, supplemental measures of therian disparity were obtained from body mass estimates and ratios of cusp height-to-tooth length. Results indicate that morphological disparity was low for both North American and Asian taxa during much of the Cretaceous and then experienced a rapid increase during the Campanian (84–72 million years ago). Results based on the global data set show a decrease in disparity during the Maastrichtian (72–66 million years ago) that is followed by an increase in the early Paleocene, but results based solely on North American taxa suggest that disparity continued to increase during the Maastrichtian. This difference may be due in part to the Maastrichtian fossil record being dominated by North American fossils, resulting in Maastrichtian disparity values that are less reflective of a global trend. Based on the current fossil record, it is concluded that therian mammals experienced morphological diversification during the Late Cretaceous, although it remains uncertain as to whether this diversification trend was maintained until the K–Pg boundary.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

CRANIAL BONE HISTOLOGY OF *METOPOSAURUS DIAGNOSTICUS* (AMPHIBIA, TEMNOSPONDYLI) FROM THE LATE TRIASSIC OF POLAND

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Up until now, histological studies of temnospondyls have focused mainly on the long bones, ribs, and vertebrae. Little information is known about the skull histology. For the first time, we present the histological analysis of all bones from one *Metoposaurus* skull. The well-preserved skull (40 cm length) was examined using 30 thin sections in order to describe the histological variability and biomechanical properties of different regions of the skull. Interpreting variation in mechanical loading of the skull regions may help explain different feeding adaptations among temnospondyls. The bone loses strength and stiffness with increasing porosity; this can be partly compensated by increasing the thickness of the bone. The bones of the skull roof show a homogeneous diploë structure with a thick external cortex consisting of well-vascularized (vascular canals present mainly in high sculptural ridges) parallel-fibered bone; a trabecular middle region; and an almost completely avascular thin, parallel-fibered internal cortex. Lines of Arrested Growth and annuli are present in the external cortex. The trabecular middle region comprises the largest part of the bone thickness and consists of both primary and secondary osteons. The thickness of most dermal bones is uniform, at about 5 mm, except the posterior areas of the skull where the bones are up to 12 mm thick. The bones from the anterior and posterior regions have the best histological properties to resist biomechanical forces. The premaxilla, maxilla, and lacrimal have the proportionally thickest middle region but are less porous than the bones of the central area of the skull. The postparietal, tabular, and quadratojugal are thicker and less porous, which would increase their stiffness and strength. Dense bundles of well-mineralized Sharpey´s fibers suggest muscle attachment. Thus, based on these properties, these bones may have played a main role during feeding and prey capture. Bones next to the sagittal axis of the skull and from the palate are the weakest, with relatively thin cortices and a middle region with large erosion cavities up to 3 mm in diameter. In contrast to the dermal bones of the skull, the quadrate and exoccipital develop from a cartilaginous precursor, as evidenced by numerous remains of calcified cartilage in the central parts of both bones. Well-mineralized Sharpey"s fibers are densely packed in thick bundles, with the most numerous in the exoccipital. Thus, strong skeletal muscles and tendons were likely attached and possibly played an important role during mouth opening.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE FIRST PHYLOGENETIC ANALYSIS OF A CAIMANINE CROCODYLIAN FROM THE EOCENE OF LAREDO, TEXAS

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Living caimans (Caimaninae) are found in South and Central America and, considered in isolation, suggest a single dispersal event from a North American ancestor, but their fossil record suggests a more complex biogeographical history. A three-dimensionally preserved skull table and braincase from the middle Eocene (Uintan) Laredo Formation of Texas represents a new caimanine based on the presence of abrupt supratemporal fenestral rims, a large supraoccipital exposure on the skull table, and a linear frontoparietal suture - all derived states diagnosing Caimaninae or subordinate clades. The supraoccipital exposure on the skull table is smaller than for other caimans of similar size, and the lateral margins of the skull table are bowed outward, a feature more commonly found in much smaller and ontogenetically younger caimanines. Although its placement in Caimaninae is robust, its incompleteness renders its precise placement within the group unclear. Maximum parsimony analyses place it as closely related to either the bizarre *Purussaurus* from the Miocene of South America or in a clade including the living dwarf caimans, *Paleosuchus*, and the North American early Eocene caiman *Tsoabichi greenrivernesis*. All of the trees recovered in our analysis support a complex biogeographical scenario involving a minimum of two dispersals between the Americas during the Paleogene, and some topologies hint at a third, further complicating the history of early caimanines. This is also one of the youngest North American caimanines and occurs at a critical stage of North American crocodyliform history, when high-diversity assemblages of the early Paleogene changed to depauperate faunas including only one or two species following the transition from hothouse to icehouse conditions in the late Eocene.

Symposium 3 (Friday, November 7, 2014, 8:45 AM)

COMBINING LIVING AND FOSSIL TAXA INTO PHYLOGENIES: THE MISSING DATA ISSUE

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Living species represent less than 1% of all species that have ever lived. Ignoring fossil taxa may lead to misinterpretation of macroevolutionary patterns and processes such as trends in species richness, biogeographical history, or paleoecology. This fact has led to an increasing consensus among scientists that both fossil and living taxa must be included in macroevolutionary studies. One approach, the Total Evidence Method, uses molecular data from living taxa and morphological data from both living and fossil taxa to infer phylogenies with both fossil and living taxa at the tips. Although the Total Evidence Method seems very promising, it requires a lot of data and is therefore likely to suffer from missing data issues which may affect its ability to infer correct phylogenies.

In this study we assess the effect of missing data on tree topologies inferred from total evidence supermatrices. Using simulations we investigate three major factors that directly affect the completeness of the morphological part of the supermatrix: (1) the proportion of living taxa with no morphological data; (2) the amount of missing data in the fossil record; and (3) the overall number of morphological characters in the supermatrix. We find that, in a Bayesian framework, difficulties in recovering a stable topology are mainly driven by the missing data in the molecular part of the matrix (for which fossil taxa have no data). In a Maximum Likelihood framework, however, topology is not directly affected by missing data per se, but by the number of morphological characters shared among the taxa. Therefore, the two main drivers of incorrect topologies are the overall number of morphological characters and the number of living species with no morphological data.

Our results suggest that, in order to use total evidence methods, one should reduce the missing data in the morphological part of the supermatrix for living species and use a Maximum Likelihood framework to fix the topology prior to the overall Bayesian phylogenetic inference process. We apply our method to a comprehensive data set of both living and fossil primates. We find that using this integrative method modifies previous estimates of rates of body mass evolution within primates emphasizing the importance of using such methods.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

PLEISTOCENE BATS FROM OLDUVAI GORGE, TANZANIA

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Olduvai Gorge in Tanzania is famous for having produced Pleistocene fossil hominins including *Paranthropus boisei* and several species of *Homo*. In 1960, one of us (PMB) was sent a collection of fossil bat material from Olduvai Bed 1 (ca. 1.85 Ma, *Zinjanthropus* layer) by Louis Leakey. This collection consists of 40 specimens including seven partial jaws, 27 humeri, and six other postcranial elements. A new appraisal of this assemblage shows that it includes representatives of five bat families: Myzopodidae (1 sp. nov.), Megadermatidae (1 sp. nov.), Miniopteridae (1 sp.), Molossidae (1 sp.) and Vespertilionidae (5 sp., 2 sp. nov.). All of these families, except Myzopodidae (Madagascar only) are present in Tanzania today. The Olduvai megadermatid represents a new species of *Cardioderma*, differing from extant *C. cor* in being larger, and in having P4 with larger styles, M1-2 with more robust mesostyles, deeper labial fossae and a deeper trigon basin, and lower molars with broader talonids and more robust and prominent metaconids. The miniopterids from Olduvai are known by one jaw with a p3 and five humeral fragments, all of which are consistent in morphology with *Miniopterus schreibersi*, present in Tanzania today. Olduvai molossids are represented by five humeral specimens, one being complete. Morphologically they are nearly identical to *Tadarida fulminans*, the only *Tadarida* species known from Tanzania. Olduvai vespertilionids include species of *Pipistrellus*, *Myotis*, *Eptesicus*, *Scotoecus*, and *Nycticeinops*. *Myotis* (one) and *Pipistrellus* (two) are poorly represented by fragmentary humeral specimens and it is not possible to assign these to any particular species. *Eptesicus* is represented by a single right distal humerus that is virtually identical in size, proportions, and morphology to *E. isabellinus*, a species only known from Europe today. *Nycticeinops* from Olduvai is similar to the only living species of the genus, *N. schlieffeni*, but differs in being larger, in having p4 taller and narrower, m1 with a more curved paracristid, a lower hypoconulid and a deeper talonid, and m3 with a heavier anterolabial cingulid, suggesting that it represents a new species. The Olduvai *Scotoecus* species differs from the extant Tanzanian species, *S. hindei* and *S. albofuscus* by c1 lacking lingual basal cuspules and having a longer posterior shelf, p2 lacking an anterolingual protrusion, p4 similar in size to p2 and lacking an anterolingual extension of the lingual cingulid, and m3 lacking a hypoconulid and having a lower hypoconid and entoconid.

Technical Session VIII (Thursday, November 6, 2014, 3:45 PM)

ECOLOGY AND TAXONOMY OF MESSEL BATS

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To date, seven fossil bat species, each filling a specific ecological role, have been recognized from the Messel Pit locality in Germany (middle Eocene, Lutetian). The only bat known from Messel that represents a modern family, *Tachypteron franzeni* (Emballonuridae), previously expanded the ecological range of this spectacularly preserved faunal assemblage towards that of extreme extant specialists adapted for rapid flight at high altitudes.

Dentitions of Messel fossils are often in occlusion, obscured by wing elements, or hidden by the plate itself and thus cannot be directly studied. In order to access morphological attributes more fully we utilized high-resolution micro-CT technology. With these new CT-scans we were able to measure different proportions of wing bones in order to assess flight capabilities of many more Messel fossil bats (e.g. aspect ratio, tip index, details of the shoulder joints). This, in turn, has enabled us to more precisely partition the aerial insectivore niche based on wing morphology of the oldest known ecologically balanced bat community.

Recently, many exceptionally small specimens of *Palaeochiropteryx* have been discovered among the Messel collections, suggesting the existence of at least one

'hidden' species besides the two already known (*P. tupaiodon* and *P. spiegeli*). This new bat does not differ substantially in dental characters from either of the other two known species. Confusion in earlier studies about differing dental characters in *P. tupaiodon* and *P. spiegeli* is now shown to instead reflect a continuous range of variation in dental morphology across all three *Palaeochiropteryx* species.

Interestingly, the new small *Palaeochiropteryx* species extends the ecological spectrum of Messel bats in yet another direction, towards extremely small and agile flyers, These bats appear to have occupied an ecological niche similar to extant hipposiderid or rhinolophid bats, thought to be among the most specialized of living taxa. Data from this and other species suggests that habitat utilization by the Messel bat fauna was more complex than previously thought.

Symposium 1 (Wednesday, November 5, 2014, 9:45 AM)

RECONSTRUCTING LOCOMOTOR PERFORMANCE IN *ARCHAEOPTERYX*

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Locomotor performance in *Archaeopteryx* continues to be a controversial topic in the literature. I revisit the problem of locomotor performance in *Archaeopteryx* by comparing several aspects of bone and wing morphology to a comparative database of morphology compiled from modern bird taxa. I utilized bone cross sectional properties, feather structure, wing morphology, and muscle mass estimation to reconstruct plausible locomotor behavior for *Archaeopteryx*. Of special interest is the Munich specimen BSP 1999 I 50, for which direct measurements of cortical bone thickness were taken from long bones in both the forelimb and hind limb. Based on a body mass of 250 grams, relative failure force was 13.17 body masses for the femur and 4.15 body masses for the humerus. Based on these calculations, the femur in *Archaeopteryx* was stronger than would be expected for a modern flying bird of similar body mass, while the humerus was significantly less robust than would be expected for a living flying bird of the same mass. The feather structure of the primaries in *Archaeopteryx* also differ from what would be expected in a volant animal. Vane asymmetry ratios for the primary feathers fall near 1.44:1 and the rachises are relatively narrow. Fluid theory predicts that these traits would make the feathers aeroelastically unstable and also prone to aerodynamic wash-in instability. This would not, however, prevent the wing from producing relatively high forces for brief intervals. Bone section moduli, wing shape, and feather traits in *Archaeopteryx* show similarities to some secondarily flightless birds that retain partial functionality of the forelimbs in locomotion (such as in wing-assisted escapes over water and other difficult terrain). These 'semi-aerial' locomotor modes require relatively modest amounts of pectoral power, since they do not involve a positive rate of climb. The similarities between *Archaeopteryx* and living flightless birds with wing-assisted locomotion may point to an incipient flight stage in *Archaeopteryx* and are consistent with hypotheses that such 'semi-aerial' behaviors were involved in the evolution of the avian flight stroke. Alternatively, *Archaeopteryx* may have been secondarily flightless.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

INDENTATION HARDNESS OF TOOTH ENAMEL OF MULTIPLE MAMMALIAN SPECIES AND THE ROLE OF ENAMEL MICROSTRUCTURE ON DENTAL WEAR MECHANICS

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Microwear has been used extensively to test hypotheses about paleodiet, though it relies on numerous poorly tested assumptions. One assumption that has gotten recent attention is the hardness of potential sources of abrasion, including phytoliths, which range from 18.0 to 191.5 Vickers hardness value (HV). The other two parts of the contact mechanical event, the upper and lower occluding teeth, are often treated as if enamel has identical material properties among species. Enamel microstructure exhibits a variety of complex organizational patterns, some of which are interpreted as increasing resistance to crack propagation, increasing its fracture toughness. We tested the Vickers indentation hardness of a number of taxa, including perissodactyls (*Ceratotherium, Tapirus, Equus*), artiodactyls (*Bos, Odocoileus, Sus*), an afrothere *(Procavia),* a carnivoran (*Canis*), a primate (*Homo*), and a marsupial (*Didelphis*). Indentation hardness was tested using a Buehler Micromet 5.1 microindentation hardness tester, making nine to eleven indents on the buccal enamel of the crown for each sample, then analyzed with descriptive statistics and an ANOVA ($p < 0.001$). Mean hardness values for species with radial enamel and the simplest Hunter-Schreger bands (HSB) were similar (*Didelphis*, 291.3 Standard Deviation (SD):19.5; *Bos*, 271.6 SD:16.7 *Odocoileus*, 315.5 SD:9.4 *Equus*, 319.8 SD:22.5; *Canis*, 308.3 SD:26.5). *Homo* and *Sus* had an intermediate hardness (*Homo*, 333.2 SD:20.3; *Sus*, 344.5 SD 34.5), reflecting their more complex HSB enamel microstructure. The hardest enamel types are those with the most complex specializations of enamel microstructure, undulating and vertical Hunter-Schreger bands (*Tapirus*, 362.3 SD:16.5; *Ceratotherium*, 364.3 SD:28.2), suggesting that these enamel microstructure specializations increase their overall resistance to indentation. Our prior investigations of ingesta indicate that of the two commonly ingested materials hypothesized to be abrasive agents (phytoliths; 18–191.5 HV) and abiogenic grit (sand and rocks, often siliciclastic: 1200 HV), grit is much more likely to indent enamel than phytoliths, even among those mammals with the simplest prismatic enamel. It is unclear why *Procavia*, which has radial enamel, had such high hardness values (375.5 SD:14.1). Further sampling of regions of different enamel microstructure within teeth are needed to understand the role of enamel microstructure on enamel hardness and the mechanics of wear.

Technical Session II (Wednesday, November 5, 2014, 12:00 PM)

PALAEOCENE TAXA SUPPORT A CRETACEOUS ORIGIN AND CENOZOIC DIVERSIFICATION OF PLACENTAL MAMMALS

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The end-Cretaceous mass extinction is traditionally considered to be a turning point in mammalian evolution. After the extinction, it is thought that placental mammals underwent an adaptive radiation, exploiting the newly opened ecospace resulting from the extinction of many groups, including non-avian dinosaurs. Counterintuitively, several recent studies of evolutionary rates during this interval have concluded that the extinction had little to no significant effect on rates of character evolution. These studies, however, include little data, if any, from fossil taxa that occur just after the Cretaceous-Palaeogene (K/Pg) boundary, relying largely or solely on extant and Cretaceous taxa. Here, we used branch sharing methods to date a new phylogeny of 174 eutherian mammals, which contains the largest sample of Palaeogene taxa (129 genera) to date, as well as 28 Cretaceous taxa. Uncertainties in first appearance dates were accounted for by randomising dates within stratigraphic ranges. Rates of discrete character evolution were calculated for each branch by taking number of changes under ACCTRAN, DELTRAN and unambiguous optimisations and dividing by branch duration. We identified branches for which the observed amount of change was significantly greater than expected by a clocklike model, and assigned branches to one million year bins. We find an increase in the proportion of branches with significantly high evolutionary rates associated with the end-Cretaceous mass extinction, and a dramatic increase in absolute rate of evolution per unit branch length. Almost 50% of branches in the first two million years of the Palaeocene have significantly more evolutionary change than expected, indicating an increase in evolutionary rate consistent with an adaptive radiation across placental mammals coincident with the K/Pg boundary, but not with the origin of Placentalia, which was resolved in the Late Cretaceous. The spike in rates drops off quickly; only 12.5% of Eocene branches have significantly higher rates. An earlier spike in rates was identified in the mid-Early Cretaceous, associated with the diversification of zalambdalestids and asioryctitheres. The difference between these results and analyses that found no change in rates associated with the K/Pg boundary can be confidently attributed to the exclusion of Palaeocene mammals from those analyses. Evidence from taxa that were present in the first few million years of the Cenozoic unambiguously supports a Cretaceous origin but dramatic Palaeocene diversification for crown Placentalia.

Education and Outreach Poster Session (Poster displayed November 5 – 8)

DINOSAURS & CAVEMEN SCIENCE EXPO: SCIENCE OUTREACH USING INTERACTIVE AND EXPERIENTIAL ANATOMICAL LEARNING

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Few subjects inspire interest in STEM topics as much as Astronomy and Paleontology. Stars and planets and fossils and anatomy are irresistible draws for eager students and families who want to discover how the planet, environment, and its living beings interact over time. Recognizing the inherent fascination of these subjects, the Integrative Anatomy and Physical Anthropology Programs at University of Missouri have collaborated with the Columbia, Missouri Public Schools Planetarium to create the "Dinosaurs and Cavemen Science Expo," an afternoon of science exploration that includes film, exhibits and activities relating to planetary change, fossils, and evolution. Given the current political climate surrounding K–12 science curricula, the expo offers a unique experience for all life-long learners and helps ensure that each new generation of students is immersed in a well-founded science education.

For the past two years, approximately 25 faculty, graduate and undergraduate students from MU Integrative Anatomy and the MO Public Schools Planetarium have co-hosted this expo, which is geared towards K–12 students. Rock Bridge High School Planetarium screens the movie "Earth's Wild Ride," a short film that focuses on major changes during the Earth's history including the Late Cretaceous mass extinction and the Late Pleistocene glaciation; hence, "Dinosaurs and Cavemen." Outside the theater are numerous hands-on activities and exhibits including "Footprints and Trackways," where students create dinosaur and hominid foot impressions on a paper trackway, "Dig a Dinosaur," where students pretend to excavate buried skeletons, and "Little Lascaux," where students use stencils or their imagination to design cave art. There are also opportunities for attendees to test their knowledge of fossils, the fossil record, and anatomy, including the tables "What's a fossil?", "Everything Tyrannosaur," "Cretaceous Fauna," "Extinction Survivors," and "Human Ancestors." Finally, posters highlighting recent MU research findings are prominently displayed so that researchers can share their work with the public. Uniting all of these activities is a keepsake Paleo Passport, a passport sized, interactive booklet that children can have 'officially' stamped at each activity they visit.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

INTRASPECIFIC VARIATION OF *SAYIMYS GIGANTEUS* ALLOWS FOR TAXONOMIC REVISION OF *SAYIMYS* AND URGES THE USE OF CAUTION WITH CLADISTICS

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Over the last decade, fossil teeth from various European and Asian sites have been ascribed to the ctenodactylid *Sayimys*, an extinct gundi (rodent). This often involved the definition of new species and using cladistic analysis to reconstruct relationships between the various species of *Sayimys* and the genera within the Ctenodactylinae. However, these reconstructions are not unambiguous, and in some of these *Sayimys* appears to be paraphyletic.

Our research focuses on a collection of over 300 fossil teeth of *Sayimys giganteus* found in Keseköy (Turkey). This large collection, including jaw fragments, enables us to redefine *S. giganteus*. Moreover, the observed intraspecific variation within this collection allows us to review the taxonomy of all species within *Sayimys*. This has resulted in a number of taxonomic emendations involving the reinstatement of the species *Sayimys minor*, the definition of a new species of *Sayimys*, and the synonymy of *Sayimys baskini* and of *Sayimys assarrarensis*.

The new data are used to perform a more thorough cladistic analysis and the construction of a cladogram for the genera and species within the Ctenodactylinae. Reconstructing phylogenetic relationships based on our data and reviewing other cladistic analyses has exposed some major pitfalls in using cladistics for reconstructing relationships between species based on fossil teeth.

The inferred phylogenetic relationships and biogeographic distribution of the various *Sayimys* species show the development of an independent lineage of *Sayimys* species in Pakistan. This lineage includes the last surviving *Sayimys* (present until ~9 Ma) after all other West-Asian and Anatolian species go extinct during the Middle Miocene Climate Transition at ~14 Ma.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A NEW FOSSIL SKELETON FROM THE LOWER JURASSIC NAVAJO SANDSTONE, SOUTHEASTERN UTAH

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The Early Jurassic documents recovery from the end-Triassic mass extinction and the diversification of taxa that dominated non-marine ecosystems for the rest of the Mesozoic. The Lower Jurassic Navajo Sandstone in southeastern Utah yields an important assemblage of Early Jurassic terrestrial vertebrates and invertebrates in an eolian paleoenvironment. Vertebrate body fossils are very rare in the formation (less than 10 specimens known), and comprise tritylodnotid cynodonts, crocodylomorphs, and sauropodomorph dinosuars. We report the discovery of a new articulated tetrapod skeleton found in the Navajo Sandstone just east of Moab, Utah. The specimen is preserved as natural molds in two adjoining blocks of sandstone. To better understand the skeletal morphology of the specimen, we CT scanned both blocks at the University of Utah Hospital,using a Siemens SOMATOM Definition 128 slice dual CT scanner, with an interslice thickness of 0.6 mm. We used these scans to make a digital cast of the natural mold on the surface of one block, which displayed the dorsal vertebral column, ribs, and portions of the radius and ulna. The CT scans further reveal that hidden in the blocks are molds of a large elongate manus articulated with these limb bones, as well as further parts of the vertebral column. Our current hypothesis is that this skeleton is most likely that of a tritylodontid cynodont, but confirmation awaits the identification of unambiguous synamorphies. These data reinforce the importance of non-destructive three-dimensional digital imaging in elucidating fossil specimens that are traditionally difficult to study (e.g., natural molds).

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

FUNCTIONAL MORPHOLOGY OF HOOF-LIKE DISTAL PHALANGES OF *BOVERISUCHUS* (CROCODYLIFORMES) FROM THE MIDDLE EOCENE OF GEISELTAL, GERMANY, USING 3D GEOMETRIC MORPHOMETRICS

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Crocodyliforms have often been regarded as 'living fossils' that have remained essentially unchanged aquatic predators for hundreds of millions of years. However, the fossil record of crocodyliforms has shown their remarkable ability to adapt to new environments. Unusual morphology in certain Paleogene crocodyliforms has led some researchers to hypothesize that some groups had adapted to a notably terrestrial habitat. However, terrestriality in these crocodyliforms has not been critically analyzed in this context. As a result, other researchers have retained the 'living fossil' concept of these crocodyliforms and support that these are still largely aquatic animals.

Modern three-dimensional methods such as geometric morphometrics facilitate the quantitative analysis of the function of morphological features. In order to better evaluate the potential for terrestrial adaptation in crocodyliforms, we studied the morphology of the unusually rounded and flattened distal phalanges, or unguals, of *Boverisuchus* from central Europe. This taxon, formerly called *Pristichampsus*, has been interpreted as terrestrial based in part on these unguals. Using a Phoenix X-ray Nanotom we obtained 3D surface models from fossil unguals of *Boverisuchus*, fossil and modern aquatic crocodyliforms, and a known cursorial animal, the primitive horse *Propalaeotherium*. This early horse possessed a primitive form of hoof, and provides an example of morphology from a highly terrestrial animal living at the same time. All fossils were collected from the middle Eocene Geiseltal Fossil Lagerstätte near Halle, Germany. We assigned 3D landmarks on a total of 36 specimens and conducted a principal components analysis to evaluate similarity of shape.

Propalaeotherium unguals occupied distinct morphospace with low scores for principal components 1 and 2, as compared to higher scores in crocodyliforms. *Boverisuchus* occupied distinct morphospace that was intermediate between *Propalaeotherium* and other crocodyliforms. Like *Propalaeotherium*, the unguals of *Boverisuchus* are anteroposteriorly shortened with a rounded anterior margin. However, their dorsoventral tapering is more characteristic of the other crocodyliforms. The intermediate ungual shape of *Boverisuchus* between that of typical aquatic crocodyliforms and the cursorial *Propalaeotherium* indicates a functional adaptation toward a terrestrial habit. This adds further support for the non-aquatic lifestyle of *Boverisuchus* as well as for the adaptability of crocodyliforms to terrestrial habitats.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

PALEOECOLOGICAL INSIGHTS FROM DENTAL MICROWEAR TEXTURES OF EXTINCT XENARTHRANS DURING GLACIAL AND INTERGLACIAL PERIODS IN PLEISTOCENE FLORIDA

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Extinct xenarthrans represent a diverse lineage of mammals whose lack of modern analogues on the basis of size, geographic range, and ecology can hamper our ability to fully understand their paleoecology. Further, the anatomy and physiology of xenarthrans can confound the results obtained from traditional proxies such as stable isotope geochemistry or dental microwear. However, examination of microwear from extant xenarthrans has increased our understanding of how dentin microwear corresponds to diet. This allows us to apply dental microwear texture analysis, a method quantifying microwear in three dimensions, to fossil xenarthrans. We examined one pampathere (*Holmesina*) and three ground sloths (*Eremotherium, Megalonyx, Paramylodon*) from fossil sites in Florida representing both glacial (Inglis 1A) and interglacial (Leisey Shell Pit 1A) periods during the Pleistocene and also compared these to extant xenarthrans. Our results indicate that there are no substantial changes in dental microwear textures of dentin within a single genus between glacial and interglacial periods. Between ground sloths, differences in dental microwear attributes were minimal. *Paramylodon* had higher anisotropy than *Megalonyx*, suggesting the consumption of tougher food items. *Holmesina* differed significantly from ground sloths in a variety of attributes (anisotropy, complexity, and textural fill volume), and exhibited substantial variance in complexity, indicating that they may not have been obligate grazers as previously suggested and instead consumed a variety of food items with different textures. *Holmesina* microwear is also significantly more complex and has higher textural fill volume than modern sloths and armadillos, indicating that they likely consumed more brittle food items and possibly occupied a niche no longer filled by extant xenarthrans. As dentin microwear does not record features the same way as enamel, and can only reveal broad differences in diet, these results should be interpreted cautiously; however, dental microwear textural data do suggest there was substantial overlap in the consumption of food items with similar textures between sympatric ground sloths.

Technical Session XI (Friday, November 7, 2014, 2:00 PM)

CHARACTERIZING ISOTOPIC VARIABILITY OF RODENTS ON LOCAL AND REGIONAL SCALES IN CENTRAL NORTH AMERICA: IMPLICATIONS FOR RECONSTRUCTING PALEODIETS AND HABITATS

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Small mammal faunas in the Great Plains record evolutionary and ecological changes in response to the evolution of C_4-dominated grasslands and long-term regional and global climatic changes. Carbon isotope compositions ($\delta^{13}C$ values) from these faunas provide a means to reconstruct food resource utilization by small bodied consumers in spatially heterogeneous habitats, but interpretation of $\delta^{13}C$ values of extinct species in such environments is difficult without understanding isotopic variation in comparable modern settings. We address this by measuring carbon and nitrogen isotope values in hair from rodent consumers at spatial scales ranging from local (macrohabitats) to regional (southern Great Plains). At the local scale, we sampled hair of live-trapped individuals in three macrohabitats that vary in abundance of C_3 (trees, shrubs, herbs, cool-growing season grasses) and C_4 (warm-growing season grasses) biomass: southwestern Kansas (sagebrush grasslands, riparian woodland), northwestern Nebraska (mixed shortgrass prairie), and northern Minnesota (coniferous forest as a C_3 only end member). At the regional scale, we sampled hair of modern museum specimens (n = 373) of 14 rodent species with distributions across the southern Great Plains. For each species, sampled specimens were uniformly spaced though the geographic range to randomly sample the landscape, and $\delta^{13}C$ values were compared to regional C_4 abundances and other potential spatial covariates. C_3 resources are the dominant energy source for most consumers, however, at the local scale, C_4 utilization increases with macrohabitat C_4 abundance. Pairwise Mann-Whitney U tests of mean small mammal $\delta^{13}C$ values (Minnesota = -27.0 ± 1.2, n = 84; Nebraska = -26.1 ± 1.7, n = 48; Kansas = -19.1 ± 3.0, n = 107) indicate the proportion of C_4-based resources increases in small mammal diets with increasing C_4 abundance on the landscape from Minnesota to Kansas. At both the local and regional scale, Pairwise Mann-Whitney U tests of $\delta^{13}C$ values grouped by species and trophic categories indicate statistically significant differences among species and trophic categories. At the regional scale, some species incorporate more C_4 resources with increasing C_4 abundance on the landscape. Higher level consumers integrate macrohabitat signatures of both primary producers and lower level consumers. Small mammal diets generally reflect macrohabitat and regional C_3 and C_4 plant abundances, but the environmental signal is biased towards C_3 resources and potentially modulated by trophic level.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

GIGANTISM OF STEGOSAURIAN OSTEODERMS

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Stegosaurs have evolved huge and/or bizarrely shaped osteoderms. Despite a long history of stegosaurian research, it remains controversial how their osteoderms evolved to extreme size and what their functions were. This controversy may be due to the focus of most previous studies only on the North American genus *Stegosaurus*. In this study, we explored the maturation of osteoderms of several stegosaurs with respect to body growth to understand the developmental process and the possible function of these osteoderms. Bone growth of both the skeleton and osteoderms was analyzed using thin sections from different sized osteoderms of the stegosaurs *Stegosaurus*, *Kentrosaurus* and *Miragaia* and compared with osteoderm growth of the ankylosaur *Pinacosaurus* and of living alligators as the outgroup.

The histological comparison between the body skeleton and osteoderms of the large-plated stegosaur *Stegosaurus* shows that the osteoderms continue to grow well after skeletal maturity has been reached. In contrast, the small-plated and/or spiked stegosaurs *Miragaia* and *Kentrosaurus* respectively, show delayed timing of growth of the skeletal elements relative to the osteoderms. Additionally, late juvenile ankylosaurs of the genus *Pinacosaurus* lack large postcranial osteoderms. This developmental delay of osteoderm formation with respect to the body skeleton is similar to that of living alligators. Contrary to this, a juvenile large-plated *Stegosaurus* already has well-developed dorsal plates.

In terms of evolutionary heterochrony, these observations indicate predisplacement and hypermorphosis in large-plated stegosaur osteoderm evolution (as in *Hesperosaurus* and *Stegosaurus*), but the change did not occur in small-plated stegosaurs. In Stegosauridae, the plesiomorphic condition is smaller osteoderms. The growth of the osteoderms in *Miragaia* and *Kentrosaurus* contrasts with that documented for *Stegosaurus*, as the timing of growth of osteoderms is accelerated relative to the skeletal elements in the latter. The increasing size and ability of the plates to function as display organs from *Miragaia* to *Stegosaurus* may account for these growth history variations.

Symposium 5 (Saturday, November 8, 2014, 4:00 PM)

HERPETOMETRICS: TESTING SIZE-BASED METABOLIC THERMOMETRY OF RECENT AND FOSSIL COLUBROID SNAKES ACROSS NORTH AMERICA

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Body size is a primary ecometric variable for examining the relationship between organism and environment, and the constraints of mass specific metabolic rate and ambient temperature on body size accurately predict maximum size for a given minimum environmental temperature in extant poikilotherms. This relationship has been extended to infer paleotemperatures based on body sizes of fossil taxa (metabolic paleothermometry), but the fundamental assumptions of the thermometric model, including conservation of both metabolic rates and thermal ecology, have not been tested for large diverse clades. As a result, extreme physiological and ecological novelty in response to climate maxima and minima has the potential to strongly misestimate paleotemperature. To test the effects of extreme ecometrics, we modeled maximum body size (measured as Snout Vent Length, SVL) changes with ambient Mean Annual Temperature (MAT) for extant North American colubroid snakes using the largest, most cold-tolerant taxon, *Thamnophis sirtalis parietalis* from Manitoba, and the largest, heat-tolerant taxon, *Drymarchon couperi* from Florida as separate calibration points. We then compared these models to maximum SVLs for colubroids from the modern Great Plains, and the Miocene fossil record of Nebraska.

Differences in model temperature values between the two taxa ranged from approximately 12°C at smallest body sizes (SVL =10-60 cm) to 3.4°C at larger sizes (SVL > 200 cm). Overall, the *Drymarchon* model performed better at estimating size-temperature relationships across North America, especially for larger taxa. The comparatively poor estimation from *T. sirtalis* likely reflects its unique adaptations to extreme cold, including short annual activity cycles and elevated metabolic rates; however, the *Thamnophis* model more accurately predicted the maximum SVL-MAT relationship for the largest extant Great Plain colubroid (*Pituophis cantifer*). Application of both models to estimated maximum SVL for a well-preserved colubroid record from the middle Miocene (Clarendonian) Ashfall site of Nebraska resulted in minimum MATs equivalent to or slightly higher than modern temperatures (8-10°C) for the *Drymarchon* model, but implausibly lower for the *Thamnophis* model (-2--4 °C). These results indicate the need for careful selection in model choice for paleothermometric reconstruction. Alternate approaches, including probabilistic models incorporating species distributions may provide a more comprehensive estimate of paleotemperature for fossil reptile faunas.

Education and Outreach Poster Session (Poster displayed November 5 – 8)

AIM-UP! MUSEUM-BASED APPROACHES TO INCREASING CORE COMPETENCIES IN UNDERGRADUATE EDUCATION

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Natural history collections provide invaluable resources for undergraduate education, allowing teachers and students to explore biodiversity directly through examination of specimens and quantitative analyses of diverse specimen-associated data sets. AIM-UP! is a US National Science Foundation-funded Research Coordination Network (NSF-RCN) developed to increase awareness of natural history collections as critical resources for undergraduate education. Specific goals include: (1) training undergraduates in museum-based research; (2) developing instructional tools based on freely-accessible online museum databases; (3) informing educators at non-museum institutions regarding the instructional power of museum collections; and (4) interacting with the public to increase awareness of the educational importance of natural history museums. Preliminary data indicate that undergraduates—including students at our own institutions—are largely unaware of the immense repositories of information contained in natural history collections. To address this gap and to promote enhanced learning opportunities for undergraduates at diverse institutions, AIM-UP! is developing multiple concept-based, hypothesis-driven educational modules that allow students to use existing museum databases to explore multiple topics in biology—including biodiversity and systematics, geographic variation, genome evolution, global climate change, and co-evolutionary relationships among diverse taxa. These modules require students to engage in experiential learning activities that address core competencies in the process of science, quantitative reasoning, and statistical analysis in an interdisciplinary context. Currently in year 4 of a 5-year award, AIM-UP! modules are freely accessible online. Instructional materials are developed for 4-year undergraduate institutions as well as junior and community colleges. Because modules revolve around queries of dynamic museum databases, they can be tailored to fit specific conceptual, geographic, temporal, or taxonomic interests. Using intensive pre- and post-implementation surveys of student participants, as well as extensive interaction with instructors, we are evaluating the effectiveness and outcomes of these modules in: (1) promoting core competencies; (2) enhancing understanding of evolutionary and environmental biology; and (3) increasing awareness of the vast educational potential of natural history museums.

Technical Session I (Wednesday, November 5, 2014, 8:30 AM)

ARTIFICIAL EXTINCTION AND THE IMPACT OF MISSING DATA ON THE PHYLOGENY OF CERVIDAE (MAMMALIA, RUMINANTIA)

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Fossils with substantial missing data may impede accurate phylogenetic reconstructions, although some previous studies of missing data have shown that inclusion of incomplete taxa can be beneficial. Here we present an approach where morphological information in extant taxa is non-randomly deleted using the missing data of a fossil as template, representing genuine preservation bias.

We sampled 21 extant cervids (including all 19 living genera), plus one tragulid to root topologies, and 13 fossil cervids ranging from the early Miocene (20 Ma) until the Pleistocene (10 ka). Both living and fossil cervids are represented by 119 craniodental characters and living taxa are also represented by mitochondrial genomes and four nuclear markers. To create an artificial fossil, characters of a living taxon (the subject) were degraded to possess only characters exhibited in a given fossil (the template). This resulted in 273 (21 subjects, 13 templates) artificial fossil topologies, analysed using maximum parsimony.

The results from comparing the artificial fossil topologies with an unaltered extant combined topology based on the same data set showed that, for this particular taxon and character sample, more missing data do not necessarily lead to more topological disarrangements; even with the inclusion of taxa with more than 70 % missing data the extant combined topology could be produced at least once with each template fossil. The resolution was lost in only one third of the cases, whereas an accurate topology was established in 24 out of the 273 cases.The type of character missing seems to play a more important role than the quantity of question marks in the matrix. Adding incomplete fossils to a dataset can be beneficial, because such taxa break long branches. Based on these results and observations we encourage that decisions about inclusion or exclusion of taxa for an analyses should not be made a priori, but after reconstructing the phylogeny and evaluating the incomplete fossil appropriately according to its potential beneficial effects.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

A GEOMETRIC MORPHOMETRIC APPROACH TO QUANTIFYING THE INTERACTION BETWEEN BIOLOGIC AND TAPHONOMIC INFLUENCES ON FOSSIL SHAPE VARIATION USING *PSITTACOSAURUS*

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Two- and three-dimensional geometric morphometrics (GM) are useful tools for quantitatively characterizing shape. These techniques have only recently been applied to understanding shape variation in the fossil record of dinosaurs. The vast majority of diagnosable dinosaur taxa are known from one or two fragmentary specimens. Therefore, it is paramount to understand the range of intraspecific variation within dinosaur taxa and how shape is related to both ontogeny and taphonomy before applying GM at broader taxonomic levels, especially as previous analyses have shown that taphonomic distortion plays a large role in determining the location of dinosaur taxa in morphospace. To examine this issue, we applied GM to multiple views of the scapulae, humeri, ilia, and femora of an intraspecific sample of *Psittacosaurus lujiatunensis*. The multiple view approach permits better quantification of three-dimensional forms and should always be used when undertaking two-dimensional GM in order to account for error generated by the z-axis. Corresponding left and right elements of the same specimen often presented obvious differences in shape related to taphonomic distortion, so we created two complementary datasets: one that included both sides of the skeleton and one that only included the less deformed side. The bilateral dataset allowed us to quantify primary biological asymmetry and taphonomic distortion by calculating Procrustes distances between both sides of the same animal. We found that left-right pairs often did not plot near each other in morphospace, indicating definitive influence of taphonomic distortion on our shape data. The dataset comprising only the less deformed side provided clearer

quantification of actual ontogenetic trajectories in the sample. We evaluated this by plotting principal components (shape data) against centroid size. As expected, when correlation between shape data and centroid size was present, it was often stronger in the unilateral dataset because taphonomic effects were minimized. Still, correlations within the unilateral dataset were relatively low and suggest that other factors apart from allometry are contributing to intraspecific shape variation in our sample. Based on these results, we caution workers to consider the impact of taphonomy on shape data when using 2D or 3D GM on fossils that have undergone taphonomic distortion.

Technical Session III (Wednesday, November 5, 2014, 3:00 PM)

A BIOMECHANICAL EXPLANATION FOR THE AMPULLAE OF TYRANNOSAURID TEETH BASED UPON FRACTURE MECHANICS

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The teeth of tyrannosaurid dinosaurs possess ampullae, rounded or circular structures found in the dentin of serration interdenticle sulci. The function of these structures has been a mystery. Hypotheses include: 1) devices to stymie the propagation of carious infections and 2) serving to maintain the structural integrity of the tooth during feeding. In the latter, the ampullae are depicted as open semi-spherical voids at the end of serration channels. Presumably, they function to decrease the stress concentrations that cause cracking, thereby inhibiting fracture. We conducted a combined histological and FEM mechanical analysis of ampullae in North American tyrannosaurid teeth. The teeth were prepared in a variety of planes using standard petrographic techniques for osseous tissues. Finite element meshes were made for the regions of interest. These incorporated our findings on tissue distribution and their inferred material properties. Meshes with and without ampullae were loaded in uniaxial tension and the comparative stress distributions analyzed using modern fracture mechanics theory. Our histological results show that fractures do in fact originate between serrations, propagating through the enamel and terminating within individual ampullae. However, we found that the ampullae are solid structures and not voids, and are composed of mantle dentine. These observations necessitated a new explanation for how crack attenuation occurs in the teeth. The FEM analysis revealed that each interdenticle sulcus acts as a stress concentrator, predisposing the tooth to crack formation at these locations. After propagating through the enamel, fractures terminate within the dentin of the ampullae. We find that stress is "absorbed" by the area of low elastic modulus, inhibiting further crack growth and protecting the tooth from catastrophic failure. However, this is only one potential toughening mechanism and we propose material property testing will be needed to further evaluate the likelihood of any of these mechanisms.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

THE DISTRIBUTION OF DENTAL FEATURES IN NON-AVIAN THEROPODS AND A PROPOSED TERMINOLOGY OF THEROPOD TEETH

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Although theropod teeth are abundant vertebrate fossil remains often reported in the literature, they are not comprehensively described despite containing extensive anatomical and taxonomic information. Often, the paucity of original descriptions makes identification of isolated teeth difficult, and thus taxonomic assignments uncertain. We propose a standardization of the anatomical and morphometric terms for each tooth anatomical sub-unit, as well as a modus operandi to describe isolated teeth. Crown, carina, cervix, denticle, interdenticular sulcus, interdenticular diaphysis, flute, longitudinal undulation, marginal undulation, longitudinal ridge, basal striation, and enamel texture are anatomical terms among others proposed to describe theropod teeth. We also investigated the distribution of 30 dental characters related to tooth size, crown shape, curvature and cross-section outline, denticle size and recurvature, position and extension of carina, and enamel texture among 113 theropod taxa. Our research shows that isolated theropod teeth are more informative than previously thought. Most isolated teeth can be identified to family-level and often below that.

Functional clues for each dental feature were assessed to provide context on the degree of homoplasy relating to function. For instance, numerous transversal undulations and marginal undulations are present in non-coelurosaur averostrans and tyrannosauroids. Hypothetically, enamel undulations may have served to minimize suction when the tooth was pulled out of the flesh, to help strengthen the crown during feeding, or may be a byproduct of growth. Fluted crowns exist in mesialmost and lateral teeth of *Coelophysis*, Spinosauridae and some dromaeosaurids, being also common in piscivorous reptiles. Flutes most likely have some piercing and gripping function, allowing the sharp ridges to pierce the skin, and keeping slippery prey in the mouth. Interdenticular sulci are present in non-coelurosaur averostrans, tyrannosauroids, and dromaeosaurines. Interdenticular sulci may play several roles such as hosting septic bacteria for an infectious bite, helping the entry of venom, distributing stresses from the base of the denticle, or preventing suction when the crown was pulled out of the flesh. As a corollary, this study exposes the importance of detailing anatomical descriptions with the purpose of clarifying taxonomy and identifying isolated theropod teeth.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE EVOLUTIONARY HISTORY OF BURROWING IN NORTH AMERICAN ANURA

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Burrowing has been used by members of all vertebrate classes to avoid unfavorable climatic conditions, escape from predators, raise young and acquire food. With their extremely permeable skin, which allows for the absorption of water and oxygen from the environment, anurans are extremely susceptible to rapid dehydration when it is hot and dry. As such, many anurans use burrows either as daytime resting chambers or aestivation chambers to avoid desiccation. Anurans also use burrows as hibernation chambers in the winter to avoid freezing, lay eggs in, avoid predators, and for subterranean food acquisition.

At least two groups of anurans with a fairly decent fossil record, Pelobatidae (pelobatoids more closely related to *Pelobates*, *Scaphiopus* and *Spea* than to Pelodytidae and Megophryidae) and Rhinophrynidae, have a skeleton specialized for burrowing. Their limb bones are short and stout, especially the tibiale and fibulare, and the distal prehallux bone is modified into a distinctively shaped spade, which in life is covered by a keratinous sheath and used for digging. Rhinophrynids tend to have stouter limb bones than pelobatids, and carry a second spade on each hind foot that is derived from the distal phalanx of the first digit.

Anurans adapted to burrowing appear in the North American fossil record well before they occur in other regions of the world. Burrowing rhinophrynids first appear in the Late Paleocene of Wyoming and occur sporadically in western North America through the late Eocene. They appear at a time when the climate was becoming steadily warmer before the Paleocene-Eocene Thermal Maximum and inhabited Calf Creek, Saskatchewan, Canada, in the Late Eocene while the climate was still warm-temperate. It appears that as the climate became cooler, rhinophrynids were unable to adapt to freezing temperatures and withdrew to their current, more southerly range in seasonally dry, tropical forests in coastal lowlands from southern Texas through Central America.

When the first burrowing pelobatid appears in the middle Eocene of Nevada, the climate there was warm-temperate. This anuran most likely used a burrow as a daytime resting chamber and/or for aestivation, as their extant counterparts do. Burrowing-adapted pelobatids next occur in the early Oligocene and their record extends through the Holocene, a period in which the climate in the North American west became drier and cooler. At some point during this interval, in which extant taxa appear, pelobatids apparently developed the ability to hibernate in burrows to avoid freezing during the winter.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

FAUNAL EVIDENCE FOR HOMININ PALEOENVIRONMENT AND BEHAVIOR IN EARLY PLEISTOCENE CHINA

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The expansion of hominins into northeastern Asia has important implications regarding their abilities to adapt to and survive in new geographic and environmental settings. Evidence of this environment and the behavior of early hominins in Asia is found at the Paleolithic archaeological site of Feiliang in the Nihewan Basin of China. This is an ancient, down-faulted lake basin located approximately 120 km west of Beijing in northwestern Hebei Province. Feiliang is situated on the eastern margin of the Nihewan Basin in the Nihewan Formation and is dated to approximately 1.2 million years ago. At this time, no hominin fossils have been found at this locality, but their presence is known based on the discovery of stone tools in association with faunal remains. *Homo erectus* is suggested to be the manufacturer of these tools, as no other hominin species are known from Asia during this time period. An analysis of the faunal collection from Feiliang includes 361 mammal specimens, of which 138 are identifiable to element and 36 are identified to family level. The ungulate families Equidae, Bovidae, and Cervidae dominate the collection, although carnivore, fish, bird, and bivalve specimens are also present. The presence of *Equus sanmeniensis,* in contrast to the earlier *Hipparion,* indicates a shift to a more open, grassland environment for hominins at Feiliang. Surface damage on the fauna, in the form of cutmarks, hammerstone percussion marks, and toothmarks, indicates both hominin and carnivore involvement in the accumulation at this site. However, cutmarks are the most common form of damage observed, occurring on over 10% of specimens (n = 22) that display low to moderate weathering and retain the original bone surface layer. This proportion of cutmarks is higher than that seen at the well-preserved site FLK-22 at Olduvai Gorge, Tanzania and indicates that early hominins at Feiliang frequently supplemented their diet with meat, possibly in higher quantities or frequencies than has been observed at some African hominin sites.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

HISTOLOGICAL ANALYSIS OF AN ENIGMATIC MICROSTRUCTURAL PALEOPATHOLOGY ON LIMB BONES OF THE THEROPOD DINOSAUR *FALCARIUS UTAHENSIS*

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Over the past decade, thousands of bones of the theropod dinosaur *Falcarius utahensis* have been recovered from the Crystal Geyser Quarry (CGQ), a mass death assemblage in the Yellow Cat Member of the Cedar Mountain Formation in east central Utah. Several appendicular elements recovered from the CGQ, including a tibia, humerus, and metatarsal, display a prominent pathology, present externally in the form of a smooth-surfaced raised bone callus. The bony calluses range in size from approximately 50 to 90 mm and remain undistorted despite widespread crushing of the medullary cavity in several *F. utahensis* specimens.

Here we comparatively examine the paleohistology of an *F. utahensis* tibia exhibiting a bony callus and a non-pathological tibia of approximately the same dimensions. The non-pathological juvenile bone in *F. utahensis* is characterized by uniform fibrolamellar cortical bone tissue. The pathological bone is characterized by a distinctive microscale, reactive bone structure at the site of the morphology. This includes a cryptogenic mass/nidus that is embedded within the primary fibrolamellar bone and deep to a narrow band of secondarily deposited lamellar bone. Capping this central nidus and extending to the periosteal surface is a domed mass of reactive, rapidly deposited, secondary bone exhibiting radial vascularization. The opposing endosteal surface exhibits a highly localized region of reactionary bone.

Literature on diagnosing paleopathologies via histological analysis is sparse. However, this technique provides an independent methodology for examining bone abnormalities that can be correlated to visualizations produced by computed tomography. Additionally, paleohistological analysis of pathologies reveals the stepwise sequence of bone remodeling that may provide new insight into disease progression. No comparative

paleopathologies are yet described matching the bone signature seen in the *F. utahensis* tibia and research into contemporary osteopathologies is inconclusive. We interpret the pathology as the result of a disease process rather than an acute injury that may be widespread in the *F. utahensis* sample. Continued research on additional diseased samples may shed light on the environmental conditions leading to the deposition of the CGQ.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

COMPARISON OF DENTAL WEAR STAGES AND RECONSTRUCTION OF THE MASTICATORY MOVEMENT IN TWO BAT SPECIES (MAMMALIA, CHIROPTERA)

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Bats (Chiroptera) are the second-largest order within Mammalia with over 1100 extant species and the only mammals that developed active flight. Different feeding strategies are reflected in their diverse dentitions. Insectivorous bats, retaining the primitive feeding strategy, have a modified form of the tribosphenic molar as do many other insectivorous mammals. For a population of the extant bat *Pipistrellus pipistrellus*, six wear stages were defined based on dentine exposure on the molar surfaces and four for a sample of the Oligocene bat *Pseudorhinolophus antiquus*. The first two wear stages are characterized by punctual dentine exposure on cusps and ridges and occur in juveniles. Adult individuals are characterized by connected dentine areas forming bands as found in the third and fourth wear stages. Most of the molar surface shows wide areas of exposed dentine and the cusps as well as the occlusal relief are drastically reduced in the last two wear stages reflecting the dental condition of old (senile) individuals. The defined wear stages for *P. antiquus* are comparable to stages 3–6 of *P. pipistrellus*, juvenile individuals were not found in the Oligocene sample. The molars of both species show wear facets with striations that follow two directions, indicating a two-phased, bucco-lingually directed masticatory movement. With progressive wear and loss of relief at the molars the masticatory movement gains more freedom. This development indicates that in both species shear-cutting dominates in the early wear stages of the mastication process, whereas in later stages the crushing component becomes more dominant due to loss of structure. Average age determination from the defined wear stages shows that about 90% of the studied *P. pipistrellus* population consists of juveniles (wear stages 1 and 2). Inexperienced juveniles often invade unsuited quarters from which they cannot escape. In the case of the studied population the individuals were trapped and killed in two ventilation pipes. In the sample of *P. antiquus* wear stages 3–5 are predominantly represented (about 95%) , which indicates an adult/senile age for most of the individuals. The combination of old age and type of deposit (karstic fissure fillings) suggests that the fossil bats probably died during hibernation.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

COMPLEX DENTAL STRUCTURES IN CERATOPSIAN DINOSAURS

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Structural makeup of dentition is among the most important aspects of animalian feeding and diet selection. Mammalian groups have demonstrated a typical dental structure made up of four distinct tissues to assist with the grinding of plant material, while the reptilian condition has employed a typical dental construction of merely two tissues. It was recently discovered that hadrosaurid dinosaurs split from the primitive reptilian form to evolve a dental composition of six tissues, one of the most sophisticated known developments. Ceratopsian dinosaurs posses a dental battery and thus employ similar feeding mechanisms as hadrosaurids. With ceratopsians present within the same order (Ornithischia) as hadrosaurids, it was thought that this group might have been utilizing a dental construction of similar complexity. Histological thin sections of several shed ceratopsian teeth from the Dinosaur Park Formation have provided great insight towards this thought. It has been determined that the complexity in dental structures of ceratopsians equals the complexity seen within hadrosaurids. Six distinct tissues have been identified including enamel, mantle dentine, secondary dentine, orthodentine, coronal cementum, and giant tubules; the very same tissues to have been discovered in hadrosaurids. Scanning Electron Microscope images of the same shed teeth display cresting and differential wear patterns between the tissue types. Angular wear facets present on the grinding surfaces also provide further insight into specific dietary behaviours. Ceratopsians possess one of the most complex dental structures present within vertebrates and, paired with the hadrosaurid condition, this represents a significant phylogenetic trait.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

EVOLUTION OF THE LOWER JAW OF GNATHOSTOMES

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The origin of the lower jaw is a key innovation that underpins the adaptive radiation of vertebrates. The jaw has undergone fundamental changes to its composition and has endured major ecological changes including the transitions from water to land, from land to the air, and from land back to water. A shift in lower jaw anatomy, or rather a transformation in lower jaw shape, may have facilitated the emergence of different feeding behaviors (for example the transition from filter and suction feeding to gape feeding, durophagy, and even herbivory). Here we present an analysis to deduce the timing (geological time) and tempo (evolutionary rates) of lower jaw shape change through gnathostome evolutionary history. We achieve this via an exploration of lower jaw morphospace and an evaluation of the functional and ecological consequences of lower jaw shape variation.

Five hundred lower jaw specimens across three major evolutionary transitions (earliest jawed vertebrates to bony fish, tetrapod to amniotes, and origin of mammals) were examined. TpsDIG was used to obtain a list of XY coordinates for the morphospace, which was created using Morphologika. Mathematica was used to perform extended eigenshape analysis to quantify variation in jaw shape.

Results indicate that principal component (PC) 1 accounts for 73% of lower jaw shape variation. PC1 shape variation describes changes to the relative length of the dentary bone and robustness in the posterior lower jaw. PC2 accounts for 14.4% of lower jaw shape variation and describes differences in jaw depth and slenderness of the dentary bone (i.e., changes to the vertical height of the mandible). Acanthodians and amphibians make relatively minor contributions to overall disparity; acanthodians cluster along the PC1 axis, where the dentary bone is elongated and the back of the jaw is short, and amphibians cluster where the back of the jaw is bulky. Archosaurs are distributed mainly along the PC1 axis, but also share a region of morphospace (near the PC2 axis) with both stem amniotes and chondrichthyans. From these results, it is most likely that both ecological and functional consequences affect lower jaw shape variation and that transformation in lower jaw shape allowed different feeding behaviors to emerge.

Technical Session XIV (Saturday, November 8, 2014, 8:45 AM)

THE MOST COMPLETE, OSSIFIED HYOBRANCHIAL APPARATUS OF A FOSSIL DINOSAUR: IMPLICATIONS FOR ONTOGENY AND FUNCTIONAL ANATOMY

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Among tetrapods, the most recognizable vestige of the primitive branchial skeleton is the hyobranchial apparatus (hyobranchium), which supports the tongue and pharyngeal musculature. In many taxa it is composed mainly of cartilage, which helps to explain its poor fossil record, particularly among dinosaurs. Commonly, only a pair of rod-shaped ceratobranchial elements are ossified. Moreover, the diverse morphology of the hyobranchium has long impeded generalizations about its function.

We report here on a new subadult specimen of the ankylosaurid *Pinacosaurus grangeri* that includes the most complete, ossified, and articulated hyobranchial apparatus yet described in a non-avian dinosaur. We used computed tomography (CT) scans and mechanical preparation to fully characterize the anatomy of the hyobranchium in this specimen. The bony apparatus includes a broad, bifurcate, midline basihyal element and paired ceratobranchial rods. Additional, smaller bones may represent elements of more caudal arches. Ventral to these elements is a large, complex, arrowhead-shaped structure formed by the midline suturing of bilateral, triradiate elements. In form and location, it closely resembles the paraglossal bone of certain birds. We propose that presence of the cartilaginous precursor of the paraglossal may represent a synapomorphy of Dinosauria.

Reassessment of other fossils thought to include only ceratobranchial rods suggests that extensive ossification of the hyobranchium may be more common in Ankylosauria than previously suspected. Comparisons with extant archosaurs facilitate the reconstruction of muscle attachments, including protractors and retractors of the apparatus. The hyobranchium of ankylosaurs likely figured prominently in lingual processing of food, but may also have played a role in behaviors unrelated to feeding. The new specimen shows that the hyobranchium ossified before adulthood in *Pinacosaurus*, and illuminates developmental trends that may more broadly characterize Ankylosauria and Ornithischia. Finally, we expose the potential preservation, collection, and preparation biases that may result in the disproportionate loss of hyobranchial structures after fossilization.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

TESTING FOR PHYLOGENETIC NICHE CONSERVATISM IN THE FOSSIL RECORD OF RHINEURIDS (AMPHISBAENIA)

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Rhineurid amphisbaenians are represented by a single living species restricted to the Florida Peninsula, despite having a rich Cenozoic fossil record in North America. Such relict endemism may be the result of phylogenetic niche conservatism (PNC), the retention of ancestral traits preventing expansion into new environments. Most tests of PNC derive ancestral niche preferences from species' extant ecologies, while ignoring relevant paleontological information. To test if PNC limits the distribution of *Rhineura floridana*, we compare its current environmental preferences (temperature, precipitation and soil) to paleoenvironmental data from the rhineurid fossil record. We find no evidence of PNC in modern *R. floridana*, as it also persisted in Florida during drier glacial periods. Ancient rhineurids also exhibited broad climatic tolerances, shifting from subtropical-humid to semi-arid savanna conditions during the Eocene-Oligocene transition. However, rhineurids nearly disappear from North America following the mid-Miocene Climatic Optimum, potentially due to the onset of prolonged freezing temperatures in their western range. This physiological limitation could be interpreted as PNC for the entire family, but also characterizes much of Amphisbaenia, emphasizing the relevance of the temporal as well as phylogenetic scale at which PNC is investigated.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A COMPLETE SKULL OF *MESODERMOCHELYS UNDURATUS* FROM THE LATE CRETACEOUS (EARLY MAASTRICHTIAN) OF SUMOTO, HYOGO PREFECTURE, WESTERN JAPAN

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Mesodermochelys unduratus is a basal dermochelyid (family Dermochelyidae) turtle from the Late Cretaceous of Japan (Hokkaido, Hyogo, and Kagawa Prefectures), characterized by especially massive peripherals. Although postcranial remains of this taxon are rather abundant, its cranial element had been hitherto virtually unknown except for the lower jaw. A nearly complete skeleton of *M. unduratus* was collected from the Kitaama Formation of Izumi Group (early Maastrichtian) of Sumoto City of the

Awajishima Island, Hyogo Prefecture in 2009 by Mr. H. Matsumoto and Kishimoto. This material contains the first known perfect skull, about 160 mm long as preserved, of *M. unduratus*. This specimen shares some derived characters, such as extremely large parietal bone and the loss of a scute sulcus, with Cenozoic dermochelyids. The processus trochelaris oticum formed by quadrate and prootic is well developed, unlike in other dermochelyids. Both upper and lower triturating surfaces have prominent lingual ridges. These characters suggest *M. unduratus* had an omnivorous diet, including hard-shelled animals, largely different from the extant leatherback turtle, *Dermochelys coriacea*, which mainly feeds on jellyfish.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

CRANIOFACIAL ONTOGENY OF *CORYTHOSAURUS* AND *LAMBEOSAURUS*: TOWARDS THE ONTOGENETIC ACQUISITION OF PHYLOGENETIC CHARACTERS

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The cranial osteology of *Corythosaurus* and *Lambeosaurus* is well known; specimens have been collected since the early 20th century from the Dinosaur Park Formation (Late Campanian, Cretaceous) in Alberta, Canada. This has resulted in a high sample size: 21 specimens of *Corythosaurus* and 21 of *Lambeosaurus*. This assemblage includes two species of *Corythosaurus* (*C. casuarius* and *C. intermedius*) and two species of *Lambeosaurus* (*L. lambei* and *L. magnicristatus*). Each taxon is represented by a growth series. Previous work on growth in these dinosaurs is size-based; however, size is variable, where it does not always represent the relative maturity of an animal. Therefore, the primary goal of this project was to test the hypothesis of the congruence between size and maturity through a numerical cladistic analysis of ontogenetic characters. The secondary goals of this study were to (1) obtain a cladistic ontogeny for *C. casuarius, C. intermedius,* and *L. lambei*, (2) compare the *Corythosaurus* data matrices to investigate the ontogenetic differences between species, and (3) compare the *Corythosaurus* and *Lambeosaurus* ontogenies to recover the ancestral ontogeny of that clade. Ontogenetic characters were obtained from the primary literature, two skulls from the Field Museum of Natural History, and a cast of a juvenile *C. casuarius* skull. Data matrices were constructed in the software program MacClade 4.0; the analyses were run in Phylogenetic Analysis Using Parsimony (PAUP 4.0*). The results include: (1) hierarchical structure was recovered for each data matrix; (2) for *C. casuarius*, 11 trees of 61 steps with a CI of 0.84, where the strict consensus tree has 6 growth stages; (3) for *C. intermedius,* 1 tree of 55 steps with a CI of 0.65, where the tree has 6 growth stages; (4) for *L. lambei*, 2 trees of 74 steps with a CI of 0.72, where the strict consensus tree has 8 growth stages; (5) comparison of the growth stages of *C. casuarius* and *L. lambei* ontogenies show three unambiguously optimized ontogenetic characters seen in the ancestral ontogeny of the clade. For each species, it was found that relative maturity is not strictly congruent with size. For future work, these results provide ontogenetic changes that can be used as potentially informative characters in cladistic analyses. Also, this work provides the foundation for investigating the acquisition of phylogenetic changes in growth series.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

EXAMINING TAPHONOMIC BIAS IN THE MORRISON FORMATION (LATE JURASSIC: KIMMERIDGIAN) OF THE WESTERN UNITED STATES

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Few dinosaur-bearing rock formations in the world have been sufficiently studied so that their faunal constituents may be considered well understood. Recent study of the Dinosaur Park Formation (DPF; Late Cretaceous: Campanian) shows a statistically significant correlation between estimated body size of constituent taxa, percent completeness of the taxa, as well as estimated body size, and times of discovery and description of each taxon. Small forms were found to be less complete, and large forms more complete, suggesting a taphonomic bias against small taxa. Small taxa were also discovered and described more slowly than large ones, suggesting a sampling bias. We examined 43 dinosaur taxa of the Morrison Formation to generalize the findings reported for the DPF. Using linear regression, we found no correlation between body size and completeness in the Morrison Formation ($r^2 \approx 0$) though two groups became apparent. A two-tailed t-test revealed two statistically significant groups of taxa (greater than 60% complete and less than 30% complete) unrelated to body size. No trend emerges between time to discovery or description and body mass. Taxa of all sizes are similarly represented in each taphonomic mode (articulated, associated, isolated). We controlled for differences in temporal/geographical range using linear regression to test the correlation of body size and percent completeness of specific sites. We analyzed the data after removing sauropod taxa due to their tendency to be poorly preserved. Finally, we removed data from the initial few years of rapid discovery/description to correct for any influence that the Bone Wars of Marsh and Cope had on the data. However, all linear regression analyses supported the original findings. The differences in trends between DPF and the Morrison may be due to factors including differences in environment (DPF being a wetter environment) and higher sedimentation rates in the DPF compared to the Morrison. Further, the Morrison represents a much longer time period than the DPF (10 My in comparison to 1.5 My) and covers a greater geographic range compared to the DPF. Future analyses of other well-studied formations will help us to better understand the factors contributing to the differences between the DPF and the Morrison Formation.

Technical Session II (Wednesday, November 5, 2014, 10:15 AM)

NEW INSIGHTS FROM THE FIRST CRANIAL REMAINS OF A GONDWANATHERIAN AND IMPLICATIONS FOR MAMMALIAFORM PHYLOGENY

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The Gondwanatheria are an enigmatic clade known only from the Cretaceous and Paleogene of South America, Africa, Madagascar, India, and the Antarctic Peninsula. To date, eight valid monotypic genera have been assigned to the Gondwanatheria, six of which are divided into two families, the low-crowned Ferugliotheriidae and the high-crowned Sudamericidae, with G*reniodon sylvaticus* and an unnamed Tanzanian taxon not allocated beyond Gondwanatheria. Most of these taxa are represented by isolated teeth; the only non-dental remains of gondwanatherians consist of fragmentary dentaries attributed, in some cases questionably, to *Sudamerica ameghinoi*, *Gondwanatherium patagonicum*, *Ferugliotherium windhauseni*, and the unnamed taxon from Tanzania. No cranial or postcranial material has heretofore been assigned to the Gondwanatheria, a severe limitation that has left their phylogenetic position within Mammaliaformes uncertain and controversial. The first cranial specimen of a gondwanatherian was recently recovered from the Upper Cretaceous (Maastrichtian) Maevarano Formation in the Mahajanga Basin of northwestern Madagascar. The nearly complete and well-preserved cranium represents a new genus and species. It provides the first opportunity to include gondwanatherians in a comprehensive phylogenetic analysis based on more than dental and mandibular remains, and thus more reliably assess the position of Gondwanatheria within Mammaliaformes. The cranium reveals an extraordinary and unique mosaic of plesiomorphic and autapomorphic features. Some of the most bizarre characteristics clearly distinguishing the Malagasy taxon from other Mesozoic mammaliaforms include a massive ventral flange of the jugal, large lacrimals, strong klinorhynchy, and exclusion of the maxilla from the midline of the palate. The Malagasy taxon is nested within Gondwanatheria, supported by several dental features such as the number of upper molariform teeth, presence of furrows and infundibula, hypsodonty, and flat occlusal wear. Gondwanatheria are recognized as monophyletic and the preliminary analysis indicates a sister relationship to Multituberculata. If this is indeed reflective of the true history of these clades, then several features generally accepted as plesiomorphic within Mammaliamorpha must have re-evolved in the lineage represented by the Malagasy taxon (e.g., basioccipital wing overlapping pars cochlearis, large septomaxilla with intranarial process, single trigeminal foramen between anterior lamina and alisphenoid).

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

THE HOMOLOGY OF THE POSTPROTOCRISTA AND ITS IMPLICATIONS FOR THE EVOLUTION OF LOPHODONTY AND MOLARIZATION OF THE UPPER PREMOLARS IN PERISSODACTYLA (MAMMALIA)

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The postprotocrista is typically identified as a crest extending distolabially from the protocone of an upper cheek tooth in mammals. It plays an important role in the formation of the metaloph and in molarization of premolars. In the upper premolars of perissodactyls, two different crests have been identified as the postprotocrista, both of which may be present in the upper premolars of some taxa and therefore cannot represent the same structure. The true postprotocrista extends distolabially and connects the protocone to the metaconule, at least primitively. The other crest, termed here the endoprotocrista, runs more distally and has no connection to the metaconule, although it often gives rise to the hypocone. In forms with more molarized premolars, the lingual end of the postprotocrista can attach more distally, i.e., not on the protocone but either on the endoprotocrista or on the hypocone. Breaking the connection between the protocone and the endoprotocrista (and hypocone) results in a fully molariform premolar.

This pattern comprises one mode of premolar molarization that can be inferred from comparisons of perissodactyl premolars. It differs from other patterns, such as a lingually displaced paraconule forming a new “protocone” and the protocone assuming the position of a hypocone, as inferred for the third upper premolars of early equids. The pattern described here also contrasts with the mode of formation of the upper molar hypocone, which apparently arises from the cingulum. The patterns described here highlight a difficulty in inferring how premolars become molarized. Inferences regarding the transformation from unmolarized to molarized premolars can only be made when appropriate intermediate stages are preserved in the static morphology of fossil taxa.

This work was funded in part by the National Science Foundation (USA).

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE EFFECTS OF USING FILTERED DATA FOR BRANCH LENGTH AND DIVERGENCE TIME ESTIMATION

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Typical morphological character matrices can be considered to be a form of filtered data because the process of scoring characters entails looking for variable traits (or only parsimony-informative characters). The importance of correcting this filtering when one estimates a phylogeny from these data has been understood for more than a decade, but applying models of ascertainment bias to paleontological data is more complex because of the relatively large number of missing data cells in a character matrix. The calculations must account for the fact that the data filtering only applies to the subset of species that are scored for a particular character. Theoretical results predict that conducting likelihood-based inference on filtered data can be reliable if corrections for ascertainment bias are used. However, the effects of data filtering on branch length estimation and divergence time estimation are poorly understood. We will present results from a computer simulation study and from the analysis of three paleontological data sets (from ursids, dinosaurs, and trilobites) to characterize the biases and loss of power induced by data filtering. The authors thank the NSF and HITS for funding.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

MODELING CRANIAL BIOMECHANICS IN ARCHOSAURS USING 3D COMPUTATIONAL METHODS

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Accurately modeling cranial function in vertebrates remains a challenging yet important tool for ecologists, functional morphologists, and paleobiologists. Three-dimensional computational methods now offer new approaches for reconstructing jaw muscle anatomy and the cranial biomechanical environment so that evolutionary and functional hypotheses can be tested. Here we present several examples that reconstruct muscle forces, joint moments and bite forces in extant and extinct archosaurs using 3D modeling techniques. 1) We compared modeled bite forces in an ontogenetic sample of *Alligator mississippiensis* with published in vivo bite forces to validate whether the method is applicable to diapsid vertebrates. 2) We modeled bite forces and joint moments within the skulls of the non-avian dinosaurs *Tyrannosaurus rex* and *Edmontosaurus regalis* to test the sensitivity of input parameters with force estimates. 3) Using these latter taxa, we compared moments about joints implicated in cranial kinesis to identify functional patterns. These models will enable us to test for coevolution between bite force and dietary correlates in fossil archosaurs, estimate loading patterns within cranial joints, and determine patterns in jaw muscle anatomy and function among tetrapods.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

EVIDENCE FOR DUROPHAGY AMONG NORTH AMERICAN PANTOLESTID CIMOLESTANS

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Many living mammals are semi-aquatic and durophagous; members of the Carnivora, particularly otters, are the best known examples. However, carnivorans have only recently exploited aquatic resources. Among ancient eutherian mammals, the earliest exploitation of this adaptive zone likely evolved in the poorly-studied pantolestid cimolestans. Ranging from the early Paleocene to middle Eocene, pantolestids are geographically widespread but comparatively uncommon in early Paleogene faunas in North America. Based principally on well preserved skeletons from the early Eocene, some taxa are interpreted as being otter-like in shape and locomotion, and the generally flat wear on their molar cusps is suggestive of hard-object feeding. However, their comparatively smaller body size and unworn tooth morphology are more similar to insectivorous mammals.

We assessed the morphological diversity of dental and mandibular specimens of pantolestids from the early Eocene Wasatch Formation of southwestern Wyoming. Our sample included many well-preserved specimens of *Palaeosinopa* and the previously-poorly known *Amaramnis gregoryi*. *Palaeosinopa*, and to a slightly lesser extent *Amaramnis* and some pentacodontine pantolestids, show aspects of mandibular morphology consistent with durophagy. These include a thickened ventral border on the dentary and a strongly ridged or even distinct bony protuberance for attachment of the temporalis muscle on the anteromedial surface near the base of the coronoid process. Where known, the angular process is strongly ridged for attachment of the pterygoid. Thickenings near the base of the coronoid process, in the area of the insertion of the temporalis, are also observed in the extinct otter *Potamatherium* and living *Lutra*. Each of these features is closely associated with durophagous feeding in carnivorans. Another feature which may reflect feeding behavior is the presence of an enlarged mandibular foramen in *Amaramnis* and *Palaeosinopa.* The size of this foramen indicates well-innervated tissue was likely present on the lower part of the snout and may correlate with numerous tactile vibrissae that are used in some extant mammals to help locate underwater prey. In strong contrast to recent semi-aquatic durophagous mammals, all pantolestids have much smaller estimated body masses than extant semi-aquatic carnivorans, ranging from an estimated 200 g to 2 kg based on molar area, and document a unique exploitation of this adaptive zone at small size.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

EVOLUTIONARY BIODIVERSITY OF MIOCENE CARNIVORANS FROM THOMAS FARM, FLORIDA

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Evolutionary biodiversity in early Miocene carnivorans is subject to substantial temporal, geographic, and taxonomic gaps in knowledge. The Thomas Farm fossil locality in North Florida presents a unique opportunity to fill some of these gaps while creating a broader evolutionary and ecological understanding of the order Carnivora. Early Miocene carnivorans are best known from the western United States and Europe. Decades of excavations at Thomas Farm have accumulated many hundreds of previously unidentified carnivoran specimens that are housed at the Florida Museum of Natural History. Multiple genera of carnivorans have been discovered at the site including species of Amphicyonidae, Ursidae, Procyonidae, Mustelidae, and Canidae. To this date, no members of the family Felidae have been found at Thomas Farm or any other early Hemingfordian locality in North America. Previous research suggests that true felids did not make their way into North America until the later Hemingfordian. Therefore, Thomas Farm provides the perfect backdrop to understanding how groups of carnivorans may have adapted to open felid-like niches. This study focuses on interpreting and identifying the smaller-bodied carnivorans discovered at Thomas Farm. Prior to this study, there were 282 catalogued mustelid specimens and 1,961 catalogued canid specimens. Only 27% of the mustelid and 14% of the canid specimens had been assigned to genus level, based primarily on cranial elements. Very few of the majority postcranial elements had generic level identifications. In addition, we are screen-washing and meticulously picking (for carnivoran and other fossils) the large backlog of excavated sediment from Thomas Farm (an estimated 1,200 bags), with an average of 3 carnivoran specimens discovered per 10 bags of sediment. Using material from the University of Florida Mammalogy and Vertebrate Paleontology Collections as well as other early Miocene faunas, identification of the hundreds of postcranial elements at Thomas Farm can help fill in the temporal, geographic, and taxonomic gaps by providing detailed anatomical information to reconstruct predator guilds, including any adaptations in response to open felid-like niches.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

NEW ADDITIONS TO THE HELL CREEK FORMATION (UPPER MAASTRICHTIAN) VERTEBRATE FAUNA OF CARTER COUNTY, MONTANA

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The Hell Creek Formation (Upper Cretaceous, upper Maastrichtian) of western North America is among the best studied Mesozoic terrestrial units. Substantial new research on the diversity of its organisms and their geographic and stratigraphic ranges in recent decades have greatly increased our ability to understand life at the end of the Cretaceous and the extinction thereafter.

Since 2001, the Burpee Museum has been involved in the documenting of the Hell Creek fauna as expressed in Carter County, MT near the town of Ekalaka. Among the more significant specimens recovered are the juvenile tyrannosaurid 'Jane' and the subadult *Triceratops* 'Homer', as well one of the most complete individuals of the alligatoroid *Stangerochampsa* known. Work has continued, and quarries in this region have yielded additional new faunal elements.

In 2011, a new mass mortality turtle locality, known as the Ninja Turtle Quarry, was discovered weathering out of a sandstone lens. Over three summers of work over 200 vertebrate fossils have been collected from this locality including fourteen partially articulated and associated turtles (baenid and trionychid) have been recovered. Also in this locality are small dinosaur remains including: three partial *Thescelosaurus* individuals; pedal elements, a caudal vertebra, and complete humerus to a small tyrannosaurid; juvenile *Triceratops* orbital horn; oviraptorosaur manual ungual. Other taxa represented among the microvertebrates are: *Lepisosteus* elements; *Myledaphus bipartus* teeth; *Champsosaurus* vertebra and ribs; crocodilian teeth; and small mammal teeth and jaws (referable to *Didelphodon* and *Pediomys*). Additional fossil flora collected from the locality indicates that stratigraphically it may lie low in the formation.

In June 2013, approximately one kilometer from the Ninja Turtle Locality, a specimen of oviraptorosaurian provisionally referred to *Anzu wylei* were collected. Material found during that field season includes distal hindlimb, pelvic elements, dorsal ribs, and caudal vertebra. Given the origination of these bones relative to the local outcrop, it seems quite likely that more the skeleton is preserved and is slated for field recovery. Previous reported specimens have been from the Dakotas, making this the westernmost occurrence of this taxon so far.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed November 5 – 8, judging occurs Thursday, November 6)

OSTEOLOGICAL REVISION OF THE HOLOTYPE OF *PATAGOSAURUS FARIASI*, A BASAL EUSAUROPOD FROM ARGENTINA

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The sauropod dinosaur *Patagosaurus* was found four decades ago in the early Middle Jurassic Canadon Asfalto Formation, Patagonia, Argentina. It has since been used in numerous phylogenetic analyses of sauropod dinosaurs. However, our current understanding of *Patagosaurus* is based on elements of several specimens collected from two localities. Furthermore, at least one specimen of one of these localities is probably a different taxon. Therefore, a revision has been started of all *Patagosaurus* material, starting with the holotype, which is described and compared to other sauropods.

The specimen has seven preserved cervical vertebrae, ten dorsals, the complete sacrum consisting of five sacral vertebrae, and caudals. Furthermore, the right ilium, pubis and the distal fused parts of the ischia, and the right femur are preserved.

The cervicals are opisthocoelous. Neurocentral sutures are present, indicating that the animal was still growing. There is a prominant ventral keel, with two lateral fossae cranially, as in *Amygdalodon*, *Lapparentosaurus* and *Spinophorosaurus*, but in contrast to *Cetiosaurus* and derived sauropods. Laterally a shallow pleurocoel is present which is deeper cranially, as in *Spinophorosaurus* and *Lapparentosaurus*, and not as in *Cetiosaurus* and *Tazoudasaurus*. Cranially, the intraprezygapophyseal laminae do not meet, as in *Tazoudasaurus* and possibly *Cetiosaurus*. The anterior and mid-dorsals are mildly opisthocoelus. The dorsal neural spines are higher than the centrum, and high neural arches with wider distal dorsal end of the neural spine as in *Amygdalodon*. A ventral keel is present in anterior and mid-dorsals but not in posterior dorsals. Laterally only a small shallow fossa is present, as in *Cetiosaurus* and *Lapparentosaurus*. An infradiapophyseal fenestra below the transverse processes is present as in *Barapasaurus* and possibly *Tazoudasaurus*. The caudals are amphicoelus, as in most basal sauropods. The ilium is highly arched and craniocaudally elongated. The pubis is twisted towards the medial plane. The femur is taphonomically deformed. The fourth trochanter is developed as a non-prominent posteromedial bulge. There is no prominent bulge on the proximolateral side as in titanosauriforms.

Incorporating the revised scorings of the holotype in an existing matrix, *Patagosaurus fariasi* is depicted as the sister taxon of *Cetiosaurus* forming a clade of eusauropods more derived than *Barapasaurus* and *Shunosaurus* but basal to *Omeisaurus* and *Mamenchisaurus*. This confirms previous ideas on the phylogeny of *Patagosaurus*.

Technical Session X (Friday, November 7, 2014, 8:00 AM)

THE FIRST CRANIAL AND POSTCRANIAL REMAINS OF THE OLDEST MOLE *EOTALPA* FROM THE UK LATE EOCENE: IMPLICATIONS FOR RELATIONSHIPS AND LIFESTYLE

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The oldest talpid, *Eotalpa*, was previously known certainly only from isolated molars. Intensive screenwashing of late Eocene sediments has yielded cranial and postcranial elements. These consist of maxilla, dentary, possible ulna, metacarpal, distal tibia, calcaneum, astragalus, and metatarsals. In addition to m1-2 myotodonty, the bones show typical talpid features like an anteroposteriorly fairly deep ulna, short astragalar neck, and astragalar body with lateral process. However, *Eotalpa* retains primitive states reminiscent of soricids such as a P4 with a mesially positioned protocone and astragalar neck strongly angled with respect to trochlear ridges, not found in modern talpids. It also has an astragalus with a medial trochlear ridge taller than the lateral one and a massive medial plantar process, a calcaneum with a short fully distal peroneal process, and ventral curvature of the distal ends of the metapodials, all typical eulipotyphlan characters. Synostosis of tibia and fibula, found in Talpidae, Soricidae, and Erinaceidae, is not present in *Eotalpa*, there being only weak syndesmosis, suggesting that the synostosis in these groups has been independently acquired. A primitive state shared with the most primitive living talpid, *Uropsilus*, is the absence of a proximal olecranon crest on the ulna. In contrast, reduction of the M1-2 hypocone and talon shelf in *Eotalpa* is a derived state common to talpids except *Uropsilus*. Cladistic analysis places *Eotalpa* as a stem member of the Talpidae and shows that a significant amount of homoplasy is involved in the early evolution of the family, knowledge of which is still scant. A life mainly restricted to the ground for *Eotalpa* is indicated by: an astragalus with a medially dipping head, curved in a single plane; a calcaneum with distal peroneal process and strongly overlapping ectal and sustentacular facets; and matching sized ectal and sustentacular facets on the calcaneum and astragalus. These features would have restricted ankle mobility. The moderately deep ulna and slightly shortened metacarpal, with proportions like those of the modern shrew-mole *Dymecodon*, suggest some fossorial activity, but a relatively short olecranon lacking a proximal crest and weak anconal process imply that this would have been limited.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

EVOLUTIONARY TENDENCY OF MOLAR TEETH IN *NEOSAIMIRI* AND *SAIMIRI*

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Neosaimiri is a middle Miocene fossil platyrrhine (New World monkeys) discovered in Columbia. The lower molar of *Neosaimiri*, which is a fossil relative of *Saimiri*, has a postentoconid notch present mesiobuccally to an entoconid. This is believed to be a feature of *Neosaimiri* and has been found in most of its fossils. In addition, the position of wear facet 8 in *Neosaimiri* is the same as that of the postentoconid notch in extant *Saimiri.* The existence of individuals with a postentoconid notch was confirmed. If the postentoconid notch occludes with the hypocone, it should show the same pit and striation microwear that forms on facet 8. In this study, the correlation between the postentoconid notch and hypocone of the two species was examined. The observed objects were assumed to be upper and lower first molars through reference to known specimens of *Neosaimiri* and *Saimiri*. The microwear pattern on wear facet 8 at each developmental stage was observed by scanning electron microscopy and digital microscopy (20-500´). Hypocone height and molar size were measured using calipers. Microwear formed on facet 8 due to a hypocone was similar to the pointed part that existed in the object forming the postentoconid notch. Hypocone height in the individual with a postentoconoid notch was greater than that in *Saimiri*, which was almost the same as *Neosaimiri*. In addition, the size of the upper molar was also larger than that in *Saimiri, w*hich had a standard molar size. The postentoconid notch and hypocone undergo attrition with each other; hence, hypocone height is believed to be important for evaluating the existence of a postentoconid notch. In the course of *Saimiri*'s evolution, height of the hypocone of the upper molar has gradually decreased and the number of individuals with a hypocone height sufficient for forming a notch has decreased.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

NERVE-LIKE STRUCTURES IN THE ENIGMATIC DOMES OF PACHYCEPHALOSAURIDS

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Paleontologists typically seek to explain the purposes of cranial ornamentations in dinosaurs using morphological analogy, prior to having an understanding of the tissue composition or structural architecture of the interpreted structure. The rounded, dome-shaped fronto-parietal morphology of pachycephalosaurid skulls inspired behavioral explanations such as head or flank butting based on mammals with a variety of rounded horn shapes. Recent histological examinations of various pachycephalosaurid domes of different taxa and ontogenetic stages reveal: (1) mineralized tissues and (2) combinations of tissues unknown in other dinosaurian (including Aves) or mammalian taxa. Pachycephalosaurid dome tissues and structures incorporated into the dome are unlike those of the animals previously used for analogy, for example, big-horn sheep and other bovids, and therefore require an alternative line of questioning.

Abundant fiber-like structures are one of the most prominent features of the bony tissues throughout ontogeny within a pachycephalosaurid dome. These structures are often oriented perpendicular to the dorsal inflationary growth surface of the dome and incorporated within the bony struts between the generally radially oriented vascular canals. Some fiber-like structures, however, are found in patches or islands and the orientation of individual fibers can appear completely random. Most of these fiber-like structures resemble Sharpey”s fibers in size and appearance, except that they are found in groups or bundles. Additionally, some of these fiber-like structures are not found simply buried in the mineralized matrix like Sharpey's fibers, but instead, originate and terminate at the walls of vascular channels. Vascular channels in bone carry blood vessels and nerves, but it is only the myelin-sheathed axon that is of equivalent size to these fiber-like structures. This observation suggests these structures represent a vast network of nerves.

â€‹The apical surface of the pachycephalosaurid dome lacks indented vessel impressions observed in keratin-covered bones of other taxa, so keratin was not likely present on the dome. The vascular canals and associated fiber-like structures breach the surface of the dome perpendicular to the apical surface, suggesting that the dome supported a structure that extended some distance above it and required an abundance of blood and nerve innervation.

Technical Session IX (Thursday, November 6, 2014, 3:15 PM)

SYNTHESIS OF FOSSIL AND MODERN DATA SHEDS LIGHT ON EARLY SNAKE ECOLOGY, BEHAVIOR, AND EVOLUTIONARY HISTORY

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The astounding diversity and disparity of snakes has long inspired debate regarding their evolutionary origin. Here, we present the first comprehensive analytical reconstruction of the ancestor of snakes, incorporating new data from species of less modified basal snakes, new information on the anatomy of the stem snake *Dinilysia patagonica*, and a deeper understanding of the distribution of phenotypic apomorphies among the major clades of fossil and recent snakes. We further infer a time-calibrated divergence tree, which provides novel insight into when, where, and how snakes originated. We infer that Henophidia first radiated in the Cenozoic around the Cretaceous-Paleogene (K/Pg) Mass Extinction. Although error margins preclude certainty as to whether crown Henophidia initially diverged before or after the K/Pg boundary, the widespread distribution and astonishing diversification of henophidian snakes clearly occurred after the mass extinction event. The snake total-group diverged earlier, sometime around 100 Ma, during a burst of radiation that coincides with the so-called 'Cretaceous Terrestrial Revolution'. Although the ancestral crown snake is inferred to have originated in Gondwana, the ancestor of the snake total-group may have originated in Laurasia, based on the biogeographic distribution of the stem-group snake *Coniophis precedens* and a succession of other anguimorph outgroups. Both the total-group and crown-group snake ancestors unambiguously reconstruct as having lived on land, thus supporting the 'terrestrial origin' hypothesis for the origin of snakes, and rejecting the controversial 'marine origin' hypothesis. For much of their early evolutionary history, snakes are inferred to have preferred warm, equable, well-watered, tropical to subtropical forests, which may account for their surprising absence among the otherwise diverse lizard faunas of the Upper Cretaceous of Mongolia. The ancestral snake emerged at night to forage for relatively large, soft-bodied prey (likely small vertebrates). Constriction, which is often associated with all snakes, did not evolve early in snake history, and the re-acquisition of diurnal habits appears to have occurred within crown-group Colubroidea, in the clade stemming from the last common ancestor of Elapidae + Colubridae. This reconstruction may explain the clade's success in the cooler and drier habitats that emerged at higher latitudes during the latter half of the Miocene, when colder night-time temperatures no longer favored the nocturnal snakes of the forest floor.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

TAPHONOMY OF FOUR ASSOCIATED BONEBEDS OF THE ORNITHOPOD DINOSAUR *DYSALOTOSAURUS LETTOWVORBECKI* FROM THE UPPER JURASSIC TENDAGURU FORMATION, TANZANIA

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The most extensive single excavation during the famous German Tendaguru expedition between 1910 and 1913 was the Ig/WJ-quarry a few kilometers northwest from Tendaguru Hill. More than 14 000 specimens of the ornithopod dinosaur *Dysalotosaurus lettowvorbecki* were cataloged. Unfortunately, quarry maps, stratigraphic profiles, or even unambiguous notices of the provenance of specimens to certain bonebeds were not made apart from approximate sketches and minor notices in letters. The genesis of the mass assemblage of more than 130 individuals is therefore difficult to reconstruct, especially because this taxon is completely unknown elsewhere in the Tendaguru Formation. All other dinosaur taxa were found in much smaller absolute numbers and in more than one or even numerous localities.

Recent examination of all traceable sketches, letters, publications, and catalogs of the former excavation leaders, Werner Janensch, Edwin Hennig, and Hans Reck, together with re-examination of specimens and sediment samples lead to some surprising new results. The two old types of labeling, Ig and WJ, were not meant to differentiate between two bonebeds, but were only chosen by two different excavation leaders to label specimens from the same bonebed. In addition, not two but four closely associated bonebeds were excavated in 1912, three at a time. Specimens of at least two bonebeds could finally be identified. Although the number of individuals of certain age classes differed, the general bimodal age distribution is still prominent in both.

This result may indicate the possible presence of more than one herd of *Dysalotosaurus* in the locality, where each of the bonebeds probably represents the remains of a different group with slightly differing proportions of age classes. The absence of *Dysalotosaurus* elsewhere in the Tendaguru Formation is likely to be related to its small size compared to most of the other common dinosaur taxa, so that it did not tend to mire in the mud. It may also have visited these tidal flats rather infrequently. The preservation of so many individuals of different ages in four closely associated bonebeds might be the result of repeated mass drowning as herds crossed the local river or tidal channel, and after each event, the bodies drifted to roughly the same spot in that channel to be deposited. This scenario might be comparable to the seasonal crossing of the Mara River by large herds of wildebeest today.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

FIRST RECORD OF A COMPLETE GIANT THEROPOD EGG CLUTCH FROM UPPER CRETACEOUS DEPOSITS, SOUTH KOREA

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We report the first occurrence of a complete *Macroelongatoolithus* clutch from outside of China. Excavated from Upper Cretaceous strata of Aphae-do in Shinan-gun, Jeollanam-do Province, South Korea, the clutch of 19 eggs is characterized by large (exceeding 40 cm in length), elongate, symmetrical eggs arranged in a single-layered ring-shaped clutch. Eggs are inclined toward the center of the 2.3 meter clutch, and average 41.17 cm long and 15.58 cm wide. Of the 19 eggs, eight clearly retain a paired configuration. This specimen represents only the second report of large theropod eggs from South Korea and is the most complete *Macroelongatoolithus* clutch known from the region to date. Eggshell microstructural features are consistent with *Macroelongatoolithus xixiaensis*, an elongatoolithid oospecies known previously only from Cenomanian strata of southeastern China. This first record of a giant theropod egg clutch, here assigned to *M. xixiaensis*, broadens the stratigraphic and paleogeographic range of *Macroelongatoolithus* eggs and parent animals to include the Campanian of South Korea. Additionally, the Aphae-do specimen lends support to the ring-shaped single layer clutch arrangement with eggs nearly horizontal to the surrounding sediment as a biologically real configuration rather than a taphonomically altered one, as this clutch configuration remains consistent from the mid-Late Cretaceous. Further detailed analysis of the eggs within the clutch may allow for a better understanding of microstructural and gross morphological variability within a single ootaxon, aiding in our understanding of what constitutes an oospecies.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

FIRST REPORT OF AN ARACHNOID MATER IN A NON-AVIAN REPTILE, *ALLIGATOR MISSISSIPPIENSIS*

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I report photographic evidence of an arachnoid mater surrounding the brain in the American alligator (*Alligator mississippiensis*). In Mammalia and Aves, the brain is surrounded by three meninges: the dura mater lining the brain cavity, the arachnoid internal to the dura, and the pia mater on the brain surface. It is generally held that non-avian reptiles lack an arachnoid mater.

I dissected unpreserved brains from freshly sacrificed adult alligators from 1.61-3.81 m total length. The dura mater is a relatively thick, translucent membrane adhering to the endocranial surface. The pia adheres closely to the brain surface. The arachnoid is transparent and separated from the underlying pia by the subarachnoid space; it lies slackly when the subarachnoid space is empty. The arachnoid is stretched tightly when dried blood occupies the subarachnoid space, as in the three largest specimens, in which only the lateral cerebral poles could be seen through the arachnoid. The rest of the brain was concealed by a layer of dried blood in the subarachnoid space and in dural venous sinuses. The dura and arachnoid are visible without magnification; both the pia and a choroid plexus in the fourth ventricle are visible under low magnification. Dorsally, the arachnoid passes from greatest convexity to greatest convexity of the cerebrum and optic lobes. Trabeculae pass from the dura mater and penetrate the arachnoid en route to attachment to the pia. From a ventral position, the right and left posterior cerebral arteries (p.c.a.) puncture the ventral arachnoid, rise dorsally between the cerebrum and optic lobes, and puncture the dorsal arachnoid before passing rostrally dorsal to the midline of the cerebrum. The dorsal longitudinal sinus runs rostrally as a distinct vessel, dorsal to the p.c.a. Posterior to the cerebrum, this sinus occupies a wide, mid-sagittal space within the dura mater.

The brain occupies a decreasing portion of the endocranial space, from 67% to 33% in the above alligator sample. Cerebrospinal fluid (CSF) and venous blood are the major contributors to the disparity, and prevent the brain from making an impression on the endocranial surface in all non-avian reptiles. Occurrence of the arachnoid in Crocodylia and Aves implies its presence in dinosaurs according to the Extant Phylogenetic Bracket method. Brains of pachycephalosaur and small theropod dinosaurs filled the endocranial cavity; in most other dinosaurs, endocasts resemble those of alligators, indicating the brain did not fill the cavity and a similar role for CSF and venous blood for the discrepancy.

Symposium 2 (Thursday, November 6, 2014, 3:15 PM)

THE FORGOTTEN LEVER: MECHANICS AND EVOLUTION OF THE PATELLAR SESAMOID IN BIRDS

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The patella is the most familiar of the broad, enigmatic class of bones called sesamoids. It is considered to play a role in alleviating compression of its knee extensor tendon and increasing the mechanical advantage (i.e. leverage) of associated muscles. A patella evolved at least three times: in squamate reptiles, mammals, and birds. However, patellar evolution in these groups is poorly resolved, and patellar function or development are almost unstudied in a modern context. We present a synthesis of anatomical, ontogenetic and biomechanical data on the evolution of the patella in birds.

While large patellae exist in more basal birds (such as the Cretaceous hesperornithiforms), our inspections of fossil and Recent birds show that a small nodule of bone is the ancestral morphology for Neornithes. This indicates many losses or enlargements of the patella, regardless of the phylogeny used.

In palaeognath birds, ostriches evolved a double patella comprising enlarged proximal and distal parts, whereas tinamous and kiwis kept the ancestral morphology. Our dissections and histological studies of emu knee extensor complexes (growth series of 9 individuals) found no ossified patella. Instead, a strange, fatty tendon is in close association with the fat pad that normally underlies a neornithine patella. The absence of an ossified patella in extinct moa (e.g., *Dinornis*) hints at a similar reversal, which also may apply to other ratites. In contrast, neognath birds convergently enlarged the patella at least four times.

These evolutionary patterns raise questions about patellar function. The ancestral patella was no larger than its tendon, and so an initial role in increasing the mechanical advantage of the triceps femoris muscles is unlikely. Rather than explicitly functional, patellar evolution may have instead been initially induced by altered limb postures and stresses in stem birds interacting with tendon mechanobiology - a 'spandrel'.

However, biplanar radiography studies of 3D patellar dynamics in running guineafowl (1 individual, multiple strides, ~2 m/s) suggest that an enlarged patella plays an appreciable role in knee joint mechanics, altering the forces in the knee extensor muscles vs. the patellar tendon. The role of a patella as a bony lever in birds is thus an example of an exaptation, which several lineages of birds (e.g., diving species including Hesperornithiformes) took to an extreme. Enlargements of the tibial crest play a different role as static levers compared to the dynamic, mobile nature of the patella.

Technical Session XVII (Saturday, November 8, 2014, 2:45 PM)

THEROCEPHALIANS (THERAPSIDA, EUTHERIODONTIA) FROM THE UPPER PERMIAN MADUMABISA MUDSTONE OF ZAMBIA AND THEIR BIOGEOGRAPHIC IMPLICATIONS

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Therocephalians, an ecologically diverse group of Middle Permian through Middle Triassic therapsids, have received recent attention because of their intermediate morphology and phylogenetic position between basal therapsids and Mammaliaformes. However, their long stratigraphic history and widespread geographic distribution during the Permo-Triassic also makes them an important group for understanding biogeographic patterns during a major faunal transition. Recent collecting efforts in the Luangwa Basin (Zambia) resulted in the discovery of several new therocephalian records from the upper Madumabisa Mudstone Formation. The therocephalians recovered include taxa known from other Gondwanan basins, including the relatively abundant whaitsiid *Theriognathus*, which is also known from *Cistecephalus* zone-equivalent rocks in Tanzania and South Africa (although it is more abundant in the lower parts of the stratigraphically higher *Dicynodon* Assemblage Zone in the latter basin), and a basal ictidosuchid baurioid similar to *Ictidosuchoides*. Interestingly, two other therocephalians are endemic but share sister group relationships with Laurasian forms, including a new eutherocephalian having affinities to the Russian *Chthonosaurus*, and a new baurioid with apparent affinities to the Russian *Karenites*. These new records mirror patterns previously known from other therapsid sister taxa, including the whaitsiids *Moschowhaitsia* (Russia) and *Theriognathus*, as well as several dicynodonts. Parsimony optimizations of geographic occurrences are ambiguous regarding the centers of origination for many of the major therocephalian subclades. However, the patterns are suggestive of either: (1) rapid, early dispersal events of Eutherocephalia and its major subgroups from a Laurasian center during the early Late Permian; or, more likely, (2) within-province diversifications with occasional dispersal events occurring between provinces. Regardless, these associations strengthen the hypothesis that unknown but effective dispersal routes to high latitudes were available to therapsids and other tetrapods at least until early Late Permian times. Supported by NSF EAR-1337569, EAR-1337291, and EAR-1336986.

Technical Session III (Wednesday, November 5, 2014, 2:30 PM)

ASSOCIATED REMAINS OF *SPINOSAURUS AEGYPTIACUS*, AN ENORMOUS PREDATORY DINOSAUR WITH SUBAQUATIC ADAPTATIONS

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Discovered over a century ago in Cretaceous rocks in Egypt, *Spinosaurus aegyptiacus* has remained an enigma, as all of the original associated bones were destroyed in a WW2 air raid and all that has come to light since are isolated specimens. In 2008, a partial skeleton was discovered by local collectors from the lower unit of the mid-Cretaceous Kem Kem sequence of Morocco. Further excavation at the site in 2013 resulted in the recovery of additional bones and teeth of a specimen that includes cranial bones, vertebrae from cervical, dorsal and caudal regions, manual bones, pelvic girdle, and hind limbs. Designated the neotype for *S. aegyptiacus*, the bones of this specimen and the most complete cranial pieces and postcranial bones of isolated individuals were computed tomography (CT)-scanned, surfaced, size-adjusted and combined to yield a digital skeletal model of an adult individual.

The low, elongate skull has an expanded, hypersensitive snout end, labially procumbent interdigitating teeth, and retracted external nares. The cervical and dorsal centra are proportionately elongate compared to the relatively short sacral series, and the pectoral girdle and forelimb are large and long, respectively, compared to the proportionately small and short pelvic girdle and hind limbs. The solid construction of many of the long bones, small pelvis, short hind limbs and flat pedal unguals contrast with the condition in other spinosaurids such as *Suchomimus* and suggest that *Spinosaurus* would have been less agile on land. On the other hand, the unusual proportions of the stout hind limb bones (femur shorter than the tibia) and the relatively large pes with flat-bottomed unguals in *Spinosaurus* resemble subaquatic adaptations for foot-propelled paddling in extant birds. Surface and cross-sectional features of the elongate dorsal spines suggest that the 'sail' of *Spinosaurus* was wrapped snugly in integument and functioned as a display structure that would have remained visible while swimming.

With an estimated adult body length of at least 15 meters, *Spinosaurus* is the longest known predatory dinosaur and may have fed on contemporary large-sized aquatic

vertebrates, such as the coelacanth *Mawsonia* and sawfish *Onchopristis*, to avoid direct competition with other large-sized theropods present in the Kem Kem sequence.

Symposium 3 (Friday, November 7, 2014, 8:15 AM)

UNDERSTANDING AND INCORPORATING GEOLOGIC INFORMATION IN DIVERGENCE DATING ANALYSES

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The temporal calibration of phylogenetic trees is a necessary prerequisite to investigating the tempo and mode of evolution. Regardless of whether fossils are included directly as terminal taxa or used to formulate node calibrations, the interpretation of geologic data is necessary to assign a numeric (absolute) age to the tips and nodes of a phylogenetic tree. Both paleontological and molecular divergence-dating analyses often ignore uncertainty in the interpretation and application of this geologic information. A major source of uncertainty is the conversion of relative geologic ages (e.g., middle Miocene or Barstovian) to a numeric age (e.g., 16.3–13.6 Ma); these values must reflect both the full age range as well as the uncertainty in the age of the boundary of the interval in question. Other uncertainties include the analytical uncertainty of a radioisotopic age, which can vary by an order of magnitude depending on the method, the geologic uncertainty of those ages (e.g., crystal residence times and detrital signatures), cross-correlation of different isotopic systems (e.g., systematic bias of Ar/Ar when compared with U-Pb) and the stratigraphic distance between geochronologic constraints and the fossiliferous stratum. All potential sources of uncertainty must be incorporated when justifying the ages of both the tips and internal nodes of a phylogenetic tree.

In many cases, these geochronologic data are used to determine hard minima and soft maxima in divergence-dating analyses; these bounds must reflect the full uncertainties for the ages of the calibrating fossils. Increasingly, such analyses are conducted in a Bayesian framework, which means that the ages and their uncertainties are converted to prior probability curves. If the geologic and paleoenvironmental biases affecting the fossil preservation of a clade are known, models of fossil occurrence data could be used to generate a prior curve that reflects available paleontological information. However, the data to support this methodology are not always readily accessible, so it has not been widely attempted. Consequently, the construction of prior probability curves is a 'black box', with little justification for widely used prior shapes (e.g., linear, parabolic, or logistic). We propose that if a clade's fossil record is well-sampled, these data should dictate the shape of such curves, by using existing methods for calculating confidence intervals for biostratigraphic ranges. In the absence of such data, flat curves between hard minima and soft maxima are the safest assumption.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

HOW DO QUADRUPEDAL ANIMALS TURN? OFF-TRACKING LIKE PHENOMENON OBSERVED IN THE TURNING TRACKWAYS OF SAUROPODS AND PROBOSCIDEANS.

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Turning trackway of large sauropods present gaps between the pesand manus trackway midlines. In the case of a left turn, the manus trackway midline is situated on the right side of the pes trackway midline. In contrast, the turning trackway of the modern Asian elephant present such a gap in the opposite direction. In the case of a left turn, the manus trackway midline is situated on the left side of the pes trackway midline. We interpret that the large sauropod manus-pes trackway midline gap at the turning point is analogous to the off-tracking phenomenon of front-wheeled steering vehicles, and modern the Asian elephant case is analogous to the same phenomenon of a rear-wheel steering forklift. The off-tracking gap is observed on the trails of turning vehicle steered only by front or rear wheels. The gap is absent or not clear in the four-wheel steering vehicle. So we estimate that sauropod dinosaurs used mainly their forelimbs to turn, and the modern Asian elephant used mainly their hindlimbs. The center of mass is positioned in the posterior part of the trunk in large sauropods, and at the anterior part in proboscideans. So we also estimate that less graviportal limbs might have more freedom to change tdirection, and are suitable to steer the body while traveling. The off-tracking phenomenon becomes more apparent with animals that have long gleno-acetabular distance, such as large sauropods. We also estimate that large sauropods with long necks, long tails, and large body weight required tremendous momentum to turn. This difference may affect the appearance of the off-tracking phenomenon in the trackways. The turning mechanism of animals is little-studied subject. Analysis of turning trackways would be useful for investigating the kinematics of extinct animals.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

CAMPYLOPRION* (CHONDRICHTHYES, EDESTOIDEA) FROM THE UPPER PENNSYLVANIAN OF NEW MEXICO AND TEXAS AND A REINTERPRETATION OF *TOXOPRION LECONTEI

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A large, incomplete symphyseal tooth whorl of *Campyloprion*, comprising five incomplete teeth, is documented from the Upper Pennsylvanian (upper part of Missourian Stage) of Socorro County in southern New Mexico. The age of the fossil-bearing bed in the Tinajas Member of the Atrasado Formation is well-dated by fusulinid and conodont biostratigraphy. The fossil came from a crinoidal sandstone that likely represents a submarine channel deposit. Two small tooth whorls of *Campyloprion* have been reported from the Upper Pennsylvanian (Virgilian Stage) Jacksboro Limestone Member of the Graham Formation of northern Texas. Tooth whorls of *Campyloprion,* like those of *Helicoprion*, are shaped like a logarithmic spiral. The angle between a tangent to the spiral and a radius from the center is about 60 degrees for *Campyloprion* as opposed to about 82 degrees for *Helicoprion.* The holotype of *Edestus lecontei* is an incomplete tooth whorl found within 1.6 km of Eureka, Nevada. The age was originally assumed to be Devonian or Carboniferous, because the sediments in that area were thought to be of those ages. Based on recent studies, the specimen must have come from the Lower Permian Carbon Ridge Formation. Devonian and Carboniferous sediments are absent from that area. *Edestus lecontei* was later referred to *Campyloprion* and still later to a new genus, *Toxoprion*. The species is reassigned to *Campyloprion,* and *Toxoprion* is held to be a junior synonym of *Campyloprion.* The holotype of *Campyloprion lecontei* is reinterpreted. The orientation of the tooth whorl (anterior vs. posterior) is reversed, based on the assumption that the tooth whorl is shaped like an expanding spiral, not a contracting one. That is, the curvature of the whorl at the posterior (later formed) end is presumed to be less than at the anterior (earlier formed) end. The blunt-tipped tooth crowns at the posterior end of the whorl are reinterpreted as apically truncated crowns having the same original shape as the sharply-pointed crowns at the anterior end.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

EVOLUTION OF DENTITION IN THE PALEOZOIC JALODONTID SHARKS

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The first jalodontid shark *Jalodus australiensis* appeared in the Late Famennian (Late Devonian) and occurs up to the Tournaisian (Mississippian, Carboniferous). Only one jalodontid taxon, *Adamantina foliacea,* was widely distributed in the Carboniferous and recorded in the Late Tournaisian to the Roadian (Guadalupian, Permian), but a second *Adamantina* species, *A. benedictae*, is known from the Roadian to the Wuchiapingian (Lopingian, Permian). The Middle Permian jalodontids, *Isacrodus marthae* and *Texasodus varidentatus* were found respectively in the Roadian and the Wordian-Capitanian. The youngest taxon was described as *Phoebodus brodiei* (= junior synonym *Ph. keuperinus*) from the Late Triassic and is attributed to a new genus of jalodontid sharks. Jalodontid teeth are characterized by peculiar features such as a crown with three to six cusps; the straight or slightly curved cusps bearing a distinct lanceolate ornamentation on the labial side; a thick base lacking a distinct apical button; one or paired labio-basal tubercles separated by a short depression; the openings of main vascular canal at the lingual rim and a basal depression. The *Jalodus* teeth have a tricuspid crown and an single labio-basal tubercle, they are slightly variable in the width of the cusps and base, in the shape of labio-basal tubercle.

Based on the analysis of dental morphology in jalodontids it seems that their development evolved in two directions. The first involves the taxa possessing teeth with a tricuspid crown and slight variations in the base structure. The latter can be expressed in the width of the base, one or two labio-basal tubercles and the width of the depression between them. Apart from *Jalodus*, this group of taxa includes *Isacrodus* and the Triassic jalodontid. The second direction demonstrates the development of considerable heterodonty in the jalodontid dentition. The teeth in the jaws of *Adamantina* and *Texasodus* vary from the tricuspid with single labio-basal tubercle and narrow base to polycuspid with two or four tubercles and a wide, arched base. The polycuspid teeth of *Adamantina* have five cusps arranged in the fan-like structure with higher central cusp. Such teeth of *Texasodus* possess up to six cusps almost equal in height. Thus, during the Paleozoic the jalodontid dentition evolved from the almost homodont to considerably heterodont.

Preparators' Symposium (Saturday, November 8, 2014, 2:15 PM)

THE RENOVATION OF THE VERTEBRATE PREPARATION LAB AT THE NATIONAL MUSEUM OF NATURAL HISTORY, SMITHSONIAN INSTITUTION

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The East Wing of the National Museum of Natural History was completed in 1964, and included the Vertebrate Paleontology Preparation Laboratory (VP Lab) on the Ground Floor. The research staff had a strong hand in the design of its laboratories, and the VP Lab consisted of a fairly large series of rooms totaling over 3,000 square feet, including an acid lab. It was spacious and equipped with all the modern accoutrements of the day. Except for a renovation of the acid lab in 1991 and the addition of a particulate extraction system in 2004, along with some cosmetic alterations, the infrastructure of the VP Lab has basically remained the same for five decades.

A major donation for the renovation of the Paleontology Halls exhibits enabled the Museum to receive Federal funding to renovate the building's HVAC systems, including those in the East Wing. The logical place to start was the Ground Floor and the labs, as they were going to be needed for the exhibit renovation and continued research prep. This would all have to be done on an extremely compressed timetable.

The NMNH's Office of Facilities, Engineering & Operations (OFEO) and the architects were very receptive of the needs of the lab staff and were valuable resources in the VP Lab's design. Continuous, seamless, chemical-resistant, light grey resin countertops line the work stations and contain a 6" backsplash, in which are located the electricity, compressed air gauges, and quick connects. There are smooth resin floors at the microscope stations to aid in locating errant fragments, and the microscope boom arms are suspended from the walls to remove the microscope from the tabletop and to be less susceptible to vibration. Low wattage yet very bright LED light sources with goosenecks and light rings sit out of the way on the backsplash. The particulate extraction system was reconfigured and the room balanced so that all the filtered air could be exhausted from the building instead of having to recirculate half of it. The renovated acid lab contains stainless steel tanks, spill pits, a shower, eye wash stations, a ½ ton hoist on a track, and hoods for hydrofluoric acid work and small volume acetic acid work.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

TARICHA OR _PALAEOTARICHA_? THE EVOLUTIONARY ENIGMA OF NORTH AMERICAN NEWTS

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The evolution and divergence of North American newts *Taricha* and *Notophthalmus* is poorly understood because we lack a fossil record that shows the morphological transitions between the distinct morphologies of these genera. Our recent morphologic analysis of some previously undescribed salamander fossils from the Oligocene of North America and reexamination of existing fossil *Taricha* indicates that these fossils show a distribution of characters that may imply an ancestral relationship with at least one, and possibly both, genera of North American newts. Features of the skull, scapulocoracoid, vertebrae, and ribs in these partial to near-complete skeletons may warrant a generic distinction from *Taricha* and *Notophthalmus* and answer long-standing questions about the ancestral morphology of these salamandrid genera. We measured several features, including the degree of expansiveness on the dermal caps of vertebrae, height of the neural spine relative to length, amount of sculpturing on the skull, especially the frontosquamosal arch, and the length of uncinate rib processes and found divergent morphologies characteristic of divisions at the generic level. *Taricha* is characterized by a lack of dermal caps on the vertebrae, moderate neural spines, little skull and frontosquamosal arch sculpture, and short uncinate rib processes. *Notophthalmus* differs in possessing small dermal caps, distinctly high neural spines, little sculpturing, and short uncinate processes. The proposed genus exhibits large dermal caps, high neural spines, apparent skull and frontosquamosal arch sculpturing, and long, robust rib processes, but shares a number of other characters with extant *Taricha*. We also examined the Oligocene salamander, *Taricha lindoei*, which may either represent the earliest occurrence of the modern *Taricha* group or a juvenile member of the aforementioned ancestral group. Given the well-known global decline in amphibians due to climate change, human activity, invasive species, and other such factors, even the most successful groups of amphibians are unlikely to escape unscathed. A better understanding of the evolutionary and ecological history of North American salamandrids is therefore necessary to maximize the success of conservation strategies.

Technical Session II (Wednesday, November 5, 2014, 9:00 AM)

CENOZOIC VERTEBRATES OF COASTAL ANGOLA

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The puzzle-like fit of Africa and South America and their subsequent drift have been geophysically modeled to improve the fit and trace their paths. The results have been correlated with patterns of sedimentation and pCO_2 mitigated climatic change, but the effects on vertebrate life and their global context have been inordinately neglected. Coastal Angola preserves a remarkable 85 million year Cretaceous and Cenozoic record of vertebrate life as Africa drifted from South America to form the growing South Atlantic Ocean. Geologic structure and latitudinally changing climatic regimes due to northward drift provide a nearshore record not available elsewhere on either side of the Atlantic. The Paleogene sequence in the northern Angolan province of Cabinda is unique because it produces fragmentary terrestrial mammals, and the southern provinces of Kwanza Sul and Benguela produce Neogene whales. In Cabinda, we have traced the stratigraphy between Landana and Malembo Point, Paleocene to near the Mio–Pliocene boundary, and sampled these deposits for pollen, stable isotopes, detrital zircons, magnetostratigraphy, and for U/Pb dating of bones, teeth, and coprolites. Although the faunas are dominated by sharks and rays, new discoveries from Landana include a complete cheloniid skull, a small snake vertebra, and a bird bone. Discoveries from the Malembo level include a narrow-snouted crocodyliform similar to *Congosaurus* and *Euthecodon*, an arsinoithere anterior tooth, an upper molar similar to that of the ptolemaiidan *Kelba*, an unidentified mammalian incisor, and a large primate-like premolar. Unconformities in the Cabinda section indicate two intervals of fossiliferous ravinement correlated with growth of the Antarctic ice sheet. In the Kwanza and Benguela basins, Miocene and Pliocene localities have produced two taxa of neobalaenid whales.

With the northward drift of Africa since the Cretaceous, latitudinally controlled climatic zones were displaced southward, moving once arid latitudes into tropical climes and restricting temperate latitudes to a small portion of southern Africa. Upwelling, usually considered to have originated with the Miocene Benguela Current, has a much longer history that facilitated an abundance of marine amniotes throughout the Late Cretaceous to the present day. The adjacent arid zones have shaped the distribution of the modern biota through the effects of climatic isolation and restriction.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

BEYOND PHOTOGRAMMETRY: NEW METHODS FOR FOSSIL DIGITIZATION APPLIED TO THE UPPER JURASSIC PTEROSAUR _SCAPHOGNATHUS CRASSIROSTRIS_

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Within the last 20 years, capturing 3D geometry and simple texture has become a standard technique for digitizing fossils. However, texture only describes object surface color. Hence, surface reflectance behavior, which incorporates the change in color values due to variations in viewpoint and lighting conditions, is not adequately captured by current methods although it may provide important insights.

We address this problem by capturing and digitally reproducing soft tissue preservation of the holotype of the rhamphorhynchoid pterosaur *Scaphognathus crassirostris* from the Upper Jurassic Solnhofen lithographic limestone. This specimen is famous for the first description of hair-like structures and wing membrane impressions. While Solnhofen fossils commonly preserve soft tissues, visualization is often challenging. We use two novel methods previously applied to digitizing cultural artifacts. One method is Reflectance Transfer Imaging (RTI), which displays surface appearance and relief under various light directions. The other is Bidirectional Texture Functions (BTFs), which describe the local surface appearance depending on the local surface point as well as direction of view and direction of light. RTI captures surface reflectance behavior by taking multiple photographs with a static camera under varying illumination conditions. This allows inspection of a 2D digital model of the object from a fixed viewpoint using synthetic light source positions, as well as synthetic modification of surface reflective behavior. BTFs additionally visualize surface reflectance properties from variable viewpoints. In our state-of-the-art approach, BTF measurements are typically combined with structured light-based techniques for 3D geometry acquisition. Actively illuminating the physical object is achieved by projecting certain patterns, in our case a series of reflected binary codes (Gray codes), onto the surface. An array of cameras observes these patterns, and correspondence between the different views of the object can be established. The result of BTF computation is a 3D digital model for which both viewpoint and light direction can be varied by the observer.

The advantage of RTI is its relatively low computing power requirements; the disadvantage is the 2D model. BTFs, on the other hand, offer the 3D model of other digital capture methods such as laser surface scanning and photogrammetry and combine them with variable object illumination, but the method requires extensive computing power and is still under development.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

3D RECONSTRUCTION OF THE ENDONEUROCRANIAL SHAPE OF A BASAL TYRANNOSAUROID

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The body proportions of the derived tyrannosaurids contrast with those of their predecessors such as the Late Jurassic *Guanlong wucaii* and the Early Cretaceous *Dilong paradoxus* from China. Enormous differences in size might have affected their predatory behavior and locomotion skills controlled and coordinated by the central nervous system. The endoneurocranial (EDN) morphology of *T. rex* is now well known. In this study we have verified the recent interpretation of *T. rex* endocasts using 3D visualization of the complete braincase of the specimen called 'Sue' (FMNH PR 2081). The brain cavity of *T. rex* has rather a tubular form with two major expansions. The first corresponds to the cerebral region that expanded laterally. The other refers to the laterally compressed cerebellar region of the endocast expanded dorsally. While the endocast is well-regionalized rostrally into spaces that accommodated large olfactory bulbs, relatively short tracts, and cerebral hemispheres, the post-cerebral endocast is somewhat amorphous except for tiny floccular protrusions and outlets of the cranial nerves and vascular structures. We also confirm the finding that the olfactory region of the nasal cavity was misinterpreted for olfactory bulbs in previous studies. EDN proportions prior to the evolution of gigantism in tyrannosauroids were studied using coronal micro-CT scans of a *Dilong* specimen with a nearly complete skull (IVPP V14243). Segmentation of the EDN was complicated by dislocation of neurocranial bones, incomplete hypophysial region, and intrusion of cranial bone fragments into the braincase cavity. The rendered endocast reveals numerous deformations due to multidirectional shifts of major brain compartments. Therefore we applied recombination of continuous EDN regions and a mild retrodeformation to restore bilateral symmetry of the objects. We have found that the restored endocast of *Dilong* substantially differs from that of *T. rex* by multiple features. It is rostro-caudally short with expanded hemispheric spaces that partly superimpose on the rest of the endocast. The most striking feature is enormous size of the flocculus. The endocast lacks any tracks of large head veins, and terminates abruptly behind the large cerebellum. We conclude that *Dilong* endocast accommodated a brain with morphology similar to maniraptoran theropods. Funded by a grant from the Czech Science Foundation (P302/12/1207).

Symposium 2 (Thursday, November 6, 2014, 3:00 PM)

LOCOMOTION IN EXTINCT GIANT KANGAROOS: WERE STHENURINES HOP-LESS MONSTERS?

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Sthenurine kangaroos (Marsupialia, Diprotodontia, Macropodiformes) are an extinct subfamily within the extant family Macropodidae (kangaroos, wallabies, and tree-kangaroos). These 'short-faced' browsing kangaroos first appeared in the middle Miocene, and radiated in the Plio–Pleistocene into a diversity of mostly large-bodied forms more robust than extant forms in their proportions. The largest (*Procoptodon goliah*) had an estimated body mass of 240 kg, three times that of the largest extant kangaroo, and there is speculation as to whether this animal was biomechanically capable of hopping locomotion. Previously described aspects of sthenurine anatomy (specialized forelimbs, relatively rigid lumbar spine) would limit their ability to perform the characteristic kangaroo pentapedal walking (using the tail as a fifth limb), an essential slow gait as slow hopping is energetically unfeasible. To investigate sthenurine anatomy in comparison with extant kangaroos, we took 94 linear measurements of the hind limb bones of macropodoids (kangaroos and rat-kangaroos), 67 individuals (45 taxa) of extant forms, and 66 individuals (19 taxa) of extinct ones, which were subjected to bivariate and multivariate analyses. The scaling of long bone dimensions indicates that sthenurines are

following the 'normal' allometric trend for macropodoids; rather than sthenurines being robust, it is the large extant kangaroos that are relatively gracile. Sthenurines show numerous differences from extant macropodoids and cluster away from the large extant kangaroos in the analyses, often showing greater similarity to the rarely hopping tree-kangaroos. In comparison with large, hopping-specialized kangaroos (genus *Macropus*), sthenurines show the following attributes: fewer specialized features for hopping (e.g., shorter ischia and calcaneal heels); morphological features indicative of supporting their body with an upright trunk (e.g., dorsally tipped ischia, enlarged area for origin of the gluteals); and morphological features indicative of supporting the weight on one leg at a time (e.g., larger hips and knees, greater stabilization of the ankle joint). We propose that sthenurines adopted a bipedal striding gait (occasionally observed in extant tree-kangaroos): in the smaller and earlier forms, this gait may have been employed as an alternative to pentapedal locomotion at slower speeds, while in the larger Plio–Pleistocene forms such a gait may have enabled them to evolve to body sizes where hopping was no longer a feasible form of rapid locomotion.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

NECK MOBILITY IN THE GIANT PLEISTOCENE HORNED TURTLE *MEIOLANIA PLATYCEPS*

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Meiolania platyceps is one of the stratigraphically latest, and osteologically best-known members of the enigmatic Paleogene-Holocene testudinatan clade Meiolaniidae. This exclusively Gondwanan lineage of bizarre horned turtles achieved gigantic body sizes (carapace lengths exceeding one meter), and seems to have paralleled northern hemisphere tortoises in occupying large terrestrial herbivore niches on remote Pacific islands. The evolutionary relationships of meiolaniids are controversial with opposing topologies inferring placement either as stem cryptodires or the last surviving basal testudinatans. Such uncertain yet unequivocally pivotal phylogenetic positioning is not only of systematic significance, but also critical for understanding the adaptive radiation of transitional turtle morphotypes. With this objective in mind, our study generated digital reconstructions of intervertebral mobility using the complete cervical series of *M. platyceps* as a paradigm character complex for the mechanism of neck retraction, and as a functional model for inferring feeding habits in giant meiolaniid taxa. A combined photogrammetric and CT data approach was used to compile surface meshes for each individual vertebra, which were then scaled, articulated, and animated to visualize maximal movement through segments radiating from the dorsoventral and mediolateral planes. The results clearly showed that *M. platyceps* was incapable of cryptodiran-like neck retraction, which is not surprising given the massive skull and prong-like squamosal horns. In addition, impeded dorsal flexion via the vertebral processes and projecting anterior margin of the carapace suggests that browsing would have been difficult. Indeed, the neck of *M. platyceps* was best capable of downward mobility with acute abduction between vertebrae I-III allowing the skull to tilt forward almost vertically. This presumably brought the tapered muzzle into a grazing position and allowed the animal to feed upon low growing herbaceous vegetation, ferns and palm fruits.

Technical Session XVII (Saturday, November 8, 2014, 3:15 PM)

THERAPSID CRANIAL ONTOGENY BASED ON 2- AND 3-DIMENSIONAL MORPHOMETRIC ANALYSIS

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Our understanding of ontogenetic patterns in the non-mammalian therapsids has historically been hindered by the complicated taxonomy of the group, with juvenile and adult specimens often referred to different taxa. Following intensive taxonomic revision, it is now possible to recognize growth series for a variety of common therapsid species. We used geometric morphometrics to visualize allometric shape changes in a broad sampling of therapsid taxa, including representatives with known growth series from every major group: Biarmosuchia (*Lemurosaurus*); Dinocephalia (*Anteosaurus*); Gorgonopsia (*Smilesaurus*); Therocephalia (*Theriognathus*); and both Permian and Triassic representatives of Anomodontia and Cynodontia (Permian *Aulacephalodon* and *Procynosuchus*; Triassic *Lystrosaurus* and *Thrinaxodon*). Previous studies have been largely restricted to 2-dimensional data, which can be prone to artifacts, like 2D orientation that limits the array of landmarks included in the same analysis. To address these possible shortcomings, we analyzed the study sample using both 2D data based on dorsal and lateral skull photographs and 3D data based on digitally photogrammetized skull models. The results of both analyses were generally consistent, indicating that shortcomings of 2D data are not overwhelming. Principal component (PC) 1 accounts for 44% (2D) and 40% (3D) of variance in the combined data set and is correlated with shape changes related to phylogenetic distance between taxa. However, PC2 (23% for 2D; 19% for 3D) is correlated with skull size in most taxa and is interpreted as representing growth-related allometric changes. Consistent changes in skull shape correlated with size were not found in *Anteosaurus*, *Lemurosaurus*, and *Thrinaxodon*, probably a result of taphonomic deformation. Gorgonopsian allometry is dominated by expansion of the snout in larger individuals, directly related to increase in size of the saber-like canine with growth. Cynodontia (*Procynosuchus*) and Therocephalia both show an increase in relative temporal fenestra size, with snout elongation as well in the therocephalian. In general, decrease in orbit size and increase in temporal fenestra size are associated with increased skull size in most study taxa. Within anomodonts, however, *Aulacephalodon* and *Lystrosaurus* show different allometric trajectories, with the latter retaining large orbits at large size, suggesting that lystrosaurids represent a paedomorphic lineage, possibly linked to elevated growth rates of Permo-Triassic therapsid survivor taxa.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

DIVERSITY AND PALAEOECOLOGY OF UPPER CRETACEOUS NON-MOSASAURID MARINE SQUAMATES FROM THE ADRIATIC PLATFORM

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Non-mosasauroid marine lizards from the Upper Cretaceous Adriatic Platform were most diverse in the middle to upper Cenomanian, but did not all go extinct at the Cenomanian-Turonian Boundary Event (CTBE) as shown by a single specimen from Dugi Otok, Croatia. The fate of contemporaneous marine snake lineages is unclear as phylogenetic relationships are problematic. The newest marine lizard specimen from the Platform, found near Split, Croatia, lacks a skull and is Santonian-Campanian in age.

Middle to upper Cenomanian marine snakes from the Adriatic Platform include *Mesophis nopcsai* and *Pachyophis woodwardi* from Bosnia-Hercegovina. Contemporaneous snakes include the limbed forms *Pachyrhachis problematicus*, *Haasiophis terrasanctus*, and *Eupodophis descouensi*; all three taxa are from Middle Eastern localities in Lebanon and near Jerusalem in Israel. The Adriatic lizards include *Adriosaurus suessi*, *Adriosaurus microbrachis, Adriosaurus skrbinensis, Acteosaurus tommasinii*, *Pontosaurus lesinensis*, *Mesoleptos zendrinii*, and *Eidolosaurus trauthi*; the Turonian record includes a new taxon of long-necked, large bodied marine lizard and the Santonian-Campanian specimen is a long bodied, short-limbed lizard. Related forms from the middle to upper Cenomanian of the Middle East include *Aphanizocnemus libanensis, Pontosaurus kornhuberi,* and *Judeasaurus tchernovi,* and from England, Germany, and Texas, *Coniasaurus crassidens, Coniasaurus gracilis,* and *Dolichosaurus longicollis*. Previous hypotheses held that these lizards went extinct at the CTBE; however the Turonian and Santonian-Campanian fossils contradict this assertion. Pre-CTBE mosasauroids were also small bodied, survived the CTBE, and successfully radiated as aquatically adapted mosasaurs.

Taphonomy and non-preservation are factors biasing understanding of non-mosasauroid marine squamate evolution and diversity post-CTBE. Extinctions and evolution were also likely driven by competition and selective pressures between small bodied mosasauroids and the non-mosasauroid lizards and snakes of the upper Cenomanian. Even though mosasauroids radiated and diversified post-Turonian, numerous niches would have been available to small-bodied marine squamates even if their diversity was reduced or restricted during the remainder of the Late Cretaceous.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE MIDDLE MIOCENE CARNIVORA OF NEW MEXICO (TESUQUE FORMATION): SPECIES PATTERNS, RICHNESS, AND FAUNAL TURNOVER

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Recent field work and research has called for a new look at the carnivorans from the middle Miocene of New Mexico. Here we sought to describe the changes in carnivoran guilds through time within the Tesuque Formation as well as the carnivoran diversity in each member. The Tesuque Formation in New Mexico is a fossiliferous rich layer of strata that spans the late Hemingfordian through the Clarendonian (and potentially into the earliest early Hemphillian). The Carnivora from this formation have been relatively well-documented, particularly from the late Barstovian Pojoaque Member. The underlying early Barstovian Skull Ridge Member has also received some study and contains a similar fauna to the Pojoaque. The oldest (late Hemingfordian Nambe Member) and youngest (late Barstovian Dixon Member and late Barstovian–Clarendonian Chama-El Rito and Ojo Caliente members) members have received less paleontological study and are less fossiliferous. The Clarendonian–early Hemphillian Dixon Member has yielded only borophagines and the Cieneguilla Member has not yielded any carnivoran fossils. Simpson's indices calculated for each member using species counts indicate the greatest diversity was present in the Nambe member (D = 0.2) followed by the Pojoaque member (D = 0.326). The least species diversity is in the Dixon member, but this member is only represented by a single specimen of *Aelurodon taxoides*. By compiling the number of carnivorans within each family in each member, we were able to see trends in appearances and extinctions over time. Hesperocyonines are only present in the early Barstovian, while the large hemicyonids are found only in the late Barstovian, potentially filling an open niche left by the hesperocyonines. While carnivoran diversity drops after the Barstovian (Chama-El Rito D = 0.53; Ojo Caliente D = 0.44), mustelids are still present in the early Clarendonian. Felids tend to become less numerous through time, perhaps allowing mustelids to fill the role of the small predators in place of *Pseudaelurus stouti* (among others), and these may have in turn been replaced by small canines. Similar to what other authors have seen, borophagines were the dominant carnivorans, and presumably the dominant predators, during the middle Miocene in New Mexico.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

POST-GLACIAL MAMMAL REMAINS FROM COLD LAKE, ALBERTA, CANADA

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Quaternary vertebrate fossils are uncommon in the modern boreal forest ecoregion in central and northern Alberta, with the exception of fluvial sands and gravels associated with major river drainages (e.g., Peace River). Rarity in non-fluvial settings is likely due (in part) to poor conditions for preservation in the acidic soils that occur throughout the boreal forest. As a result, there is a significant geographic gap in our understanding of Quaternary faunas that re-occupied northern Alberta and other parts of the southern boreal ecoregion in the post-glacial period. New faunal records from Cold Lake, Alberta, highlight the potential for improving our understanding of the late Quaternary vertebrate record of those areas.

Cold Lake is situated in east-central Alberta, near the southern boundary of the modern boreal forest. The lake is about 23 km wide and up to 100 m deep. Post-glacial vertebrate remains were recovered from three localities (French Bay, Murray Island, and Alberta-Saskatchewan border site) occurring at comparatively shallow depths in restricted littoral or near-shore areas of the lake. The specimens were collected by Charles Ehrich, a certified diver who donated them for further study.

Collectively, the remains include bison (*Bison* sp.), moose (*Alces alces*), elk (*Cervus elaphus*), deer (*Odocoileus* sp.), river otter (*Lutra canadensis*), beaver (*Castor canadensis*), and muskrat (*Ondatra zibethicus*). For the large mammal remains, we interpret the localities as representing primary context for the specimens, possibly indicative of areas where animals fell through ice and drowned. The oldest Cold Lake specimen is a bison skull from the Alberta-Saskatchewan border site, radiocarbon dated at 10,350 ± 40 yr BP, indicating an early post-glacial age. Remains from French Bay were radiocarbon dated to the late Holocene; remains from Murray Island are thought to be of similar age. Collectively, the vertebrate remains from Cold Lake begin to fill a spatial gap in our understanding of the Quaternary faunal record of Alberta. Furthermore, the remains highlight the potential of lakes situated in the boreal forest as significant sources of information regarding the Quaternary vertebrate record of northern Alberta.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE XINGYI MARINE REPTILE FAUNA FROM SOUTH CHINA: MAJOR ECOLOGICAL EXPANSION INTO THE OPEN OCEAN DURING THE LATE LADINIAN (MIDDLE TRIASSIC)

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Mesozoic marine reptiles were the top predators of the marine ecosystem that evolved about 4 million years after the end-Permian mass extinction. The Early Triassic (Spathian, Olenekian) Chaohu Fauna is a diversified marine reptile fauna from the north slope of South China Block, yielding at least eight reptile taxa including *Chaohusaurus* and *Majiashanosaurus*, the geological oldest records of ichthyopterygians and sauropterygians known so far. The fauna represents the beginning of a biotic radiation that followed the depression caused by the mass extinction. The Middle Triassic (Pelsonian, Anisian) Panxian and Luoping Fauna, yielding more than 15 species of marine reptiles including *Mixosaurus*, *Phalarodon*, *Placodus*, *Nothosaurus*, *Lariosaurus* and saurosphargids, indicates a close paleobiogeographic affinity to the west Tethys. This fauna also marks a recovery from the extinction, documenting a rapid radiation and expansion of the tetrapod-controlled new ecosystem along the coasts which mainly developed in the Tethys.

The Middle Triassic (Ladinian) Xingyi Fauna comprises 15 or more taxa of marine reptiles. The thick fossiliferous level can be subdivided into two beds. The lower bed contains mostly coastal taxa including the pachypleurosaur *Keichousaurus*, the nothosaurians *Nothosaurus* and *Lariosaurus*, the protorosaurs *Macrocnemus*, *Fuyuansaurus* and *Tanystropheus*, and the archosaur *Diandongosuchus*, representing a near-shore ecosystem on the carbonate platform with western Tethyan affinities. The upper bed yields the large ichthyosaur *Guizhouichthyosaurus* which may grow to 8 m in length and is the sister-taxon of the North American *Shastasaurus*, the euichthyosaur *Qianichthyosaurus* which may grow to 2 m in length, a taxon with a distinct tailbend that is phylogenetically close to the North American *Toretocnemus*, and the pistosaur *Yunguisaurus* which is phylogenetic close to plesiosaurs. The oldest 'flying fish' *Thoracopterus* also comes from this bed, together with a large paleonisciform showing light scale covering. The findings display diversified ecological strategies, the capability to cruise into the open ocean, and a big faunal geographical change, indicating a major transition from coastal to open ocean environments.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

MOSASAUR RECORD (SQUAMATA: MOSASAUROIDEA) FROM THE UPPER CRETACEOUS OF CHILE

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Mosasaurs were a successful group of marine reptiles, diverse and widespread in the seas during the Late Cretaceous. In contrast to the abundant record of elasmosaurid plesiosaurs and turtles from the Late Cretaceous of the eastern margin of the Pacific, the occurrences of mosasaurs are still very limited. All the material collected comes from localities distributed along the coast of central Chile, which are all assigned a Maastrichtian age. Recovered materials include isolated teeth, as well as pelvic girdle elements, vertebrae, and one fragmentary upper and lower jaw, all of them recovered from upper Maastrichtian levels. The limited materials make it difficult to identify taxa at genus or species level, though clade affinities can be recognized. The striations and curvature of some of the isolated teeth are similar to those of tylosaurine mosasaurs; isolated dorsal, pygal, and intermediate caudal vertebrae show similarities to mosasaurines; a fragmented sigmoidal-shaped ischium has been attributed to a tylosaurine; and the fragmentary jaws, with fourteen teeth or sockets, have been attributed to cf. Halisaurinae. Although this record of mosasaurs is fragmentary, it shows that on the eastern Pacific margin there were at least three mosasaur clades present: tylosaurines, mosasaurines and halisaurines. The geographical distribution of the Chilean record includes the first remains tentatively referred to Halisaurinae in the Weddellian Province, being the only record of this subfamily in South America to date. The presence of Tylosaurinae in two localities (Faro Carranza and Lirquen) is interesting, because unlike the records from late Campanian of Antarctica and New Zealand, the presence of the group in the late Maastrichtian of the Quiriquina Formation shows that the group was present until shortly before the Cretaceous-Paleogene event on the coast of the Eastern Pacific, proving a widespread Weddellian distribution prior to their extinction. The study of the fossil record of mosasaurs in central Chile is particularly important, as it includes the northernmost and one of the youngest localities within the Weddellian Biogeographic Province. RAO was supported by the Antarctic Ring Project ACT-105, Conicyt-Chile.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

APPROXIMATE BRAIN PROPORTIONS DERIVED FROM THE ENDOCAST OF A JUVENILE HADROSAUR DINOSAUR

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The brain morphology of non-avialan dinosaurs is historically thought to differ from the shape of endoneurocranium (ENC) itself. The brain is usually separated from the braincase by an interstice that contains protective components, cerebrospinal fluid and meningeal membranes, which might have been much thinner around the rostral than caudal compartments of the brain. The thinner meninges are generally associated with the presence of valleculae on the inner braincase of some dinosaurs including hadrosaurs. Earlier studies suggest that the endocasts of hadrosaurs are organized in a linear rather than a superimposed pattern. The closest living relatives of dinosaurs with the longitudinally arranged brain compartments are crocodiles. The expanded cerebral hemispheres and the presence of the cerebral valleculae in hadrosaurs demonstrate the hadrosaur forebrain had likely filled much more of the rostral interstice than in adults of recent crocodiles. We suggest that the most appropriate available model to extrapolate brain parameters from hadrosaur braincase are juvenile stages of the recent crocodiles. First, we have studied developmental aspects of 3D interface between the brain and ENC surfaces in *Caiman* using magnetic resonance high resolution imaging, manual segmentation, and geometry morphometrics. Second, a digital endocast was made from partly distorted and sagittally sectioned braincase of a juvenile hadrosaur (RTMP 82.19.72) from Dinosaur Provincial Park. Unilateral damage to the braincase was compensated for by mirroring with the better-preserved counterpart using custom made modules of Ellipse. The skew effect was solved by retrodeformation of the coronal sections. The endocast is most reminiscent of that of subadult *Corythosaurus* sp. (CMN 34825) in having the abrupt cerebellar descent located anterior to the crus communis of the inner ear. In contrast to all known hadrosaur endocasts, this RTMP specimen has considerably dorsoventrally flattened cerebral hemispheres. Further, it provides the first evidence about the position of the midbrain in hadrosaurs that correspond to the linear patterns of the crocodilians. Finally, we extrapolated the crocodilian interstice modules of juvenile crocodiles on the hadrosaur endocast to retrieve the approximate shape of its brain. A surface model of the crocodile ENC with brain is fitted to the hadrosaur ENC using landmarks of salient features in the ENC models and thin plate spline deformation of the crocodile model. Funded by a grant from the Czech Science Foundation (P302/12/1207).

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

THE APPARENT ABSENCE OF THE FRESHWATER XENACANTH SHARK *ORTHACANTHUS PLATYPTERNUS* FROM THE BRIAR CREEK BONEBED, LOWER PERMIAN OF TEXAS, USA

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Two species of *Orthacanthus* nearly always occur together in the Wichita Group of Texas: of 28 faunas obtained by screen-washing, each containing more than 100 *O. texensis* teeth, none lack *O. platypternus* teeth. In the Briar Creek fauna (Nocona Formation, basal Wichita Group), 710 *O. texensis* teeth, as well as germinal and pathologically deformed teeth, were recovered. But only one tooth of *O. platypternus* was present, and possibly a tooth of *O. compressus*; both are incomplete. Stratigraphically higher in the Nocona Formation, the Geraldine Bonebed yielded 1808 *O. texensis* teeth and 88 *O. platypternus* teeth. Near the top of that formation, one of the Rattlesnake Canyon Bonebeds yielded 427 *O. texensis* teeth and only three *O. platypternus* teeth. *Orthacanthus platypternus* occurs throughout most of the overlying Clear Fork Group, whereas *O. texensis* is confined to the Wichita Group. Subjacent to the Nocona Formation, in the Archer City Formation (Bowie Group), both species are absent. Instead, only >*O.*? *compressus* adult and juvenile teeth are present in the Archer City Bonebed 3 and stratigraphically equivalent Conner Ranch fauna.

All of the above faunas (except Conner Ranch) contain evidence of marine shark species (e.g., *Helodus* sp. and especially iniopterygians in the Rattlesnake Canyon faunas), but the faunas are otherwise overwhelmingly nonmarine (Geraldine and Briar Creek are famous for yielding tetrapod skeletons). *Orthacanthus platypternus* was undoubtedly a nonmarine shark, so its near absence at Briar Creek remains a mystery. It may be possible that it did not venture into the coastal plain realm, but preferred streams of greater gradient in floodplains, despite occurring in mixed marine/nonmarine (hybodonts, etc.) faunas higher in the Wichita Group.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

RE-DESCRIPTION OF *STENEOSAURUS OBTUSIDENS*, A LONG-BODIED CROCODYLOMORPH FROM THE MIDDLE JURASSIC OF ENGLAND (THALATTOSUCHIA; TELEOSAURIDAE)

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Teleosauridae was a group of longirostrine, large-bodied semi-marine Jurassic crocodylomorphs superficially resembling extant gharials. Along with Metriorhynchidae, they constitute the larger clade Thalattosuchia. Multiple specimens have been collected from the Callovian (Middle Jurassic) of the Oxford Clay Formation (OCF) of the Peterborough Member in the United Kingdom. While all teleosaurids from the OCF have been attributed to the genus *Steneosaurus*, recent phylogenetic work has demonstrated that *Steneosaurus* is paraphyletic and badly in need of revision. One particular species from the OCF, *Steneosaurus obtusidens*, is thought to be closely related to the Late Jurassic *Machimosaurus*. *Steneosaurus obtusidens* was originally named and described

over a century ago, and is based on specimens from the Natural History Museum (NHM) in London. Since then, little anatomical work has been done on the material of this species, aside from scanning electron microscopy of teeth and dorsal-view skull morphometric studies involving the holotype.

Here we report our findings based on re-examination of the holotype of *Steneosaurus obtusidens* (NHMUK PV R3168), as well as two other specimens that have been labelled under the same name (NHMUK PV R3169 and NHMUK PV R3898). The holotype, represented by a nearly complete skeleton, reveals over 14 apomorphic characters. These include three sacral vertebrae, large anteromedial supratemporal fossae, no axis diapophyses, and serrated teeth. *Steneosaurus obtusidens* displays an unusual mixture of metriorhynchid and teleosaurid characteristics, questioning the position and validity of this species. The two other specimens originally referred to *Steneosaurus obtusidens* (NHMUK PV R3169 and NHMUK PV R3898) more closely resemble *Steneosaurus durobrivensis* than *Steneosaurus obtusidens*. *Steneosaurus obtusidens* has been considered to be the largest-bodied Middle Jurassic teleosaurid. Measuring the skull and vertebral column of the holotype, and estimating for missing vertebrae, the specimen would have been around 5.3 meters long. However, comparable measurements show NHMUK PV R3898, which we consider to be *Steneosaurus durobrivensis*, was from a larger individual than the *Steneosaurus obtusidens* holotype.

Romer Prize Session (Thursday, November 6, 2014, 9:30 AM)

THE AXIAL SKELETON: A MISSING PUZZLE PIECE IN THE EVOLUTION OF CURSORIAL LOCOMOTION IN HORSES

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Adaptation of ungulate limbs for cursoriality is an excellent example of convergent evolution for a specialized function. However, the role of the axial skeleton is virtually unknown, despite its considerable functional importance. Here I re-examine a classic case of adaptive evolution, that of the evolution of cursoriality in fossil horses, from a new perspective by looking at their lumbosacral vertebrae. Modern horses are characterized by a sagittally-mobile, hinge-like lumbosacral joint accompanied by an extremely rigid lumbar region. Lumbosacral bending is functionally important as it increases running efficiency by promoting locomotor-respiratory coupling, which ties stride movements to lung ventilation. Further, the amplitude of this bending during asymmetric gaits (canter and gallop) is correlated with running speed. This study asks when a. the hinge-like lumbosacral joint and b. lumbar rigidity arose, and if body size increases have influenced axial evolution.

I examined 106 lumbar vertebrae from 78 specimens of fossil perissodactyls from 10 genera dating back to the Eocene and compared them to extant horses. Morphology of proximal, mid, and last lumbar joints was captured using 60 2D sliding semilandmarks on endplates and zygapophyses, and effects of craniocaudal position and body size were tested using a MANCOVA. Key features associated with vertebral and limb function were optimized onto a phylogeny to determine the evolutionary sequence of postcranial adaptations.

Axial joint shape varied significantly along the column and with body size, although more proximal joints had steeper allometric slopes. A hinge-like lumbosacral joint, specialized for sagittal mobility, was present to some extent in the earliest digitigrade horses. Accessory joints on the transverse processes which stabilize the lumbosacral joint against lateral movements first appeared in *Mesohippus*. However, features associated with rigidity in more proximal lumbar joints evolved later and are correlated with body size increases. Lumbosacral flexion is therefore one of the oldest adaptations for asymmetric gaits in horses and forms part of an ancestral locomotor pattern which has been enhanced through equid evolution. This case study illustrates that the axial skeleton is a critical part of the mammalian locomotor apparatus which can provide novel insights into major evolutionary transitions.

Funding for this work was provided by AMNH, Sigma Xi, and American Society of Mammalogists.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

TENOTOMY OF THE CAUDOFEMORALIS LONGUS MUSCLE IN AMERICAN ALLIGATORS ELICITS NO CHANGES IN SKELETAL MORPHOLOGY DESPITE SIGNIFICANT MUSCULAR CHANGES: UNEXPECTED IMPLICATIONS FOR THE EVOLUTION OF THEROPOD LOCOMOTION

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Evolutionary changes to hind limb orientation and tail morphology among theropod dinosaurs have been ascribed to a reduced role of the caudofemoralis longus muscle (CFL) in terrestrial locomotion. Originating on the transverse processes and chevron bones of the caudal vertebrae and inserting on the fourth trochanter of the femur, the CFL is well-developed in reptiles with a sprawling gait and a long tail. Studies have shown the CFL to be a major retractor and medial rotator of the femur and it is considered the main propulsive muscle of the femoral retraction system. Bony features such as the prominence of the fourth trochanter and depth of the caudal chevron bones are hypothesized to correlate with the importance of the CFL to locomotion. As no experimental alteration of CFL function has been attempted to investigate the interplay between CFL and skeleton, we chose to use bilateral tenotomy to deactivate the CFL in juvenile (n=24) American alligators (*Alligator mississippiensis*). After eight months, experimental animals exhibited no significant differences in macromorphology of the femur or chevron bones, including; femur length, external diameter at the fourth trochanter, and average chevron length. Additionally, cross sections of the femora taken at the level of the fourth trochanter showed that experimental and control animals had similar polar moments of inertia and cross sectional areas of the fourth trochanter. In contrast, experimental CFL wet mass and fiber length were found to be significantly reduced, by 23% and 13% respectively, compared to controls. CFL tenotomy thus elicited changes at the muscular level, but not at the skeletal level. Given that no significant changes were observed in terrestrial locomotor performance (as determined by 2D walking kinematics) following tenotomy, our results suggest that voluntary locomotor patterns in crocodilians are dictated primarily by skeletal morphology rather than muscle morphology. This decoupling of muscular and skeletal components could have implications for the origin of birds, which exhibit robust femora despite minimization of the CFL. Further monitoring of bone growth/remodeling following tenotomy, and extension of the current study, will allow us to investigate the CFL-driven phenotypic plasticity of the archosaur locomotor system and elucidate the role of musculoskeletal strain in shaping the evolutionary transformation of the hind limb/tail module in archosaurs.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A JUVENILE SPECIMEN OF THE MULTIPLE-TOOTH-ROWED REPTILE *LABIDOSAURIKOS* (EUREPTILIA, CAPTORHINIDAE, MORADISAURINAE) FROM THE LOWER PERMIAN OF NORTH-CENTRAL TEXAS

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MCZ 1352 is a partial maxillary toothplate recovered from the Clear Fork Group Undivided, Early Permian of Baylor County, north-central Texas. It was originally considered to be a pelycosaur ('*Trichasaurus*') in a review of the Pelycosauria. It was later identified it as a captorhinid reptile, *Labidosaurikos*, in a review of the fauna of the Texas Vale and Choza Formations. The specimen displays the straight rows of teeth characteristic of the Moradisaurinae. It is nearly identical in shape to the maxilla of *Labidosaurikos meachami*, though it displays only five maxillary tooth rows as opposed to six, and is only approximately 40% of the size of an adult. The labial-most row has 17 tooth positions, exactly as in adult *L. meachami*. The remaining tooth rows possess relatively fewer teeth than the 17-19 teeth found in adults, having 14, 16, 14, and 8, labially to lingually. Larger, more mesial individual teeth conform to the dental pattern previously determined for adults of the genus. Despite the incompleteness of the specimen, the maxillary tooth rows appear completely intact. Notably, the lingual-most row is positioned at the apex between the horizontal and vertical surfaces of the maxillary plate, with the mesial-most teeth of this row angled lingually and likely protruding into the narial opening. Many of the teeth are broken but the size of their bases in the five parallel rows demonstrates no trend of decreasing mesially as in adults of the genus. In the completely preserved teeth, morphology matches that of adults—bullet-shaped and lacking any detectable crest or ridge traversing their crowns. Adults of *L. meachami* are known to possess six maxillary tooth rows, whereas MCZ 1352 has only five. The genus *Captorhinus* provides precedent for differing numbers of tooth rows in different species of a captohinid genus, so it could be suggested MCZ 1352 is assignable to *L. barkeri*. However, it is significantly larger than presumably mature specimens of that species. Although only a partial specimen, it appears MCZ 1352 is most likely a juvenile specimen of *L. meachmi*. If correct, the comparative sizes of juvenile and adult maxillae suggest isometric growth of this element. The orientation of the lingual-most row of teeth, and the five, as opposed to six, maxillary tooth rows suggest either new tooth rows may move labially during development or bone growth and remodeling occur lingually, resulting in the development of a margin of maxillary bone between the fifth (and subsequent) tooth row and the lingual edge of the maxilla.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

THE FIRST GORGON: A NEW LARGE-BODIED GORGONOPSIAN FROM THE BASE OF THE *TAPINOCEPHALUS* ASSEMBLAGE ZONE OF SOUTH AFRICA

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Gorgonopsians were the dominant group of predatory therapsids in the late Permian. In the middle Permian, however, gorgonopsians were very rare, both compared to their late Permian descendants and to coeval members of other therapsid clades, such as dicynodonts and therocephalians. Following recent revisions, the only currently recognized valid species of middle Permian gorgonopsian is *Eriphostoma microdon* from the upper *Tapinocephalus* and *Pristerognathus* assemblage zones (AZ) of South Africa. *Eriphostoma* is small-bodied animal (skull length ~10 cm), and it has been suggested that middle Permian gorgonopsians were restricted to small size due to competition with the numerically dominant, large-bodied predatory therocephalians of the time (i.e., scylacosaurids, and lycosuchids). Here we present a new taxon of gorgonopsian from the very base of the *Tapinocephalus* AZ that is comparable in size to coeval therocephalians. This new taxon is represented by two specimens: the rear half of a skull and an isolated occiput. Gorgonopsian identification of these specimens is supported by the combination of a broad intertemporal region and low, wide occiput. Within Gorgonopsia, the new taxon can be diagnosed by the autapomorphic presence of knob-like protuberances at the base of the basisphenoid tubera. These protuberances are located in the same position on both skulls, indicating that they are not pathological. The new taxon can further be distinguished from *Eriphostoma* by its taller zygoma and vertically-oriented occiput. Inclusion of this taxon in a recent phylogeny of early therapsids confirms its gorgonopsian placement, as part of a basal polytomy with *Eriphostoma*. The new *Tapinocephalus* AZ specimens represent the oldest known well-supported record of a gorgonopsian and suggest complex shifts in the ecological roles of the various theriodont lineages in the middle Permian.

Technical Session XI (Friday, November 7, 2014, 3:00 PM)

CHEWING MACHINE AND TOOTH WEAR: HOW PLANT MATERIALS AND GRIT AFFECT TEETH

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In the last few years, the causes of tooth wear have again become a subject of active discussion. While progress may still be possible through improved analysis of existing data, the most urgent need now is for experimental work. Instead of using real animals and facing the limitations of standardization and repeatability, we introduced some time ago a simple chewing machine for wearing real teeth under fully controllable conditions. We have previously shown that attrition and abrasion can be produced according to predictions of traditional wear theory using artificial abrasives. Here we report results from experiments with real plant material with and without added grit.

The plant materials used in this research consists of pelleted diet preparations of increasing abrasiveness (as determined by acid insoluble ash content), consisting of lucerne (L; lowest abrasiveness, very few phytoliths), grass (G; higher abrasiveness, more phytoliths), a mixture of grass and rice hulls (GR; again increased abrasiveness due to high phytolith content in rice hulls), and the grass/rice hull-mixture with added grit (GRS). Unlike in actual animal experiments, we were also able to test for attrition, wear caused by direct tooth-tooth contact in the absence of food materials. Real horse teeth were immersed in a relatively thick and saline plant slurry, which was turbidated to ensure material circulation. The chewing machine is able to perform 260 cycles per minute (4–5 times the speed of a horse) with controlled and constant movement and force. In this study, tooth pairs were chewed for 6.5 hours resulting in 100,000 repetitions, equal to several days in horse time.

Our results show clear differences between attrition and abrasion. At the scale of dental microwear, attrition is characterized by pitting of polished areas, while abrasion is characterized by striation. At the macroscopic level quantitative analysis based on 3D scanning shows that attrition causes the development of distinct, planar facets while abrasion causes facet-less, curved wear surfaces in this machine.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

ONTOGENETIC CHANGES IN THE CHICKEN BRAIN

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Although many studies have focused on the change in brain volume and/or brain regions during ontogeny in Aves, including both embryonic and posthatching growth of the brain, post-hatching ontogenetic changes in the shape of the brain are still poorly understood. On the other hand, though the brains of many extinct species from various clades have been analyzed, interspecific or ontogenetic variation in the brains of fossil taxa has rarely been examined. The ontogenetic brain shape data of extant species is required for comparison with that of extinct species. Lack of knowledge of ontogeny could result in a misunderstanding of the morphology of biological organs of fossil species. Hence, in this study, brain shape was compared among various developmental stages of chicken using three-dimensional geometric morphometric analysis, and the growth rate of the brain regions was evaluated using simple regression analysis to explore posthatching morphological changes in the chicken brain. Micro-magnetic resonance imaging (μMRI) is a noninvasive method that allows differentiation of brain regions from each other. Furthermore, it permits repeated viewing of the same living specimen. Hence, μMRI was used to acquire in vivo data and postmortem data on the chicken brain. In the resulting principal component analysis (PCA), the telencephalon rotates caudodorsally with decreasing PC1 score. This change in shape leads to a relative caudoventral rotation of the cerebellum and myelencephalon. With decreasing PC1 scores, all brain regions elongate rostrocaudally, indicating a more slender brain shape. Because PC1 explained a considerable degree of shape variation, the shape change accompanying brain growth can be summarized as the shape change with a decrease in the PC1 score. Additionally, the correlation between the PC1 score and brain size was significant. Thus, brain shape along PC1 corresponded with an increase in size. The growth rates of each brain region were constant, and the slopes of growth formulae were parallel. The dominant pattern of ontogenetic shape change corresponded with that of the interspecific shape changes with increase in brain size. That is, the interspecific and ontogenetic change in brain shape with increase in size demonstrated the same pattern. The shape of the brain and each brain region interestingly changed considerably; on the other hand, the volume ratio of each brain region did not change. This suggests that the brain can change its shape after completing functional differentiation of the brain regions.

Technical Session V (Wednesday, November 5, 2014, 3:45 PM)

BIOMECHANICAL COMPARISONS OF MODERN ANALOGS FOR UNDERSTANDING THE FUNCTIONAL EVOLUTION OF TERRESTRIAL LOCOMOTION IN EARLY STEM TETRAPODS

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Investigations of extant taxa that serve as modern analogs to early stem tetrapods have been used to gain additional insight into the evolution of vertebrate terrestriality and locomotor function.

Extant salamanders have often been used to represent the basal tetrapod bauplan in these contexts. Yet, studies on the walking biomechanics of salamanders have typically focused on more terrestrial taxa and, thus, may best reflect the function of terrestrial crownward tetrapods. Given that the earliest tetrapods were likely aquatic, a salamander group with greater aquatic tendencies may be a more appropriate model for the incipient stages of terrestrial locomotion in early stem tetrapods. We evaluated three-dimensional ground reaction forces (GRFs) produced by individual limbs of the predominantly aquatic newt, *Pleurodeles waltl*, and then compared these results to similar data on the terrestrial locomotor function of pectoral fins in the mudskipper fish *Periophthalmus barbarus*, and fore- and hind limbs of the terrestrial tiger salamander *Ambystoma tigrinum*, to gain insight into the functional changes associated at analogous evolutionary landmarks in appendicular structure (i.e., fin, aquatic limb, and terrestrial limb). We found that the biomechanical function of aquatic limbs was intermediate between fish fins and the terrestrial limbs during terrestrial locomotion. Specifically, the GRFs produced by *P. waltl* forelimbs were most similar to those from fish fins, whereas the GRFs of *P. waltl* hind limbs were more similar to the terrestrial *A. tigrinum* hind limbs. These data provide additional insight into modeling an early stage of 'rear-wheel drive' in stem tetrapods, with forelimb function still sharing similarities to fish fins. In a broader context, these comparisons establish a framework for generating hypotheses about whether functional capabilities can evolve through coupling with structural changes (e.g., fin to limb) or through gradual steps that are not closely coupled with structural changes. The integration of biomechanical evaluations with morphological analyses of fossil stem tetrapods will add valuable perspective for developing a more comprehensive understanding of how changes to the musculoskeletal design of vertebrates contributed towards tetrapods with digit-bearing limbs conquering the land, leaving other fishes at the water′s edge.

Technical Session XIV (Saturday, November 8, 2014, 10:15 AM)

EVOLUTION OF COMPLEX DENTAL ARCHITECTURE AND SLICING DENTITIONS IN CERATOPSIDS

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Throughout vertebrate evolution, a number of lineages evolved dental occlusion, whereby the contact faces of the teeth self-wear to their functional morphology. It has been shown that in mammals, increases in dental complexity accompany such changes. These presumably allowed for modifications in biomechanical form, function and performance relevant to dietary ecology. Recently, it was shown that a lineage of reptiles, the duck-billed dinosaurs (Hadrosauridae) evolved among the most architecturally sophisticated teeth known in association with their acquisition of a grinding dentition. Independently, another lineage of ornithischian dinosaurs, the horned dinosaurs (Ceratopsia) evolved dental occlusion in the form of slicing cheek teeth. Here we test the hypothesis that neoceratopsians evolved a richer ensemble of dental tissues in association with their acquisition of occluding dentitions and make inferences on the possible functional significance of those findings. Transverse and occlusal plane histological sections were made using cheek teeth from representative Ornithischia spanning the transformation series leading to the evolution of slicing in ceratopsians. The sections were viewed with dissecting and polarizing light microscopy. The microstructure was described and phylogenetically character-mapped in association with whole-tooth and wear facet morphological attributes. Our results show that ceratopsian teeth are considerably more complex than those of outgroup ornithischians in possessing four distinct tissues: enamel, orthodentine, coronal cementum, and vasodentine. Coronal cementum evolved in association with functional dental cohesion and a shearing masticatory system in the common ancestor of *Leptoceratops* + *Triceratops.* Vasodentine, a tissue typically found in teleost fishes, appeared in the common ancestor of *Protoceratops* + *Triceratops* in association with high-angled slicing. These findings represent the second demonstration of complex dental architecture outside of Mammalia, and show that some reptiles rivaled if not exceeded most mammals in dental complexity. Wear testing and tribological modeling suggest the material properties of these dental tissues are preserved in some specimens. The most notable finding pertains to vasodentine with low wear resistance and a distribution that allows for self-wear to a shallow wear basin. Our findings support the hypothesis that complex histological attributes in teeth appear in association with precise dental occlusion.

Education and Outreach Poster Session (Poster displayed November 5 – 8)

CENSORSHIP OF HUMAN EVOLUTION EDUCATION IN TURKEY

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Efforts stemming from the Turkish government's religious agenda to severely censor students' access to modern evolution theory threatens educational freedom. In Turkish high school classrooms, the coverage of evolution is vague and human evolution is ignored entirely, leaving any questions about human origins to be answered by creationist ideas taught simultaneously in mandatory religion courses and science class. This study addresses the connection between students in the Turkish public education system who are deprived of the principles of human evolution and educators who are intellectually and pedagogically unequipped to teach the scientific facts of human origins. All high school textbooks are either written by or filtered through the Ministry of National Education, and therefore are subject to political bias. The content of Finnish high school biology textbooks is analyzed and used here as a counter example in critiquing and making recommendations for amending the coverage of human evolution in Turkish high school biology textbooks. We suggest a framework for an effective coverage of human evolution at the high school level and material pertinent to additional human evolution coverage added to curricula for university students in biology and science education. We offer possible repercussions, both for the paradoxically secular Turkish education system and society at large, of teaching human evolution.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

PALEOECOLOGY AND MAGNETOSTRATIGRAPHY OF THE HOMINOID BEARING LOCALITY CORAKYERLER, TUGLU FORMATION (CANKIRI BASIN, CENTRAL ANATOLIA)

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Discovery of the great ape *Ouranopithecus turkae* in Corakyerler presented a number of chronological, faunal, and paleoecological questions so far unanswered. Here we provide a new date for Corakyerler based on magnetostratigraphic correlation and offer a new interpretation of the paleobiogeographical and paleoecological faunal settings. The Corakyerler section is correlated with the 4n and 3B chrons, with three possible age correlations between 8.13 Ma to 7.15 Ma. The presence of freshwater molluscs together with an alternation of gypsum, marls, laminated claystones, and shales indicate a lacustrine origin for Corakyerler's depositional environment. it contrasts with many other fossil deposits of the time that were formed by fluvial deposition. The geographic distribution of the genus-level faunal similarity index and mean hypsodonty paleoprecipitation analyses shows that Corakyerler is a good representative of the Pikermian chronofauna and represents woodland habitats with partially open areas. We suggest that, while the overall region suffered arid conditions, the Corakyerler, as a humid refugium in a more arid context, provided favorable environmental conditions for hominoid primates.

Technical Session XIII (Friday, November 7, 2014, 1:45 PM)

ASPIDIN: A BONE OF CONTENTION

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Living jawed vertebrates (gnathostomes) primitively possess a complex mineralized skeleton constructed from bone, enamel(oid), dentine and cartilage. Such a skeleton is absent in their extant sister-taxon (cyclostomes); thus in order to understand the evolution of vertebrate mineralized tissues, we must instead consider the extinct taxa that reside on the gnathostome stem-lineage. Among these fossil fishes, the jawless heterostracans, anaspids and thelodonts are the stratigraphically earliest occurring and phylogenetically most primitive vertebrates with a homologous mineralized skeleton. As such, they have featured prominently in discussion about the evolutionary and developmental origins of vertebrate mineralized tissues. Unfortunately, rudimentary knowledge of the histological diversity among these groups, as well as lack of phylogenetic synthesis, has impeded insight into the plesiomorphic state of the vertebrate skeleton. The root of the problem is a lack of agreement concerning the nature of aspidin, an acellular tissue present within the dermoskeleton of heterostracans, and possibly also anaspids and thelodonts. Numerous conflicting hypotheses have been put forward to explain the microstructure and homology of aspidin, spilling into the wider debate on the primacy of cellular versus acellular bone. In order to resolve the nature of aspidin, we survey the structure of the dermoskeleton among heterostracans, infer the plesiomorphic heterostracan skeletal microstructure, and compare it to the skeletal histology of anaspids and thelodonts. Our results indicate that aspidin is a type of acellular bone that exhibits osteon-like centripetal development around an extensive vascular system, forming an intersecting network of radial walls. These contain an orthogonal fabric of thread-like spaces, interpreted as cell migration tracts, which distort the mineral matrix. A second homogenous tissue, containing a meshwork of collagen fibers, develops via remodeling the centripetal tissue within the core of the intersecting radial walls. Our reappraisal of aspidin indicates that it is apomorphic with respect to heterostracans and falls within a spectrum of bone histologies exemplified by stem-gnathostomes.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

PTEROSAUR BONE BED FROM A LATE CRETACEOUS OASIS FROM BRAZIL AND CONTRIBUTION TO THE BIOLOGY OF FLYING REPTILES

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Although having been recorded from all continents, most pterosaur material is fragmentary, often poorly preserved and found isolated. The lack of specimens that can be confidently assigned to one population has masked several aspects of their biology, such as ontogeny, individual variation, and sexual dimorphism, including in the latter the role of cranial crests. Systematic field work performed in the last two years in the outskirts of the town Cruzeiro do Oeste, ParanáState, has revealed the first pterosaur bone bed known from Brazil. The deposit corresponds to the Goio-Erê Formation (Turonian-Campanian), part of the CaiuáGroup which was an extensive paleodesert that covered the southern part of the country during the Late Cretaceous. There are four distinct levels with pterosaur remains confined in about 1 m, corresponding to an interdunal wetland. In an area of less than 20 m^2 hundreds of 3D preserved bones have been recovered representing over 40 pterosaur individuals, but the actual number might be in the hundreds. There are a few articulated and closely associated skeletons, but most were mixed together. All are toothless, have the rostrum downturned and present other typical features of the Tapejarinae (Pterodactyloidea, Tapejaridae). Some features (e.g., premaxillary ventral bony expansion projected inside the nasoantorbital fenestra; rounded depression on the occlusal surface of dentary) indicates that this material represents a new taxon, the southernmost tapejarid recorded so far and the youngest record of that clade. Wingspans vary from 0.65 to 2.35 m and animals of different ontogenetic stages are represented, mostly juveniles or very young individuals. The main ontogenetic variation in the new species is reflected by the size and development of the premaxillary cranial crest, that in young animals is reduced and inclined posteriorly (~115°) and in older individuals is very large and vertical (~90°). No significant variation in postcranial elements attributable to ontogeny were observed, excect for the stronger and larger distal plate of the prepubis, the stronger ossification of the sternum (and other portions of the skeleton), and a more developed ventral expansion in the coracoid in ontogenetically older individuals. Taphonomic data suggest that this pterosaur bone bed encases part of a pterosaur population, indicating that this species was gregarious and most likely lived in colonies. It further shows that at least in this pterosaur species, the presence of cranial crests cannot be regarded as a sexually dimorphic character.

Technical Session VI (Thursday, November 6, 2014, 10:30 AM)

RATES OF HOMOPLASY IN THE MAMMALIAN SKELETON AND APPLICATION TO THE PRIMATE FOSSIL RECORD

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The utility of a morphological trait for inferring evolutionary history or reconstructing phylogeny is related to its probability of exhibiting homoplasy. Homoplasy can be quantified within a clade using the Consistency Index (CI), however, no previous study has found a significant difference in CI values between cranial, dental, and postcranial classes of morphological traits in mammals. Additionally, calculated CI values may have potential for evaluating relative levels of clade support and competing phylogenetic hypotheses in the fossil record.

We use data from a single character-taxon matrix to calculate CI values for 1240 dental, 1175 cranial, and 912 postcranial traits on a well-resolved molecular phylogeny of 45 extant mammalian taxa. Power analyses were used to determine appropriate significance levels given the large sample sizes. We demonstrate the used of CIs in comparing relative clade support using two clades near the base of the primate radiation—crown Primates and the proposed Euprimateformes (Primates + Plesiadapoidea). We also demonstrate the use of CIs in evaluating two alternative hypotheses for the phylogenetic placement of an assemblage of fossil platyrrhine taxa. The Long Lineage Hypothesis (LLH) places these fossil taxa as stem members of extant family level groups while the Short Lineage Hypothesis (SLH) places the fossil taxa as stem platyrrhines.

Trait class has a significant influence on CI in a one-way ANOVA ($p < 0.005$) driven by the very low CI values of postcranial characters. CI values are significantly higher for Primate synapomorphies than for Euprimateformes synapomorphies ($p < 0.05$). These results indicate that Primate synapomorphies are less frequently homoplastic across extant mammals and provide greater clade support. CI values are significantly higher for the SLH synapomorphies than for the LLH synapomorphies ($p < 0.01$), indicating relatively greater support for the SLH. Our results demonstrate a significant difference in the homoplasy rates of mammalian skeletal trait classes, as well as calculated CIs' potential as a line of evidence in evaluating fossil clades.

Technical Session IX (Thursday, November 6, 2014, 4:00 PM)

SELECTIVITY AND HETEROGENEITY OF EXTINCTION IN CARIBBEAN LIZARD COMMUNITIES

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Lizards (Lacertilia) are a highly diverse and globally distributed group of reptiles (Squamata). Originating in the Jurassic, they exhibit broad life histories and phenotypes, rendering them a unique model system in evolutionary ecology. However, little is known about extinction within this group. The fossil record allows us to see how communities and their environments change through time, and helps us identify which perturbations hinder the persistence of species. We take advantage of the replicate nature of insular systems to understand patterns of selectivity, intensity, and heterogeneity of extinction in the charismatic lizard fauna of the Caribbean. With our dataset, the rich Quaternary record of extinctions and extirpations from within the archipelago, we ask whether extinction is selective and heterogeneous. We find that extinction is size-selective throughout the Caribbean, and that certain taxonomic groups have a higher incidence of extinction. Despite these general patterns, extinction is heterogeneous at a local scale. We implicate introduced predators and human-mediated habitat loss in the extinction of endemic Caribbean lizards, and emphasize that continued perturbation of natural ecosystems will lead to additional, non-random extinction events.

Technical Session XV (Saturday, November 8, 2014, 9:15 AM)

ENERGETIC BENEFITS AND ADAPTATIONS IN MAMMALIAN DESIGN: SCALE EFFECTS AND SELECTIVE PRESSURES

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Differences in the shape and size of limbs are one of the most evident features of morphological diversity in mammals, being present in some of the earliest fossil taxa. However, the relevance of limb shape and size to locomotor costs has long been subject to debate. Recent studies have found that the metabolic cost of swinging the limbs is significant, aligning with previous suggestions that whole limb size and shape should influence locomotor energetics. Furthermore, previous studies have implicitly assumed that limb morphology has been under selection for lower locomotor costs. To test whether: (1) whole limb size and shape have the potential to influence locomotor costs; and whether (2) limb morphology has been under selection for lower locomotor costs, I collected data on limb moment of inertia (MOI) for 44 species of terrestrial mammals. MOI constitutes the limb's intrinsic resistance (and the required effort) to swing the limb forward to take a step. I investigated the potential for limb MOI to influence locomotor costs by examining the scaling of this trait against limb length using bivarate regressions and testing against a model of isometry. Limb MOI scales with negative allometry, resulting in a substantial 40% reduction in MOI relative to isometry for my largest

sampled taxa. The negative allometry of limb MOI demonstrates a potential to influence locomotor costs, coinciding with decreasing mass-specific locomotor costs in mammals with increasing limb length. However, a phylogenetic regression finds that limb MOI scales isometrically. Testing whether decreased locomotor cost constitutes a selective pressure acting upon limb design, I fit the co-variation of limb MOI and length (using regression residuals a proxy) to models of trait diversification. Models included single- and multi-rate Brownian motion and single- and multi-optima Ornstein-Uhlenbeck (OU) processes. A multi-optima OU model is the best descriptor of the co-diversification of limb MOI and limb length, with differing optima corresponding to the following locomotor types: running, climbing, digging, swimming, and generalized. Thus, the negative allometry of limb MOI is not the result of selection but rather a byproduct of the functional diversity within terrestrial mammals, further emphasizing the importance of locomotor specializations in mammalian evolution. Combining tests of scaling null models and models of trait diversification presents a framework to identify if scaling trends and observed trait-covariation are the products of selection.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

COMPARATIVE STRUCTURE AND PHASE ANALYSES OF THE RIGHT AND LEFT FEMORA OF *KOREANOSAURUS BOSEONGENSIS* FROM MACRO TO NANO SCALES

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We have investigated structural and chemical features of left and right femora from macro to nano scales in order to discern the mode of preservation and intraspecific variation in osteohistology, analyzing the diaphyseal region of both femora. These fossil femora were initially discovered at different sites and states within the dinosaur egg fossil locality in Boseong, South Korea. Optical microscopy revealed that the osteohistological features of both specimens were well-preserved. The right femur had alternating sizes and arrangement of vascular channels from the outer to inner compact bone regions, and the bone matrix was primarily pseudo-lamellar and woven bone. The left femur had a relatively uniform circumferential arrangement of vascular channels, and the main compact bone matrix was pseudo-lamellar bone. According to X-ray diffraction data, the main phases of both specimens were calcite, fluorapatite, and quartz, while illite was an additional phase in the left femur specimen. Energy dispersive spectroscopy and electron probe microanalysis mapping revealed that the bone matrix of the right femur was rich in Si, Al, K and Mg despite being discovered encased in calcite nodules. The relatively lower amount of these elements in the left femur (except for the uninterrupted anterior region) may be explained by the extensive intrusion of calcite veins throughout the bone matrix. Calcite was the main phase occupying the medullary cavity of both femora, while a significant amount of illite was also present in the left femur. Through transmission electron microscopy investigations, bone matrix samples prepared by focused ion beam milling displayed closely packed euhedral apatite crystals of 10-200 nm in size, mostly around 80-100 nm. More preferential arrangement of apatite crystals was observed from samples prepared for cross view compared to samples for plane view. Although we suggest that these features are important to explain how fossil bone retains its original structure, clarification of the relationship between apatite crystals and the minerals that have occupied the space that once housed the organic phase needs further investigation. As for the relationship between the femora, erosion cavities of the right femur indicate that it may have come from a more mature individual despite the similarity in size. We are hoping to shed light on how these features reflect the physiological and taphonomical aspects of these specimens from a quantitative viewpoint.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

RELATIONSHIPS AMONG BRAIN, ENDOCRANIAL CAVITY, AND BODY SIZES IN REPTILES

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In birds and mammals, the enlarged brain nearly fills the bony endocranial cavity, the boundary of which is defined by the braincase bones. However, in extant non-avian reptiles, the brain fills a much smaller proportion of the endocranium, the remainder of which is occupied by connective tissue, venous sinuses, and cerebrospinal fluid. In studies related to brain size evolution in extinct non-avian reptiles, an untested assumption that the brain fills fifty-percent (50%) the endocranial volume (EV) is commonly employed to estimate the size of the brain in non-avian reptiles, notably dinosaurs. This estimate appears to be based largely on anecdotal reports from classical anatomical works. In this study, the size of the brain compared to that of the endocranial cavity in non-avian reptiles is empirically assessed for the first time. We quantified the extent to which the brain fills the endocranial cavity in 16 extant non-avian reptile species representing 13 families within Squamata and a turtle (Emydidae). Three separate methods were used to measure the brain volume and EV: virtual endocranial cast (endocast) reconstruction using computed tomography (CT), dissection with direct measurement, and co-registered magnetic resonance and CT imaging.

A wide range of brain-endocranial cavity proportions were found within the extant sample, with a mean of 0.70 and a standard deviation of 0.19. The lowest brain-EV ratio (0.35) was found in *Gekko gecko*, whereas *Callopistes maculatus* exhibited a brain that nearly filled the endocranial cavity (0.97). Therefore, our results reject the use of the 50% standard for estimating brain size in fossil reptiles based on their EV. Furthermore, regression analyses were performed to infer the relationships among brain size, body size, and EV. Regressions showed a significant linear relationships between brain volume and EV; brain size and body size; and between EV and body mass. Most importantly, birds and non-avian reptiles show significant differences in their endocranial volume for a given body mass, although the slope of the scaling relationship remains the statistically indistinguishable, allowing fossil taxa to be assessed without the need to estimate brain size. The neoceratopsian *Leptoceratops* has an EV within the reptile range, where as the manirpatoran theropod *Troodon* is within the range of extant birds. The primitive avialian *Archaeopteryx* has an EV intermediate between birds and non-avian reptiles.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

CLASSICAL MURINE LINEAGES HAVE BEEN MISUSED AS A FOSSIL-BASED CALIBRATION POINT OF MOLECULAR PHYLOGENY

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Fossil mice and rats (*Progonomys* clade and *Karnimata* clade) from the Miocene Siwalik rocks of Pakistan represent the densest known record of early evolution of the Murinae. These fossils are commonly used to specify a fossil-based calibration point for the molecular phylogeny of muroid rodents because they show transitional divergence of dental morphology in a well-constrained magnetostratigraphic framework. This calibration point is recognized by the first appearance of *Progonomys*, which possesses a modern murine dental pattern, at ~12 Ma. This paleontological event has been considered a maximum age for the *Mus*/*Rattus* split (true mice/true rats) or to approximate the *Phloeomys*/remaining murines split (the most basal divergence within the Murinae). In spite of the popular application of the Siwalik fossils to date the molecular clock, paleontological evidence that morphological divergence of the fossils lead to *Mus* and *Rattus* has been in fact absent. The nodal assignment to the *Phloeomys*/remaining murines split is based on topology of recent molecular phylogenetic studies and relies on an assumption that the appearance of *Progonomys* in Siwalik rocks represents the earliest divergence in the Murinae. This study aims to refine the nodal assignment of the classical murine lineages and provide an updated divergence time for the node. Dental morphology of upper first molars (M1) was examined in the Siwalik murine clades and modern species.

In the fossil lineages, the *Karnimata* clade progressively acquired a new character complex for the metacone, a combination of small size and vertical orientation, through time. For modern species, this is most likely a synapomorphy of the Arvicanthini-Otomyini-Millardini clade. New observations indicate that Siwalik fossils of the *Karnimata* clade are fossil members of the Arvicanthini-Otomyini-Millardini clade. Combining the new interpretation with the widely accepted hypothesis that the *Progonomys* clade includes *Mus*, the morphological divergence in Siwalik murine rodents represents the *Mus*/*Arvicanthis* split (true mice/grass rats), which is nodally more internal than the *Mus*/*Rattus* split at the tribe level. We suggest that the age of first appearance of ? *Karnimata* (11.2 Ma) be the fossil-based date of the new *Mus*/*Arvicanthis* calibration point.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

LINKING HOMININ EVOLUTION AND CLIMATE IN THE BARINGO BASIN, KENYA: THE HOMININ SITES AND PALEOLAKES DRILLING PROJECT (HSPDP)

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Rift related ecosystems of East Africa are unique in tropical Africa in their topographically mediated habitat heterogeneity, localized climatic patterns, and perennial lake systems. While early stages of human evolution were not confined to rift valley ecosystems, early hominins utilized these distinctive biomes and reconstructing environmental flux in these habitats has significance for interpreting selective pressures faced by our ancestral populations. Developing and testing hypotheses linking environmental change and human evolution requires detailed climatic, tectonic, and hydrographic records for relevant depositional basins. Fossiliferous sediments in the Baringo Basin (Central Kenyan Rift Valley) comprise the most complete late Neogene section documented in the African rift system and was targeted as part of the HSPDP project. A sedimentary sequence spanning a portion of the Pliocene Chemeron Formation in the Tugen Hills between ~3.5 and 2.5 Ma that includes over 100 fossil vertebrate localities, three of which are hominin sites, is the focus of this study. Depositional facies in the upper part of this sequence reveal abrupt and repeated cycling of major lake systems at 23 ka precessional pacing, occurring at the maximum of an Earth orbital eccentricity cycle. Detailed chronostratigraphic investigations have explored the nature of environmental change associated with shifting insolation patterns and assessed specific terrestrial community response to pervasive, short-term climatic change through the interval of Northern Hemisphere glacial intensification. Drilling at the Tugen Hills site took place in June, 2013, yielding ~228m of core with excellent recovery (> 93%). Down-hole and preliminary MSCL logs, along with field and split-core observations indicate considerable paleolake level and environmental variability in the sequence, allowing us to refine the nature and timing of climate and environmental changes at various time scales. An extensive suite of paleoecological, geochemical, and physical properties analyses, along with modeling experiments are currently being conducted to quantitatively reconstruct temperature, precipitation, and seasonality. Preliminary results of agent-based modeling, developed to experimentally develop and evaluate hypotheses of how early hominins evolved in response to specific environmental parameters, suggest that despite overall resilience to environmental change, hominins and their terrestrial communities are highly sensitive to climatic perturbations.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

TRIASSIC ARCHOSAUR FOOTPRINTS: EVOLUTION AND DISTRIBUTION OF TRACKMAKERS - AN UPDATE FROM RECENT DISCOVERIES AND RESEARCH

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Footprints of archosaurs dominate most Triassic tetrapod ichnoassemblages and are known from a global record with abundant and well preserved specimens. Pentadactyl chirotheriid trackways represent obligate quadrupeds and facultative bipeds and have been documented from Olenekian to Rhaetian (Nonesian-Apachean) deposits of Europe, Greenland, North and South America, northern and southern Africa and China. Differences in digit proportions, overall shape and trackway pattern suggest the presence of diverse archosaur communities that included non-crown-group archosaurs, stem-crocodylians and avemetatarsalians. The latter may be represented by the ichnogenera *Chirotherium* and *Rotodactylus,* which possess a functionally tridactyl pes with a pronounced digit group II-IV, and a strong reduction of digits I and V, features seen, for example, in the pes skeletons of dinosauromorphs such as *Lagerpeton*, *Marasuchus* and *Silesaurus* but also in some stem-crocodylians.

Co-occurring, and beginning in the late Anisian (Perovkan), are trackways with tridactyl pes imprints and sometimes associated small tri-pentadactyl manus imprints (*Atreipus-Grallator*). They belong to obligate and facultative bipeds and have generally been assigned to dinosauromorph and dinosaurian (theropod, ornithischian) groups, respectively, whereas recent research demonstrates that some stem-crocodylian archosaurs with very dinosaur-like feet such as *Poposaurus* from the Upper Triassic of North America are also potential trackmakers.

Other Late Triassic archosaur footprints from Europe, North America and southern Africa (*Tetrasauropus*, *Pseudotetrasauropus*, *Eosauropus*, *Evazoum*) have variously been attributed to sauropodomorphs and stem-crocodylians by different authors. Footprints of semi-aquatic phytosaurs (*Apatopus*) also have a wide paleogeographic distribution, and have recently been proposed to form a hypothetical evolutionary sequence from the chirotheriid *Synaptichnium* to basal, fully terrestrial phytosaurs.

New discoveries of chirotheriids, grallatorids, *Rotodactylus* and *Apatopus* in Middle-Upper Triassic deposits of Morocco, Greenland and China document a Pangea-wide distribution of trackmakers and extend the stratigraphic range of some typical Middle Triassic footprints into the Upper Triassic. In parallel, basal archosaurian groups known from skeletal remains such as poposauroids, lagerpetonids and silesaurids are also well documented from both Middle and Upper Triassic strata.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

TEN MILLION YEARS OF BIRD HISTORY: A SPECIMEN-BASED APPROACH TO RECONSTRUCTING THE LATE NEOGENE BIRD COMMUNITIES OF CALIFORNIA

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California boasts a rich fossil record of Miocene seabirds. Previous studies, based entirely on data from the literature, have correlated the appearance and disappearance of species to tectonism and climate change. We are using a specimen-based approach to test and refine diversity patterns derived from the literature, and describe patterns of relative abundance and occurrence of seabirds through time. The foundation of our research is a previously unstudied collection of >300 bird specimens from a relatively complete sequence of strata ('Topanga', Monterey, and Capistrano Formations) that spans ~10 million years of the middle Miocene to early Pliocene. We compare this new collection with bird specimens from other museums in order to provide a more complete and detailed view of avian communities during this period. We have discovered several new records, such as earlier occurrences of Laridae, Podicipedidae, and Ardeidae in California than were previously known. Our data also show that, in addition to the previously noted speciation of alcids, the relative abundance of specimens indicates they dominated the seabird communities in California from the late Miocene to early Pliocene. Some of the changes are coincident with global temperature decrease following the Middle Miocene Climatic Optimum and changing circulation patterns in the North Pacific resulting from the development of the Isthmus of Panama and movement of Australia. Previous studies of contemporaneous faunal groups (marine mammals and fish) linked observed changes in diversity and morphology to nutrient upwelling and the increased abundance of phytoplankton that results from shifting circulation patterns. The abundance and diversity changes that we find in late Miocene avian communities are also likely the result of changing circulation and upwelling in the region.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

ONTOGENETIC STAGES IN THE LONG BONE HISTOLOGY OF *DIMETRODON* (LOWER PERMIAN, SPHENACODONTIDAE)

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Dimetrodon species are mostly distinguished on the basis of body size. This has caused controversy over the validity of certain species. Alternative interpretations for the differing sizes and observed morphological features include sexual dimorphism or ontogeny. Previously, histology has been used to partially resolve this issue, identifying sympatric morphotypes at a single locality. Here, we provide a comparative assessment of histologic and morphometric ontogenetic changes of thirteen *Dimetrodon* femora across five lower Permian localities in Texas and Oklahoma, USA, and within four formations.

Large *Dimetrodon* species have trabecular bone present in the central medullary cavity as opposed to the much smaller *D. natalis*. Generally, the bone histology consists of lamellar, parallel-fibered, and woven bone. Incipient primary osteons, together with woven bone, form incipient fibrolamellar bone.

Histologic ontogenetic stages have been assessed for selected femora based on micro-anatomical structures, and categorized to correspond with previously determined morphological stages of development. The youngest ontogenetic stage observed is characterized by very high vascularity with a high degree of anastomosis in the cortex, while the latest ontogenetic stage features an external fundamental system, low vascularity, and a low degree of anastomosis with scattered erosion cavities in the cortex.

Among samples from the Sid McAdams (Taylor County, Vale Formation) locality of Texas are smaller femora of late ontogenetic stage and larger specimens of more juvenile stage, indicating the presence of different morphotypes of significantly differing size similar to what has been observed at Briar Creek Bone Bed (Archer County, Texas, Nocona Formation). Consequently, an ontogenetic origin of size classes can be ruled out. Whether these types represent sympatric species or sexual dimorphism remains inconclusive.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE BRAIN AND INNER EAR OF THE SAUROPOD DINOSAURS FROM TENDAGURU (TANZANIA) IN THE CONTEXT OF SAUROPOD EVOLUTION: A UNIQUE GLIMPSE INTO THE SENSORY WORLD OF GONDWANAN JURASSIC GIANTS

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The iconic sauropods *Brachiosaurus* (now *Giraffatitan*) *brancai* and *Dicraeosaurus hansemanni* were described a century ago from the Tendaguru hill in the former German East Africa (now Tanzania). In the mid-1930s, meticulous descriptions of plaster casts of the endocranial cavity of several specimens largely defined our understanding of sauropod paleoneurology for the rest of the 20th century. We seek to bring this analysis into the 21st century by reanalyzing the historic Tendaguru sample with modern imaging techniques in the context of our current understanding of sauropod phylogeny and brain evolution.

Previously, only three species were thought to be represented in the cranial material from Tendaguru: *G. brancai*, '*Barosaurus*' africanus (now *Tornieria africana*), and *D. hansemanni*. It is now generally thought that two of the braincases referred to as '*Barosaurus*' *africanus* possibly represent separate species of indeterminate flagellicaudatan diplodocoids**.** We used computed tomography (CT) to scan seven of these sauropod braincases, generated 3D renderings of the cranial endocast and inner-ear system where possible, and compared them with Morrison Formation sauropods such as *Camarasaurus*, *Diplodocus*, and *Suuwassea*, as well as other related sauropods.

The endocast of *Giraffatitan* is flexed so that the ventral border of the olfactory tract is dorsal to the dorsal margin of the medulla oblongata. Perhaps surprisingly, the relative development of the vestibular system is distinctly different in the two braincases referred to *G. brancai*. As the osteology of these specimens does indeed support their belonging to the same species, this variation suggests weak stabilizing selection on the balance organ, which, in turn, might be related to relatively sluggish behavior and/or little reliance on highly coordinated eye movements. Both endocasts of *Dicraeosaurus* support a massive dorsal excrescence of the dural venous sinuses unmatched in any other sauropod and extending through the parietal and postparietal openings onto the skull roof; the basal dicraeosaurid *Suuwassea* has a less pronounced version of this apomorphy. The frontals of *Dicraeosaurus* cover larger olfactory bulbs than observed in any other sauropod. The triangular semicircular canals of *Dicraeosaurus* are also at odds with those of other sauropods. The endocast of *Tornieria* is basically similar to those of the two other '*Barosaurus*' braincases. They are not fundamentally different from *Diplodocus*, which helps clarify the diplodocine relationships of these specimens.

Preparators' Symposium (Saturday, November 8, 2014, 2:45 PM)

A SONG OF BLASTING AND FIRE: *EUROPASAURUS HOLGERI*

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The Late Jurassic dwarf sauropod dinosaur *Europasaurus holgeri* from the Langenberg Quarry near Goslar, Lower Saxony, Germany, is one of the best known sauropods worldwide. The material belongs not only to at least 20 individuals, it also contains different ontogenetic stages and two adult morphotypes. During almost 15 years of work with *Europasaurus*, various methods have been applied during excavation and preparation of the bone-bearing marine micritic limestones. Special geological conditions in the active quarry prevent normal excavation methods. The limestones and marls are overturned and incline with 60°-70°. Quarrying proceeds along strike by explosive blasting, exposing the beds only in cross section at >20 m high walls and not along bedding planes. This, and the very patchy distribution of bones in the stratum, make in situ discoveries extremely rare and excavation very difficult. Most bones were retrieved in smaller blocks from heaps of debris after blasting. In this situation, the small size of *Europasaurus* bones (humerus length: 12-45 cm) compared to other sauropods are a clear advantage because they receive less damage during the explosions. Still, many bones are severely damaged, resulting in large bone puzzles. Half broken limb bones or ribs are quite easy to stabilize and fix, but fragile vertebrae with multiple breaks or delicate cranial elements require endless patience and elaborate preparation skills.

Another disaster affected the material the night of October 4-5, 2003: a big fire, caused by malicious arson, razed the DFMMh/FV laboratory and exhibition hall, destroying 106 bones, including the best semi-articulated axial material. The fire not only destroyed 15% of the bones prepared at that time, it also harmed most unprepared blocks in storage, damaging exposed bones and causing a black, charred surface. Firefighting water had an additional damaging effect on the hot and dry limestone blocks, breaking them further apart. The unique situation described makes the preparation of *Europasaurus* bones a very difficult task and a major challenge. Because most taphonomic context was destroyed during blasting, blocks containing several bones are carefully documented in 3D with photogrammetry. Special techniques, methods, tools and ideas developed during our preparation involve surface-structure-transfer of missing

bone fragments with epoxy resin and the in situ preparation of large limestone blocks from all sides to access the maximal scientific information.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

NEW ORNITHOMIMID FROM THE UPPER CRETACEOUS BAYANSHIREE FORMATION OF MONGOLIA

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An expedition by Hokkaido University and the Mongolian Academy of Sciences in 2005 discovered an articulated skeleton of a new ornithomimid dinosaur from the lower Upper Cretaceous Bayanshiree Formation (Cenomanian-Santonian) at the Shin Us Khudag locality in southeastern Mongolia. Most dinosaur specimens at this locality are isolated elements, associated with other vertebrates (turtles and crocodiles). A multitaxic dinosaur bonebed at this locality is dominated by ornithomimosaurs (70%) and includes ornithopods, theropods (deinonychosaur, therizinosauroid, and tyrannosauroid), and sauropods. Articulated skeletons are extremely rare, but this specimen preserves most of the skeleton except the skull.

The only ornithomimosaur known previously from the Bayanshiree Formation is *Garudimimus brevipes*, an edentulous non-ornithomimid ornithomimosaur. The new material differs from *Garudimimus* in having arctometatarsalian metatarsals and the presence of pedal digit I and clearly belongs to Ornithomimidae. The new taxon shows some unique features of the manual phalanges, femur, and metatarsal V. All of the manual phalanges are twisted. Right phalanx I-1 is twisted clockwise, suggesting that, during extension, the first digit opened more medially than other ornithomimosaurs. On the anterior aspect of the intercondylar groove of the distal end of the femur is a shallow depression, unlike other ornithomimosaurs. Metatarsal V is thick, whereas those of other ornithomimosaurs are thin.

Co-occurrences of multiple ornithomimosaur taxa from the same formation are known only in the latest Cretaceous deposits (Campanian-Maastrichtian) of Asia (*Gallimimus*, *Anserimimus*, and *Deinocheirus*) and North America (*Ornithomimus* and *Struthiomimus*). This is the second record of a co-occurrence of primitive (non-ornithomimid) and derived (ornithomimid) ornithomimosaurs, and is the oldest record of an ornithomimosaur assemblage.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

NEW REPTILES AND BIRDS FROM WEEKE'S CAVE (QUATERNARY, SOUTH AUSTRALIA)

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Weeke's Cave is an extremely productive deposit from the Pleistocene and Holocene of South Australia, and we report here on new avian and herpetological records. Previous studies have identified a relatively diverse avifauna, including at least 11 species. The new fossils, collected by Ernie and Judy Lundelius and Bill Turnbull in the 1950‘s and 60‘s, reveal commonalities such as confirming the prescence of masked owls (*Tyto novahollandae*) and honeyeaters (Meliphagidae). However, they also offer a more detailed glimpse into the Quaternary ecosystem by demonstrating the presence of two species of larks (Alaudidae), a megapode (*Leipoa*), and an additional genus of honeyeaters (*Meliphaga*). Further, our reexamination of the Weeke's Cave fauna has revealed a rich record of reptile fossils that have gone previously unreported. We used an explicitly apomorphic approach to identify the hundreds of skull and pectoral elements. We scored 38 characters across eight different cranial and girdle elements, all of which were isolated. However, we found seven unambiguous synapomorphies that allow us to assign all of the bones to Gekkota. These synapomorphies are that the frontals are fused, the frontal sub olfactory process is arched and fused, postorbital is absent, parietal foramen is absent, divided tympanic recess, closed and fused Meckel's canal, pubic tubercle close to symphysis. We found no evidence of other lizard taxa, however nonsynapomorphic differences suggest at least three different geckos. Since gekkotans are predominantly nocturnal and the majority of fossils recovered are mammals, our data support previous interpretations of the cave as a predator accumulation, especially given the unambiguous presence of masked owls. The new records help flesh out the picture of the Pleistocene ecosystems of South Australia, and will help form a useful baseline for understanding how divergent modern ecosystems have become.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

TRIASSIC SAURICHTHYID FISHES AS PREDATORS AND PREY - EVIDENCE FROM THE FOSSIL RECORD

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A novel morphotype of actinopterygian fishes appeared near the Permian-Triassic boundary with the family Saurichthyidae. With their streamlined, elongated heads bearing long, pointed jaws armed with conical teeth, their slender bodies and the disposition of median fins in the posterior part of the body, including the symmetrical tail - the so-called 'double-tail configuration' - saurichthyids were optimally equipped to be efficient fast-start (ambush) predators. These predatory fishes up to 1.5 m long already had a worldwide distribution in the Early Triassic, and are found in all major marine and freshwater fossil assemblages.

Saurichthyids are usually placed at higher trophic levels within ancient aquatic food webs based on their size, general morphology and actualistic comparisons. However, direct evidence of predation in fossil animals can only be obtained from preserved stomach contents or in-situ coprolites, which are rare and have sometimes also been overlooked. We survey the fossil record of predation in saurichthyids based on some new and restudied material from the Triassic and document several fossils with ingested fishes and even one specimen with possible remains of a small tetrapod. Although, unlike teleostean fishes, the paleopterygian saurichthyids did not evolve a mechanism to enlarge the mouth cavity, they apparently were able to catch and engulf relatively big animals. Yet, swallowing large prey frequently had lethal consequences, as can be seen in several specimens of *Saurichthys* with congeneric individuals of nearly equal body length as the predator itself stuck in the predator”s mouth. Predatory fishes that succumbed from engulfing overly large prey are known from both fossil and recent examples.

Early Triassic saurichthyids with large prey preserved in their digestive tract substantiate the assumption that these fishes occupied high positions within trophic networks very early after the end-Permian mass extinction. Furthermore, specimens from the Middle Triassic of China with identifiable prey in the gut permit the establishment of ecological interrelationships between some saurichthyid species, which implies somewhat overlapping niches of these forms, thus a more complicated trophic structure of marine ecosystems than previously thought.

The fast-start predator bauplan of the saurichthyid type, unknown among Paleozoic fishes, became first established during the major turnover near the Permian-Triassic boundary, in the course of the transition from Paleozoic towards modern communities.

Romer Prize Session (Thursday, November 6, 2014, 9:15 AM)

BONE AND TOOTH GROWTH IN FOSSIL AND RECENT DEER AND IMPLICATIONS FOR BODY SIZE AND LIFE HISTORY EVOLUTION

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Several lineages of mammals have evolved remarkable changes in body size following island isolation, including many cases recorded by fossils. These patterns are the result of complex interplay of multiple variables, including resource limitation and ecological release. To understand the mechanisms behind them, it is paramount to study growth and life history evolution. For this, the use of palaeohistological methods to study bones and teeth can provide critical information. An exploration of methods and signal across taxa reveals that counting rest lines in tooth cementum is informative in some clades and less so in others, and certain methods to estimate growth rate based on bone histology have limitations.

An illustrative case study in mammals is that of the Pleistocene deer genus *Candiacervus* from Crete, including morphotypes of very small size, and its close megacerine relatives including the giant deer *Megaloceros giganteus*. To understand life history traits in this clade, a broad sampling of recent and stem cervids was conducted. Histological analysis of bones and teeth reveal similarity of bone tissues, indicating a comparable mode of growth across deer species. Low growth rates characterize small morphotypes of *Candiacervus*, whereas high rates characterize the giant *Megaloceros*. Growth rates of the Miocene small stem cervid *Procervulus praelucidus* were lowest among sampled deer. Tooth cementum analyses indicate a longevity of up to 18 years in small *Candiacervus* and up to 19 years in *Megaloceros*. Small *Candiacervus* thus, in an allometric context, show an extended lifespan compared to other deer of similar body size. Skeletal maturity estimates indicate late attainment in *Candiacervus* and *Procervulus,* demonstrating the variability of life history parameters in island as well as continental cervids.

Comparison with other clades of mammals, including extinct island rodents and lagomorphs such as *Mikrotia* and *Prolagus*, reveals that changes in size and life history in evolution have occurred in parallel, with various modes of skeletal tissue modification.

Eruption and wear of permanent teeth follow non-random sequences and take place in chronological periods which are relatively independent from the physiological state of the animal. A detailed study on the tooth eruption and wear of fallow deer populations (*Dama dama*) from southern Spain provides additional life history data and correlation with its close extinct relatives, *Megaloceros* and *Candiacervus,* provides the basis for determination of relative age in the fossil species.

Symposium 4 (Friday, November 7, 2014, 9:30 AM)

INTERPRETING PALEOHISTOLOGY AND MODE OF LIFE AMONG TEMNOSPONDYLS

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Bone microanatomy has been shown in several studies to correlate with the mode of life of an animal. Bones of amniotes are well investigated histologically, in contrast to the amphibian group, the temnospondyls. In the last few years, knowledge about temnospondyl bone structure has significantly increased, helping to solve controversies about their biology, phylogeny, and evolution. Long bone histology is useful for interpreting various ecological aspects of life or local environmental conditions, whereas vertebrae are more conservative in their developmental plasticity, and provide important phylogenetic information. Histological studies on dermal bones from the skull help to confirm types of feeding behavior of temnospondyls. However, numerous unclear aspects regarding the interpretation of the histological signal recorded in temnospondyl bones still exist. Most importantly, the histological interpretations are based on amniotes and it is not clear how far they may be adapted to clarify the mode of life or phylogenetic issues for non-amniotes. Another issue is the relatively low number of articulated specimens and poor knowledge about the morphological variability of the postcranial skeleton of temnospondyls. *Eryops* is a classic example of the discrepancy between the morphological and histological signal. New, disarticulated bones, determined as *Eryops* from the Lower Permian of Texas illustrate this problem. Based on its morphology, *Eryops* is considered to be a terrestrial member of the group; however, the histology suggests an amphibious or even an aquatic mode of life. In the new material, morphologically similar bones represent three different histotypes of the cortex: thin with regular rows of small vascular canals, thick with irregularly arranged trabeculae and large cavities, and finally, Haversian tissue with an outermost layer of avascular lamellar bone. The three microstructural frameworks may suggest a whole range of different environmental adaptations. The range of sizes of bones and the histological variety excludes an ontogenetic explanation of the observed variability. Rather the variable structure is the result of taxonomic differences. Therefore, for future studies on

temnospondyl histology, interpreting disarticulated elements, particularly with unclear taxonomic affinity, must be done with careful consideration.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

NEW FINDINGD OF *PRAEPUSA* (CARNIVORA, PHOCIDAE, PHOCINAE) FROM THE EASTERN SHORE OF THE NORTH ATLANTIC OCEAN

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Examination of new fossil material (humerus and sacrum) from The Netherlands reveals morphologically-distinctive characters, allowing the description of a previously unknown late Miocene-early Pliocene representative (*Praepusa* sp. nov) of the subfamily Phocinae. Diagnostic humeral differences in the shape of the coronoid (oval in male or triangular in female) and depth of the olecranon fossae (shallow in male or deep in female), as well as the presence of a rounded first ventral foramen and thick lateral wall in the male sacrum, reveal the first account of sexual dimorphism in the postcranial bones of the genus *Praepusa*.

The newly described species adds new information into the distribution of true seals as an assessment of biogeography shows the likely dispersal pattern of species in this genus across the Paratethys from east to west. Strong endemism due to closure of the Paratethyan seaway, and climatic, geological, and stratigraphic differences in recovered fossils support that the genus *Praepusa* first inhabited the Eastern Paratethys (early-middle Miocene, 16.5-13.6 Ma) before dispersing to the Central (Middle Miocene, 13.6-11.2 Ma) and, later, Western (late Miocene-early Pliocene, 11.6-3.6 Ma) Paratethys.

The Pr. sp. nov. fossils are the youngest to date and are dispersed the farthest west of any previously described material of this genus. These findings help explain the origin and dispersal among described species of the genus *Praepusa* in comparison with other genera of the subfamily Phocinae.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

TOOTH REPLACEMENT AND DENTITION IN *GIRAFFATITAN BRANCAI*

KOSCH, Jens, Freie Universität Berlin, Berlin, Germany; SCHWARZ-WINGS, Daniela, Museum fur Naturkunde, Berlin, Germany; FRITSCH, Guido, Leibniz Institute for Zoo and Wildlife Research, Berlin, Germany; ISSEVER, Ahi Sema, Charité - Universitätsmedizin Berlin, Berlin, Germany

The tooth bearing jaw elements of *Giraffatitan brancai* were subject to a computed tomography (CT) for the first time to study tooth replacement in this sauropod taxon. The CT scans revealed a maximum number of two replacement teeth per functional tooth. There are four alveoli in the premaxilla, eleven to thirteen in the maxilla and thirteen to fifteen in the dentary, all separated from each other by complete interalveolar septa. Additionally, rows of functional teeth preserved as 'dentures' were used to reconstruct zahnreihen by using wear facets on the teeth. The three types of wear facet are mesio-lingual, labio-distal and terminal wear facets. Whereas the first two facets are the result of tooth-to-tooth contact in a non-precise occlusional shearing bite, the terminal facet is the result of tooth-to-food contact mostly produced by a raking motion. Based on ten developmental stages including four stages of functional teeth defined the development of wear facets, a Z-spacing of three and front-to-back replacement were recognized. Replacement rates of 64 to 89 days in the premaxilla and 92 days (with large variation) in the maxilla and dentary were calculated. *Giraffatitan* is the first basal titanosauriform and the second macronarian, after *Camarasaurus*, for which the tooth bearing jaw elements are studied using CT scans. The taxon thus provides the first model for tooth organisation in Titanosauriformes. It is also the first definite high-browsing sauropod for which this kind of data is available.

Technical Session XV (Saturday, November 8, 2014, 11:30 AM)

MACROEVOLUTIONARY PATTERNS IN MAMMALIAN CRANIOGENESIS REVEALS MODULAR EVOLUTION AND A LINK BETWEEN CRANIAL DEVELOPMENT AND BRAIN SIZE

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The multiple skeletal components of the skull originate asynchronously, and their developmental schedule varies across land vertebrates. However, the phylogenetic patterns and mechanisms of evolutionary changes in ontogeny remain to be resolved. Here we present the embryonic ossification sequence of 134 species, covering all major groups of mammals and non-mammalian amniotes. This comprehensive dataset allows reconstruction of the heterochronic and modular evolution of the skull and the condition of the last common ancestor of mammals. We show that the mode of ossification (dermal or endochondral) unites bones into integrated evolutionary modules of heterochronic changes and imposes evolutionary constraints on cranial heterochrony despite the variation across mammalian phylogeny. However, skull roof bones exhibit evolutionary degrees of freedom in these constraints. Our results recover that ossification of the neurocranium came considerably earlier than other regions of the skull during the origin of mammals. Association between developmental timing of the skull roof bones and brain size was identified among land vertebrates. We argue that cranial heterochrony in mammals occurred in concert with encephalization but within a conserved modular organization.

Technical Session VI (Thursday, November 6, 2014, 8:15 AM)

EVOLUTION, ECOLOGY, AND MODULARITY OF THE LAGOMORPH SKULL

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The lagomorph skull exhibits a unique set of features that distinguish it from most other mammals. Most prominent among these traits is a broad arching of the skull roof that is observed in all living leporids, but is minimally present within fossil lagomorphs and the living sister group to leporids, the pikas. Our study aims to understand the transformed morphology of leporid skull relative to other living and fossil lagomorphs to determine what evolutionary, developmental, and ecological forces may have shaped the lagomorph skull. We compiled an extensive 3D dataset of over 200 skulls from 21 extant species of leporids and multiple fossil taxa, using μCT and surface laser scans. We combined morphological data on skull shape derived from landmark-based geometric morphometric methods with a phylomorphospace approach and phylogenetic comparative methods to infer evolutionary change along branches of a phylogeny. Our analyses identified three distinct morphological groups within living leporids, two of which are not monophyletic. The first comprises the near-endangered *Brachylagus*, and several rare species, often thought to be evolutionary basal, unite to form the second. The third and largest cluster comprises the more specious *Lepus* and *Sylvilagus* and several other species. Our analyses also demonstrate skull shape differs with locomotor style; skulls with less dorsal arching are more likely to exhibit a more generalized, non-hopping locomotor style, and skulls with strongly arched skull roof are found in fast-moving species. Furthermore, we find that modern leporid skulls exhibit modularity, where the basicranial and facial regions are relatively independent units. These results align with that we find in the fossil record, where facial evolution within lagomorphs occurred millions of years prior to evolution within the basicranial region, suggesting that the developmental modularity evidenced in modern leporids likely played an integral role in early lagomorph evolution. Additionally, the correlation of arching of the skull roof to locomotor style (i.e., hopping, and then cursoriality) suggests the delayed appearance of saltation within the order.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A THREE-DIMENSIONAL MORPHOMETRIC ANALYSIS OF THE BASICRANIUM IN *PARAPITHECUS GRANGERI* (ANTHROPOIDEA, PARAPITHECIDAE) AND IMPLICATIONS FOR ANTHROPOID ORIGINS

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The Parapithecidae is an extinct primate family thought to be stem Anthropoidea that shares features with both platyrrhine and catarrhine primates. Features they share with platyrrhine primates include a ring-like ectotympanic bone, a large zygomaticofacial foramen, and relatively small upper third molars. With catarrhines, they share alisphenoid-frontal contact. *Parapithecus grangeri,* a parapithecid recovered from early Oligocene beds (33 Ma) in the Fayum depression of Egypt, displays a lateral pterygoid plate that extends posteriorly to adjoin the lateral bullar wall. This feature, which is shared with tarsiers, omomyids, and some strepsirrhines, may relate to the presence of a large superficial head of the medial pterygoid muscle and a lack of post-orbital closure. As a trait shared with tarsiers that may be older than the divergence between platyrrhines and catarrhines, it is hypothesized that the pterygoid and bullar region of the ventral surface on *P. grangeri* is more similar to that of tarsiers than to other anthropoids. To test this, landmark data were collected from the ventral surface of several extant primates, including catarrhines, platyrrhines, strepsirrhines and tarsiers. Landmark selection focused on the pterygoid plates and the shape of the bulla, but also encompassed skull dimensions. In order to collect landmark data from the *P. grangeri* cranium,which is relatively undistorted, CT scanning enabled retrodeformation and mirroring. Results from preliminary principal components analyses (PCA) show that PC1 describes 25% of the variation, and PC2 18% of the variation. Strepsirrhines and tarsiers are clearly separated from anthropoids in both PC1, which describes skull length, and PC2, describing basicranium height and degree of klinorhynchy. This change in height is largely centered on the pterygoid region. *P. grangeri* falls between strepsirrhines and tarsiers in both PC1 and PC2, away from other anthropoids. These findings support the hypothesis and indicate parapithecids share traits with tarsiers as well as platyrrhine and catarrhine primates.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

NEW INFORMATION ON THE INNER EAR OF THE STEGOSAURIAN DINOSAUR *KENTROSAURUS AETHIOPICUS* BASED ON MICRO-COMPUTED TOMOGRAPHY

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The stegosaurian dinosaur *Kentrosaurus aethiopicus* was first described at the beginning of the last century from the Upper Jurassic Tendaguru Formation in Tanzania, Africa. Among the material there are four well-preserved braincases, three from the Kindope location (St460, St702, St) and one from Kijenere (Ki124). The latter is the most complete, comprising the braincase roof and floor, lateral and anterior walls, and occiput. All four specimens were subjected to micro-computed tomography analysis at the Museum für Naturkunde Berlin. The scanning results revealed that most of the inner ear structures are well preserved in the specimens, especially in St460. The vestibule is oval in shape and measures 15.87 mm x 13.07 mm x 7.77 mm (length x width x height), while the cochlea is straight and short, 6.96 mm in length. The separation between vestibular and cochlear portions is not well-defined, but the latter is considered to begin at the ventral portion of the former, where it narrows weakly. The extensions of both structures are similar to the putative plesiomorphic condition in Archosauria. The semicircular canals have approximately the same length, although the anterior one is slightly longer, at 11.11 mm, whereas the lateral and posterior canals measure 10.08 mm and 9.81 mm, respectively. The inner ear structure of *Kentrosaurus* differs from those of other ornithischian dinosaurs for which data is available, such as the sympatric basal ornithopod *Dysalotosaurus*. In the latter case, the lateral semicircular canal is slightly longer than the other two, which conforms to the plesiomorphic condition for tetrapods. However, a relatively longer anterior semicircular canal is found in arboreal taxa such as birds. It has been hypothesized that a longer anterior semicircular canal is responsible for precise movements and maneuverability, crucial for the survivorship in a more three-dimensional environment. The fact that a terrestrial animal usually considered as having

very limited motor ability possesses a relatively longer anterior semicircular canal is therefore unexpected. Identifying the processes underlying this uncommon pattern will help fill an important gap in the knowledge of stegosaurian biology.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

HISTOLOGICAL AND MORPHOLOGICAL ONTOGENY OF *PACHYRHINOSAURUS* NASAL BOSSES

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Pachyrhinosaurus is a centrosaurine ceratopsian found only in Alberta and Alaska in North America that, instead of bony horncores, has cranial bosses. Here we examine a juvenile and several adult nasal bosses of *Pachyrhinosaurus lakustai* from the Pipestone Creek Bonebed and additional adult bosses of *Pachyrhinosaurus* sp. from the stratigraphically higher (by 160 m) Wapiti Bonebed, both located near Grande Prairie, Alberta. Superficially, the juvenile nasal boss bears almost no resemblance to the adult specimens and more closely resembles a horncore rather than a boss. The juvenile nasal boss is ridge-like in dorsal view and the surface texture includes neurovascular grooves extending predominantly dorsoventrally and foramina for nerves or blood vessels. In contrast, the adult bosses are large, coalesced masses that are spongy with resorption pits and are roughly triangular in dorsal view. Histologically, however, the juvenile nasal boss is composed of mostly fibrolamellar bone. The adult nasal bosses from Pipestone have a combination of spongy bone with thick trabeculae and compact bone consisting of several generations of secondary osteons. One adult boss from the Wapiti Bonebed consists of secondary trabecular bone, whereas another has dense Haversian bone with some primary fibrolamellar bone adjacent to the external surface. This boss is histologically less spongy than the others, which could imply that it is ontogenetically younger. Although *Pachyrhinosaurus* nasal bosses differ superficially in juvenile versus adult specimens, histologically similar tissues may be found in both. It is possible, based on the differences observed in the Wapiti Bonebed specimens, that nasal boss microstructure may be useful in determining finer ontogenetic stages (e.g., subadult versus adult) than morphology alone.

Symposium 3 (Friday, November 7, 2014, 10:15 AM)

PUTTING FOSSIL BIRDS IN TREES: EMPIRICAL EVIDENCE FOR BIASES IN DATING THE AVIAN TREE OF LIFE

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Birds are the most diverse extant tetrapod clade, but the timing of the crown avian radiation remains controversial. In general, the fossil record supports a primarily Cenozoic radiation, whereas divergence dating analyses push many splits into the Cretaceous. One underappreciated phenomenon is that disparity between fossil ages and molecular dates tends to be proportionally greater for shallower nodes in the Avian Tree of Life. However, because individual analyses differ in variables such as model choice, taxonomic representation and calibration strategy, it has previously not been possible to test for patterns of disparity in a controlled setting.

We conducted a series of divergence dating analyses in BEAST 1.75 to test the effects of calibration depth and gene type on divergence estimates. Complete mitochondrial genomes (11 193 bp) and a 27-gene nuclear dataset (7 208 protein coding bp and 14 691 non-coding bp) were aligned for 72 taxa. We formulated 17 node age priors that meet recently proposed Best Practices for fossil calibrations. Each calibration was based on an individual fossil specimen that has been phylogenetically and stratigraphically vetted. Priors included hard minimum ages based on the minimum possible age of each calibrating specimen (inclusive of dating error) and soft maximum ages based on global preservation patterns.

All analyses supported a mid-Cretaceous origin of Aves and placed several neoavian divergences in the latest Cretaceous. However, the major early diversification phase placed in the Campanian by some studies is instead associated with recovery after the Cretaceous-Paleogene in our results. Several interesting patterns emerged. We found that when mitochondrial sequences were analysed using purine/pyrimidine (RY) rather than standard nucleotide (NT) coding strategies, mean node age of the tree as a whole decreased. Critically, this pattern was strongest for shallow nodes and reversed for the deepest nodes in the tree. This provides empirical support for simulations that suggest 'tree compression' due to model misspecification will tend to overestimate shallow node ages. It offers a plausible explanation for some of the disparity between the fossil record and molecular dates in birds. The results also support anecdotal observations that mitochondrial genes have yielded older dates than nuclear genes for birds. Vetting fossil calibrations and accounting for model biases offers the potential for substantial reconciliation between molecular and fossil interpretations of the radiation of modern birds.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

PALEOECOLOGICAL RECONSTRUCTION OF LATE PLEISTOCENE DEER FROM THE RYUKYU ISLANDS, JAPAN: A COMBINED EVIDENCE OF MESOWEAR AND STABLE ISOTOPE ANALYSES

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The Ryukyu Islands (Amami Islands, Okinawa Islands, and Sakishima Islands) form an island arch situated in the southern end of the Japanese archipelago. In this area, there are numerous fossiliferous localities estimated to date from the end of the Pleistocene, which have yielded abundant vertebrate fossil remains. Among the excavated fossils of terrestrial vertebrates, two extinct deer species: *Cervus astylodon* and *Dicrocerus sp.* (muntjac-like species), are representative of the Late Pleistocene fauna in the Okinawa Islands. However, their ecological characteristics have been largely unknown to date.

In this study, we reconstructed the paleoecology of the deer species using mesowear analysis and stable isotope analysis of tooth remains excavated from the Hananda-Gama Cave, Okinawa Island. Mesowear analysis estimates consumed food property from facet development of ungulate cheekteeth, with more abrasive diets (i.e., graminoids) resulting in more rounded cusps with a lower profile. Carbon isotopic composition ($\delta^{13}C$) reflects relative contribution of C_3 (woody and most herbaceous plants) and C_4 (graminoids that grow in temperate to tropical regions) plants in diets, with the former showing lower $\delta^{13}C$ values.

Both extinct deer had sharp cusps with high profiles, which implied a significant amount of browse in diets. Our stable isotope analysis corroborated this: the $\delta^{13}C$ values were in the range between extant pure C_3 feeders and C_3-C_4 mixed feeders. Species ranges overlapped each other, but *C. astylodon* had a more expanded range in to the higher $\delta^{13}C$ value (more C_4 plants) range. The combined evidence that indicated browse-dominant diet of the extinct deer was also concordant with previous palynological results, which indicated low frequency of herbaceous pollens including graminoids.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A NEW METHOD FOR CHRONOBIOGEOGRAPHY USING PATRISTIC DISTANCES

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The potential merit of using fossil data in biogeography is adding a temporal axis to spatial data. Utilizing temporal data in biogeography can eliminate an unlikely biogeographical hypothesis or reveal a complex biogeographic history that was masked by mixing taxa from a wide temporal range in a biogeographical analysis. For example, a closer relationship between the same biogeographic area(s) of different ages indicates strong endemism, whereas a closer relationship between different biogeographic areas of the same age indicates intense biotic interchange between these areas. However, no practical algorithm has been proposed to implement temporal data in biogeographical analyses and only contemporaneous biogeographical areas were compared in previous studies of biogeography.

I will present an algorithm of chronobiogeography that can compare biogeographic areas from different ages. The algorithm is simple, using average smallest patristic distances between taxa from two different chronobiogeographical areas as the distance index between these two chronobiogeographical areas. The new algorithm is applied to a cladogram of dinosaurs to show the biogeographic relationship of dinosaurs of Late Triassic to Cretaceous age from different continents. The result is assessed by checking congruence with Mesozoic paleogeography, and advantages and disadvantages of the new method are discussed.

Symposium 1 (Wednesday, November 5, 2014, 8:45 AM)

THE DAITING SPECIMEN OF *ARCHAEOPTERYX*

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Since the first discovery in 1861, only eleven skeletal specimens of *Archaeopteryx* have been officially announced to the public. Here we report on previously unknown anatomy of the Urvogel, based on a study of the 8th specimen, which was supposedly discovered in a Bavarian quarry near Daiting in the early 1990s. Recently, owner Raimund Albersdoerfer secured the scientific accessibility of this specimen by offering it on long-term loan to the Bavarian State Collection of Paleontology and Geology in Munich. If the 8th specimen is indeed from Daiting, then it belongs to the Moernsheim Formation (MF), which overlies the Solnhofen Formation (SF), the major horizon which yielded all other known specimens. XRD analysis of major and trace-elements in limestone samples collected from five SF and three MF localities, and the matrix derived from the Daiting specimen, shows that this specimen and the MF samples contain significantly larger amounts of zinc and silicon dioxide than the SF samples, thus supporting the attribution. These results imply that the Daiting specimen is the youngest of all known Bavarian archaeopterygids and may shed new light on the evolution of *Archaeopteryx*. Previous research on *Archaeopteryx* relied almost entirely on external 2D observations. Here we apply a 3D synchrotron-based microtomographic approach to the study of its anatomy and bone structure. The cranial remains of the Daiting specimen, which are strongly compressed, fragmented and partly hidden, provide a dramatic demonstration of the unique capability of this technique. All craniofacial bones and most of the braincase have been virtually freed from the matrix, are available in all views, and reveal previously unknown anatomical features including extensive pneumaticity of each skull element. Notably, shoulder girdles and wing bones revealed a relatively thick cortex with dense vascularity, whereas some of the carpal and metacarpal elements are found to be coossified. Numerous vascular foramina present on the surface of several cranial and postcranial bones suggest that the Datinig specimen represents a juvenile. However, the internasal and interfrontal sutures are obliterated in the Daiting specimen in contrast to the Eichstätt and Thermopolis specimens which are of similar size. This and numerous other cranial features that distinguish the Daiting specimen from the other specimens of *Archaeopteryx* suggest that it may represent a new species. Funded by grants from the ESRF (EC-689) and Swedish Research Council (Linneaus Framework).

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

CROCODYLIFORMS FROM THE LATE CRETACEOUS SHAKH-SHAKH LOCALITY (KAZAKHSTAN)

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The composition of Late Cretaceous crocodyliform assemblages of Asia differs from that of North America and Europe in dominance of non-eusuchian neosuchians, presence of 'protosuchians' and rarity of eusuchians. Moreover, Late Cretaceous eusuchians record in Asia is limited largely to Middle Asia and Kazakhstan. Fossils from these regions are potentially significant for clarifying the evolutionary history and paleobiogeography of crocodyliforms (first of all eusuchians) during that interval on the Asian continent. The Santonian-early Campanian Shakh-Shakh locality of the Bostobe Formation in

Kazakhstan has produced disarticulated remains of diverse vertebrate taxa, including crocodyliforms. Initial studies of the crocodyliforms from Shakh-Shakh revealed presence of three taxa: goniopholidid *Turanosuchus aralensis*, paralligatorid or goniopholidid ? *Kansajsuchus* sp. and an identifiable crocodylid (possibly *Tadzhikosuchus* sp.). Later, *Turanosuchus aralensis* was considered as a nomen dubium. Study of all available crocodyliform materials from Shakh-Shakh (including newly collected material) shows that only two taxa can be distinctively recognized: large non-eusuchian neosuchian (possibly *Kansajsuchus* sp.) and relatively small eusuchian (possibly *Tadzhikosuchus* sp.). The composition of large non-eusuchian neosuchians and relatively small eusuchians were stable during the Late Cretaceous of Middle Asia and Kazakhstan and existed from the Turonian (Bissekty Formation in Uzbekistan) until the Santonian (Yalovach Formation in Tajikistan, Bostobe Formation in Kazakhstan).

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A NEW OVIRAPTORID DINOSAUR (DINOSAURIA: OVIRAPTOROSAURIA) FROM THE LATE CRETACEOUS OF SOUTHERN CHINA AND ITS PALEOGEOGRAPHICAL IMPLICATIONS

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The Ganzhou area of Jiangxi Province, southern China is becoming one of the most productive oviraptorosaurian localities in the world, with at least four genera of oviraptorosaurs reported to date from the late Late Cretaceous Nanxiong Formation. Within an area of about 40 square kilometers, more than 200 oviraptorosaurian nests with eggs have been discovered. In addition to the oviraptorosaur skeletons, other dinosaurs, including a large sauropod *Gannansaurus sinensis*, and an unnamed tyrannosaurid, as well as lizards have also been excavated.

Herein we report a new oviraptorid dinosaur from the site of the Ganzhou Railway Station Extension Project in Ganzhou City. The specimen is preserved as a partial skeleton with a nearly complete beautiful skull and lower jaw. It is characterized by an anterodorsally sloping occiput and quadrate (shared with *Citipati*), a small circular supertemporal fenestra (much smaller than the lower temporal fenenstra), and the dorsal margin of the dentary above the external mandibular fenestra is strongly concave ventrally. A phylogenetic analysis recovers the new oviraptorid as sister taxon to the Mongolian *Citipati*, sharing a synapomorphy of anterodorsally sloping occiput and quadrate. The close relationship between this new taxon and *Citipati* from widely disparate sites across Asia (southern China and Mongolia) suggests that this clade was broadly distributed and a key member of dinosaur ecosystems in Asia during the few million years before the end of the Cretaceous.

Technical Session XVII (Saturday, November 8, 2014, 3:30 PM)

WHAT DO INNER AND MIDDLE EAR ANATOMY TELL US ABOUT HEARING CAPABILITIES, BEHAVIOR, AND LIFESTYLE OF NON-MAMMALIAN SYNAPSIDS?

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Previous investigations of the hearing apparatus of non-mammalian synapsids predominantly focused on evolutionary changes of the middle ear during the transition from cynodonts to mammals. Consequently, little is known about the ears of other groups of non-mammalian synapsids, their hearing capabilities, behavior, and lifestyle.

We reconstructed the ears of different non-mammalian synapsids from neutron tomographic data and collected a data set of middle and inner ear parameters from virtual 3D reconstructions, measurements on original material, and the literature.

A comparison of the middle and inner ears of different therapsids revealed striking differences between fossorial and non-fossorial species. Fossorial species usually possess downward sloping stapes. The transformer ratios of the middle ear are usually under ten, which results from larger stapes footplate areas, but not from unusual sizes of the eardrums, which is consistent with the condition in fossorial mammals. All inner ears of fossorial taxa lack distinctive cochlear cavities and the oval windows are situated at the ventral apices of the vestibules. The vestibules of fossorial taxa are usually larger than those of non-fossorial species, and in the anomodonts *Cistecephalus* and *Kawingasaurus* they are extraordinarily inflated.

Non-fossorial species tend to have more horizontal directed stapes with smaller footplate areas and, thus, have higher transformer ratios of the middle ear. Their inner ears differ from those of fossorial taxa in having a more laterally positioned oval window. In some cases a distinctive short cochlear cavity at the ventral apex of the vestibule is present.

The orientation of the stapes, the enlarged stapes footplate areas as well as the low transformer ratios of the middle ears of fossorial species suggest an adaptation to bone-conduction hearing and a vestigial or reduced sensitivity to airborne sound. The inflated vestibules of *Cistecephalus* and *Kawingasaurus* may be an adaptation to compressional bone-conduction hearing by the skull roof.

In contrast, the described anatomical characteristics of the ears of non-fossorial species suggest an enhanced sensitivity to low frequency airborne sound, which supports the hypothesis that therapsids, probably with the exception of some fossorial taxa, were able to tympanic hearing via an eardrum at the mandible.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed November 5 – 8, judging occurs Thursday, November 6)

INTERPRETATION OF FOSSIL VERTEBRATE TRACKS WITH A SOIL MECHANICAL APPROACH FOR BODY MASS ESTIMATION

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Countless tracks and traces are left behind by an animal during its lifetime and a few of these can be found in Recent as well as in fossil sediments. The shape and morphology of a single footprint, the substrate that bears the tracks, and the record of the footfall pattern in a trackway can provide information on the trackmaker's mode of locomotion, biometry, and its behavior. Furthermore, by using a combined approach of multiple methods, the knowledge about tracks and the trackmaker's paleobiology can be greatly improved.

This study combines analyses of footprint geometry and track-bearing sediments from the Jurassic sauropod track locality Copper Ridge in Utah and proboscidean tracks of the Miocene Barstow Formation, California. The morphology of the footprints, that is, the vertical displacement (the depth) and diameter, was documented by photogrammetry to generate a 3D surface model. These photogrammetric models provided accurate measurements for deriving the detailed geometry needed for a numerical model based on finite element analysis (FEA). The footfall patterns of forefeet and hindfeet of a trackmaker were also inferred from 3D models of trackways. Deformation of the substrate caused by the trackmaker was modeled using FEA. The model requires input of sediment parameters relevant for the deformation. Thus, the indurated sediments of the fossil track bearing layers, and the equivalent, recent soft sediments were analyzed for comparison using principles of soil mechanics. Soil mechanical analyses such as sediment classification (i.e., grain size and grain size distribution, obtained by micro-CT analyses) and soil parameter determination in the laboratory (i.e., stiffness of the sediment) provided the basis for the FEA. These data were then used to reconstruct the loading conditions that produced a particular footprint, which allows the mass of the trackmaker to be estimated. This study demonstrates the value of tracks in providing insights into paleobiological questions such as mass estimates and gait reconstruction.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

THE FIRST RECORD OF POPOSAURIDAE FOR BRAZIL, LATE TRIASSIC CATURRITA FORMATION

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The Triassic of Rio Grande do Sul, Brazil, yielded an important record of basal archosauriforms (Proterochampsidae, Doswellidae, and Phytosauria), pseudosuchians (Aetosauria, Rauisuchidae, 'Prestosuchidae'), and ornithodirans (Silesauridae, Herrerasauria, and basal Sauropodomorpha). Recently, two fragmentary specimens were independently collected in the Cerro Botucaraí locality, Caturrita Formation (*Riograndia* Assembladge Zone, Late Triassic, Norian), which also yielded phytosaur, dinosaur, dicynodont (*Jachaleria*), and stereospondyl remains. The specimen MCP-0204-PV is composed of two partially preserved sacral vertebrae, with co-ossified centra and zygapophyses, along with an incomplete zygapophysis of a third vertebra. The vertebrae display centra that are taller than long, with low neural spines (about 20% of the total vertebral height). The second specimen is unnumbered, housed at Aristides Carlos Rodrigues Museum, in Candelária-RS, and includes four partial sacral vertebrae, also with co-ossified centra and zygapophyses. The centra are also taller than long, but the neural spines are taller (about 35% of the total vertebral height). More than three sacral vertebrae, with co-ossified centra and zygapophyses, are typical of some highly nested Poposauridae, such as *Arizonasaurus*, *Poposaurus*, *Lotosaurus*, *Sillosuchus*, *Effigia* and *Shuvosaurus*. Among these, the morphology of the second specimen approaches that of *Poposaurus*, with centra longer than wide, and elongated neural spines. However, MCP-0204-PV is closer to *Sillosuchus*, *Effigia* and *Shuvosaurus*, as suggested by its lower neural spines and less differentiated sacral centra, although the centra of these genera are also taller than long. The presence of poposaurids adds to the diversity of the Brazilian Triassic, and extends the paleobiogeographical range of the group.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

SOLVING THE MICROBIOTHERE MARSUPIALS RELATIONSHIPS WITHIN AUSTRALIDELPHIA THROUGH THE REAPPRAISAL OF BASICRANIAL CHARACTERS

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Tracking marsupial evolution has been the subject of decades-long debates, mainly focused on solving the living South American and Australian marsupials‘ evolutionary relationships. Nonetheless, neither molecules nor morphology has aimed at producing a consensus phylogenetic hypothesis. Lately, the inclusion of fossils in an attempt to provide more powerful phylogenetic approach has improved our understanding of the evolutionary history of metatherians (more inclusive group that contains living marsupials and their fossil relatives), but the relationships of the southern hemisphere marsupials are still debated. The sticking point is the curious monito del monte (*Dromiciops gliroides*), the sole living representative of Microbiotheria, a group probably originating in the Paleocene with past occurrencea in South America, Antarctica, and maybe Australia (microbiothere-like fossils). Many ‘Australian-like features‘ have been highlighted in *Dromiciops*, which is clearly included in the Australidelphia clade, but its relationships with some Australian taxa are unclear.

The present study focuses on the basicranial anatomy of two microbiotheres: *Dromiciops gliroides* and *Microbiotherium tehuelchum* (Santacruzian, Argentina). This anatomical region has proven to be of phylogenetic importance, and, included in a comprehensive cladistic analysis based on cranial, dental, and post-cranial characters and fossil and living taxa, is likely to answer the question of the microbiotheres relationships within Australidelphia. In previous studies, I confirmed that the ancient split of Australidelphia and Eometatheria (grouping of microbiotheres and all australidelphians

but Peramelina) from other marsupials is as old as the Late Cretaceous. The inclusion of Palaeocene taxa in the crown group Marsupialia and in the Eometatheria radiation points to an early emergence of these clades in South America, instead of Australasia or eastern Gondwana, and corroborates the main molecular hypotheses.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

ON THE OLDEST TETRAPOD FOOTPRINTS FROM AFRICA

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Tetrapod footprints are among the most common fossils in late Paleozoic continental deposits. Despite their great abundance, our knowledge of vertebrate ichnofaunas from this period remains a patchwork because the vast majority of finds comes from deposits of latest Pennsylvanian (Gzhelian) and early Permian (Asselian–Artinskian) age representing a rather narrow stratigraphic interval. Therefore, potentially track-bearing strata of older or younger age are of special interest for fossil footprint exploration. With this background, the Sidi Kassem Basin of NW Africa was explored in 2010. The Sidi Kassem Basin is the only limnic basin of Westphalian age in Morocco. It is built up of 1,250 m of alluvio-fluvial to lacustrine deposits that have so far yielded plant fossils and invertebrate remains only. Our activities focused on floodplain-deposits of the basin and revealed a moderately diverse vertebrate ichnofauna composed of tracks assigned to cf. *Batrachichnus*, cf. *Hylopus*, *Dimetropus*, and *Notalacerta*. The tracks can be referred to temnospondyl, anamniote reptiliomorph, pelycosaurian-grade synapsid, and captorhinomorph trackmakers. This ichnoassemblage is important in at least three aspects. (1) It suggests an Early to mid-Pennsylvanian age for the footprint-bearing strata of the study area. (2) It is the oldest association of tetrapod footprints from Africa. (3) It is the first evidence of the relatively rare ichnogenera cf. *Hylopus* and *Notalacerta* outside of North America and Europe. Judged from the variety of tetrapod tracks and previously collected floral remains, the Sidi Kassem Basin must have represented a well-established continental ecosystem during Pennsylvanian time. Further exploration for trace and body fossils of Paleozoic vertebrates in this basin may be important for the reconstruction of early tetrapod evolution.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

NUTRIENT FORAMINA AS A POTENTIAL PROXY FOR VERTEBRATE POSTURE

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The posture of an animal is an intrinsic character of its biology. The posture of extant animals is clear through observation, but posture and gait in the fossil record are harder to determine. There are a number of proposed methods for determining the posture of an extinct animal, none of which is without error. These range from skeletal reconstruction aiming to determine the range of motion between elements to looking at footprints to generating digital models. The hypothesis that is tested is that, due to the greater relative use of the hind limbs than the forelimbs in non-volant bipeds, a biped would require relatively greater blood flow to its hind limbs than to its forelimbs compared with a quadruped. This blood supply in long bones is introduced through nutrient foramina, the size of which can be quantified. We tested this hypothesis by measuring the nutrient foramina of 176 different specimens of extant mammals including both bipeds (n=129) and quadrupeds (n=47). The dataset includes anomalurids (scaly-tailed squirrels), dipodids (jumping mice and jerboas), geomyids (gophers), heteromyids (kangaroo rats), macropods (kangaroos and wallabies), pedetids (springhares), manids (pangolins), potorids (bettongs and rat-kangaroos), and vombatids (wombats). These taxa range in size from 42 g to 33 kg. Nutrient foramen measurements were taken from the femora, humeri, tibiae, and ulnae of these taxa resulting in 1500 individual measurements that were then scaled by body mass which was taken from the literature. The forelimb measurements were then statistically compared to those of the hind limbs using model II regression analysis. A discriminant function analysis was also used to determine the efficacy of the nutrient foramen ratio with regard to posture. Bipeds and quadrupeds show statistically significantly different mean nutrient foramen ratios, but the slopes are not significantly different. The discriminant analysis correctly categorized 71% of the data. Future work will include phylogenetic independent contrasts, more accurate estimates of body mass, and a more robust dataset.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

JUVENILE SPECIMENS OF *OPHIOPSIS* (HALECOMORPHI, OPHIOPSIDAE) IN THE SOLNHOFEN ARCHIPELAGO OF GERMANY, AND THE FIRST EVIDENCE OF THE POSTCRANIAL SKELETON IN THESE GANOIN-SCALED FISH

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The genus *Ophiopsis* (ranging from the Upper Triassic to the Lower Cretaceous) is a member of the Halecomorphi, a clade of Neopterygii that was widespread during the Mesozoic but is now reduced to a single extant species (the bowfin *Amia calva*). The postcranial skeletal morphology of *Ophiopsis* is poorly known due to the thick, opaque, ganoin-covered scales found in adult specimens. Five newly discovered, unusually well-preserved specimens of juvenile *Ophiopsis attenuata* from Ettling (Solnhofen Archipelago, Bavaria, Germany) provide the opportunity to study the postcranial skeleton in *Ophiopsis* for the first time. All five specimens are articulated, complete or nearly-complete individuals. They range in size from 1.6 cm to 4 cm in total length, presenting a partial ontogenetic growth series that allows patterns of development and ossification to be examined.

In two of the five new juvenile specimens, evidence of early scale development is visible in the posterior region of the body. Although the internal skeleton in juveniles is not completely ossified, the cartilage is very well preserved. UV light was used to visualize fine structures in remarkable detail, including vertebrae, neural and haemal spines, ribs, dorsal pterygiophores, and hypurals as well as cranial bones and structures of the pectoral and pelvic fins and girdles. In the cranial region and anterior parts of the fins, the ossification of the juvenile specimens is nearly complete. The cranium of various juvenile specimens is visible in dorsal, ventral, and lateral view, depending on the specimen. Under UV light, nearly all of the cranial bones are easily identifiable. The first rhomboidal scales are visible in the caudal area in somewhat larger specimens of about 4 cm total length. Adult specimens from the same locality (Ettling) reach up to 21 cm standard length (SL), which is the maximum size currently known for *Ophiopsis attenuata*. Currently, seven adult specimens of *O. attenuata* are known from Ettling, in addition to the five new juveniles here described.

Technical Session III (Wednesday, November 5, 2014, 1:45 PM)

NEW THEROPOD MATERIAL FROM THE TRIASSIC-JURASSIC BOUNDARY OF THE VENEZUELAN ANDES

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Dinosaur skeletal remains are almost unknown from parts of Gondwana such as northern South America. One of the few exceptions comes from a small outcrop in the northernmost extension of the Andes, along the western border of Venezuela, where strata of the La Quinta Formation have yielded a basal saurischian ilium, as well as isolated bones and teeth of a small, non-cerapodan ornithischian. The specimens reported here include an isolated ischium and tibia, which can be assigned to a small theropod with an estimated body length slightly over 1.5 meters. The new form can be distinguished from non-neotheropod taxa by its well-developed cnemial crest (making up half or more of the craniocaudal width of the proximal tibia) and fibular crest, and a craniocaudally narrow slot to receive the ascending process of the astragalus. The latter feature, coupled with a distally extensive lateral malleolus, further indicates that the new theropod is closer to Averostra than to coelophysoids or members of the '*Dilophosaurus* clade'. However, several traits suggest a placement outside Averostra/Tetanurae, including a proximally extensive fibular crest and a narrow but measurable astragalar buttress, which forms a straight, oblique (lateroproximally to mediodistally oriented) platform. Moreover, the tibia of the new form has a unique fibular condyle, which extends slightly more caudally than the medial condyle and has a sharply angled caudolateral corner. Phylogenetic analyses based on the scoring of the specimens into published taxon/character matrices for theropod dinosaurs generally agree with the above comparisons. The new form is placed as the sister taxon to Averostra, a group better known from the Middle Jurassic onwards. A new U-Pb zircon date (isotope dilution thermal ionization mass spectrometry [ID-TIMS] method) from the bone bed matrix suggests a terminal Triassic maximum age for the burial of the dinosaur. Thus, the new results hint at an older age for the averostran lineage than previously thought, as well as at its possible Gondwanan origin.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

GEOMETRIC MORPHOMETRICS OF SMALL THEROPOD FRONTALS FROM THE DINOSAUR PARK FORMATION, ALBERTA

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Small theropod specimens are particularly rare due to strong taphonomic biases against their preservation. Although dromaeosaurs, troodontids, and oviraptorosaurs are well documented in Late Cretaceous assemblages from North America, taxonomic assessments are frequently made based on isolated fragmentary skeletal elements. Frontals are among the most diagnostic elements of coelurosaurs, although few taxa are known from more than a single specimen. The Campanian Dinosaur Park Formation has the best record of skull material for Late Cretaceous small theropods, and new specimens allow the variation in skull roof morphology within species to be assessed and compared to other small theropod frontals from the Late Cretaceous of North America. Our sample included 19 largely complete frontals (*Troodon*, n=8, *Saurornitholestes*, n=7, *Dromaeosaurus*, n=2). We also included a frontal (CMN 12355) referred to the therizinosauroid *Erlikosaurus*, also from the Dinosaur Park Formation of Alberta, Canada, and the holotype of the putative dromaeosaurid *Saurornitholestes robustus* (SMP VP-1955) from the Kirtland Formation of New Mexico in order to test their debated taxonomic identifications. We conducted a 2D geometric morphometric analysis using five dorsal landmarks and examined the results in principal component (PC) morphospace.

Troodon and dromaeosaurids are easily separated in morphospace, driven by differences in the lateral extent of the parietal contact on the skull roof and the position of the anterior margin of the orbit. Both CMN 12355 and SMP VP-1955 fall within the range of variation in morphospace seen in Albertan troodontids, suggesting these specimens represent indeterminate troodontids. Morphometric results are also supported by a qualitative assessment of characters. SMP VP-1955 shares the following features with *Troodon*: a shallow lateral wall defining the fossae for the olfactory system, the exclusion of the supratemporal fossa from the dorsal surface of the frontal, and a raised orbital rim. These features also occur in CMN 12355, which also differs from the holotype of *Erlikosaurus* (IGM 100/111) in the construction of the lacrimal-frontal joint. We therefore identify both CMN 12355 and SMP VP-1955 as indeterminate troodontids. Although this removes the only record of a therizinosaur from the well-sampled Campanian-Maastrichtian fossil record of North America, suggesting the extinction of this group in North America prior to the Campanian, it provides the only skeletal record of Troodontidae in the Kirtland Formation.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

FIRST INSIGHTS INTO THE DENTAL MICROSTRUCTURE OF ELASMOSAURID PLESIOSAURIANS

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Plesiosauria was a clade of marine lepidosauromorphs whose fossil record spans from the end of the Triassic to the Cretaceous-Paleogene boundary. Their distinctive skeletal morphology includes a polyphyodont dentition, which often manifests as abundant shed teeth offering an informative yet currently underexplored tool for investigating plesiosaurian paleobiology. This study focused upon reconstructing dental microstructure patterns within a model plesiosaurian lineage, Elasmosauridae, whose readily diagnostic tooth morphotype is virtually ubiquitous in Cretaceous marine deposits, and is also thought to reflect a generalized predator of pelagic vertebrates, cephalopods, and possibly even benthic molluscs. A test sample of 60 isolated teeth was selected from collections (Museum of Evolution, Uppsala & Lund University Historical Museum, Lund) originating in the Kristianstad Basin of Scania, southern Sweden. These remains derived from two localities (Blaksudden and Åsen) within a restricted sequence of the Late Cretaceous (middle Campanian) shallow marine strata.

The external surfaces of the teeth display numerous (20-100) enamel ridges that run perpendicular to the long axis of the tooth lingually but are lacking on the labial side. This common trait of the elasmosaurid plesiosaurians has been used to taxonomically discriminate the clade. Microscopic examination of the enamel ridges demonstrate that incremental deposition (Retzius lines) are thicker in the enamel ridges compared to enamel in between the ridges. Some of the specimens also display incremental growth lines inside the dentine (lines of von Ebner). These fine depositions are known to follow a circadian rhythm in recent archosaurs. Each line of von Ebner appeared to be consistently spread across each specimen with 3 µm between each line. Given the fact that the inter-distances between lines of von Ebner were the same in each specimen, the maximum number of lines available was obtained by extrapolation and approximated to 333 lines of von Ebner per millimeter. Counts of the lines of von Ebner imply a retarded rate of tooth replacement and a regular depositional thickness that might have corresponded to well-maintained metabolic rates of the elasmosaurid plesiosaurs.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

JUVENILE PLATYPUS (*ORNITHORHYNCHUS ANATINUS*) TEETH ARE DIVERSE: MORPHOLOGICAL FEATURES AND EVOLUTIONARY IMPLICATIONS OF A REDUCED DENTITION

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Although all extant adult monotremes are edentulous, the deciduous teeth of the juvenile platypus, *Ornithorhynchus anatinus*, have general similarity to teeth from extinct monotremes. The variability of the deciduous teeth of the extant platypus is not well represented in the literature, and the teeth are not readily available in collections. New imagery of juvenile platypus teeth from high-resolution x-ray computed tomography and scanning electron microscopy shows their unique morphology. These teeth are highly variable across multiple specimens and asymmetrical across the left and right of single individuals, but early-forming features are generally consistent. Stable features include the two major cusps per tooth and transverse valleys that separate them, and are most likely represent phylogenetically informative features. Transverse lophs on the major cusps contain complexity not reflected by cusps and cuspules alone. Cuspules and relative tooth size are generally inconsistent across individuals, and cuspules are extremely variable. New imagery highlights potential phylogenetically informative morphology in the pulp cavity and roots. Several characteristics of the dentition of juvenile platypus are similar to those from teeth of extinct adult monotremes including the number of teeth, the presence of premolars and molars, cusp, and root morphology. This suggests that the juvenile platypus dentition is a peramorphic expression of an ancestrally adult dentition, making way for specialized keratin plates in the adult platypus.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

USING DIGITAL RECONSTRUCTION TECHNIQUES TO RECONSTRUCT THE CRANIAL OSTEOLOGY AND MYOLOGY OF NON-MAMMALIAN CYNODONTS

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The origin of mammals from non-mammalian therapsid ancestors is a key event in the evolutionary history of tetrapods and accompanied by a number of morphological and functional modifications in their hard- and soft-tissue anatomy. These modifications are most pronounced in the cranial skeleton, including a differentiated, heterodont dentition, the development of a secondary bony palate, and the transformation of the jaw joint, resulting in the reduction of the tooth-bearing bones and the evolution of a unique auditory system. Although these osteological modifications are well-documented in the fossil record, the fossil remains of cynodonts are, as usual, imperfect in the fossil record, often subject to taphonomic deformation, disarticulated, and incompletely preserved. Here we present digital reconstructions of the cranial skeleton and the adductor musculature of the non-mammalian cynodonts *Thrinaxodon liorhinus* and *Probainognathus jenseni,* and the mammaliaform *Morganucodon oehleri.* Based on computed tomography (CT) scanning, models of the cranial skeleton of these taxa were digitally reconstructed using a variety of techniques, such as the removal of small breaks and holes, the superimposition of two or more incomplete elements, reflection and duplication of individual structures or complete elements, and retrodeformation. Building upon the reconstructed skull models, the muscle architecture was reconstructed in an iterative approach, consisting of: (1) the identification of muscle attachment sites both in the actual specimens as well as in the digital models; (2) the mapping of the muscle topology using simplified muscle cylinders; and (3) the final volumetric reconstruction of the individual muscles. Results of the reconstruction process confirm previous studies that there is an increase in size of the temporal fenestra towards the more derived taxa in this study. Lateral expansion of the temporal fenestra is accompanied by increased size of the muscle attachment sites for the temporalis muscle on the skull as well as on the mandible, resulting in increased muscle size and volume. At the same time, the dorsolateral deflection of the zygomatic arch allows for an increased size of the masseter muscle.

Technical Session III (Wednesday, November 5, 2014, 3:15 PM)

THE BRAIN OF *DEINOCHEIRUS MIRIFICUS*, A GIGANTIC ORNITHOMIMOSAURIAN DINOSAUR FROM THE CRETACEOUS OF MONGOLIA

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A poached skull and associated material of the gigantic ornithomimosaurian dinosaur *Deinocheirus mirificus*, from the Nemegt Formation (Late Campanian-Early Maastrichtian) of southern Mongolia, was recently found in a private collection in Europe, then returned to the Central Museum of Mongolian Dinosaurs at Ulan Bator. The skull of *Deinocheirus* was very long (> 1 m), with an elongated and transversely expanded snout and a deep dentary. The rostral surface of the snout is pitted, indicating the presence of a keratinous rhamphotheca in life. Teeth are completely absent, showing that *Deinocheirus* was, in any case, not a predator. Information on the structure of its brain is based on three-dimensional reconstruction from a computed tomography (CT) scan dataset. The brain of *Deinocheirus* is similar in shape to that in birds and troodontid dinosaurs, characterized by a large and globular brain. The cerebrum is expanded laterally and dorsally, as in most theropod dinosaurs. The olfactory tracts are large but not as developed as in more primitive theropods, more closely resembling the condition in the oviraptorosaurian *Citipati*. The brain of *Deinocheirus* is proportionally small and particularly compact. The estimated Reptile Encephalization Quotient is 0.69. This value is low, close to the estimated Reptile Encephalization Quotient in sauropods and clearly lower than in other theropods. This situation contrasts with Reptile Encephalization Quotient evaluations in other ornithomimosaurs, characterized by their proportionally large brains. Negative allometry might explain the small relative size of the brain in the gigantic *Deinocheirus*. However, similar-sized predatory theropods are characterized by a much higher Reptile Encephalization Quotient (*Tyrannosaurus rex*: 5.44-7.63). Therefore, it may be hypothesized that the small brain of *Deinocheirus* might also partially reflect its social behavior and/or its presumed herbivorous or omnivorous diet. Unlike carnivorous dinosaurs, *Deinocheirus* would not have relied on a good coordination and balance to catch its food. Its size and weight made it a big and slow-moving animal, with no predisposition to agility.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

AN INTERMEDIATE PADDLE BETWEEN BASAL THUNNOSAURIAN AND OPTHALMOSAURIAN ICHTHYOSAURS FROM THE HISTORIC R.W. HOOLEY COLLECTION, LYME REGIS

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Historically Lyme Regis is an important locality for ichthyosaurs of Liassic age from the time of Mary Anning to the present day. A specimen found in the Hampshire County Council Museum Service, specimen A5286 is an opthalmosaurian-like forefin including a left humerus with four distal facets and 29 disarticulated digit elements. The original label claims that A5286 derives from the R.W. Hooley collection and was collected from Lyme Regis, making the specimen from the Lias and Early Jurassic in age. There is no sediment associated with the disarticulated elements to allow palynological test to confirm this. A reconstruction of the fin indicates an intermediate form with features from both opthalmosaurian and basal thunnosaurian ichthyosaurs.

The proximal and distal ends of the A5286 humerus are roughly equal in length, which fits both families. The humerus has a robust proximal head that is more prominent and robust than the distal end, consistent with *Ichthyosaurus*, but not the case in most opthalmosaurids. The humerus is also proximodistally longer than is normal for *I. communis*, but has the more hourglass shape that seems to be consistent in the species. When reconstructed, the phalanges seem to be more closely packed, but with more rectangular distal elements than found in ophthalmosaurids. The dorsal process is prominent, but does not twist towards the anterior as seen in opthalmosaurids. Ontogeny suggests that this specimen is from a young adult because of its moderately developed midshaft and moderately smooth bone surface.

As this is a historic specimen, we are unsure if this specimen truly originates from Lyme Regis, or is actually from another locality on the Dorset Coast that is more stratigraphically consistent with opthalmosaurians such as the Oxford Clay. Either way, the paddle represents a transitional ophthalmosaurid-type plan, but with a humerus and distal elements more fitting of a basal thunnosaurian. The presence of an ophthalmosaurian forefin from the Lower Jurassic could have interesting implications for the understanding of the phylogeny of this clade. Although, this specimen highlights an ongoing problem with ichthyosaurs, due to the inconsistency in much of ichthyosaur phylogeny, isolated elements such as this remain difficult to confidently identify to genus or species level.

Technical Sesssion XII (Friday, November 7, 2014, 2:15 PM)

TOOTH SOCKETS AND INTERDENTAL PLATES: THE DEVELOPMENT AND HISTOLOGY OF THECODONTY IN AMNIOTES

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Mammals and crocodilians are considered as the only extant vertebrates to possess true thecodonty, in which teeth are deeply implanted in the jaw and are suspended in the socket by a ligament. However, the definition of thecodonty has been debated, especially for fossil taxa, where the nature of tooth implantation often focuses on the absence or presence of four-walled tooth sockets. This can lead to conflicting phylogenetic or taxonomic conclusions for fossil amniotes and is incentive to investigate the development of tooth sockets within Amniota from evolutionary and developmental perspectives.

The purpose of this study is to describe the histology of amniote tooth sockets and describe how tooth attachment tissues develop through ontogeny. First, we provide a definition of a tooth socket based on the current understanding of tooth development and new histological thin sections of mammals and crocodilians. We also examine thin sections of hatchling, juvenile, and adult *Alligator mississippiensis* to define the precise relationship between tooth attachment tissues and the surrounding jawbone and how they contribute to the tooth socket through ontogeny. Finally, we compare these histological sections to a large taxonomic sample of amniotes, including synapsids, early eureptiles, and dinosaurs to create a histological definition of thecodonty.

Results show that during the course of tooth replacement, remnants of tooth sockets remain embedded in the jaws and are built upon by new layers of alveolar bone, a bone tissue that is formed by each developing tooth. Successive tooth generations accumulate layers of alveolar bone, and even dentine, that can form thick floors and walls to a socket. The walls that form in between tooth positions are interdental plates, which become larger over several generations of tooth replacement to form the four-walled socket in many taxa. Given that the developing tooth forms sockets through formation of alveolar bone in all amniotes, we argue that the conventional definition of thecodonty only describes the depth to which a tooth is embedded in the jaw, but should actually refer to a condition in which teeth and alveolar bone are implanted into a groove in the jaw bone.

We conclude from these comparisons that alveolar bone is an evolutionarily conserved tissue that forms anew with each replacement tooth in all amniotes. We also conclude that tooth sockets are defined by alveolar bone, not jaw bone, and are prone to a suite of ontogenetic changes that could go unnoticed in fossils without an in-depth examination of thin sections.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

THE FIRST CROCODILIAN TRACKWAY FROM THE UPPER CRETACEOUS BAYANSHIREE FORMATION OF MONGOLIA

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Crocodilian tracks are now known from the lower Upper Cretaceous Bayanshiree Formation (Cenomanian-Santonian) at the Shine Us Khudag locality in southeastern Mongolia. The tracks were discovered by a joint expedition from Korea, Japan, and Mongolia in 2013. Nine tracks are preserved as natural casts, forming a trackway with a quadrupedal gait pattern without tail trails. All tracks are short and wide, and dominated by toe traces without plantar impressions. The average manus and pes width is 5.52 cm and 6.38 cm, respectively. The stride length, pace length, pace angulation, and gait-width of the pes (average 65.7 cm, 52.4 cm, 73.2°, 39.8 cm, respectively) are slightly larger than those of the manus (average 63.2 cm, 48.4 cm, 64.4°, 30.6 cm, respectively). Pes tracks are characterized by four deep toe impressions and backward push marks behind them. Manus tracks have shallow toe impressions and well-developed long, subparallel scratch marks behind. The number and length of these drag marks are not consistent among manus tracks. Pes tracks are anterior to the manus tracks in manus-pes sets, which is in the opposite order of crocodilian walking. The preferential association of the scratch marks with only the distal digit impressions, and an unusual and irregular trackway pattern support a subaqueous setting for this trackway, suggesting a semi-buoyant mode of propulsion or locomotion in fairly shallow water. The backward-directed push marks of pes tracks may have been made while pushing off the bottom with its hind feet to propel the crocodilian forward. Alternatively, long, subparallel scratch marks behind manus tracks may indicate that the animal's front feet were dragging while their claws were touching the bottom. These crocodilian 'swim tracks' (ichnogenus *Hatcherichnus*) are consistent with abundant neosuchian crocodylomorphs (*Shamosuchus gradilifrons*, *S. major*, *S. ulgicus*) found in the fluvio-lacustrine environments of the Bayanshiree Formation.

Symposium 1 (Wednesday, November 5, 2014, 10:45 AM)

NEW BASAL AVIALAE FROM THE JURASSIC OF CHINA

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Four feathered theropods have already been described from the Middle-Late Jurassic Tiaojishan Formation in Liaoning Province (China): *Anchiornis huxleyi*, *Xiaotingia zhengi*, *Eosinopteryx brevipenna*, and *Aurornis xui*. The Yizhou Fossil & Geology Park (Toutai, Liaoning) has recently acquired three specimens (YFGP-T5199, T5200, T5201) of small paravian theropods from the Tiaojishan Formation in Jianchang County, obviously belonging to three new taxa. A phylogenetic analysis places them as basalmost Avialae.

The tetrapterygian condition, thought to be a basal condition in birds, is challenged by *Eosinopteryx*, regarded in our phylogenetic analysis as a basal Aviale, and by YFGP-T5199, with symmetrical pennaceous feathers on its forelimbs and unbranched structures around all the other parts of its body, including its hind limbs and its tail. Paleohistological investigations show that YFGP-T5199 and the holotype of *Eosinopteryx* are both immature individuals. Therefore, the absence of rectrices and of pennaceous feathers along the distal hind limb might alternatively be regarded as juvenile characters. However, rectrices are well developed along the tail of YFGP-T5200, another juvenile specimen, suggesting that the plumage of basalmost Avialae was already diversified and adapted to different ecological niches. The skull of YFGP-T5201 displays several characters previously thought to be synapomorphic for Troodontidae. Re-evaluation of these characters reinforces the sister-group relationships between Avialae and Troodontidae.

Basal Avialae were unexpectedly diversified in the Middle-Late Jurassic of China, implying a more complex picture in terms of the origin of flight than often supposed. Surprisingly, dromaeosaurids, the dominant non-avian theropods from the Early Cretaceous Jehol Biota, are apparently absent from the Jurassic formations in Asia.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

BONE HISTOLOGY, PHYLOGENY, AND PALAEOGNATHOUS BIRDS (AVES, PALAEOGNATHAE)

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Phylogenetic signal has been defined as "a tendency for related species to resemble each other more than they resemble species drawn at random from the tree". For years, phylogenetic comparative methods have been used to measure phylogenetic signal on various quantitative characters in systematics, but the presence of a phylogenetic signal in the variation of osteohistological features has been recently debated in the literature. Previous studies have found a significant signal for some of these features, but these results were obtained on a small amount of characters and a reduced sample relative to the size of the considered clade.

Here we performed a comprehensive study in which we quantified the phylogenetic signal on sixty-two osteohistological features in an exhaustive sample of extant and extinct palaeognathous birds (Aves, Palaeognathae). We used four different estimators to measure phylogenetic signal-Pagel's λ, Abouheif's C_{mean}, Blomberg's K, and Diniz-Filho's PVR- and four topologies taken from the literature. Most features measured at the macrostructural level exhibit a strong phylogenetic signal, whereas all but four features measured at the histological level exhibit a weak signal. We also found that the impact of the topologies used in the analyses is very low compared to that of sample size. We conclude that the analysis of a comprehensive sample is crucial to obtain reliable quantifications of the phylogenetic signal, and that the use of phylogenetic comparative methods could give paleohistologists a better understanding of the different signals in fossil bone histology.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

AVIAN NESTING SITES ASSOCIATED WITH CADDISFLY-DOMINATED MICROBIAL-CARBONATE BIOHERMS AND BARRIER BAR DEPOSITS IN THE WILKINS PEAK MEMBER OF THE EOCENE GREEN RIVER FORMATION

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Abundant avian eggshell fragments occur in a nearshore freshwater facies of the saline Wilkins Peak Member of the Green River Formation near the northwestern edge of Eocene Lake Gosiute. The fossils are found at Radio Tower Mesa, about 13 km north of La Barge, Wyoming. The eggshell fragments are associated with *Presbyornis* (Aves: Anseriformes) bones and occur in multiple stratigraphic intervals between the layered tuff (a well known Wilkins Peak marker bed) and a 1.5 m thick dark oil shale at the local top of the Wilkins Peak Member of the Green River Formation. The eggshell fragments and bones occur in intermound deposits associated with caddisfly-dominated microbial-carbonate bioherms up to 15 m thick, and are also associated with ostracods, caddisfly larval cases, microbialites, intraclast micrite, and carbonate barrier bar deposits.

Eggshell fragments were studied by light microscopy, by polarized light microscopy, and by scanning electron microscopy. The resultant micrographs were compared with published reports of modern and fossil ornithoid, crocodiloid, testudoid and geckoid eggshell. The Wilkins Peak eggshell fragments show the following microstructure zones (from internal to external): 1) an organic core, 2) a zone of radial calcite plates, 3) a zone of tabular crystallite plates, 4) a zone of squamatic aggregates and 5) an external zone of vertical calcite crystals. Macrostructure zones (from internal to external) are: 1) wedges of the mamillary layer (diverging outward from the central core), grading into 2) long vertical columns of the prismatic layer. These findings are similar to the characteristics of modern neognathous eggshell.

The caddisfly larval cases, microbialites, intraclast micrite, carbonate barrier bars, and avian eggshell fragments are strong evidence for a lake margin depositional environment. The abundant avian eggshell fragments and abundant avian bones support the nesting site hypothesis. The barrier bars likely formed a natural division between the saline/alkaline Lake Gosiute and a nearshore, freshwater-dominated depositional environment (with local subaerial exposure) where the birds were able to nest.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

NEW FIELDWORK AT KARUNGU (EARLY MIOCENE; LAKE VICTORIA, KENYA): PRELIMINARY PALEONTOLOGICAL AND GEOLOGICAL RESULTS

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Karungu is one of the first fossil sites discovered in Kenya. Surveyed mostly before 1950, more than 1600 early Miocene fossils were collected, including the holotypes of *Prodeinotherium hobleyi*, *Myohyrax oswaldi*, and *Paraphiomys pigotti*. Although Karungu shows a diverse fauna, few fossil primates were discovered, suggesting that the site was not ecologically attractive for them. In the framework of the REACHE project, we have begun new research at Karungu focused on reconstructing its paleoenvironments and assessing why primates are so rare, especially in comparison to the nearby, and possibly age equivalent, sites on Rusinga Island. Our fieldwork focused on revising local stratigraphy and collecting new fossils in a stratigraphically controlled manner. The early Miocene strata at Karungu consist of fluvial and lacustrine deposits and associated paleosols. At the base of the section is a thick, very well-developed paleosol with features indicating development during an interval of prolonged landscape stability of > ~100,000 years. This paleosol is overlain by fluvial and lacustrine deposits, wherein most fossils were collected. Poorly developed paleosols formed in association with the latter deposits reflect short periods of landscape stability (~10s–100s of years) during lake lowstands. The sequence is capped by lacustrine deposits, which likely formed during a prolonged lake-level highstand. Our fossil collections double the number of specimens known from Karungu and include the skull of a primitive gomphotheriine, the partial skeleton of a rare aardvark, five new primate specimens, and a large assortment of aquatic species. We also revisited the type horizon for *P. hobleyi* and located fossiliferous pockets containing microfauna (underrepresented in collections so far). Importantly, our fieldwork added several new taxa to the faunal list such as Chalicotheriidae, Pedetidae, Bathyergidae, and indicate that the Karungu fauna as a whole bears resemblance with that of Rusinga, except in its paucity of smaller taxa. The sedimentological characteristics of the deposits at Karungu are considerably different from those on Rusinga, which are comprised primarily of fluvial, volcaniclastic, and volcanic deposits. Such dissimilarities reflect taphonomic and/or environmental differences between the sites and may help explain the differential preservation of primates and microfauna. Future fieldwork focused on the new microfaunal sites will help to test these hypotheses.

The REACHE project is supported by NSF Grant BCS 1241807.

Technical Session XVI (Saturday, November 8, 2014, 10:45 AM)

FUNCTIONAL IMPLICATIONS OF PLATYROSTRAL SKULLS FOR FEEDING IN WATER WITH INSIGHTS INTO THE CRANIAL MORPHOLOGY OF *TIKTAALIK ROSEAE*

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The evolution of a platyrostral (dorsoventrally compressed) skull has occurred independently many times among aquatic gnathostomes, including the lineage of sarcopterygian fishes leading to tetrapods. While the adaptive purpose of this trait may not be the same for all groups that exhibit it, there are functional implications in terms of feeding mechanics that result from the morphology. The elpistostegids are the first taxa to exhibit the broad, flat skulls characteristic of early tetrapods, but the functional significance of this important restructuring of the skull in terms of feeding mechanics is not yet fully understood. This study seeks to understand these functional implications by analyzing the sutural morphology, structure, and hydrodynamics of the skull of the elpistostegid, *Tiktaalik*, and comparing it with other modern platyrostral taxa. We used computed tomography (CT) data from specimens of *Tiktaalik*, *Alligator*, *Lepisosteus*, and *Atractosteus* to digitally reconstruct bones and sutures of the crania. The lateral two-thirds of the tooth row of *Tiktaalik* is associated with features that resist torsional loads, such as broad overlapping scarf joints and a primary palate that spans the roof of the buccal cavity. The anterior one-third of the tooth row is associated with features that resist bending with a robust parasphenoid strut that runs along the midline. Comparing this morphology with gars and crocodilians suggests a functionally subdivided feeding system capable of resisting loads differentially depending on where along the tooth row the bite occurred.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

BONE HISTOLOGY OF CENTROSAURINE CERATOPSID DINOSAURS FROM THE CAMPANIAN OF SOUTHERN UTAH

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The long bones of the centrosaurine ceratopsid dinosaurs *Pachyrhinosaurus perotorum*, *Centrosaurus apertus*, and *Einiosaurus procurvicornis* from the Campanian-Maastrichtian of northern Laramidia (western North America), display multiple lines of arrested growth (LAGs), which indicate a yearly momentary cessation of bone growth. However, *Utahceratops gettyi* and *Kosmoceratops richardsoni*, chasmosaurine ceratopsids from Utah, do not preserve any observable LAGs. I previously hypothesized that this might reflect a Late Cretaceous latitudinal gradient of climate in Laramidia.

To test this hypothesis, I histologically sampled and analyzed centrosaurines from Grand Staircase-Escalante National Monument of southern Utah. These include the humerus and ulna of the holotype of *Nasutoceratops titusi*, a centrosaurine from the middle Campanian Kaiparowits Formation that is coeval with *Utahceratops* and *Kosmoceratops*. I also sampled indeterminate ceratopsid postcrania (humerus, femur, and indeterminate limb shafts) from the underlying lower Campanian Wahweap Formation, which so far is known only to preserve centrosaurine ceratopsids.

Growth of these large, quadrupedal centrosaurine and chasmosaurine dinosaurs from Utah followed a similar pattern. The bones of *Nasutoceratops* have dense osteocytes and dominantly longitudinal canals, comparable to those of *Utahceratops* and *Kosmoceratops*. There is considerable remodeling present throughout the cortex. 1 mm from the periosteum, a single LAG is present the ulna of *Nasutoceratops*. This differs from *Utahceratops* and *Kosmoceratops*, where no LAGs were present in any sampled specimens. *Centrosaurus* ulnae of similar size (circumference of 155 mm) possess 3 LAGs. These data are still consistent with a latitudinal gradient in maximum number of LAGs, because northern forms possess multiple LAGs when compared with the maximum of a single LAG in southern ceratopsids.

Technical Session X (Friday, November 7, 2014, 9:45 AM)

CARNIVOROUS MAMMALS IN THE KENYAN MIOCENE: POSTCRANIAL EVIDENCE

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During the Miocene, a major shift took place within African carnivore guilds with the extinction of the Hyaenodontida (formerly part of “Creodonta”). Kenya provides an excellent means of studying this shift due to the temporal distribution of sites throughout the Miocene. While taxonomic identification of postcrania is difficult, these specimens provide unique information about behavior and ecology, even if it is not clear to what species they belong. This study analyzed postcranial material from Kenyan sites such as Rusinga and Maboko to reconstruct carnivore behavior and ecology as a means of better understanding shifts in Miocene carnivore guilds. Multivariate analyses were performed on scale-free shape data (measurements divided by their geometric mean).

Miocene carnivores vary in locomotor adaptations. Some hyaenodontidans possess a flattened distal humeral articular surface and an anteriorly placed radius indicating great loading of the radius during locomotion and inability to supinate. This condition is seen in taxa ranging from lynx-sized material from Rusinga to the largest hyainailourines of Kenya, but not in carnivorans. In contrast, a wolf-sized species from Maboko has adaptations for cursoriality that preserve some rotatory ability, as in extant canids. Amphicyonids vary greatly in body size and have forelimbs indicating ambulatory to cursorial behavior, while barbourofelids resemble modern prey-grappling felids. Hind limb morphology of hyaenodontidans and carnivorans indicates the presence of ambulatory and cursorial taxa, as well as smaller scansorial species.

Eastern African carnivore guilds of the early and middle Miocene were similar in some ways to later guilds: medium-sized cursors, small leaping and climbing species, prey-grappling ambush predators, and others. These roles were filled by hyaenodontidans and carnivorans including amphicyonids, barbourofelids, herpestids, and viverrids. Percrocutids, mustelids, and small felids were present, but not common. By the late Miocene, hyaenodontidans and barbourofelids were gone and amphicyonids were in decline. Hyaenids and canids appeared and felids and mustelids diversified. Early/middle Miocene niches filled by larger hyaenodontidans and amphicyonids may have been partially filled by large mustelids and ursids in the late Miocene, but remain empty today. By the end of the Miocene, only extant families remained; the stage was set for the last flowering of diversity before the precipitous drop to the modern depauperate African carnivore guilds.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A FALCONID FROM THE LATE MIOCENE OF NORTHWESTERN CHINA YIELDS FURTHER EVIDENCE OF TRANSITION IN LATE NEOGENE STEPPE COMMUNITIES

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Although the Falconidae, which includes extant falcons and caracaras, has a long evolutionary history, most previously reported fossils referred to this family are isolated single elements. Here, we report a new species, *Falco hezhengensis*, represented by a nearly complete and articulated skeleton from the late Miocene deposits of Linxia Basin in northwestern China. The new fossil shares an array of derived morphologies with the genus *Falco* and analysis of the largest morphological dataset for Falconidae, sampling most genera, identifies the specimen as a new stem kestrel. The phylogeny shows a high degree of congruence with published molecular phylogenies and time trees supporting a Miocene radiation of Falconidae. The species provides a new calibration for the divergence of extant kestrels from other *Falco*. Remains of a small mammal, a jerboa (Dipodidae), are preserved in the abdominal region of the specimen. Integrated with data from other avian remains from the Linxia Basin, the new fossil provides further support for changes in the open steppe environment of Central Asia since the late Miocene. Changes in falconid ecology and diet, shifts in small mammal abundances, as well as the extinction of the Central Asian ostrich may be involved in community turnover in the Late Neogene.

Technical Session I (Wednesday, November 5, 2014, 10:15 AM)

A NEW ANTHRACOTHERE FROM THE OLIGOCENE OF KENYA EVENTUALLY ROOTS THE HIPPOPOTAMIDAE DEEP INTO THE PALEOGENE

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Twenty years ago, molecular phylogenists suggested that dolphins are more closely related to Hippopotamus than pigs, conflicting with and soon invalidating classical

hypotheses of hippopotamid origins within Suoidea. On the other hand, an emergence from anthracotheres seemed better supported. Yet, the exact rooting of the semiaquatic Hippopotamidae remained uncertain, with two alternative evolutionary pathways: with archaic anthracotheres reaching Africa close to the Eocene/Oligocene transition, or with more advanced forms colonizing Africa after its early Miocene collision with Eurasia. The scarce Oligocene record in Africa has been recognized as a possible explanation for the apparent morphological gap between Miocene archaic hippopotamids and possibly related anthracotheres.

Recent investigations in the Oligocene deposits of the Lokone Sandstone Formation (northern Kenya) filled this gap by revealing a new lineage of bothriodontine anthracotheres. This new taxon, with squat and bunoselenodont teeth, was integrated into an original cladistic analysis of the Hippopotamoidea and other cetartiodactyls. It indicates that the new taxon is the sister group of the Hippopotamidae, anchoring the family well into the Paleogene of Africa. The new taxon itself relates to a late Eocene anthracothere from Asia. Future prospects include further investigations within Paleogene Eurasian cetartiodactyls in order to resolve putative relationships between archaic anthracotheres and early cetaceans.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

NEW DATA ON EARLY JURASSIC THEROPOD DIVERSITY AND FEEDING BEHAVIOR IN THE LUFENG FORMATION OF YUNNAN PROVINCE, CHINA

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A number of examples of bite marks and shed teeth from feeding theropods are known, but remain rare. Here we describe two new incidences associated with Hettangian (Early Jurassic) prosauropod remains from Lufeng County, Yunnan Province. Both specimens were recovered from the 'Lufeng Formation' which is now restricted to the unit previously known as the Lower Lufeng Formation or Series. Within this revised nomenclature, the formation consists of two subunits: the older Shawan Member and the younger Zhangjia'ao Member, representing the former 'Dark Purple' and 'Deep Red' Beds, respectively. Recently a prosauropod specimen consisting of three closely associated sequences of articulated vertebrae was recovered from near DaWaShan. One of the cervicals displayed distinct signs of localized brittle deformation, and within 200 mm of this vertebra, parts of five teeth were recovered. One of the teeth fitted well in one of the brittle deformation recesses in the centrum of the cervical vertebra, which is interpreted as a bite mark. A further sauropodomorph specimen referred to *Yunnanosaurus* and consisting of disarticulated cranial material, most of the vertebral column, and limb girdle elements was excavated from the Shawan Member during work for a relocated ironworks at Qingliangshan. Three shed theropod teeth, matching those of the contemporaneous *Sinosaurus triassicus* and ranging from 25-30 mm in crown height, were recovered among its pelvic elements. Morphometric analyses of these teeth show that they plot distinctly from those of theropod taxa so far examined in broad studies, the crown angle being unusually low at 50-64° for the 15 mm crown base length. The teeth also feature an unusually high denticle density on the distal carina, producing a particularly low denticle size difference index range of 0.62-0.88. As well as further supporting the recent transfer of the material of this taxon from the genus *Dilophosaurus*, this also indicates a possible unusual and distinctive functionality, compared with other analyzed theropod teeth. The teeth from DaWaShan are not as well-preserved as those from Qingliangshan, but their form can clearly be identified as distinct from *Sinosaurus triassicus* and indeed all other theropod taxa currently known from the Lufeng fauna. Thus, over seventy years since it was first reported, the Hettangian-Sinemurian Lufeng Formation of Yunnan Province continues to provide fresh insights into our poor knowledge of Early Jurassic theropod evolution and carnivore habits.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A NEW SUCKER (TELEOSTEI, CATOSTOMIDAE) FROM THE EOCENE KISHENEHN FORMATION OF MONTANA AND THE SYSTEMATIC POSITION OF *AMYZON*

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A new species of the Eocene catostomid genus *Amyzon* is recognized based on recently collected materials from the Kishenehn Formation in Montana, U.S.A. The mouth gape consisting of premaxilla, maxilla, and dentary, as well as a robust fourth pleural rib associated with the Weberian apparatus, indicate it belongs to the family Catostomidae (Ostariophysi, Cypriniformes). The new species shares plesiomorphies with all known *Amyzon* in having a deep body in adults, a moderate number of dorsal fin rays (16-33; within Catostomidae, the highest number of dorsal fin rays is in Myxocyprininae with 52-57, and the lowest is in Catostominae with 10-18, so the range of counts in *Amyzon* is intermediate), anal fin rays more than seven, anterior (ethmoid-frontal) and posterior (fronto-parietal) fontanelles present in adults, and anterior edge of frontal truncated. It differs from other species of *Amyzon* in the combination of the following characters: 1) fewer principal pectoral fin rays (9-12, mostly 12); fewer principal pelvic fin rays (7-10); hypural 3 occasionally fused to the caudal compound centrum; and shallower body in juveniles compared to other similarly sized *Amyzon*. Furthermore, a geometric morphometric analysis of Eocene *Amyzon*, including samples of *A. commune*, *A. brevipinne*, *A. aggregatum,* and *A. gosiutense*, indicates that the Kishenehn *Amyzon* is different from the others in body shape. By adding well-preserved specimens of a species of *Amyzon*, this new species also sheds light on the systematic position of the genus within Catostomidae. *Amyzon* is usually resolved as a basal clade within the subfamily Ictiobinae. However, a suite of characters uniquely shared by *Amyzon* and the subfamily Catostominae, most notably the elongated posteroventral process of the dentary and the moderately forked pelvic bone, both seen in the new Kishenehn species of *Amyzon*, suggest that *Amyzon* diverged from the stem of Catostominae rather than Ictiobinae.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

THE JIYUAN TETRAPOD FAUNA OF THE UPPER PERMIAN OF CHINA

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The Jiyuan Fauna is an assemblage of Late Permian tetrapods from the Huakedaliang fossil locality in Henan Province. Young identified the following taxonomic components from this assemblage: three "labyrinthodonts" including *Bystrowiana sinica*; two pareiasaurs, *Honania complicidentata* and *Tsiyuania simplicidentata*; one dinocephalian, *Taihangshania imperfacta*; one gorgonopsian, *Wangwusaurus tayuensis*; and one cynodont, *Hwanghocynodon multienspidus*. Based on this composition, he correlated Jiyuan with the Russian Zone III and the South African *Endothiodon* Zone.

We recently began a reinvestigation of the Jiyuan fauna, including a reexamination of the original collections as well as renewing efforts to collect new specimens from the original localities. Though pareiasaur bones dominate the locality numerically, there is no evidence that more than a single pareisaur species, *Honania complicidentata*, was present. In addition to *Bystrowiana sinica*, two new bystrowianid species are established based on the distinctiveness of their armor scutes. No teeth can definitely be referred to Gorgonopsia, but a new tooth is tentatively referred to this group. The cynodont affinity of *Hwanghocynodon multienspidus* is unchanged. Based on our revisions and additions, Jiyuan is now roughly correlated to the slightly younger Ilinskoe Subassemblage of the Sokolki Assemblage of Russia and the *Cistecephalus* Assemblage Zone of South Africa.

One of the most intriguing of our discoveries is from the original collection where we have identified a new, relatively derived diadectomorph. Diadectomorpha is an important group—not only is it the sister taxon to crown-group Amniota but it represents the first tetrapod radiation of high-fiber herbivores. The Jiyuan specimen is the first record of this clade outside the Euramerican Landmass (all previous records are from either North America or Germany) indicating a previously unrecognized biogeographic complexity for the group. The specimen also extends the stratigraphic range of Diadectomorpha more than 15 million years and is the first evidence we have that diadectomorphs survived the Early Permian.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A GIGANTIC NOTHOSAUR (REPTILIA: SAUROPTERYGIA) FROM THE MIDDLE TRIASSIC OF SOUTHWESTERN CHINA AND ITS IMPLICATION FOR THE BIOTIC RECOVERY FROM THE PERMIAN-TRIASSIC MASS EXTINCTION

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Timing of biotic recovery from the most devastating catastrophe of life, the Permian-Triassic mass extinction (PTME), remains controversial. The presence of gigantic apex marine predators in the eastern Panthalassic and western Tethyan provinces suggests that complex ecosystems in the sea had become re-established at least by the early Middle Triassic in these regions. However, it is not clear if oceanic ecosystem recovery from the PTME is global or not because of the lack of such predators in the eastern Tethyan/western Panthalassic region prior to the Late Triassic. Here we report a gigantic nothosaur, estimated at 5-7 m long, from the early Middle Triassic Luoping biota in South China, of which the cranial skeleton ranks as the largest among Triassic sauropterygians where a complete skull or lower jaw is known. A new species-level data matrix was constructed to clarify the phylogenetic relationships of nothosaurs. The result challenges the conventional view of two monophyletic clades among nothosaurid sauropterygians, and suggests parallel evolution of the gigantic skull in Triassic sauropterygians. The presence of this gigantic nothosaur and associated diverse marine reptiles in the Luoping biota indicates global ecosystem recovery from PTME in the sea by the early Middle Triassic.

Symposium 3 (Friday, November 7, 2014, 12:00 PM)

A PROBABILISTICALLY TIME-SCALED 1000-TAXON PHYLOGENETIC HYPOTHESIS FOR MESOZOIC DINOSAURS AND THE ORIGINS OF FLIGHT AND CROWN-BIRDS

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Fossil-calibrated molecular clocks are often used to broadly bracket the timing of many key branching events in the history of life, such as the origin of avian flight, in contrast to literal interpretations based on the timing of fossil occurrences. However, two new approaches allow for probabilistic dating of phylogenetic nodes based on appearance times in the fossil record, without reference to a molecular or morphological clock. The first of these is a modification of a simple Bayesian approach that utilizes the sequence of sister group ages leading to each node. The second is a stochastic method that uses prior estimates of sampling, origination and extinction rates in a branching model before producing a set of time-scaled trees. Here we apply both approaches to attempt to answer three questions. 1) What is the probability that dinosaurs emerged prior to the end-Permian mass extinction? 2) When did avian flight first evolve? 3) When did crown birds originate?

Our phylogenetic hypothesis contains over 1000 unique taxa and is a novel formal supertree based on over 1500 data sets. We implemented several methodological improvements over previous approaches, including: 1) increased automation, reducing both labor and human error, 2) increased information content of input trees (all equally optimal topologies are retained), 3) inclusion of taxonomy as an additional input tree to increase coverage, 4) pruning of fixed outgroup taxa from input trees, 5) numerical determination of a cut-off point that maximizes coverage while minimizing redundancy,

6) automated removal of superseded data sets and shared weighting of sets of equally dependent input trees, 7) up-weighting of more recent studies over older studies, and 8) implementation of safe taxonomic reduction.

Parallelized tree searches in TNT produced 11 087 equally optimal topologies and the two dating approaches were applied (results given in respective order of their introduction above). In both cases a pre-Mesozoic origin for dinosaurs cannot be rejected at an alpha of 0.05 (p = 0.098 or 0.331). Other estimates agree closely, with avian flight estimated at 152.39-172.69 Ma or 156.6-167.9 Ma, and crown-birds estimated at 70.12-107.52 Ma or 70.7-97.8 Ma (all ranges are 95% CIs). These last sets of dates can be compared to molecular estimates, which are broadly older. We propose that elevated rates of molecular evolution at the base of the extant dinosaur radiation may be necessary to reconcile these differences between molecular and model-based paleontological estimates of branching times.

Technical Session I (Wednesday, November 5, 2014, 11:00 AM)

THE ENAMEL ULTRASTRUCTURE OF FOSSIL CETACEANS (CETACEA, ARCHAEOCETI AND ODONTOCETI)

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The transition from terrestrial ancestry to a fully aquatic life resulted in deep changes to the body systems of cetaceans, with some of the most extreme morphological changes being observed in the skull and feeding apparatus. Archaeocetes (stem Cetacea) had elongated jaws, and differentiated dentitions similar to those in some terrestrial mammals. Conversely, for Neoceti, most living odontocetes have extremely simplified and numerous teeth, whereas living baleen whales have no adult teeth. Details of dental structure and evolution are poorly known for the archaeocete–neocete transition. Here we report the morphology of teeth and ultrastructure of enamel in archaeocetes, and fossil platanistoids and delphinoids ranging from late Oligocene (Waitaki Valley, New Zealand) to Pliocene (Caldera, Chile). Teeth were embedded in epoxy resin, sectioned in cross and longitudinal planes, polished, etched, and gold coated for SEM observation. SEM images showed that in archaeocetes, squalodontids, and *Prosqualodon*, taxa with heterodont and nonpolydont/limited polydont teeth, the inner enamel was organized in Hunter-Schreger bands (HSB) with an outer layer of radial enamel. This is a common pattern in most large-bodied mammals and is regarded as a biomechanical adaptation related to food processing and crack resistance. In these taxa, the enamel layer was also moderately thick (about 300–380 µm). Fossil squalodelphinids and delphinoids, which have more teeth but with a simpler shape, showed a simpler structure with inner radial and outer prismless enamel. The enamel layer was also thinner, ranging from 75–200 µm. Radial enamel is regarded as more wear-resistant and has been retained in several mammal taxa in which opposing tooth surfaces slide over each other. These observations suggest that the transition from a heterodont and nonpolydont/limited polydont dentition in archaeocetes and early odontocetes to homodont and polydont teeth in crownward odontocetes was also linked to a marked simplification in the enamel schmelzmuster. These patterns were likely related to functional changes, especially a shift in food processing from shear-and-mastication to pierce-and-grasp occlusion, with the implication of less demanding feeding biomechanics than seen in most extant odontocetes.

Symposium 1 (Wednesday, November 5, 2014, 9:30 AM)

PRIMITIVE FEATHER ARRANGEMENT IN *ARCHAEOPTERYX LITHOGRAPHICA* SHEDS LIGHT ON THE ORIGIN AND EVOLUTION OF BIRDS

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As the oldest and most primitive known bird, *Archaeopteryx* has played a central role in understanding avian origins and the evolution of flight. In particular, exceptional preservation of the plumage offers the potential to shed light on flight evolution. It has traditionally been assumed that the structure and arrangement of the flight feathers was relatively modern, however recent studies reveal that, like the skeleton, the plumage is a mosaic of advanced and primitive characters.

The most striking feature is the presence of tracts of short flight feathers on the hind limbs, where overlapping, vaned feathers extend from the thigh and shin to form a pair of auxiliary airfoils. These winglets may have enhanced maneuverability and stability while decreasing stall speed. The presence of flight feathers on the legs supports the hypothesis that a four-winged morphology is primitive for birds, and probably originated as an adaptation for arboreal parachuting and gliding. These airfoils are relatively small in *Archaeopteryx*, however, being intermediate between the condition seen in non-avialan maniraptorans such as *Anchiornis* and *Microraptor*, and derived, two-winged avialans.

The wings themselves are also primitive. Unlike modern birds, where a single layer of remiges forms the bulk of the airfoil surface, the wings are composed of multiple layers of feathers, with the remiges being overlapped by elongate dorsal and ventral coverts. This arrangement would have produced a strong airfoil, but would limit the ability of the feathers to form slots or separate on the upstroke. This would not have interfered with high-speed flapping flight or arboreal launches, but may have limited the ability of *Archaeopteryx* to fly at low speed or take off from the ground.

Finally, new information on the tail suggests that previous reconstructions and functional interpretations must be reconsidered. Rather than having a single pair of rectrices on each of the distal and middle caudals, there are approximately 35-40 pairs of rectrices, attaching to the 21 caudals and the sacrum. There is no strict correspondence between vertebrae and feathers. This in turn suggests that the tail feathers did not rigidly attach to the caudal skeleton, but were instead supported by soft tissue. *Archaeopteryx* likely had a primitive tail-fanning mechanism, allowing the tail to be fanned to improve control, maneuverability, and stall speed. Together, the feathers of the legs, wings, and tail suggest that the form and function of *Archaeopteryx* was far from modern.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

THE RODENT FAUNA FROM THE ROTEM BASIN (EARLY MIOCENE OF ISRAEL): AFRICAN, ASIAN, BOTH, OR NEITHER?

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During the early Miocene, obstruction of the Tethys Sea and establishment of a passageway between the Afro-Arabian plate and Eurasia led to intercontinental faunal exchanges. However, the timing, exact location, and effects of this major palaeogeographic event on mammal communities are poorly understood. This is, in part, because early Miocene mammals from the southern side of the contact zone are only found in very few poorly-studied localities. The Rotem Basin (Negev, Israel) is one of these rare places. Recovery of large mammals fossils began in the area in the 1950's, but collection of micromammals was only initiated in 1979. Preliminary work by previous workers suggested the presence of at least four species of rodents in the Rotem Formation, identified as the pedetid *Megapedetes* cf. *pentadactylus*, the ctenodactylid "*Metasayimys*" cf. *intermedius*, the bathyergoidid *Bathyergoides* sp., and an indeterminate species that was either a cricetid or a sciurid. However, most of the rodents were identified using incisors and were never described. Here we re-examine the rodent material from the early Miocene of the Rotem Basin in light of new discoveries and using cheek teeth. All the rodent fossils were recovered from sediments of the Rotem Formation, within the Hatzeva Group, biochronologically dated to 17–18 Ma.

Using the newly available cheek teeth, we can only demonstrate the presence of a pedetid and a ctenodactylid in the early Miocene of the Rotem Basin. The pedetid is indistinguishable from *Rusingapedetes*, from the early Miocene of Kenya, in its morphology, brachyodonty, and small size. The Rotem ctenodactylid can be distinguished from *Sayimys intermedius*, and instead resembles *Sayimys baskini* from the early Miocene of Pakistan in characters of the m1–2 (e.g., the mesoflexid shorter than the hypoflexid, the obliquely orientated hypolophid, and the presence of a very strong posterolabial ledge) and the upper molars (e.g., the paraflexus that is longer than the metaflexus). However, morphological (e.g., presence of a well-developed paraflexus on unworn upper molars) and dimensional (in particular, the DP4 and M1–M2) differences between the Rotem gundi and *S. baskini* distinguish them and demonstrate that the former is a new, endemic species.

Thus, the rodents from the Rotem Basin demonstrate that during the early Miocene the Negev was a crossroads where African (*Rusingapedetes*) and Eurasian (*Sayimys*) taxa traversed on their way to and from across the newly formed land bridge.

Technical Session XIII (Friday, November 7, 2014, 3:30 PM)

MODULARITY IN THE AXIAL SKELETON OF ACTINOPTERYGIANS

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Patterns of regionalization of the axial skeleton of actinopterygian fishes have received little attention and the morphology of actinopterygian vertebrae has not been studied in detail for most fish groups. Nonetheless, a dorsal + anal fin positioning module, associated with the boundary between the abdominal and caudal vertebral regions, has been proposed as a conservative feature for all actinopterygian fishes. Fossils, however, indicate a different and rather complex history of this module. Although the vertebral column of most non-neopterygian actinopterygians is incompletely ossified and usually hidden by the armour of ganoid scales, the few available examples do not support the hypothesis of this median fins positioning module, indicating that such a developmental module arose at a higher level in the actinopterygian tree.

Delimiting vertebral regions in actinopterygians is difficult, but at least three regions are present in all of these fishes: the abdominal, caudal and ural regions. A fourth region including vertebrae of transitional morphology is present between the abdominal and caudal regions in basal halecomorphs and basal teleosts. Analysing the patterns of axial regionalization and relative position of the dorsal and anal fins at different phylogenetic levels indicates that modularity developed several times and in different ways in the actinopterygian tree. Within Chondrostei, the relative position of the dorsal and anal fins is constant in Acipenseriformes and their closest relatives, including Coccolepidae and *Birgeria*, but not Saurichthyidae. Within Neopterygii, the anterior insertion of the anal fin is found within the transitional region between the abdominal and caudal regions in basal halecomorphs and basal teleosts. Within Teleostei, at least in euteleosts the relative position of the anal fin becomes fixed to approximately the boundary between the abdominal and caudal vertebral regions, a transitional region is generally absent, and the first anal pterygiophore is attached to the first haemal spine in acanthomorphs.

On the other hand, in agreement with the fin fold theory, the dorsal + anal fin patterning module is evident in all actinopterygians, but it acquires a one to one relationship between radials and fin rays only in Neopterygii.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE IMPACT OF FOSSILS ON LIKELIHOOD ESTIMATES OF THE BIOGEOGRAPHIC ORIGINS OF MAJOR PRIMATE CLADES

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The study of the biogeographic origins of major primate clades has received surprisingly little attention in the literature. Parsimony methods have been criticized in ancestral area reconstruction analyses, while likelihood methods have been suggested to give better results. However, past studies using likelihood have not included fossils. As a result, they have failed to consider the full biogeographic range of Primates through time. In particular, it is clear from the fossil record that North America was a major centre of early primate diversification, but since there are no extant primates indigenous to North America, likelihood studies have ignored the relevance of that continent to primate biogeographic origins.

A likelihood analysis based on a supertree with 488 primate taxa, including 134 fossil taxa, was performed to test hypotheses of ancestral areas. The results show significant differences from previous analyses that did not include fossil primates. Primates *sensu lato* (including Plesiadapiformes) are inferred to have originated in North America. This is supported by the presence in North America of the oldest and most primitive group of stem primates, the Purgatoriidae. The most likely location of origin for Euprimates is also North America, contrary to previous studies that considered the location to be Eurasia. The many North American representatives of the Omomyoidea and Adapoidea are likely responsible for this result. Strepsirrhini *sensu lato* (including adapoids) appears to be Asian in origin, in opposition to previous analyses that have considered them Malagasy, Eurasian, and/or African. This stems from the presence in Asia of numerous primitive adapoids, such as *Rencunius*, *Asiadapis*, and *Marcgodinotius*. In contrast, crown strepsirrhines are inferred to have originated in Africa. With respect to the biogeographic origins of anthropoids, contrary to some previous analyses, none of the most likely resolutions include Africa. Finally, the biogeographic history of great apes is tied to Eurasia. Previous analyses placed great ape origins in Eurasia and "African" ape (hominine) origins in both Eurasia and Africa. While pongines probably originated in Eastern Asia, hominines most likely originated in Europe or in Western Asia (i.e. Anatolia). Adding data on fossil euprimates and stem primates significantly changes the ancestral areas inferred relative to previous analyses that used likelihood methods, demonstrating that extinct forms are critical to refining ancestral area reconstructions.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

UPPER CRETACEOUS (MAASTRICHTIAN) FISH REMAINS FROM THE DECCAN INTERTRAPPEAN BEDS OF PIPLANARAYANWAR, CENTRAL INDIA: IMPLICATIONS FOR PALEOENVIRONMENT AND PALEOGEOGRAPHY

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In search of Cretaceous mammals, extensive field exploration work has been carried out in the Deccan volcanic province of India. As a consequence, a new 2 m thick, fossiliferous intertrappean section was found 2.5 km west of Piplanarayanwar village in Chhindwara District, Madhya Pradesh, Central India. Following wet screen washing of 500 kg of samples from this intertrappean sedimentary sequence comprising of sandy marl and mudstone, a large number of vertebrate microfossils have been recovered. The recovered vertebrate fauna from this site includes fish, such as *Igdabatis indicus*, *Rhombodus*, *Lepisosteus indicus*, osteoglossids, and pycnodontids; frogs, such as Anura indet.; crocodiles, such as Crocodilia indet.; a snake, *Indophis sahnii*, and dinosaur eggshells. In addition to this vertebrate fauna, a large number of pulmonate gastropods, ostracods and charophytes have also been recovered from this site. Because of the presence of *Igdabatis* and *Rhombodus* in the fauna, which have previously been recorded from the Maastrichtian strata of Niger, Spain and India, the intertrappean section of Piplanarayanwar is considered as Late Cretaceous in age. The fish fauna, particularly *Igdabatis*, *Rhombodus*, and pycnodontids assume great significance from paleoenvironmental and paleogeographic points of view. The Deccan intertrappean beds of peninsular India are generally regarded as freshwater lacustrine deposits. The co-occurrence of marine batoid and pycnodontid and non-marine osteoglossid and lepisosteid fish, pulmonate gastropods, ostracods and charophytes points to a coastal-plain, brackish water environment of deposition for this intertrappean sequence. Recently, based on the occurrence of planktonic foraminifera in the intertrappean beds of Jhilmili, Chhindwara District, Madhya Pradesh, it has been suggested that a marine incursion into Central India took place in the Early Paleocene from the west coast of India along the Narmada valley. However, until now, no Maastrichtian or Danian marine strata were recorded from the Narmada valley. Since the batoid fish *Igdabatis* and *Rhombodus* along with pycnodontids have been documented from the infratrappean beds of Marepalli, Pisdura and Jabalpur and the intertrappean beds of Asifabad, Nagpur, Kislapuri and currently from Piplanarayanwar, mostly located along Godavari valley, we suggest here that marine incursion might have taken place along the Godavari valley rather than along the Narmada valley at the end of Cretaceous.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

NEW INVESTIGATIONS INTO THE PLIOCENE-AGED VERTEBRATE BEARING BEDS OF THE CHINCHILLA SAND FORMATION, NORTHEASTERN AUSTRALIA

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The Pliocene Chinchilla Sand is a > 20 m deep fluviatile deposit consisting of interbedded clay, sandstone and conglomerate located in the western Darling Downs, southeast Queensland, Australia. The fauna derived from these beds represents an incredibly diverse (ca. 63 taxa in 31 families) assemblage of terrestrial and aquatic organisms preserved in high energy flood and low-energy meandering channels. This locality is a rare representative of a critical period in the development of Australian vertebrate ecosystems, during which a long-term trend towards cooling and aridification and marked vegetation shifts, including the emergence of widespread grasslands, precipitated the earliest appearance of numerous ecologically important and successful taxa, including many genera that are still extant today. However, despite over 150 years of collection and study of the Chinchilla Local Fauna, many uncertainties remain as to which taxa were present due to a dearth of stratigraphically controlled excavations, specimen loss and destruction, and poorly documented provenance data. We present an update of the vertebrate fauna, its taxonomic status and its depositional and environmental context, as well as the first intensive palaeomagnetic and sedimentological analyses aimed at determining the age and time-depth of the deposits. We targeted 10 stratigraphic horizons and collected ca. 60 independent samples for palaeomagnetic dating. The upper beds have a normal polarity, while the lower beds have a reversed polarity. Based on this polarity sequence and biostratigraphy, the reversal at the site is considered to be the boundary between the Gilbert and Gauss Chrons at 3.6 Ma. This would make the upper beds between 3.6 and 3.3 Ma and the lower beds between 4.2 and 3.6 Ma, although perhaps closer to 3.6 Ma in each case. These data suggest that the fauna from the site should not be considered a single temporal entity but could represent variation over as much as 900 ka. Taken together, this data allows us to reconstruct some of the most significant changes that Australian vertebrate faunas have experienced in response to increased aridity over the last 3.6 Ma or so.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

THE EFFECT OF ABSENCE OF PREDATORS ON JUVENILE SURVIVAL IN THE INSULAR PLEISTOCENE DEER *CANDIACERVUS* (CETARTIODACTYLA, RUMINANTIA, CERVIDAE)

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Judging from worldwide patterns, commitment to predator-free island life tends to have significant consequences for the species concerned—for example, marked changes in body size (the island trend). But what would a total lack of ecologically relevant predators have on traits *other than* body size? For this we evaluated population structure and dynamics in two fossil dwarf deer taxa (*Candiacervus* spp.) from the Late Pleistocene of Crete, Greece.

We hypothesize that life tables of these populations should differ characteristically from those of wild deer living on mainlands with predators. Importantly, these deer became extinct before any plausible date for human arrival, and therefore the impact of human-caused mortality can be ruled out. However, age-graded fossils of species from two well-sampled cave sites reveal unexpectedly high juvenile mortality (0-2 Red Deer Years) of about 50%, similar to that reported for extant mainland ruminants. Age profiles additionally reveal that deer surviving past the fawn stage were relatively long-lived for ruminants, with an adult peak mortality at about 70% of maximum longevity (16 Red Deer Years).

The mortality profile for *Candiacervus* spp. indicates that high juvenile mortality was not an expression of their living a “fast” life. Our results are similar to those found for two populations of extant sika deer (*Cervus nippon*), one on a predator-free island (Kinkazan, Honshu) and one in a protected area in which hunting is prohibited (Nara Park, Honshu). So did lack of predators have any effect on Cretan deer? *Candiacervus* is remarkable for its variability; whether this reflects actual speciation or unusual ecomorphological differentiation has long been controversial. The effects of variables such as fatal accidents, starvation, and disease on survivorship are difficult to gauge in extinct taxa. However, the presence of extreme morphological variability within nominal species of *Candiacervus* is consistent with the view that high juvenile mortality can function as a key innovation permitting rapid adaptation (via high levels of variation) in insular contexts.

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Technical Sesssion XII (Friday, November 7, 2014, 3:30 PM)

ORIGIN OF THE UNIQUE VENTILATORY APPARATUS OF TURTLES

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The turtle body plan differs markedly from that of other vertebrates and serves as a model system for studying structural and developmental evolution. Incorporation of the ribs into the iconic turtle shell negates the rib movements that effect lung ventilation in the majority of air-breathing amniotes (the clade encompassing mammals, lizards, turtles, birds, and crocodilians). Instead, turtles have a novel abdominal-muscle-based ventilatory apparatus whose evolutionary origin remains a mystery. Here we show through broadly comparative anatomical and histological analyses that the earliest stem-group turtle from the middle Permian (260 Ma), *Eunotosaurus africanus*, has several turtle-specific lung ventilation characters: rigid ribcage, inferred loss of intercostal muscles which drive lung ventilation in all other amniotes, and histological correlates for the primary abdominal muscle, M. transversus, used in exhalation. Our results place the origin of the unique lung ventilatory apparatus of extant turtles shortly after the divergence of turtles from other reptiles and approximately 50 million years before the oldest known fully developed shell. These data indicate that it was an easing of structural constraints through division of function (divergent specialization) between the ribs and abdominal musculature that facilitated the evolution of both the novel turtle lung ventilation mechanism and the turtle shell.

Technical Session XV (Saturday, November 8, 2014, 10:30 AM)

MATRIX VS. MONOGRAPHS: COMPARISON OF PHENOTYPIC RICHNESS ACROSS DATA SOURCES.

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How fully do morphological phylogenetic matrices represent the range of phenotypes preserved in a fossil organism? Are there phenotypic classes that are not seen in matrices, and what kind of comparative or functional information do they hold? To address these questions we chose four well-characterized taxa for the fin to limb transition (*Eusthenopteron*, *Panderichthys*, *Tiktaalik*, and *Acanthostega*) and examined

the difference in number and type of anatomical annotations seen between a text-based description and a related morphological matrix. Using the Phenoscape Entity-Quality (E-Q) annotation method we generated comparable evolutionary phenotype statements for sentence-based free text descriptions in descriptive papers and morphological characters from matrices. Direct comparisons show that even for well-characterized anatomy such as the pectoral fin and girdle of *Tiktaalik*, over twice as many E-Q statements are generated from a descriptive paper (104) than the related matrix (40). These include phenotypes with functional significance such as elbow joint mobility, which are often underrepresented in matrices because they are not phylogenetically informative. Conversely, morphologies that are widespread across the clade, but are important for establishing outgroup relations, such as the flattened and rectangular humerus of *Tiktaalik*, may not be documented in monographic treatments. These results argue for extracting phenotypes from both monographic and phylogenetic treatments for the fullest phenotypic representation of an organism. We also discuss the need for a scalable method for extracting phenotypic data from existing treatments including efforts to incorporate text-mining tools to partially automate this process. By coupling monographic data with that derived from phylogenetic matrices and using inference based reasoning techniques to increase phenotypic coverage, we can generate large synthetic supermatrices across any slice of data or taxa housed in Phenoscape.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

PLICIDENTINE AMONG EARLY PERMIAN PARAREPTILES, ITS FUNCTIONAL AND PHYLOGENETIC SIGNIFICANCE

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Plicidentine, the infolding of dentine around the pulp cavity of a tooth, was originally a characteristic thought to be exclusive to anamniotes. However, it is now well known that this is not the case, with plicidentine being found in several amniote groups. Historically, parareptiles were considered to lack any infolding of the dentine, and most phylogenetic analyses of Parareptilia have reflected this long held view. It is now apparent that this is not the case, as a recent study has shown that there is indeed dentine infolding clearly visible in broken teeth of the parareptile *Colobomycter pholeter*, however, aside from noting the presence of folded dentine there has been little work done on the subject. In order to obtain a better understanding of the extent and nature of folded dentine within Parareptilia the teeth of several parareptiles were examined using histological analysis and computed tomography scans. The results of this research revealed that plicidentine is found in several Early Permian parareptile taxa, and that parareptilian plicidentine is highly variable, both among taxa and even within the dentition of a single species. The bolosaurid *Bolosaurus striatus* exhibits dentition that does not possess plicidentine, whereas *Microleter mckinzieorum*, *Colobomycter pholeter*, *Feeserpeton oklahomensis*, and a new species of *Delorhynchus* all exhibit dentitions that show the presence of infolded dentine. The plicidentine found in the teeth of *Colobomycter pholeter* is particularly interesting, as its complexity varies based on which tooth position is being looked at, it ranges from extremely complex plicidentine reminiscent of anamniote tetrapods in its enlarged teeth, to plicidentine that is more akin to the looser infolding observed in *Microleter mckinzieorum* and the new species of *Delorhynchus*. Due to the large variability in plicidentine among the parareptile taxa that were studied it is apparent that its use as a phylogenetic character is problematic, thus we suggest that it should be excluded as a character from phylogenetic analyses of Parareptilia. We also propose that one functional purpose of plicidentine in parareptiles was to increase the surface area for attachment tissues, as is exemplified by the enlarged teeth of *Colobomycter pholeter*, which possess the most convoluted plicidentine of all the parareptiles studied.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

RE-DEFINITION OF THE FAMILY OPHIOPSIDAE (ACTINOPTERYGII, HALECOMORPHI), BASED ON ANATOMICAL COMPARISON WITH MACROSEMIID FISH

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Ophiopsids are fossil fishes that inhabited both the marine and freshwater in Europe, Africa, North and South America from the Triassic to the Cretaceous. *Ophiopsis procera* was the first ophiopsid species described and was placed in the family Macrosemiidae. The genus was later placed in a new family Ophiopsidae, alongside with *Macrepistius*. The family Ophiopsidae is currently represented by five genera (*Ophiopsis*, *Macrepistius*, *Teoichthys*, *Placidichthys* and *Furo*) and fourteen nominal species, and is placed together with Ionoscopidae in the Ionoscopiformes, an extinct halecomorph order. The monophyly of the family has never been tested and the relationships within the group remain unknown, notably the placement of most nominal species of *Ophiopsis* and of the genera *Placidichthys* and *Furo*. Moreover, the monophyly of Ionoscopiformes has been questioned, for instance *Placidichthys* has recently been suggested to belong to Macrosemiidae. The families Macrosemiidae and Ophiopsidae belong to two distinct actinopterygian lineages, the Ginglymodi (the gar group) and the Halecomorphi (*Amia* group) respectively, but their members are often confused mostly due to a common body shape cover by ganoid scales, generally serrated on their posterior margins, and also by the presence of a divided dorsal fin observed in certain members of both families. Here, we present the results of an extensive comparison of the anatomy of ophiopsid and macrosemiid species, and provide an accurate definition of the family Ophiopsidae. We emphasis our results throughout the case study of *Placidichthys bidorsalis*, which is certainly the most macrosemiid-like ophiopsid fish notably because of its dorsal morphology. The combination of a massive lacrimal, the presence of three to four deep infraorbital bones and the lateral line extending into the caudal fin are among the most relevant characters that we found to define the family Ophiopsidae. This study precludes the phylogenetic analysis of the Ionoscopiformes interrelationships.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

RECONSTRUCTION OF THE DIETARY NICHES OF PLIO-PLEISTOCENE HOMININS, OR 'WHY WE NEED A MULTIDISCIPLINARY RESEARCH PROTOCOL'

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The marked increase in brain size in hominins, their extended life histories, and their increasingly complex sociality were most certainly triggered by environmental changes and facilitated by changes in dietary ecologies. The mechanisms remain poorly understood, however. Hominins evolved into an open, apparently resource-limited environment with increased seasonality and high predation risk. These conditions predict selection for body -rather than brain-size, and rapid life histories. In the absence of technology and the habitual consumption of meat, how could hominins have met their daily nutrient requirements?

Hominins began to broaden their dietary niche by about 4.2 Ma (*Australopithecus anamensis*) and expanded it further at about 3.5 Ma (*A. afarensis*) to incorporate substantial amounts of C_4 foods, which are commonly considered to be abundant, but of low quality. Morphological differences among hominins indicate different dietary adaptations/radiations, but traditional approaches have thus far led to conflicting interpretations on what these were. Here I advocate a bottom-up approach, whereby functional and biomechanical analyses should be employed first to determine what a hominin could not have masticated. Information thus obtained should then be combined with energetic considerations for that species (e.g., body mass, brain size etc.) and analysed against information about the resources available within the hominin´s environment. The combined information allow us to reconstruct the likely dietary niche(s). Here I illustrate the usefulness of such a modelling approach for South and East African hominins, which are similar in overall dentocranial morphology, but differ in enamel microstructure, microwear pattern, and,in part, stable isotope values, and between *Paranthropus boisei* and *Australopithecus bahrelghazali,* which are comparable in isotope values but differ in dentognathic morphology. Results suggest that *A. bahrelghazali* may have been the most stenobiotic of the hominins analysed. Despite its derived dentocranial morphology, in contrast, *P. boisei* appears to bea dietary generalist, which may explain the evolutionary success and long history of this species. Unlike extant great apes, all hominins apparently exploited starch-rich foods, as evinced by the thick=enameled bunodont teeth common to them all. It is argued that the consumption of such energy-dense starchy foods may have been the key to the success of hominins that allowed them to overcome the constraints imposed by the environment.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

HERBIVOROUS DINOSAUR DISPARITY AND ITS RELATIONSHIP TO EXTRINSIC EVOLUTIONARY AND ECOLOGICAL DRIVERS

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The radiation of herbivorous dinosaurs was punctuated by ecologically significant events, including two mass extinctions (Triassic-Jurassic [Tr/J] and Jurassic-Cretaceous [J/K]), the decline of cycadophytes and the origin of flowering plants (angiosperms). Assessing biomechanical trait variation within mandibular elements offers insights into any effects these events may have had on the feeding variation in herbivorous dinosaurs. Here we present the first analysis of biomechanical disparity in the jaws of herbivorous (sauropodomorph and ornithischian) dinosaurs. 18 biomechanical traits were calculated from images (lateral view) of 44 sauropodomorph and 123 ornithischian jaws; traits included mechanical advantage and relative length of the functional dental row. Our results suggest herbivorous dinosaurs rapidly exploited available feeding niches, with discrete biomechanical morphospace occupation by different clades occurring by the Mid-Upper Jurassic. High-browsing sauropods were shown to exhibit relatively diverse biomechanical traits, despite a low taxon count, suggesting exploitation of novel feeding opportunities in the Upper Jurassic. Neither the Tr/J mass extinction nor the proliferation of flowering plants are correlated with any significant changes in biomechanical disparity; however, the reduction in disparity across the J/K boundary is shown to be significant, and coincident with a major sauropod extinction. We conclude that extrinsic ecological events had little impact on biomechanical profile diversity in herbivorous non-avian dinosaurs, which had already reached potential saturation by the Jurassic.

Technical Session XV (Saturday, November 8, 2014, 9:30 AM)

NEW MORPHOLOGIES FOR OLD: APPLICATION OF THREE DIMENSIONAL SURFACE ANALYSIS & COMPUTER VISION/MACHINE LEARNING TECHNIQUES TO COMPARATIVE ANATOMY WITH SPECIAL EMPHASIS ON VERTEBRATE PALEONTOLOGY

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New tools based on 3D scanning, computer vision, computer modeling, and artificial intelligence are now available to assist paleontologists in making far more detailed and informative mathematical descriptions and comparisons between modern and/or fossil morphologies than has been possible heretofore. To exemplify the advantages of employing these techniques various permutations of eigensurface and eigenimage analysis have been applied to a diverse sample of modern mammalian radial head morphologies that have been parsed a priori into different functional groups based on observations of preferred habitat and locomotor mode. Prior analysis of these data using 2D eigenshape analysis of their outlines largely failed to distinguish between the radial head morphologies characteristic of different mammalian functional groups. However, all 3D data-based approaches employed here performed very well in this context, producing results that not only make intuitive sense but that also pass rigorous statistical hypothesis

tests to a very high degree of confidence. In addition, application of 3D virtual modeling techniques to the results of these analyses enable highly resolved and nuanced interpretations to be made of the complex mathematical form and shape spaces in which these data reside in a natural manner, that does not require a detailed understanding of these spaces' underlying mathematics. Using these approaches vertebrate paleontologists now have the tools necessary to identify and assess patterns of 3D morphological variation across space and time as well as to examine these data for patterns of covariation between morphology and a wide range of the pertinent putative causal factors and processes thought to be responsible for creating and maintaining this variation. To illustrate the practical utility of these methods the modern mammal radial head functional space is used to compare and interpret the morphologies of a variety of fossil taxa. Results of these analyses indicate that comparisons of fossil morphologies with those of recent mammals should be done in the form space rather than the shape space.

Technical Session IV (Wednesday, November 5, 2014, 1:45 PM)

BARCODING THE DEAD: ANCIENT PROTEIN SEQUENCING RESOLVES LITOPTERN AND NOTOUNGULATE SUPERORDINAL AFFINITIES

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Recent speculations concerning the affinities of South American native ungulates (SANUs) assert that at least some members of this ?paraphyletic group are not laurasiatheres but are instead either sister to Afrotheria or part of a distinct clade that includes afrotheres. Testing of this controversial hypothesis is desirable, optimally with data independent of phenotypic interpretation. Such a test might come from molecular data using short DNA sequences as barcodes (cf. Barcode of Life), but all efforts to acquire such information from SANU fossils have so far failed. There is an alternative: backbones of proteins such as collagen (latter comprising >90% of all bone proteins) are an order of magnitude more stable than DNA and therefore more likely to survive taphonomically.

We screened 34 Pleistocene bone samples of *Toxodon* (Notoungulata) and *Macrauchenia* (Litopterna) for collagen and DNA. Autochthonous DNA was not recovered, but collagen yield was often excellent. Using soft-ionization tandem mass spectrometry we obtained >90% sequence coverage of COL1α1 and COL1α2 sequences (1057 and 1040 residues, respectively) on the 4 best samples (2 per taxon), yielding 21,428 matching spectra. Aligned fossil sequences were mapped onto a mammalian phylogeny based on collagen gene transcripts from available genomes and MS/MS collagen data obtained for this study or from the literature.

Our collagen tree is in overall good agreement with recent genomic and phenomic phylogenies of Placentalia. Importantly, however, it exhibits a basal split between conventional Afrotheria and all other placentals in the sample, with SANU taxa invariably placing inside Euungulata (Laurasiatheria) as follows: (((*Toxodon*, *Macrauchenia*)(Perissodactyla))(Cetartiodactyla)).

Representative notoungulate and litoptern taxa fall next to crown Perissodactyla, deep within Laurasiatheria and at the opposite end of the cladogram from Afrotheria. This is consistent with the long-standing view that at least some SANU lineages may have originated from northern archaic ungulates ("condylarths"). To further test SANU affinities and their possible monophyly (as so-called "meridiungulates"), analyses of representative Astrapotheria, Xenungulata, and Pyrotheria would be needed. With improvements in instrumentation and analytical procedures, proteomics may produce a revolution in systematics like that achieved by DNA genomics, but with the possibility of working on much deeper timescales. Partly supported by SYNTAX award "Barcode of Death" & NSF OPP 1142052.

Technical Session XV (Saturday, November 8, 2014, 8:30 AM)

EARTH SURFACE PROCESSES IN THE EVOLUTION OF MAMMALIAN TOOTH SHAPE

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The Cenozoic fossil record of terrestrial mammals documents innumerable examples of the evolution of tooth structures for resisting abrasive wear, including hypsodonty and ever-growing teeth. The most conspicuous examples come from tectonically active areas of Andean South America, the western interior of North America, the rift system of East Africa, and islands in the Western Mediterranean. Until now, this pervasive pattern has been understood to relate to the rigors of herbivory and grazing behavior. Coincidentally, the evolutionary pattern is often associated with silicic volcanism and earth surface processes that mobilize mineral abrasives into, through, and beyond the herbivore environment. These coincidences suggest a working hypothesis that accumulations of readily eroded sediment (e.g., volcanic ash) accessible to erosion, plus the properties of mineral particles (e.g., volcanic glass) that make them abrasives of industrial significance, plus the active role of surface processes that mobilize these mineral particles, together conspire to drive the evolutionary increase in crown height. At ecological timescales, annual tooth wear rates are positively correlated with soil loss expressed as mineral particle flux. Both direct soil ingestion and the soil load on plants may be significant, but are rarely distinguished. On islands, where rates of morphological evolution are high and the selection pressure unavoidable, variation in tooth wear rates reflect the type of soil exposed at the surface and surface processes that mobilize it. Erosion rates are high in tectonically active areas, but are still higher in volcanic landscapes. The production and accumulation of volcanic ash provides a potential long-term source of mineral particle abrasives. Where fossil mammals are recovered from volcaniclastic sediments and where a downwind record of erosion intensity is preserved in the sea-floor sediment record, we find a remarkable correlation between changing rates of dental evolution and the varying intensity of mineral particle flux. Relating sediment accumulation on the sea-floor to the earth surface processes operating where herbivores lived and evolved, requires following mineral particles from their source to their ultimate sink. Where orbital time-scale variation in the surface processes that deliver mineral abrasives into and through the herbivore environment can be documented, we find evidence of evolutionary response.

Technical Session V (Wednesday, November 5, 2014, 3:30 PM)

EXPERIMENTALLY INDUCED HOMEOTIC SHIFTS IN ANTERIOR AXIAL PATTERNING MIMIC EVENTS IN THE EVOLUTION OF THE TETRAPOD SKULL

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The origin and evolution of the skull has been a topic of intense study for over two centuries. Whereas early theories of skull origin, such as the influential vertebral origin theory, have been largely refuted with respect to the anterior part of the skull, the occipital region is known to be derived from the anteriormost axial segments (somites). Among living tetrapods, amniotes incorporate more somites than amphibians into the occiput. The distribution of occipital patterns among living tetrapods has led to the hypothesis of increased occipitalization considered to characterize the transition towards the amniote skull. However, using osteological proxies of somite incorporation, such as foramina that transmit nerves that emerge in register with somites, within a broad phylogenetic framework including an extensive paleontological sample, the amniote-like occiput is found to appear at the base of Tetrapoda. Consequently, the relatively reduced occiput observed in lissamphibians is interpreted as secondarily derived from the amniote-like condition via a developmental mechanism that is poorly understood. To explore this, we experimentally modified the number of occipital segments in the salamander axolotl. In normal development the head-trunk boundary is located within somite 3 (S3) in axolotl. Treatment with retinoic acid (RA) produces additional vertebral segments anterior to the first cervical vertebra, which is suggestive of a homeotic shift in segment identity. This shift is confirmed by somite transplantation experiments in which S3 forms only vertebral segments when exposed to RA. The opposite is obtained when embryos are treated with RA inhibitors. These experimentally induced homeotic shifts mimic events that took place in the evolution of the tetrapod skull, such as the secondary transformation of occipital somites into trunk somites during the origin of lissamphibians. Recent advances in our understanding of axial patterning and its regulation in amniotes support the hypothesis that perturbation of the RA signaling pathway and the changes in Hox gene expression boundaries may underlie aspects of the evolution of cranial diversity in tetrapods.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

AT CLOSE RANGE: MICROMAMMAL BIOGEOGRAPHY OF THE MIDDLE/LATE MIOCENE WITHIN THE IBERIAN PENSINSULA

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As classical Neogene sites in the Vallès-Penedès have been re-opened, and new excavations in the area yielded a wealth of data, the 'Vallesian Crisis' has again become a hot topic of debate in the last couple of years. Originally considered a local event within the Vallès-Penedès, the notion of a major faunal change during the early late Miocene has been considered to be a continent wide event by some. However, doubts have been cast on the extent and severity of this event.

It has been previously noted that the biodiversity in the Vallès-Penedès in the MN unit preceding the Vallesian Turnover (MN 9) is considerably higher than in the inland basins. This is, in fact, considered common knowledge. Many mammals from the Catalan basin are not known from inland, with the primates, purported victims of the Vallesian Crisis, being the best known example.

Here, we present an analysis of the differences in micromammal composition between the coastal Vallès-Penedès and the inland Teruel Basin (including the Daroca Calamocha area) before and after the Vallesian Crisis. These basins are geographically close, at a distance of c. 300 km. We focus on micromammals since these have been well sampled in a dense stratigraphical record in both areas, incorporating data from the NOW database, supplemented with data from literature and recent additions. Our analyses cover the MN units 7 + 8–11 (late Aragonian to early Turolian).

It is evident that several groups from the coastal area never made it inland, such as the flying squirrels and a large number of insectivores. Surprisingly, the diversity peaks in the two areas do not coincide. Whereas the largest diversity the Vallès-Penedès is found in MN 9 (just prior to the turnover) biodiversity peaks in the inland basins in MN 7 + 8. Moreover, the similarity between the coastal area and the inlands is lowest during MN 9, suggesting that the Vallès-Penedès at this time was indeed somewhat extraordinary. The large differences even at relatively short distances support the idea that the 'Vallesian Crisis' is at the most a local event.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

NEW SAUROPOD MATERIAL FROM THE NEMEGT FORMATION SUPPORTS THE CONSPECIFICITY OF *OPISTHOCOELICAUDIA SKARZYNSKII* AND *NEMEGTOSAURUS MONGOLIENSIS* (SAUROPODA, TITANOSAURIA)

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Although notable for their massive body plan and a wide paleobiogeographical distribution during the Late Cretaceous, the phylogeny of advanced titanosaur sauropods is difficult to infer. The main reason for the problems is probably the incomplete nature of the fossil material. However, additional difficulties might also stem from inclusion of

incorrectly interpreted taxa. The skull named *Nemegtosaurus mongoliensis* and the postcranial skeleton described as *Opisthocoelicaudia skarzynskii*, both from the mid-Maastrichtian strata of the Nemegt Formation (Mongolia), are usually treated as belonging to separate species of advanced lithostrotians. Indeed, the vast majority of phylogenetic studies suggest different placements for both taxa, although *N. mongoliensis* is often a wildcard taxon with weakly supported connections to other titanosaurs. A revision of the dinosaur remains collected by the Polish-Mongolian paleontological expeditions to the Gobi Desert, however, revealed five ungual phalanges and two caudal vertebrae belonging to sauropods. All unguals are almost complete and strongly resemble those of *O. skarzynskii* in their crescent-shaped morphology, great bilateral flattening, and generally subtriangular cross-sections adjacent to their proximal articular surfaces. Both vertebrae are known solely from their centra which are slightly opisthocoelous and subcircular in cross-section. The material comes from different fossil sites of the Nemegt Formation (Khermeen Tsav, Altan Uul II, and Nemegt Uul). Thus, all specimens are of the same age as the types of *N. mongoliensis* and *O. skarzynskii*. Since the postcranial elements provide no evidence for the presence of more than one titanosaur in the mid-Maastrichtian of the Nemegt Formation, there is no reason to assume that the type of *N. mongoliensis* belongs to a different species. When combined into a single OTU, preliminary phylogenetic analysis reconstructs it as the sister taxon to *Alamosaurus sanjuanensis*. The results suggest that the positions previously inferred for *N. mongoliensis* were likely due to the lack of knowledge concerning titanosaur cranial material.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A REVISION OF THE SHORT-SNOUTED STEREOSPONDYLS *MAHAVISAURUS DENTATUS* AND *LYROSAURUS AUSTRALIS* FROM THE LOWER TRIASSIC OF MADAGASCAR: CRANIAL ANATOMY, PHYLOGENY, ONTOGENETIC REMARKS, PALEOECOLOGY, AND THE PHYLOGENY OF THE RHYTHIDOSTEIDS

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The species *Mahavisaurus dentatus* and *Lyrosaurus australis* were erected for fossil specimens from the Lower Triassic of the Ankitokazo Basin, northwestern Madagascar. Validity of the two species and assignment of the referred specimens have been questioned by several authors, who, however, did not redescribe the fossil material. Moreover, both species are usually assigned to the Rhytidosteidae, but the monophyly of the group and its phylogenetic relationships with the other stereospondyls are still uncertain.

Here we describe nine specimens of *M. dentatus* and *L. australis*, including holotypic and new material, housed at the Muséum National d'Histoire Naturelle, Paris, and the Museo di Storia Naturale di Milano.

A phylogenetic analysis (109 characters, 80 taxa), performed to test the position of the studied specimens within the clade Stereospondyli, supports their referral to a single species of rhytidosteid stereospondyl, *Mahavisaurus dentatus*. The Rhytidosteidae are found to be monophyletic, and are part of the short-snouted stereospondyl radiation, which also include more derived forms such as plagiosauroids, metoposaurids, and brachyopoids.

All the material is ascribed to *M. dentatus*, of which *L. australis* represents the juvenile stage. The ontogenetic variation between adult and juvenile individuals includes: dermosensory canals of the lateral line system more developed in juveniles; pits and grooves composing the ornamentation of the skull roof anastomosed in adults; skull becoming deeper and narrower during ontogeny.

The detailed osteological description focuses on poorly known areas: the occiput, showing the palatoquadrate fissure; the palate, with remarks on the parasphenoid-pterygoid complex and a composite reconstruction of the skull in ventral view; and the postglenoid area of the mandible. New information on the skull roof is also provided, showing the presence of a interpremaxillary foramen as well as features and contacts of the bones in ventral view.

M. dentatus inhabited estuarine/deltaic and coastal, shallow marine environments. In combination, the sharp marginal teeth and palatal tusks, well-suited for holding on to mobile prey, and the palatal and coronoid denticles, forming dense pavements of blunted cusps well-adapted to crushing both the shells of invertebrates and the ganoid scales of osteichthyans, strongly suggest a semi-durophagous diet.

Technical Session IX (Thursday, November 6, 2014, 3:45 PM)

THE FIRST ARTICULATED SKULL OF A MIOCENE NATRICINE SNAKE AS REVEALED BY X-RAY COMPUTED TOMOGRAPHY

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Natricine snakes constitute a major globally distributed clade within Colubroidea and today consist of 30 officially recognized genera. Fossil natricines are known since the late early Miocene, but their fossil record has so far been restricted to individual vertebrae and isolated cranial elements. Here we report on the first articulated skull of a fossil natricine snake from the middle Miocene of Oehningen, Germany. The specimen, which was found in the 19th century but was never studied or prepared, consists of part and counterpart of a crushed skull with adjacent cervical vertebrae. We applied micro-computed tomography to visualize its anatomy, revealing that much of the skull is still comparatively well preserved, except for parts of the posterior skull table and braincase. The specimen is anatomically characterized by 17 maxillary teeth, with one posterior tooth notably larger than the others but without evidence of a venom groove or a diastema, and 27 dentary teeth increasing in size posteriorly. The palatine contains 16 and the pterygoid up to 25 teeth, which decrease in size posteriorly. Further characteristics are a U-shaped anterior and posterior border of the frontals, the presence of a distinct angular and splenial in the mandible, and a short and broad quadrate. Especially the latter trait is characteristic of natricines, although not unique for the clade. When entering the available morphological information into a character matrix of 80 characters and 24 taxa comprising all major clades of colubroid snakes and their outgroups, the specimen clusters within crown-group Natricinae close to *Thamnophis* and *Natrix*, with which it shares anatomical traits like the shape of the maxillary tooth row and the morphology of the pterygoid. A more thorough phylogenetic placement within Natricinae, however, is currently hampered by the lack of comparative anatomical knowledge of natricine morphology at the generic level, which is a problem that also applies to most other caenophidian snake taxa. Further comparative studies of the morphology of extant snakes are therefore necessary for better integration of fossil and recent data.

Technical Session XIV (Saturday, November 8, 2014, 8:30 AM)

NANO-ANALYTICAL TECHNIQUES REVEAL BLOOD CELLS, BANDED COLLAGEN FIBERS AND AMINO ACIDS PRESERVED IN 75 MILLION YEAR OLD DINOSAUR SPECIMENS

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Exceptionally preserved organic remains are known throughout the vertebrate fossil record and have been recognised for over a century. Recently, such remains have been examined using nano-analytical methods and have revealed the preservation of cellular structures such as melanosomes, indicating coloration in dinosaurs and marine reptiles and muscle fibres in fish and amphibians. We examined samples from eight 75 million-year-old dinosaur specimens using a variety of nano-analytical techniques. None of the specimens are exceptionally preserved and none show any external indication of soft tissue or organic preservation. Ovoid structures highly reminiscent of avian erythrocytes (red blood cells) were observed in two specimens, and structures that appear to be lymphocytes (white blood cells) were seen in one of these. A focused ion beam was used to serial section the erythrocytes, and dense internal structures resembling nuclei were found to be present. Fibers within the crystalline bone matrix were seen in four specimens and 67 nm banding was observed on these fibers in one specimen under transmission electron microscopy. This suggests the fibers are collagen and the original quaternary structure of the collagen molecule is preserved, an observation supported by ramen spectroscopy. Mass spectrometry indicated the presence of amino acids including glycine, alanine and proline, the most abundant amino acids in collagen. Six of eight specimens we sampled preserved soft tissues of some form, suggesting that preservation of organic remains at the micro-scale is much more common than previously thought and is not restricted to exceptionally preserved fossils. This finding requires a fundamental shift in our understanding of the fossilization process. Common preservation of the molecular structure of proteins over geological timescales provides the potential to research the physiology and biochemistry of long extinct animals, and leads to the possibility that it may one day be possible to extract genetic material from fossils.

Technical Session I (Wednesday, November 5, 2014, 8:45 AM)

DIRECT CONNECTION BETWEEN CAVUM TYMPANI AND CAVUM CRANII: A NEW APOMORPHY OF RUMINANTS (CETARTIODACTYLA, MAMMALIA)

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In all extant Cetartiodactyla, the anterior part of the tympanic cavity houses the enlarged medial process of the malleus, which is in fact the medial process of the prearticular bone (processus gracilis or processus Folianus). In the past, this process was called ossiculum accessorium malleoli. However, it remained largely unknown because it normally breaks off at its extremely delicate pedicle. During ontogeny, this medial process at first contacts the tegmen tympani, later on it also tends to fuse with the ectotympanic. To elucidate this pattern in extant cetartiodactyls, we investigated 23 species by histological serial sections of perinatal stages and by µCT scans of juvenile and adult skulls. In all studied non-ruminant cetartiodactyls (camelids, suids, hippopotamids, cetaceans) the tegmen tympani is very thick both in fetuses and adults, and it well separates the tympanic cavity and its contents from the medial cranial cavity. In contrast, all studied ruminants (tragulids, giraffids, cervids, moschids, bovids) have the tegmen tympani more or less completely reduced resulting in a connection between the cavum tympani and the cavum cranii. Thus, the bulgy medial process of the prearticular almost contacts the dura mater. Therefore, in cleaned skulls the medial process of the prearticular bone is normally exposed at the floor of the cranial cavity and visible in medial view.

We consider this derived structural arrangement, whose functional meaning we do not yet understand, as a new apomorphy of the Ruminantia. Future investigations should also include fossil taxa to elucidate the evolution of this derived pattern.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

MECHANICAL PERFORMANCE OF CERATOPSIAN LOWER JAWS: NEW INSIGHT REVEALED BY FINITE ELEMENT ANALYSIS

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Ceratopsians (Dinosauria, Ornithischia) were herbivorous dinosaurs widespread in Laurasia from the Late Jurassic through the Late Cretaceous. They developed a wide range of mandibular morphologies during their evolutionary history, probably reflecting a variety of dietary adaptations. We combined 2D geometric morphometrics, using a configuration of 30 landmarks for 116 lower jaws, and finite element analysis to examine mechanical performance of the mandibular elements relative to shape. We calculated von Mises stress on the whole mandible and maximum surface traction (reaction force) on the constrained posterior edge to explore the mechanical behavior of ceratopsian lower jaws. Mandibular shape is not significantly related to von Mises stress, whereas it is significantly correlated with surface traction. By contrast, after accounting for phylogeny (Phylogenetic Generalized Least Squares), the relationship between shape and stress is significant, whereas shape is not significantly related to surface traction. Moreover, results are non-significant when regressing shape on stress and with surface traction size-corrected, thus taking into account the evolutionary allometric effect. Shape variation is highly constrained by phylogeny, as shown by a Mantel test between the

phylogenetic covariance and Procrustes distance matrices. Phylogenetic ANOVAs reveal that size and surface traction are phylogenetically constrained within Ceratopsia, whereas von Mises stress is not. Additionally, von Mises stress is not significantly different among the ceratopsian clades. Ceratopsids possess a lower surface traction than psittacosaurids. When exploring evolutionary models for stress and surface traction, von Mises stress does not show any significant phylogenetic signal, whereas Brownian Motion is the best descriptor for surface traction. The results of this study highlighted a non-phylogenetically structured von Mises stress for lower jaws when loaded to simulate biting, strongly correlated with mandibular shape. The evolution of this phenotype seems mainly a result of adaptation rather than shared ancestry. Shape evolves through time to arrange a lower jaw able to produce low stresses in the morphology. Size variation does not significantly influence structural performance within Ceratopsia. Moreover, the elongation of the coronoid process produced a structure less affected by surface traction.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

IMPROVING THE DIAGNOSIS OF CROWN GROUP CHONDRICHTHYANS FOR THE TREE OF LIFE PROJECT

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Among modern jawed vertebrates, elasmobranchs sensu lato have been widely viewed as a morphologically generalized sister group to holocephalans (chimaeras) within the class Chondrichthyes, mainly because many extinct shark-like chondrichthyans were erroneously classified along with modern taxa as elasmobranchs. Recently, however, the early 20th hypothesis of a chondrichthyan stem has been resurrected (with a few semantic changes), whereby not all extinct fishes with a shark-like gestalt are classified as elasmobranchs, and the chondrichthyan stem includes both 'putative chondrichthyans' such as acanthodians and 'conventional chondrichthyans' with tessellated calcified cartilage. Recent phylogenetic analyses and improved understanding of Paleozoic chondrichthyan anatomy suggests that modern elasmobranchs and holocephalans are both more specialized than was previously hypothesized. These new data support the need for a revision of the apomorphic features of the chondrichthyan crown taxa. Suites of apomorphic characters distinguish modern elasmobranchs ('neoselachians') and holocephalans both from each other and from more basal chondrichthyans and the osteichthyan outgroup. Furthermore, an array of characters (including several newly recognized features of the cranium and visceral arches) supports the hypothesis that hybodontiform sharks represent an extinct group of crown chondrichthyans more closely related to modern elasmobranchs than to holocephalans. Although the phylogenetic position of many Paleozoic shark-like chondrichthyans (even well-known forms such as xenacanths and 'ctenacanths') relative to the chondrichthyan crown is still poorly resolved, this situation will likely improve with the incorporation of new morphological data into phylogenetic analyses.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

NEW ADDITIONS TO THE DIVERSITY OF THE MUSSENTUCHIT MEMBER, CEDAR MOUNTAIN FORMATION DINOSAUR FAUNA

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The Albian-Cenomanian Mussentuchit Member of the Cedar Mountain Formation (CMF) is exposed on the western side of the San Rafael Swell, Utah, and is known to produce a diverse tetrapod fauna. Until recently, the dinosaur fauna of this unit remained poorly known with only one hadrosauroid and four ankylosaurian species named. Evidence of other dinosaur clades had been recovered, but was insufficient to allow confident assignment at generic and specific levels.

The Field Museum has conducted fieldwork in the CMF exposures since 2008, and jointly with the North Carolina Museum of Natural Sciences since 2012. These expeditions have led to the discovery of new dinosaur species, including three new theropod taxa and a new basal neornithischian.

To date, theropod diversity is represented by the recently described neovenatorid *Siats meekerorum*, a new taxon of oviraptorosaurian, and a small bodied coelurosaur. *Siats* is known from two partial specimens comprising much of the axial column, pelvis, and hind limb. It represents the first occurrence of Neovenatoridae as well as the youngest record of Allosauria in North America and is only the second carcharodontosaurian known from the continent.

A partial skeleton of a giant oviraptorosaurian discovered in 2012 is second only to the Chinese oviratorosaur *Gigantoraptor* in size. Almost all recovered elements exhibit synapomorphies of Oviraptorosauria. For example, a midcaudal vertebra is highly pneumatic, and a series of four distal caudals form a pygostyle-like structure. Previous evidence of oviraptorosaurs in the CMF was restricted to eggshells referred to the ootaxon *Macroelongatoolithus carlylensis.* A concentration of *Macroelongatoolithus* eggshell in situ was discovered 150 meters away from, and at the same stratigraphic level as, the skeleton. This close occurrence, combined with size and character considerations, renders it likely that the new oviraptorosaur taxon is the parent of *Macroelongatoolithus carlylensis*.

A partial skeleton comprising bones from the axial column, pectoral girdle, and fore- and hind limbs represents a new basal neornithischian taxon related to other North American taxa like *Thescelosaurus*. The scapula is broad and straight as in *Thescelosaurus*, but unlike the curved scapula of *Oryctodromaeus*. The new dinosaurs have significant impact on our understanding of biogeographic affinities and faunal composition of the North American dinosaur fauna at the transition from the Lower to the Upper Cretaceous.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

NEW CRANIAL REMAINS ASSIGNED TO MEGALOSAURIDAE (DINOSAURIA: THEROPODA) FROM THE LATE JURASSIC OF LUSITANIAN BASIN (PORTUGAL)

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New cranial elements of a megalosaurid theropod from the Late Jurassic of the Lusitanian Basin (central-west Portugal) are reported. The new specimen includes several cranial fragments including an incomplete left maxilla. It was collected on the cliffs of Praia da Corva (Torres Vedras municipality). The sediments in this area consist of siltstones and mudstones, interpreted as deposits of alluvial fans. These deposits correspond to the lower levels of the Lourinhã Formation (late Kimmeridgian in age).

The new specimen presents a character combination compatible with megalosaurid theropods, including the dorsal position of the palatal process of the maxilla. This process is immediately ventral to the dorsal surface of the anterior ramus, as typically occurs in most tetanurans. The ventrally oriented anterior junction between the medial wall of the maxilla and the paradental plates is distinct from most ceratosaurs and some basal tetanurans, including *Eustreptospondylus*, *Piatnitzkysaurus* and *Allosaurus*. The blade-shaped morphology of the palatal process in the new specimen is different from the tapered ridge in *Torvosaurus* and *Megalosaurus*. This process projects slightly ventrally and is well developed, but does not extend beyond the anterior margin of the maxilla. On the contrary, in most allosauroids it is straight and longer anteriorly. The premaxillary suture has two small foramina at about its mid-height but not a large foramen as occurs in *Torvosaurus*. The interdental plates are fused and present shallow ornamentation composed of thin vertical ridges, especially evident in the first plate. Strongly ornamented interdental plates are typical of abelisaurids, but thin crests are also present on *Megalosaurus*, *Piatnitzkysaurus* and *Carcharodontosaurus*.

Phylogenetic analyses incorporating data of the specimen from Praia da Corva result in a position within Megalosauroidea but distinct of other Portuguese members of the clade (e.g., *Torvosaurus*). This new specimen suggests, as was previously proposed based in some recent interpretation of the species *Lourinhanosaurus antunesi*, a greater diversity of megalosauroid theropods in the Late Jurassic of the Lusitanian Basin than currently appreciated.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

OSTEOLOGY AND PHYLOGENETIC ANALYSIS OF A *THORACOSAURUS NEOCESARIENSIS* SPECIMEN FROM THE UPPER CRETACEOUS HORNERSTOWN FORMATION, MANTUA TOWNSHIP, NEW JERSEY

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A recently discovered *Thoracosaurus neocesariensis* specimen from a shallow marine, Maastrichtian-Danian site in Mantua Township, New Jersey represents the most complete individual of the species yet described. This partially articulated specimen was discovered in the Main Fossiliferous Layer of the Hornerstown Formation in association with other vertebrate and invertebrate fossils. Elements previously discovered but never described include a partial femur and a nearly complete vertebral column including the atlas and axis. The vertebral column preserves all nine cervical vertebrae, fifteen dorsal vertebrae, and six caudal vertebrae. The atlas preserves the intercentrum and portions of the atlantal neural arch. The centrum of the axis is preserved including the odontoid process and the hypapophysis. The partial femur is sigmoidal in dorsal view as typically seen in Crocodyliformes. Description of these elements and comparisons with related taxa reveal novel taxonomic insights including, 1) the atlas intercentrum is wedge-shaped in lateral view with insignificant parapophyseal processes, and 2) a hypapophyseal keel is present on the 11th vertebra behind the atlas. This new specimen has provided a more complete view of thoracosaurian gavialoid osteology due to the preservation of these elements.

Education and Outreach Poster Session (Poster displayed November 5 – 8)

VIRTUAL FIELD TRIPS: USING REAL-TIME VIDEO CONFERENCING SOFTWARE IN RESPONSE TO THE DECLINE IN ON-SITE FIELD TRIPS.

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On-site field trips have been declining at museums in general and at Burpee Museum of Natural History specifically for the past several years. This decline correlates with an increase in transportation costs (including, but not limited to gas, chaperones, and staff time) for Illinois public schools to send their students on field trips as well as increasing logistical demands and a greater emphasis placed on standardized test preparedness within the school curriculum. Educators who understand that field trips are an asset to the curriculum are often met with steep challenges to get approval for class or grade-wide trips. Virtual Field Trips meet the needs of both students and educators without compromising the educational content that the museum has to offer with lower cost and less liability for the schools.

Burpee Museum houses unique specimens which, through this means, become available to teachers and students across the country. The experience can be geared towards the specific age range and tailored to fit the time frame set by the school′s schedule. While there is nothing like the experience of actually visiting a museum and getting close up to real artifacts and specimens, the reality is that many students are unable to make the journey for one reason or another. A live Virtual Field Trip offers a cost effective alternative, and uses technology available in most schools and with which many teachers (and students) are familiar.

Burpee Museum began providing live, Virtual Field Trips to classes in 2013 in response to the decline in on-site field trips and as outreach to schools that normally would be unable to visit because of travel distance. Since that time, Virtual Field Trips

have been conducted for public and private schools in the Midwest and on the East Coast, with highly positive feedback from those participating. These Virtual Field Trips can use existing field trip frameworks, or be customized to the group′s specific needs. Most importantly, each Virtual Field Trip is led by a museum educator or museum professional. This allows the students to engage directly with an expert as part of their experience.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

FOSSIL LONGBONE CARTILAGE PRESERVED IN STEGOSAURS?

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Soft tissues normally do not fossilize, and if they do they are typically preserved as thin, carbon-rich films. The cartilage caps that cover archosaur limb bone ends are only rarely preserved, such as in the sole case of 3D cartilage preservation on a sauropod femur.

The stegosaurian dinosaur *Kentrosaurus aethiopicus* from the Jurassic Tendaguru localities of Tanzania is known from a plethora of bone elements. Several individuals preserve what appears to be fossilzed articular cartilage. In some specimens the tissue is up to 10 mm thick. The surface of the putative cartilage shows fibers up to ~1 mm thick and several millimeters long, similar to fibrous cartilage in extant archosaurs. The preserved tissue covers not only the articular surfaces of the elements, but also portions of the metaphyseal surfaces, further suggesting portions of the tissue were likely fibrocartilage.

The putative cartilaginous tissue is found in histologically mature individuals, but not in juveniles. Although the available data are insufficient to clearly determine if taphonomic conditions in the main *Kentrosaurus* quarry in Tendaguru caused the preservation, the bones investigated do not suggest a local taphonomic aberration, as specimens from other quarries also appear to show small amounts of fossil cartilage.

We hypothesize that the unusual preservation of large amounts of cartilage is caused by an *in vivo* ossification of fibrous cartilage. It is unclear whether this ossification was caused by a regular growth-related process, as the distribution only across (sub-) adult individuals seems to suggest, or by a pathological condition. Planned destructive study (coring and thin sectioning) of specimens will clarify this issue. Further studies on thyreophorans in general are needed to determine if similar fossil tissues exist outside Stegosauria, what their biomechanical relevance may have been, and how their preservation can be explained.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

NEW SPECIMENS OF THE RARE CHASMOSAURINE *ARRHINOCERATOPS* (DINOSAURIA: CERATOPSIDAE) FROM THE UPPER CAMPANIAN-LOWER MAASTRICHTIAN HORSESHOE CANYON FORMATION OF ALBERTA

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Historically, the ceratopsid *Arrhinoceratops* was known from only a single skull. Although it is well preserved, extensive coossification, preservational artifacts, and other idiosyncrasies of the specimen have resulted in conflicting interpretations of its morphology and phylogenetic relationships. Two previously undescribed specimens of *Arrhinoceratops*, from the Royal Ontario Museum (ROM 1439) and Canadian Museum of Nature (CMN 8882), provide new information. ROM 1439 includes a nearly complete skull. Distinctive features not preserved on the holotype include a steeply inclined triturating surface of the predentary (otherwise seen only in centrosaurines) and a hypertrophied lateral dentary ridge (otherwise seen to a lesser degree in *Anchiceratops* and basal ceratopsians). Suturally distinct epiossifications show that *Arrhinoceratops* has an epinasal (contrary to past interpretations) and lacks a midline P0 epiparietal. CMN 8882 is a partial skull of a juvenile, assigned to *Arrhinoceratops* based on a hypertrophied lateral dentary ridge, steeply inclined triturating surface of the predentary, and simple frill ornamentation. The skull, approximately 75% maximum size, has an abbreviated face, short, recurved postorbital horncores, delta-shaped frill epiossifications, a bumpy dorsal margin of the posterior postorbital, and other features shared with immature *Triceratops*. Thus, a recently proposed *Triceratops* growth model is probably representative of other long-horned chasmosaurines. The well-developed lateral dentary ridge of CMN 8882 indicates that this feature was also present in young *Arrhinoceratops*, and was probably not sexually significant. It may, instead, be related to the jaw mechanism. Although revised character codings for *Arrhinoceratops* fail to resolve its relationship to other chasmosaurines within a parsimony analysis, the analysis provides tentative support for a deep split within Chasmosaurinae, with one lineage leading to *Chasmosaurus* and another to *Triceratops*.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

DAGGERS, SWORDS, SCYTHES AND SICKLES: PACHYCORMID FINS AS ECOLOGICAL PREDICTORS

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Pachycormids occupy a key position within Actinopterygii, as part of the Holostei-Teleostei Transition, although their precise position in this hierarchy has been fought over for some years. New discoveries in the Toarcian of Scotland, as well as the Kimmeridgian and Turonian of North America, have expanded our global knowledge of the diversity, distribution and success of pachycormids, continuing the recent 'Pachycormid Renaissance'. However, clarity over the definitions of pachycormid taxa (as with many fossils) has been undermined by the number of type specimens destroyed during World War II. This has introduced a need for neotype material to be identified (e.g. for *Asthenocormus titanius* and *Hypsocormus macrodon*). Furthermore, new comparative work has revealed how poorly constrained a number of historical genera are, particularly those of the Toarcian (Early Jurassic) Holzmaden shale fauna, taxa that were the foundation of Arthur Smith Woodward's family Pachycormidae in 1895. This series of historical problems with descriptions and material has undermined confidence in recent phylogenetic analyses. In lieu of the necessary large-scale systematic overhaul of this group to stabilize and clarify its internal relationships, a more limited cross-family review of core characters historically associated with the group was conducted. A detailed sampling of over 90 specimens from 16 recognised pachycormid genera was assessed, clearly demonstrating that the ubiquitously stated 'scythe'-like pectoral fin is not in fact a pachycormid synapomorphy. Three clear and distinct pectoral fin structural morphotypes emerged, reflecting a diversity of pachycormid lifestyles that changed throughout the Mesozoic. Use of a variety of pectoral fin characteristics including aspect ratio, proportional fin length and body position further support recent analyses that show two distinct ('toothed' and 'tusked') diverging tribes of pachycormids. The unusually long pectoral fins appear to have developed in conjunction with otherwise reduced skeletal ossification to counteract buoyancy problems in a group apparently lacking a gas bladder. Closer analysis also reveals adaptations of a primitive morphology to suit a suite of lifestyles from agile pursuit predator to slow-cruising suspension feeder. Unsurprisingly, some of the pectoral fin morphotypes mirror some of the most modern fuel saving wingtip designs from today's aerodynamicists, converging on similar solutions to these enigmatic and fascinating fish some 160 million years later.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

NEW RECORDS OF EARLY EOCENE ELASMOBRANCHS FROM THE KYZYLKUM DESERT, UZBEKISTAN

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As part of an international expedition to Uzbekistan to study the stratigraphy and the fossil vertebrate faunas in the central Kyzylkum desert, the locality of Sarbatyr was visited. The lower Eocene deposits at the locality comprise the Alai and underlying Suzak formations. Phosphorite horizons at the base of the both formations were bulk sampled and dry screened yielding shark and ray teeth. Most were well-preserved, whole or slightly broken and not noticeably reworked. The assemblage from the Alai Formation included *Hexanchus* cf. *agassizi*, *Echinorhinus* sp., *Palaeorhincodon dartevellei*, *Xiphodolamia ensis*, *Isurolamna inflata*, *Otodus obliquus*, *O. aksuaticus, Abdounia beaugei* , *A*. sp., *Premontreia* cf. *subuidens*, *Triakis* sp., *Danogaleus* cf. *gueriri*, *Physogaleus* sp., *Pachygaleus* sp., *Burnhamia* sp., *Archaeomanta* sp.

Previous researchers determined the age of the Alai Formation as late Ypresian-Lutetian. The combined presence of *O. obliquus* and *O. aksuaticus* in the base of Alai Formation indicates a mid Ypresian age within the second half of nannoplanktonic zone NP12. The taxonomic diversity and number of benthic species indicates a shallow continental shelf environment.

The sharks from the phosphorite at the base of the Suzak Formation are less abundant and less taxonomically diverse. They include *Carcharias* sp., *Striatolamia striata*, *Otodus obliquus*, *Premontreia* sp. and palatal teeth of pycnodonts. The assemblage is probably late Paleocene or early Ypresian in age.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

TRACE-METAL JACKET: THE ROLE OF MELANIN PIGMENT IN THE PRESERVATION OF *ARCHAEOPTERYX* FEATHERS

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Synchrotron-based elemental mapping and spectroscopy of *Archaeopteryx* have made it possible to identify the presence and distribution of melanin pigment. Pigment patterns are controlled by melanocytes during feather growth. There are two main melanin pigments in animal tissues, eumelanins and pheomelanins. The former are more prevalent (>75%) and furnish dark black or brown hues in both invertebrates and vertebrates. A diagnostic and functional component of the molecular structure of melanin is their carboxyl and porphyrin substituents. These negatively charged end-groups function as cation chelators, selectively binding positively charged particles such as free radicals and transition metals. Consequently, melanin granules in extant bird feather melanosomes display high concentrations of zinc, copper, calcium and iron. Results from synchrotron-based imaging show clear evidence for the presence of Cu-O/Cu-N complexation, indicative of endogenous melanin pigments being preserved within the exceptionally preserved feathers of *Archaeopteryx*. The distribution of metal chelates in such soft tissue provides a useful biomarker for eumelanin patterning in this extinct bird. The presence of trace metals in melanin may play a key role in feather function and also their preservation. When the black and white feathers of domestic chickens are exposed to feather-degrading bacteria (*Bacillus licheniformes*), white feather breakdown is significantly faster than in black melanised feathers. Such studies suggest plumage colour might be an evolutionary response to the presence of feather-degrading bacteria, with high melanic content being more resistant to decay. The biocidal properties and associated non-biodegradability of eumelanin allows for a useful proxy to reconstruct pigment patterns through mapping the trace-metal chemistry associated with feathers. However, the trace-metal coordinated biochemistry of melanin-type pigments that played a key role in life might also have impacted upon the taphonomic history of

Archaeopteryx. Feathers, rich in trace metals, may have functioned as a 'natural biocide' protecting keratinous integument from bacterial decay in life, but also delivering a multitude of selective advantages through color (such as camouflage, display, etc.). The same trace metals that protected feathers in life, might well have contributed to the fossilization of integument that might not otherwise have been preserved in this remarkable early bird.

Technical Session VII (Thursday, November 6, 2014, 10:15 AM)

CLIMATE DRIVES SPATIOTEMPORAL PATTERNS IN CROCODYLOMORPH DIVERSITY

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Whereas extant crocodylomorphs are semi-aquatic predators, with low morphological diversity, and are restricted to tropical and subtropical latitudes, their fossil record reveals a much richer evolutionary history. To understand what drives the distribution of living crocodylians, which is critical for assessing extinction risk, we examine spatiotemporal diversity patterns in crocodylomorphs over their 220 million year history. We apply several analytical methods (subsampling, modeling approaches, and phylogenetic diversity estimates) to reconstruct past diversity, utilizing a comprehensive dataset of fossil occurrences (2250 occurrences of >500 species). After their Jurassic radiation, crocodylomorphs suffered a staggered extinction across the Jurassic-Cretaceous boundary, with marine thalattosuchians the primary victims. Terrestrial species and other marine groups flourished in the Cretaceous, but there was an overall decline in the latest Cretaceous, with most non-crocodylian groups disappearing prior to the Cretaceous-Paleogene boundary (K/Pg), although this might be an artefact of uncertain dating of the species-rich Adamantina Formation, as well as the Signor-Lipps effect. Only a small number of non-crocodylians survived into the Cenozoic, but total global crocodylomorph diversity was largely unaffected by the mass extinction. There is evidence for latitudinal decoupling of Cenozoic diversity patterns. Whereas Paleocene extratropical diversity was comparable to latest Cretaceous levels, tropical diversity greatly exceeded that of the latest Cretaceous paleotropics. Tropical diversity declined in the early Eocene, whereas a fall in extratropical diversity began later, during the cooling period of the late Eocene. While extratropical diversity continued to decrease through the Oligocene and into the Neogene, tropical species richness increased and maintained higher diversity levels than the extratropics, forming the latitudinal biodiversity gradient we see today. Statistical comparisons between crocodylomorph diversity and climatic proxies demonstrate a strong correlation over the last 100 million years, interrupted only during the Paleocene. Warm intervals coincide with extratropical peaks, with heightened tropical diversity during cold intervals, but in the chaotic aftermath of the K/Pg mass extinction it is possible that crocodylomorph diversity was decoupled from its environmental driver. Ongoing climate change is likely to have profound repercussions for extant crocodylians.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

IMPROVING COLLABORATION BETWEEN PALEONTOLOGISTS AND PALEOARTISTS: A CASE STUDY, FOCUSED ON THE CERATOPSID DINOSAUR *STYRACOSAURUS*

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Since the origin of the science of paleontology, illustrators and sculptors have cooperated with paleontologists in reconstructing and interpreting fossil organisms. Our aim is to promote and facilitate this scientist-artist cooperation, providing both categories with a technical literature aimed at the comprehensive analysis of the reconstructions. This literature supports the paleontologists in giving reliable references to the paleoartists, which, in turn, can make artwork that is more appropriate for supporting research and for enhancing educational effectiveness for the general public. Therefore, both popularization and academic studies can take advantage of the improved accuracy of their iconographic apparatus.

The tools proposed are: a study able to collect and summarize the data dealing with a topic, from the paleobiological and historical-iconographic points of view; and the use of three-dimensional fossil scans and digital models, accessible to a wide audience, that can be easily updated and modified in case of new discoveries and/or revised interpretations.

The example presented here focuses on *Styracosaurus*, a ceratopsid dinosaur from the Upper Cretaceous of the Dinosaur Provincial Park, Alberta, Canada. New, updated skeletal and muscular reconstructions are proposed. The restoration of the skin is based on fossil evidences in strictly related taxa. Biomechanical, paleoethological, and paleoecological hypotheses are also summarized and reviewed. The application of the extant phylogenetic bracketing (EPB) permits the analysis of some of the most speculative aspects (e.g., soft tissues, behavior) that are fundamental for the 'in vivo' restorations. A three-dimensional digital model is proposed based on the data analyzed. A summary of the paleoenvironmental data is also given, with remarks on paleofaunal and paleofloral assemblages, to make the framework as complete as possible.

In the end, in order to show the practical utility of our research, we present some illustrations and a life-sized flesh model by several Italian artists, made by applying different levels of depth of our research.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

SYSTEMATICS AND BIOGEOGRAPHY OF PALEOGENE NYCTITHERIIDAE (MAMMALIA, EULIPOTYPHLA?)

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Nyctitheriidae is a diverse clade of small, insectivorous mammals from the Paleogene of Asia, North America, and Europe that have alternately been linked to Eulipotyphla (shrews, moles, hedgehogs), Euarchonta (primates, tree shrews, dermopterans), or Chiroptera (bats). Even intrafamilial relationships are poorly understood, resulting in ambiguity regarding morphological character polarity critical for evaluating supraordinal relationships and uncertainty regarding biogeography for the clade. To address this problem we ran a cladistic analysis of 66 dental characters coded for 51 nyctitheriid taxa, 2 non-nyctitheriid amphilemurid insectivores, and rooted with *Maelestes gobiensis*. While the oldest known nyctitheriids are found in the early Paleocene of North America, a strict consensus of the two equally most-parsimonious cladograms (330 steps; retention index: 0.601) finds all Asian taxa included in this analysis, including representatives from all three late Paleocene-Eocene Asian subfamilies, basal and paraphyletic with respect to the rest of Nyctitheriidae. This result, while sensitive to outgroup choice, at least suggests an Asian origin for the family by the early Paleocene, with dispersal into North America by the Torrejonian. In the nested North American and European taxa, the subfamilies Nyctitheriinae and Amphidozotheriinae are not monophyletic and may need to be abandoned. The genera *Leptacodon* and *Saturninia* are also not monophyletic and should be revised. The multi-species genera *Nyctitherium*, *Plagioctenodon*, *Plagioctenoides*, *Cryptotopos*, and *Euronyctia* are found to be monophyletic and *Wyonycteris* species are paraphyletic with respect to *Pontifactor bestiola*. Nyctitheriids are first documented in Europe in the early Eocene. The presence of the earliest known European taxa in four otherwise strictly North American clades with late Paleocene members (*Leptacodon nascimentoi* with *L. choristus* + *L. packi*; *Placentidens lotus* with *Ceutholestes dolosus*; *P. dormaalensis* in *Plagioctenodon*; and *W. richardi* in *Wyonycteris* + *Pontifactor*) suggests an earliest Eocene dispersal event from North America to Europe in at least four nyctitheriid clades, possibly via similar routes as other taxa proposed to be dispersing between the two continents, such as *Palaeonictis*, *Macrocranion*, and *Teilhardina*. This event coincides with a major climatic event and Holarctic dispersal of the mammalian orders Primates, Artiodactyla, Perissodactyla, and hyaenodontid creodonts at the Paleocene–Eocene Boundary.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

THE ROLE OF DESCRIPTIVE STATISTICS IN FINITE ELEMENT RESULTS: A CINGULATA JAW AS A CASE STUDY

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Comparative Biology has a historical background in the comparison of anatomical features of organisms in biology for centuries. In recent works using virtual reconstruction of vertebrate structures the combination of different computational methods, such as Finite Element Analysis (FEA), as well as mathematical, statistical, and engineering approaches, are opening new and challenging ways to research skeletal form and function in evolutionary biology.

FEA enables stress distribution patterns of different individuals to be obtained by simulating loadings and forces involved in their behavior. To compute the average stress of the whole FEA model, a new approach has been used recently in different works in order to obtain a single measurement that gives the researcher an idea of the relative strength of the structure. However, due to the nature of the FEA data, it needs to be fully developed, taking into account the influence of the weight of the mesh in the results and trying to avoid the artificial noise produced in FEA due to the numerical singularities of the mesh. Consequently, new methodologies including, along with other statistics, mesh-weighted arithmetic mean and mesh-weighted median, are developed herein to make the results obtained in different models comparable independent from the type and size of Finite Element mesh and avoid artificial noise in the results.

These new indicators are first defined and tested in two-dimensional finite element models to later be transferred to 3D models. In order to check their suitability, one Cingulata jaw has been used as a case study and solved using FEA with different meshes. Additionally, FEA has been applied to different members of Cingulata suborders, including eleven extant armadillo taxa and three extinct taxa in order to evaluate and compare its biomechanical behaviour.

Our results suggest that the proposed methodologies provide powerful indicators that are suitable to use in comparing different patterns of stress distribution. In particular, the new methods proposed are shown to be extremely useful when exploring the effect of the shape in the strength and stiffness of vertebrate bone structures.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

THE SAUROPOD THAT STOPPED THE TRAIN

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Lo Hueco quarry (Upper Cretaceous; Cuenca, Spain) was found in 2007 during the installation of the tracks of the Madrid-Valencia high-speed rail line. The Konzentrat-Lagerstätten of Lo Hueco constitutes a singular accumulation of fossils, especially representing titanosaur sauropods. The site has provided partial skeletons in anatomical connection or with a low dispersion, producing a unique record in Europe. Fieldwork and preparation of the first partial titanosaur skeleton from Lo Hueco (EC1), which is currently regarded as the holotype of a new species, is here reported.

In the field, EC1 was exposed to distinct weather conditions affecting its state of preservation, and resulting in changes of the conservation protocols. More than one hundred bone elements where profiled and consolidated before its extraction. Three large

jackets with connected bones were built including sacrum and proximal part of the tail, middle-to-posterior dorsal vertebrae and cervical remains. The jackets were built with bandages drenched in Paraloid B-72 solved in acetone. A coat of expanded polyurethane was used to ensure cohesion of the blocks, and an outer metal frame was made for removal. A detailed documentation from distinct sedimentary levels, geo-referenced data, draws, maps, photos and videos was recompiled.

Phases of preparation include: 1) removing extraction structures (metal frame, polyurethane, and bandages) using different techniques; 2) elimination of matrix (mainly clays) using mechanical techniques, both manual and with tools; 3) use of paraloid resin with microspheres to fill the present cracks in order to stabilize them and prevent the propagation of the vibration caused by airscribe, avoiding damage on the bone surface; 4) use of a kind of epoxy resin on problematic fractures using its high stability and machining characteristics (used in restoration of wood sculptures), avoiding dissolution processes in the posterior consolidation of the bone; and 5) when gypsum produced irreversible damage to the bone, it was decided not to withdraw it.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

ELEPHAS AND OTHER VERTEBRATE FOSSILS NEAR TAGHROUT, MOROCCO

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The paleontological richness of Morocco has been scientifically known since at least the early 20th century. However, the Middle Atlas region, more specifically the Boulemane area, has only been sparsely studied since the 1960s, when it supplied various vertebrate fossils from the Middle Jurassic, mainly dinosaur and crocodilomorph bones. In 2003, some fossil bones were discovered in Anchrif valley formed by river Guigou, near the village of Taghrout, in the Fés-Boulemane Province. In September 2013, a Moroccan-Portuguese expedition made excavations in the site engaging local helpers. The Anchrif fossil site was dated to mid-Pleistocene, based on mammal material and hominid tools. It is a small high-altitude sedimentary basin, uncharted in previous geological maps, and surrounded mostly by shallow marine Middle Jurassic rocks (Bathonian). The excavations yielded bones from large mammals, with the most common findings as elephants ascribed to the genus *Elephas*, but unidentified artiodactyls, tortoises, and hominid Acheulean tools were also collected. One Acheulean amygdaloidal biface was recovered in situ, in the same layer as some of the proboscidean remains. So far, there are no signs of predation of elephants by humans in the site.

The proboscideans were found in two distinct layers and included: one skull, two tusks, two ilia, one scapula, several ribs and cervical vertebrae, one patella, a femur, a molar, and a possible radius and ulna. The remains can be attributed to at least three adults and one juvenile, classified as *Elephas iolensis*. The tusks have a circular section and are relatively straight when compared with other elephants. The molar enamel is thin (less than 2 mm) and does not present a median sinus. The enamel figures are symmetrical and parallel sided, with almost no folding.

Apart from the Anchrif dig site, the expedition also explored a nearby cave with Holocene material ascribed to the mammals genera *Hystrix*, *Syncerus*, *Panthera*, *Lepus*, and unidentified artiodactyls, as well as the tortoises genera *Mauremys* and *Testudo*. Some bones present porcupine (likely *Hystrix cristata*) bite marks.

The Bathonian sediments around Taghrout present theropod tracks and at least two layers rich in bivalves, plants and brachiopod fossils. The Bathonian sites near El-Mers were also revisited. The new findings include sauropod and tridactyl track and bones of possible crocodylomorphs.

Symposium 4 (Friday, November 7, 2014, 8:00 AM)

TEMNOSPONDYL ORIGINS IN A PHYLOGENETIC CONTEXT: AQUATIC, AMPHIBIOUS, OR TERRESTRIAL?

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Temnospondyli is a large group of Carboniferous to Cretaceous tetrapods that is widely thought to contain Lissamphibia, although some controversy remains. Even without Lissamphibia, Temnospondyli comprises a wide range of body sizes and habitats from terrestrial adults to obligatorily aquatic ones. There is no consensus on which of these lifestyles is ancestral. It has recently been proposed that the original temnospondyl ontogeny is that of *Sclerocephalus*, in which only the oldest, best-ossified individuals were able to walk on land and maybe act as a dispersal stage between bodies of water; alternatively, the possibility has been floated that an aquatic lifestyle may be ancestral, so that terrestriality evolved several times within Tetrapoda, fitting the recent finding that many aquatic temnospondyls replaced their external gills with internal ones in ontogeny. Internal gills are not known in any extant tetrapod; the gills of tadpoles are homologous to external gills and to the septa between internal gills. Any resolution of this question will depend on improved determination of the lifestyles of temnospondyl species, but also on temnospondyl phylogeny – the latest analyses of which find wildly divergent results. Outgroup choice has been found to be critical in determining how the aquatic temnospondyls are distributed over the tree. Because the relationships of the potential outgroups are unclear, I use an analysis of tetrapod phylogeny to tackle the problem. I find that the lissamphibians are not temnospondyls, but well supported as "lepospondyls". Temnospondyli is sister to (((((((Amniota, Diadectomorpha) Amphibia) Seymouriamorpha) *Solenodonsaurus*) Chroniosuchia) *Bruktererpeton*) *Gephyrostegus*); Anthracosauria lies more rootward than Temnospondyli. *Caerorhachis* ?= *Casineria* is the sister-group to all other temnospondyls. The likely amphibious *Balanerpeton* and *Dendrerpeton* form the sister-group to a largely terrestrial zatracheid/dissorophoid/*Palatinerpeton* clade, across which the "branchiosaurs" are scattered. The aquatic Dvinosauria is nested within the mostly aquatic Stereospondylomorpha, close to *Eryops* (slightly more terrestrial than *Sclerocephalus*), the aquatic and/or amphibious "edopoids" and *Capetus*, and the seashore-dweller *Iberospondylus*.

Amphibious adults thus seem to be ancestral for temnospondyls. Loss of the tail fin skeleton and the postbranchial lamina on the cleithrum may be synapomorphies of Temnospondyli and its sister-group; they are not shared by the aquatic Anthracosauria.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A MORPHOTYPE-BASED RANKING APPROACH TO MEASURE DENTAL COMPLEXITY IN ARVICOLINES AND ITS APPLICATION TO REVEALING PATTERNS OF DENTAL VARIATION IN LIVING AND EXTINCT FORMS

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In order to improve resolving power of morphological methods in studying the Quaternary fossil record of arvicolines (one of the most abundant rodent groups in the Northern Hemisphere during the last 2.6 Ma), we develop a unified approach to measuring dental complexity based on counting the number of additional prisms of the crown and the respective number of dentine elements of the occlusal surface. The novelty of the approach is determined by unification of the criteria to establish morphotype dental patterns and by using the same scale to measure dental complexity of any molar in a tooth row in any arvicoline taxa, living or extinct. The approach is used to describe dental variability patterns in phylogenetically distant species (16 widespread arvicolines in the Late Pleistocene and modern fauna of northern Eurasia) and to test several hypotheses to reveal the most important sources of dental variation in modern hypselodont arvicolines (genus *Microtus*). Ontogenetic changes in molar complexity and bilateral symmetry among right and left molars of the same individual during the process of tooth wear were assessed in *M. gregalis* using an intravital tooth-printing method. Moreover, a geographic sampling of *M. gregalis, M. oeconomus*, and *M. arvalis obscurus* was undertaken in different landscape-geographic zones in the central part of northern Eurasia in order to compare the amounts of dental variation related to geography and to age of an individual (based on the percentage of skull maturity). The results suggest that in captivity, for animals of 1 month and older, the age differences in morphotype dental patterns are non-significant and negligible compared to among-individual variation. Within-individual differences among right and left molars, when present, were not related to age of an animal suggesting that bilateral asymmetry of morphotype dental pattern could be regarded as inherent characteristic of an individual persisting during post-juvenile tooth wear. However, in natural populations of *Microtus* occurring along the environmental gradients, age component could not be excluded from the list of significant sources of dental variability.

The study is supported by RFBR grant ?12-04-01377.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE AGE OF THE KAYENTA FORMATION OF NORTHEASTERN ARIZONA: OVERCOMING THE CHALLENGES OF DATING FOSSIL BONE

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The Glen Canyon Group spans a period of Earth history that records the Triassic-Jurassic boundary and a biotic response to the end-Triassic mass extinction. Owing to the absence of datable ash beds or useful biostratigraphic invertebrate fossils, the Early Jurassic has been poorly constrained in western North America and its chronology has been constructed upon difficult superpositional relationships and the presence of vertebrate taxa. The Kayenta Formation is host to a number of important taxa such as some of the first frogs, caecilians, turtles, crocodyliforms, ornithischians, and large-bodied saurischian dinosaurs in North America. However, that unit has been assigned to either the Triassic or Jurassic nineteen different times since it was first mapped in 1882. Here, we attempt to directly date fossil bone from the Kayenta Formation from a single quarry near Gold Spring, AZ that produced skeletons of the theropod *Dilophosaurus wetherilli* and early sauropodomorph *Sarahsaurus aurifontanalis*. Electron-dispersive spectroscopy of bones from this quarry shows that they comprise recrystallized hydroxylapatite with pore spaces permineralized by calcite, iron-rich calcite, and barite. We analyzed two bones from the Gold Spring quarry using a laser ablation multicollector-inductively coupled plasma mass spectrometer (LA-MC-ICP-MS) configuration but the calculated apatite ages are too young to corroborate the stratigraphic evidence suggesting that the Kayenta Formation is either Late Triassic or Early Jurassic. Further investigations into the spatial distribution of elements in the bones shows that concentrations of major and trace elements decrease moving away from the bone surface. Lead concentrations are highly variable within the fossil bone suggesting that some regions may have been subjected to Pb loss. However, the anomalously-young apatite ages are mostly a result of U enrichment, where U concentrations are as high as 1100 ppm in the fossil bone. We collected detrital zircons from matrix removed from the Gold Spring quarry and four other localities within the Kayenta Formation and calculated U-Pb ages using high-resolution LA-ICP-MS. One of these dates, 183.7 +/- 2.7 Ma, is the first deposition-age radiometric date from the Kayenta Formation and shifts the age designation for this Early Jurassic unit from the Sinemurian-Pliensbachian to the Pliensbachian-Toarcian. Future efforts will sample the rest of the Glen Canyon Group in order to construct the first chronology of the Early Jurassic in western North America.

Symposium 4 (Friday, November 7, 2014, 8:30 AM)

A SPECTACULARLY PRESERVED EARLY PERMIAN DVINOSAUR (TEMNOSPONDYLI) FROM THE PARNAÍBA BASIN (BRAZIL) ILLUMINATES THE ANATOMY, FUNCTIONAL MORPHOLOGY, AND EVOLUTION OF AQUATIC LOCOMOTION IN THE CLADE

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Since 2011, fieldwork has been conducted in the early Permian Pedra de Fogo Formation (PFF) of the Parnaíba Basin to study its age, depositional environments, and vertebrate faunas. Discoveries include several articulated skeletons of a new temnospondyl. Phylogenetic analysis indicates that the species is a basal dvinosaur. The Brazilian dvinosaur has a well-ossified skeleton, and is characterized by a large head and ceratobranchials, a robust pectoral girdle, rhachitomous vertebrae with a large notochordal space, and caudal vertebrae and ribs that are modified into a rigid fin-like structure. Small limbs are present and include ossified stylopodial, zeugopodial, and autopodial elements. The Brazilian species shares an elongate body plan with the Permian and Early Triassic tupilakosaurids, but the structure of the vertebrae differs. The short, disc-like diplospondylous centra of tupilakosaurids resemble the centra of taxa such as whales and ichthyosaurs, which have inflexible vertebral columns. In contrast the vertebrae of the Brazilian species are more elongate and consist of a ring of bone that surrounded the notochord. We interpret this morphology as indicative of a highly flexible vertebral column. Together, these characters suggest a fully aquatic animal that was well adapted to anguilliform swimming. The large head may have been used in combination with powerful body movements for penetrating dense aquatic vegetation, but the limbs were better suited to fine movements and position holding. The phylogenetic placement of the new taxon implies that this general bauplan evolved before the origin of tupilakosaurids; further refinement within the clade included the evolution of a more rigid vertebral column. The PFF dvinosaur is a member of a complex lacustrine ecosystem characterized by several guilds of aquatic secondary consumers, and at least some localities seem to preserve mass death assemblages of the species. The PFF samples a previously unknown biogeographic province in western tropical Gondwana, and other members of the lacustrine community include a new trimerorhachid and the oldest and northernmost occurrence of a rhinesuchid.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

THE BROMACKER LOCALITY: THE MOST IMPORTANT PALEONTOLOGICAL SITE OF LOWER PERMIAN TERRESTRIAL VERTEBRATE FOSSILS OUTSIDE OF NORTH AMERICA

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The early Permian Bromacker quarry, located in the middle part of the Upper Rotliegend Tambach Formation near Gotha, central Germany, is a highly prolific site that yields terrestrially adapted invertebrate, vertebrate, and plant fossils. In numbers of individuals, diversity of taxa, and quality of preservation, the vertebrates far surpass those of all other European sites combined of comparable age. Whereas the Bromacker taxa are unique to Europe, they are identical or very clocely related to forms known elsewhere almost exclusively from the lower Permian of the U.S. To date, thirteen vertebrates, eight to ten invertebrates, four invertebrate and six vertebrate traces, and three to four plants have been identified. The unique commonality of all vertebrates with those of North America has been relevant in resolving important areas of inquiry: (1) accurately assessing the biostratigraphic position and age of the Tambach Formation and therefore the base of the Rotliegend; (2) providing the first irrefutable, biological evidence of a predrift, continuous landmass of Laurasia during the early Permian; (3) contributing significant, new information about the global distribution patterns of early Permian tetrapods across southern Laurasia; and (4) providing direct evidence that faunal interchange across southern Laurasia of many terrestrial species during this time was not impeded by biological, environmental, and physical barriers. Geological evidence indicates that the Tambach Basin during Tambach Formation deposition represented a 'truly upland' paleoenvironmental setting, which is supported by the Bromacker fossils and sediment marks: (1) first geological evidence of temperatures below zero near the equator (ice marks); (2) lack of any obligatory aquatic or semi-terrestrial forms (fish and most amphibians); (3) the amphibians, which include two to four dissorophoids and *Seymouria*, are widely viewed as highly adapted to an active, terrestrial existence; (4) presence of four taxa of terrestrial herbivores presumably capable of consuming high-fiber vegetation, which doubles that for any assemblage of comparable age; (5) minimal number of individuals counts indicate that the herbivores outnumber the two top predators by a ratio of 7:1; (6) using the same measurement herbivores represent nearly 50% and top predators 7% of the total population; (7) presence of large tetrapod burrows; and (8) presence of the ephemerally-adapted invertebrate Conchostraca.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

VERTEBRATE FEEDING TRACE FOSSILS IN THE CEDAR MOUNTAIN FORMATION (LOWER CRETACEOUS), ARCHES NATIONAL PARK, UTAH (USA): BIRD, PTEROSAUR, OR UNKNOWN TRACEMAKER?

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Abundant linear grooves on sandstone bedding planes of the Ruby Ranch Member of the Cedar Mountain Formation (Lower Cretaceous) in Arches National Park (Utah, USA) are interpreted as feeding traces made by a beaked vertebrate, such as a bird or pterosaur. These grooves have regular lengths (15.7 ± 2.0 mm), widths (3.4 ± 0.3 mm), and depths (1.5 ± 0.7 mm; n = 30), indicating a common origin related to the behavior and anatomy of their tracemakers. The trace fossils are either: solitary, bundled together as parallel groups of 4-8 grooves, or form semi-circular to circular patterns of 35-70. Bundles forming arc-like patterns are 13-15 cm wide. Grooves are on the same surface with runzelmarken, invertebrate trails, tridactyl theropod tracks, and a didactyl dromaeosaurid track.

Forms and patterns of these features do not correspond to any known inorganic structures or invertebrate traces, nor traces made by fish. Thus they are considered as trace fossils made by either birds or pterosaurs. Runzelmarken and laminations imply that algal films bound sedimentary surfaces and helped to preserve these trace fossils and their associated theropod tracks. Hence the grooves may have been grazing traces, in which tracemakers gouged just underneath and parallel to algal films by using hard body parts, such as beaks. If so, beaks would have been 3-4 mm wide and groove lengths would have been linked to beak length and neck movement. The diameter of the semi-circular and circular patterns suggests that the tracemakers were relatively small vertebrates. Arc-like patterns of clustered grooves could have been made by the tracemaker standing in one spot or shifting laterally to systematically mine the surface. However, no pes tracks were observed in direct association with these grooves. Hence the traces also may have been formed while the tracemakers floated in shallow water just above sedimentary surfaces.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

BONE MASS AND AIR SPACE PROPORTION OF PTEROSAURS

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High-resolution computed tomography (CT) scanning is becoming more common to visualize fossils in three-dimensions, especially fragile, compressed, or hard to prepare specimens. However, the application of CT approaches to pterosaur fossils has so far been uncommon; work to-date has focused mainly on the cranial and axial skeleton of *Anhanguera* and *Rhamphorhynchus*, gathering qualitative information (for coding and general specimen description) rather than quantitative measurements for biomechanical and flight studies.

Quantitative data from CT scans of pterodactyloid pterosaur wing bones and previously published scans of pterodactyloid axial skeletons and wing bones are reported here to evaluate bone masses and pneumaticity. Bone mass is estimated using the bone volume calculated from the CT scans multiplied by estimated density, while pneumaticity is quantified using air space proportion (ASP) - the ratio of the air space in a bone to the total volume. ASP can be evaluated throughout the bone in order to document any variation or changes within a single bone.

Estimating the masses of large pterosaurs has been widely debated. Bone mass estimates presented here are substantially larger than previous ones, which suggests that contrary to previous proposals, pterosaurs may not share the relationship seen in birds between skeletal mass and total mass. In addition, our estimates for ASP vary within a single bone, being generally higher at the ends of the bone than in the shaft. This observation has major implications for previous pneumaticity estimates based on single cross-sections through bone in archosaurs including birds, sauropods and pterosaurs. Generally these ASP estimates are taken from measurements of broken shafts of long bones, yet the ends actually show higher ASP, which means that pneumaticity may previously have been systematically underestimated. Our measurements of ASP for different sizes of pterosaurs suggests that it increases with size, which may be related to increased bending stiffness in response to the greater flight pressures related to large size.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A NEW BALAENOPTERID (CETACEA, MYSTICETI) FROM THE UPPER MIOCENE EASTOVER FORMATION, VIRGINIA

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A new balaenopterid species is described from the vertebrate paleontology collections of the University of Texas. The new specimen was originally recovered in a salvage project in the state of Virginia by staff at William and Mary College in 1987, and was later moved to Texas with a member of the original project. This whale was discovered in sediments of the Upper Miocene aged Eastover Formation. This formation has historically produced numerous cetacean fossils, though the mysticete (baleen whale) material has been limited by poor preservation and lack of description.

Despite partial crushing and major disarticulation from a backhoe, roughly 90% of the specimen was recovered, including a basicranium, fragments of the rostrum, vertebrae, ribs, and a majority of both flippers and mandibles. One tympanic bulla is still present in situ.

The new specimen is clearly a member of Balaenopteridae, based on possession of balaenopterid characteristics such as a slender, anterolaterally directed zygomatic processes of the squamosal, dorsoventrally flattened supraorbital process of the frontal, shape of cornoid process of the mandible, hatchet-like proximal process of the ulna, and hourglass-shaped phalanges. The specimen represents a distinct species due to the unique combination of morphological characteristics, such as the position of the foramen pseudovale within the squamosal and pterygoid, the exposure of the alisphenoid, and periotic and tympanic bullae features. The interdigitation of the bones of the temporal wall is a distinguishing characteristic among balaenopterids and in this specimen a distinct round exposure of the alisphenoid is present. Also present is a long exposure of the squamosal into the temporal region. Preliminary phylogenetic analysis positions the new fossil taxon within Balaenopteridae, in contentious relation to other extinct members of the clade.

This specimen also represents a young individual due to the spongy and unfused state of the epiphyseal plates of the long bones and vertebrae. Cetacean ontogeny has been an

area of recent research interest and this specimen adds to the growing list of subadult individuals recognized from the fossil record.

Technical Session II (Wednesday, November 5, 2014, 9:30 AM)

MAMMALS FROM THE MIDDLE JURASSIC OF WESTERN SIBERIA

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More than 350 mammalian specimens have been recovered to date from the Bathonian Itat Formation at Berezovsk Quarry, Krasnoyarsk Territory, West Siberia, Russia during the joint Russian-German field project in 2010-2013. This is the second largest Middle Jurassic mammal assemblage after that from the Bathonian Forest Marble Formation in England.

The haramiyidans are represented by two taxa. The more common is the eleutherodontid *Sineleutherus issedonicus*, which is very close to *S. uyguricus* from the Oxfordian Qigu Formation in Xinjiang, China. A distinctly larger new arboroharamiyid is known from few teeth. Numerous isolated upper haramiyidan incisors suggest that their diversity was possibly higher. The most diverse and abundant group are docodonts. The basal docodontan *Itatodon tatarinovi,* with carnivorous adaptations in the dentition, is the largest and rarest. The most common docodontan is the small simpsonodontid *Simpsonodon sibiricus*, which is very similar to *S. oxfordensis* from the Bathonian Forest Marble Formation of England. Next common is the medium-sized tegotheriid *Hutegotherium yaomingi*. Three isolated petrosals are referable to two different docodontan taxa and document the diversity of ear morphology in this group.

Eutriconodontans are represented by a single large gobiconodontid-like molar. Tooth fragments can be referred to a tinodontid symmetrodontan.

Several isolated teeth and jaw fragments have been assigned to the basal dryolestid *Anthracolestes sergeii* which is the oldest dryolestid taxon and the only known from Asia.

Two taxa of stem therians are represented by few isolated teeth and jaw fragments: a smaller cf. *Amphitherium* sp. and a larger *Amphibetulimus krasnolutskii*.

The mammalian assemblage from Berezovsk Quarry represents a complex paleocommunity consisting of plant-eating, possible frugivorous taxa (eleutherodontids and arboroharamiyids), insectivorous taxa (dryolestid, smaller stem therian, and the possible tinodontid), and insectivorous to omnivorous taxa (simpsonodontid and tegotheriid docodonts). Two large taxa, *Itatodon* and *Amphibetulimus*, were likely predators consuming a variety of invertebrates and small vertebrates. However, the largest species in the mammal assemblage is the new plant-eating arboroharamiyid. The Berezovsk Quarry mammal assemblage documents an important episode of the great Middle Jurassic mammalian radiation that followed the homogenous haramiyid-morganucodontan-*Kuehneotherium* Laurasian mammal fauna that was dominant during the Early Jurassic.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

NEW AMIID FISH FROM THE EARLY CRETACEOUS WETLAND OF LAS HOYAS AND ITS SYSTEMATIC IMPLICATIONS

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The description and systematic study of numerous specimens of amiiform fishes from the Early Cretaceous continental beds of Las Hoyas (upper Barremian, Cuenca, Spain) has revealed the presence of a new amiid taxon. The material had been previously referred to as *Amiopsis woodwardi*, a species firstly described from the Early Cretaceous (Berriasian-Valanginian) of El Montsec (Lérida, Spain), due to the overall similarity between both taxa. However, study of new material and revision of previously known specimens has shown that the new taxon differs from *A. woodwardi*. It is diagnosed by the following unique combination of characters: presence of three or more lateral fossae on most vertebral centra; a single articular element on the lower jaw; absence of suborbital bones; weak ornamentation on dermal skull bones; absence of scapulocoracoid ossification; a relatively short parietal with a high width-to-length ratio; 10 or fewer ural centra; crescent-shaped, long and narrow preopercle; labiolingually compressed caps of jaw teeth; posttemporal wider than long; a relatively narrow opercle. The inclusion of this new taxon into the current systematics of the amiiform fishes introduces some modifications. The new species from Las Hoyas appears as the sister-group to the subfamily Vidalamiinae, and is thus considered plesion Vidalamiinae. In turn, the subfamily Amiopsinae, previously interpreted as a monophyletic and monogeneric clade with several species, collapses and becomes paraphyletic. This pattern arises because the species of *Amiopsis* form a pectinate topology on all alternative most parsimonious trees, consequently forming a polytomy in the consensus tree. Therefore, the paraphyletic genus *Amiopsis* is in need of revision.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

THE POSTCRANIAL SKELETON OF *BRASILODON QUADRANGULARIS* (CYNODONTIA, PROZOSTRODONTIA) FROM THE LATE TRIASSIC OF BRAZIL

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The probainognathian cynodont *Brasilodon quadrangularis* and its closest allied *Brasilitherium riograndensis* (although considered to be a junior synonym by some authors), from the early Norian of southern Brazil, are the sister taxa of Mammaliaformes. Different from other cynodonts, they have a slender and low zygomatic arch; muzzle longer than the temporal portion of the skull; lack prefrontals and postorbitals; wide primary palate, posterior to choana; separated fenestra rotunda and foramen jugular; fused opisthotic and prootic (petrosal) with well-defined promontorium; foramen for the prootic sinus vein; quadrate with well-developed stapedial process; dentary reaching squamosal; position and relative size of the main crown cusps similar to morganucodontids with cusps e and g on middle postcanines; lower postcanines with a tongue (by cusp d) and groove-like (by cusps b and e) system, among others.

Postcranial bones of these taxa are by far poorly known and only a few remains have been briefly described yet. We focus our study on associated postcranial bones referred to a single specimen of *Brasilodon*, which includes a partial right scapula, left humerus, radii and ulnae, partial right pelvis, femora, partial right tibia and fibula, and phalanges, rib, and vertebral fragments. The scapula has a poorly developed acromion, placed higher in comparison to the glenoid, as in *Morganucodon*. The infraspinous fossa is large, the posterior edge is inflexed with a posterior postscapular fossa. The humerus is slender with a hemispheroidal head and distinctive greater and lesser tuberosities, lacking ectepicondylar foramen. The ulnar (smaller) and radial (larger) condyles are well-developed, subespherical, mainly disposed on the anterior surface and the radial condyle also with great contribution on the posterior one. The ulna has a well-ossified olecranon process. The pelvis has a large obturator foramen, with an apparent elongated iliac blade. The femur has a notorious hemispherical head, dorsomedially reflected, with greater and lesser trochanters separated by notches from the head. All these postcranial bones have a similar configuration to that of early mammaliaforms (e.g., *Morganucodon*, *Eozostrodon*). As many other cranio-dental features, the postcranial anatomy of *Brasilodon* reveals a unique pattern more closely related to mammaliaforms than to any other cynodonts, with similar ecological strategies (such as fossoriality).

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A PRELIMINARY HISTOLOGICAL ANALYSIS OF THE GENUS *ANCHITHERIUM* FROM SPAIN: DESCRIPTION OF THE BONE MICROSTRUCTURE AND BIOLOGICAL INFERENCES

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We present the first histological study on the genus *Anchitherium* to characterize its histological structure, to infer biological features of different populations, and to analyze the differences between *Anchitherium* and *Hipparion*. *Anchitherium* is an extinct horse originating in North America in the lower Miocene that migrated to Eurasia through the Bering Strait. In Spain, this horse characterized the lower and early middle Miocene faunas. *Anchitherium* was a browser horse characterized by three-toed autopodial and a small-medium size related to forest habitats. We have analyzed three *Anchitherium* species from the lower Aragonian sites of Spain (MN5), *A. castellanum* (Tajo Basin), *A. matritense* and *A. alberdiae* (both from Madrid Basin). Histological sections from the midshaft of metapodials were analyzed with bright light microscope. Bones are characterized by fibrolamellar bone tissue with a reticular vascular pattern in the inner cortical whereas the outer cortical shows longitudinal primary osteons in circumferential rows. This microstructural organization is similar to that observed in *Hipparion concudense* and the extant horses. However, we have observed interspecific differences with regard growth marks, lines of arrested growth (LAGs) and external fundamental system (EFS). *A. matritense* and *A. alberdiae* show a similar pattern of growth marks with two LAGs and EFS, which is also similar to that observed in *Hipparion*. On contrary, *A. castellanum* displayed a high variability in growth marks with specimens with one, two, or three LAGs and EFS. These data show differences in the growth pattern and life history among *Anchitherium* species that could be due to different environment. The particular development of *A. castellanum* could explain its particular morphological features associated to the tropical habitat such as the increase of the dentition size and the robust limbs. In addition, we have observed bone remodeling in the region related to the lateral metapodials as occur in *Hipparion*. Nevertheless, the distribution of secondary osteons differs between *Anchitherium* and *Hipparion* indicating biomechanical differences between both genera as result of changes in the role of the lateral metapodials in the locomotion. This study is funded by the CGL2010-19116/BOS of DGCYT and CMM is granted by a JAE-DOC contract (CSIC cofounded by the European Social Fund).

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

ASSESSING FORELIMB ADAPTATIONS IN CARNIVORANS: INFERENCES IN BOROPHAGINAE (MAMMALIA, CARNIVORA, CANIDAE)

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One of the most recurrent issues in carnivoran paleobiology is to infer locomotor behaviour and hunting style for extinct taxa. With this in mind, paleobiologists have studied the appendicular skeleton of carnivores in the search of morphological traits that reflect their ecological adaptations to different modes of locomotion, hunting strategies, or habitat occupation. In this study, we test which of these ecological aspects is better reflected in the morphology of carnivoran forelimb bones. Afterwards, we explore the functional implications of these morphological traits in order to estimate the adaptations of borophagine canids (Carnivora, Canidae, Borophaginae), because there are aspects of both the locomotor and hunting behaviour of this extinct canid subfamily that are still controversial.

To do this, we captured the shape of the humerus, radius, and ulna in a wide sample of extant carnivores using 3D-landmarks. We performed a series of Principal Components Analyses (PCA) of shape data. We also conducted Multivariate Analyses of Variance (MANOVA) from the resulting PCs to differentiate among hunting strategies, locomotor modes, and habitat occupation with each forelimb bone shape.

MANOVA tests showed that the morphology of the forelimb bones is better correlated with hunting strategies than with locomotion modes or habitat preference. The main morphological adaptations are involved in: *1*) increasing the energetic efficiency during locomotion (pounce/pursuit and pursuit hunters) or, in contrast, increasing the resistance to stresses (ambushers and occasional hunters); *2*) optimizing the parasagittal movement of the limb (pursuits) or increasing joint mobility (occasional hunters); *3*) increasing the mechanical advantage of the triceps brachii and hence enhancing its power in forearm extension (ambushers); and *4*) acquiring an upright posture (pursuers) or a flexed posture (ambushers).

Within this context, borophagines generally depict an intermediate morphology. They have a relatively robust humerus, although optimized for parasagittal movements, and their radius is slender, showing a low mobility in the elbow joint. All of this suggests that they were not as efficient runners as the living pursuit carnivores (e.g., canine canids and hyaenids) but they did not manipulate their prey as much as the modern ambushers do (e.g., felids).

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

STORK NEOICHNOLOGY FOR A BETTER UNDERSTANDING OF LARGE CENOZOIC ANISODACTYL BIRD TRACKS

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Anisodactyl bird tracks up to 15 cm long were discovered in the Oligocene subalpine Molasse near Schangnau (Central Switzerland). The tracks are preserved as natural casts and are characterized by slender, elongated digits generally in connection with a prominent central pad. Some of them exhibit a well-preserved hallux (digit I) impression, while others do not. This striking variation can be observed within trackways, suggesting that the presence or absence of the digit I impression is related to behavior (kinematics) of the trackmaker and/or substrate properties. This also implies that this feature is not necessarily useful in ichnotaxonomical diagnoses.

The Oligocene Swiss bird tracks with a preserved hallux impression are similar to the ichnotaxon *Gruipeda* characterized by the presence of three (dII-dIII-dIV) large, forward- and one (dI) spur-like, short, backward-directed digit impressions. Tracks without hallux impression and digits not connected to the central pad, however, more closely resemble ichnotaxa characterized by the lack of a hallux impression such as *Uvaichnites* from the Miocene of Spain.

During neoichnological experiments at Vogelpark Marlow (Berlin), white storks (*Ciconia ciconia*) walked slowly over prepared areas with two different kinds of sandy substrates. On compacted wet sand, the tracks are generally well defined with clear track walls, preserving small details even in shallow tracks. On loose dry sand, the tracks are less well defined due to a partial collapse of the walls. Some tracks lack a hallux impression and are clearly tridactyl and this variation also occurs along trackways.

3D models produced with photogrammetry of the modern stork tracks were compared to those of the Oligocene *Gruipeda*-type bird tracks from Switzerland and the Miocene *Uvaichnites* holotype from Spain. Generally speaking, the Swiss tracks are most similar to the stork tracks left on compacted wet sand, and are less similar to the stork tracks left on loose dry sand and to the *Uvaichnites* holotype.

It seems likely that the trackmaker of the Oligocene Swiss tracks was a ciconiiform bird similar to a modern white stork that left both tracks with and without hallux impression. To further confirm this hypothesis, we will carry out additional neoichnological experiments, also with other ciconiiform and gruiform birds (herons, cranes) to (1) expand the range of possible track morphologies and (2) test and quantify the influence of different behaviors (wading, perching, foraging) on track morphology (e.g., presence/absence of a hallux impression).

Education and Outreach Poster Session (Poster displayed November 5 – 8)

HOW DOES TAKING A CLASS WITH SKELETAL SPECIMENS MAKE STUDENT INTEREST CHANGE? SOME REPORTS OF PRACTICE COURSES WITH HANDS-ON SPECIMENS TO A HIGH SCHOOL AND COLLEGES IN JAPAN

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In museums and schools, the use of hands-on specimens makes participant interest increase. In vertebrate paleontology, fossils and skeletons are used as hands-on specimens.

But when their specimens are used for students not studying vertebrate paleontology, how do the students feel? Does their interest in vertebrate paleontology change? In this study, we held practice courses with skeletal specimens at a high school and two colleges in Japan, then conducted questionnaire surveys of these students.

We held the practice courses at Harima High School, Hyogo prefecture; Osaka College of Eco & Animals, Osaka prefecture; and Nagoya Communication Arts College, Aichi prefecture. 31 high school students were studying subjects for university entrance exams. 146 college students were preparing for jobs involving animals, such as breeding staff and dolphin trainer. Morphology, ecology, and evolution of marine mammals, especially dolphins and porpoises, were chosen as themes of these courses. For example, students compared skulls and forelimbs of marine mammals with terrestrial animals to understand their aquatic adaptations. Students in the lecture learned how to observe skulls of dolphins and porpoises mainly with hands-on specimens and tried to put disarticulated parts into whole articulated skeleton by themselves.

In the results of the questionnaires, almost all the students had touched skeletal specimens no times or a few times before the class. The majority of students had potential interests and positive images of skeletons. On the other hand, some students, especially at high school, had negative images of skeletons. This result might come from the background of each student.

Questionnaires after the lectures reveal that about 90% of students became more interested in bones than before. It may be that direct engagement with skeletal parts with their own hands made students feel strong affinities with specimens.

In the science curriculum of elementary and junior high schools in Japan, the students have little opportunity to touch skeletal specimens in class and to become interested in comparative morphology. As a result, some students have negative images of skeletons. In this study, the practice courses with skeletal specimens could remove this bad image from the students, and inspire them to take an interest in vertebrate paleontology. In the future, we will try to hold more practice courses and to make questionnaires for these activities in order to improve them.

Technical Session II (Wednesday, November 5, 2014, 8:45 AM)

EARLY CRETACEOUS TRACKS OF A LARGE MAMMALIAMORPH, A CROCODYLOMORPH, AND DINOSAURS FROM AN ANGOLAN DIAMOND MINE

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We report the first occurrence of mammaliamorph, crocodylomorph, and dinosaur tracks from the active Catoca diamond mine, northeast Angola. The tracks were preserved in a small sedimentary basin that formed in the crater of a kimberlite pipe, dated at about 118 Ma (mid Late Aptian), using the U-Pb method on kimberlitic zircon. Tracks, mud-cracks, ripple marks, and other sedimentary features indicate a shallow lacustrine depositional environment. Sixty-nine distinct crocodile-like and mammal-like tracks were recovered from the upper portion of a section 25–30 m thick. In addition, 18 dinosaur tracks were found nearby, one of which preserves a skin impression.

The best preserved tracks are interpreted as mammaliamorph based on a mesaxonic, functionally pentadactyl, and plantigrade morphology, digit length up to 1.5 cm, divergent central digits (II–IV), shorter and more divergent lateral digits (I and V), blunt digit tips, and no claw impressions. The track sizes, proportions, digit lengths and divarications are similar to the Late Triassic to Middle Jurassic ichnogenus *Ameghinichnus*; however, the average length of 2.7 cm and width of 3.2 cm suggest the track-maker was as big as a modern raccoon. Exceptionally large for its time, it is comparable in size to *Repenomamus*, the largest known Cretaceous mammal body-fossil, with a total length up to 68 cm. The tracks are much too large to have been produced by Early Cretaceous *Abelodon* from Cameroon, or the gondwanathere reported from Tanzania.

One trackway with 10 tracks is interpreted as crocodylomorph based on a mesaxonic, functionally tetradactyl and plantigrade pes and manus, medio-distally bent digits, and claw marks. Average manus length is 3.0 cm, width 3.4 cm; pes length 5.3 cm, width 3.7 cm. The manus is laterally rotated to 118° with respect to the pes. The narrow trackway has a manus pace angulation of 148°, and manus pace and stride lengths of respectively 13.9 cm and 23.8 cm; pes pace angulation is of 145°, and pes pace and stride lengths of respectively 14 cm and 25.1 cm.

Two narrow-gauge dinosaur trackways were also found. The larger-bodied one comprised four tracks with sub-round outline, no digits visible, footprint width up to 51 cm, one with skin impressions. The trackway stride length was between 150 cm and 170 cm and the width of 116 cm, thus interpreted as sauropod. The second trackway had 14 ellipsoid tracks and undertracks, with a pace length of 75 cm, making it unclear if was a smaller sauropod or a stegosaur.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

A CRIPPLED YOUNG WOOLLY MAMMOTH (*MAMMUTHUS PRIMIGENIUS*), FROM THE TAIMYR PENINSULA, RUSSIA: NEW DATA ON THE ONTOGENETIC DEVELOPMENT OF THE SPECIES

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The partial carcass of a male woolly mammoth, *M. primigenius* nicknamed 'Mammoth Zhenya' was found in 2012 on the Sopochnaya Karga Cape of the Yenisei River Gulf, the Taimyr Peninsula. The accelerator mass spectrometry date (bone) is about 45,000 yr BP. The articulated carcass preserved most of the skeleton, the right torso hide, fore and hind feet flesh, and some inner organs and their fragments. The specimen appears to be very important for calibrating developmental stages of the species skeleton maturation, which is yet poorly studied for the older juveniles, adolescents and sub-adults.

It has an unusual combination of dental and skeletal features, as well as abnormal molar development. The skull has all but the occipital bones fused. The cheek teeth (DP4 (ml)/M1 (m)) have normal wear development, with a more advanced (older) state than that of the mammoth Yuka (6–8 Indian Elephant years old), and younger than the Yuribei mammoth (10–12 IEYO), placing Zhenya at the 8–10 IEYO interval. The unerupted M2, which in normal individuals is composed of a higher number of plates than M1, contains unfused, rootless, and cementum-less clusters of 6–9 cones in the small alveoli.

The right permanent tusk (max curvature length 1,600 mm, max diameter 93.0 mm) had a very short pulp cavity; the left tusk was absent in the undeveloped alveoli with the abnormally small (about 25 mm in diameter) opening. The alveoli's size and asymmetry with the right tusk indicates that the tusk was not developed from the initial stages of the specimen's ontogenesis, or was gone shortly after replacing the calf's tush.

The axial and appendicular skeletal elements were developed normally, and no injuries were present on the bones. The cervical vertebral plates were not completely closed centrally, having from three-to-nine small holes (0.5–2 mm in diameter). The thoracic and lumbar vertebrae plates also had nutritional openings (up to 2 mm in diameter) in central parts.

The condition of the Zhenya skeleton (unfused vertebral neural arches, all vertebral plates, sacral vertebrae, and all but the distal humerus epiphyses of long bones; not completely ossified apophysis of rib heads and spinal processes of the thoracic vertebrae; and un-ossified apophyses of the transverse processes of all vertebrae) indicates an older juvenile specimen, with most of the bones still growing. The cause of the death has not yet been determined, but the individual age and the deposits where the carcass was found (peat lense), might suggest for fatal entrapment of the young and unexperienced individual roaming alone.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

THE LATE TRIASSIC OF JAMESON LAND REVISITED: NEW VERTEBRATE FINDINGS AND THE FIRST PHYTOSAUR FROM GREENLAND

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An expedition to Jameson Land (East Greenland) was conducted in July of 2012, involving twelve researchers and technicians from Denmark, Germany, and Portugal. The fieldwork focused on two sites: Lepidopteris Elv and Macknight Bjerg, both within the Norian-Rhaetian Malmros Klint and Ørsted Dal Members of the Fleming Fjord Formation.

One of the main findings include partial phytosaur skeletons at Lepidopteris Elv (middle Malmros Klint Mb, ~211-210 Ma, Norian), including well preserved cranial and postcranial elements. Disarticulated skull material includes the mandible, jugals, postorbital, angular and quadrate. Many axial and appendicular bones were collected. Considering size ranges and duplication of bones, the phytosaur material pertains to at least to four individuals and three size ranges. Most bones are adult size with an estimated body length of about 3.8 m, including three identical humeri of the same size (two left and one right side, between 255 and 264 mm) that provide evidence for at least two individuals.

Three complete dorsal neural arches and one centrum, all with unfused open neurocentral sutures, and an anterior part of a dentary about 63 mm long show the additional presence of an animal with 1-2 m body length. The third and smallest body size is deduced from a complete left scapula only 34 mm in length, corresponding to a body length of 45 to 55 cm. This totals four individuals. These are the first well documented phytosaurs in Greenland because bones of previous expeditions belong to temnospondyls.

The prosauropod *Plateosaurus* site found in the 1990s at Macknight Bjerg (top of Malmros Klint Mb) was excavated. The number of bones and their relative size indicate that more than one individual and body size is present.

A new basal Testudinata specimen, very fragmented due to solifluction, was also collected at Macknight Bjerg (Ørsted Dal Mb). The suture pattern of the carapace shows a basal condition and cf. *Proganochelys* was previously documented to the area.

Numerous theropod tracks were revisited and additional tracks were found: cheirotherid tracks at Lepidopteris Elv (Ørsted Dal Mb)and large sauropod and prosauropod tracks in outcrops near Macknight Bjerg.

A new locality, ″Burned Paper-Shale site″, at the base of the Rhaetian Kap Stewart Fm yielded numerous coprolites, shark remains, and temnospondyls. The faunal list is similar to fossil localities in Central Europe and may indicate the typical vertebrate assemblage in a stable Late Triassic terrestrial ecosystem.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

THE OLDEST RECORD OF *PALEOPARADOXIA* FROM THE NORTHWEST PACIFIC AND ITS IMPLICATION ON THE EARLY EVOLUTION OF PALEOPARADOXIINAE (MAMMALIA, DESMOSTYLIA)

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Paleoparadoxia is an extinct marine mammal taxon belonging to Paleoparadoxiinae and has been found from the lowest through lower upper Miocene. The basal paleoparadoxiine *Archaeoparadoxia* was found from the lowest Miocene (23–20.8 Ma) in the Northeast Pacific and *Paleoparadoxia*, one of the derived paleoparadoxiines, had been reported from the lower Miocene (18–17 Ma) in the Northwest Pacific. Here we report new material of *Paleoparadoxia* found from Hokkaido, Japan, in the Northwest Pacific, which are considerably older than the previous records of this genus. The material consists of a proximal part of the scapula and a proximal end of the humerus from the left side, as well as a fragmentary rib, preserved in a float of calcareous fine sandstone. The specimen is referred to Desmostylia based on diagnostic characteristics such as a straight humeral body and an unexpanded deltoid ridge. We identified this new specimen as an adult *Paleoparadoxia* sp. based on such characteristics as the greater tubercle extending toward the proximal side above the head and the distinct lesser tubercle located on medial side projected medially, which we newly identified as characteristics diagnostic of the genus *Paleoparadoxia* based on comparisons of a wide range of desmostylid specimens.

The float contains diatoms, molluscan shells, and wood fragments. The lithology and associated fossil fauna of the float suggest that it was derived from the lower Miocene Sankebetsu Formation outcropping in the area where it was found. The published age estimate of the formation indicates that the age of the present specimen falls within a range between 23.8 ± 1.5 and 20.6 ± 1.0 Ma. This represents the oldest record of *Paleoparadoxia* presently known, also nearly matching the oldest record of Paleoparadoxiinae in the Northwest Pacific. This indicates that the currently-known oldest occurrences of basal and derived paleoparadoxiines (i.e., *Archaeoparadoxia* from the Northeast Pacific and *Paleoparadoxia* from the Northwest Pacific, respectively) overlap in age. Accordingly, it is likely that the geographic range of Paleoparadoxiinae had already expanded from the Northeast to Northwest Pacific in the early stage of evolution of this clade.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

FUNCTIONAL MORPHOLOGY OF THE PALATAL DENTITION IN THE REPTILIAN GROUP, CHORISTODERA

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Within amniotes, palatal teeth and palatal rugae have an important role in holding food within the mouth as it is manipulated by the tongue and jaws. During feeding, the tongue and palate cooperate in gripping, intra-oral transport, and swallowing, thus modification of the palatal surface should reflect changes in feeding behavior and/or changes in the anatomy of the oral soft tissues. There is a general acceptance that a full palatal dentition is plesiomorphic for amniotes, and a review of palate structure across tetrapods shows a general trend toward reduction or loss of the dentition in derived members of most major lineages. The challenge is then to provide an explanation, in terms of diet and/or feeding strategy, for changes in this important gripping surface.

Freshwater choristoderes differ from most tetrapod groups in retaining a palatal dentition in even the most derived taxa. Detailed examination of several genera shows that the orientation of the palatal tooth crowns changes with their position on the palate, supporting the view that they are involved in intra-oral food transportation, presumably in combination with a fleshy tongue. Moreover, observed variation in palatal tooth shape and the width of palatal tooth batteries may provide additional clues about diet, and therefore about niche segregation where two or more species co-occur. A study of the extant fish (*Cichlasoma*) found a correspondence between palatal tooth morphology and diet: those with pointed teeth showed a greater preference for soft prey than those with more robust rounded teeth. Relating this to choristoderes, the European *Simoedosaurus lemoinei* has sharper palatal teeth than its North American counterpart, *S. dakotensis,* suggesting a preference for softer prey: a conclusion consistent with the more gracile teeth and narrower snout. Similarly, juveniles of C*hampsosaurus lindoei* have sharper palatal teeth than adults, indicative of a dietary shift during ontogeny from soft to harder prey, as in modern crocodiles.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A MULTI-DIMENSIONAL LOOK AT MORPHOLOGICAL VARIATION IN ICHNOFAUNA: TRACKING CHANGES WITHIN AND BETWEEN ICHNOTAXA

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Categorizing fossil footprints according to ichnotaxa can be problematic due to a number of variables, including the diversity of trackmakers, dynamics of the biomechanical interaction of foot and substrate, variations in type and consistency of substrate, preservational dynamics, and subsequent erosional processes. In addition, traditional methods of data collection and comparison have largely been limited to 2D drawings and landmark analysis in which a limited number of tracks (occasionally only an isolated footprint) and track features are characterized, often making assignment of ichnotaxa problematic. However, increased availability of dense 3D point cloud data combined with low cost or open source point cloud registration and triangular meshes software supports quantitative comparison of 3D footprint data and provides an additional avenue for the assignment of ichnotaxa.

In order to improve understanding of variability among ichnotaxa, it is important to first understand the morphometric variability within a particular ichnotaxon, especially that preserved in a single trackway or by an individual track. 3D data sets and analysis software are used to quantify the variability of ichnites within a single locality, a single trackway, or within the preservational layers of a single footprint. Photogrammetry (deriving a 3D point cloud from a series of overlapping stereo photographs) has proven to be a highly accurate and cost-effective method for capturing data. These data sets can be created not only for individual tracks, but for entire trackways in a matter of hours. Over the past 15 years photogrammetric image sets have been captured of tracksites from around the world by a number of researchers. Now via cloud computing these datasets are shared and analyzed to determine within locality morphometric variations. Once locality morphometric variations are quantified, sets of footprints within ichnotaxa are examined from various localities and shed light on quantified variation and parameters for comparison between ichnotaxa. Dinosaur ichnotaxa at sites within the United States (e.g., Wyoming, Colorado, and Utah) were analyzed and compared with analogous sites within the United Kingdom (e.g., Isle of Wight and Isle of Skye) and Germany (Lower Saxony). Increasing our understanding of locality morphometric variations through the use of photogrammetry and 3D surface analysis software expands our understanding of ichnofaunal communities and their interrelationships around the world.

Symposium 3 (Friday, November 7, 2014, 8:00 AM)

INCORPORATION OF ABSOLUTE AND RELATIVE FOSSIL DATING INFORMATION IN BAYESIAN TIP-DATING ANALYSES USING THE R PACKAGE BEASTMASTERR: EXAMPLES FROM ASSASSIN SPIDERS, SALMONIDS, AND HOMINIDS

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Until recently, Bayesian phylogenetic dating analyses (e.g., in the program BEAST) used fossils only to inform prior distributions on the dates of certain nodes (‘node-dating‘) in molecular phylogenies; the fossil data was effectively ‘thrown away‘ in subsequent analysis of the dated, molecules-only tree. However, recent advances allow simultaneous inference of dating and the phylogenetic position of dated fossils (‘tip-dating‘). Tip-dating has great potential to increase the use of hard-won paleontological data in phylogenetics: dated fossil tips represent direct observation of character states at particular times, and these inform the estimation of rates of character evolution, divergence times, and allow direct inclusion of fossils in phylogenetic comparative methods. Tip-dating raises numerous theoretical issues concerning priors and models, and exploration of these issues has been limited by the practical difficulty of implementing different models in BEAST. To aid this research, we present BEASTmasteR, an R package that can convert standard NEXUS files into BEAST XML files. BEASTmasteR also produces XML Bayesian hierarchical models encoding absolute or relative dating information, including: (1) fossil tips with uncertain dates (e.g., date-ranges based on stratigraphic bins, or distributions derived from radiometric dates); (2) relative dating information for tips (e.g., in some cases two fossils from the same deposit have

approximately the same date, despite their absolute date being uncertain; or one fossil may be known to be older than another); and (3) relative dating information for nodes with linked dates. These approaches are demonstrated on several invertebrate and vertebrate datasets. In assassin spiders, inclusion of amber-preserved fossils as tips supports divergences consistent with ancient Gondwanan vicariance. In salmonids, inclusion of *Eosalmo* as a tip suggests that genome duplication preceded the evolution of anadromy by 45–60 My. In hominids, linking nodes of a gene tree/species tree analysis to a fossil tip-dated phylogeny inferred a human-chimp divergence at 4.38–5.54 Ma, while a morphology-only analysis yielded 4.5–8.95 Ma.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

ORIGIN AND EARLY EVOLUTION OF MAMMAL ACROSS THE TRIASSIC–JURASSIC TRANSITION: NEW LIGHT FROM MORGANUCODONTS

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New data on the morganucodonts from Saint-Nicolas-de-Port (Rhaetian, France) shed new light on the evolutionary history of this mammalian order form the Upper Triassic through Lower Jurassic. First, morganucodonts are the most diversified Rhaetian mammals with at least eleven species, which are contemporaneous to six species of "symmetrodonts" and six species of haramiyids. All these Rhaetian morganucodonts are restricted to Europe, which supports it was their centre of initial diversification. Second, in addition to *Morganucodon*, three morganucodont genera are currently recorded before and after the Triassic–Jurassic boundary, i.e., across one of the Big Five biological Phanerozoic crises. This indicates that morganucodonts were little or not affected by the Triassic–Jurassic extinction event. European faunas emphasize some general trends in the evolutionary history of Triassic mammals. Before the Rhaetian, mammals are much less diversified. In the Norian, morganucodonts, "symmetrodonts" and haramiyids were found together (in Europe) but are represented by one or two species.

This supports that the first radiation of mammals began before the T/J event and continued to develop across it, although our fossil knowledge on this early key step of mammalian evolution remains weak.

Technical Session XIV (Saturday, November 8, 2014, 11:45 AM)

A NEW ICHTHYOSAUR FROM THE MIDDLE JURASSIC OF GERMANY PROVIDES INSIGHTS INTO THE ASSOCIATION BETWEEN LIMB FORM AND FUNCTION

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Loss of proximodistal regionalization in the forelimb of ichthyosaurs is associated with the evolution of flippers. The diaphysis of the distal limb elements is gradually reduced via delayed perichondral ossification to a small series of notches on the anterior edges of the bones in the most anterior digit, and is lost completely in the youngest clade, Ophthalmosauridae. This trend has led to the argument that the retention of an ossified diaphysis is a primitive characteristic. A new ichthyosaur from the Middle Jurassic of Germany provides insight into possible functional underpinnings of this trait. The new taxon is based on a single large individual comprising the skull, partial vertebral column, pectoral girdle, forelimbs, and proximal hind limb. Parsimony analysis places it near the base of the Neoichthyosauria based on characteristics of the braincase and temporal region, suggesting a close affinity to the Early Jurassic genus *Suevoleviathan.* However, *Suevoleviathan* and the new taxon differ in flipper structure. *Suevoleviathan* has a broad, palmate forelimb, and diaphyseal ossification is absent in the distal limb. In the new taxon, the flipper is narrower than in *Suevoleviathan* and the diaphyses are retained on the anterior edges of the bones of the most anterior digit. We tested the association between flipper shape and diaphyseal ossification in parvipelvian ichthyosaurs by examining the relationship between flipper aspect ratio, as measured by the ratio between maximum length and chord of the limb skeleton, and the number of elements with ossified diaphyses in 19 neoichthyosaurian ichthyosaurs using independent contrasts. We recovered a significant relationship between the two variables, with long, narrow flippers having a higher number of elements retaining ossified diaphyses than shorter, broader flippers. Thus, flipper aspect ratio, a highly adaptive trait relating to locomotion and maneuverability, may directly influence diaphyseal ossification independent of phylogenetic relatedness. We suggest that pressure along the leading edge of the limb in taxa with high aspect ratio flippers induces diaphyseal ossification. These findings contradict the historical view of diaphyseal reduction over evolutionary time being a progressive process without functional correlates, and suggests that a locomotor shift favoring short, broad flippers is responsible for the loss of diaphyseal ossification in ophthalmosaurids and may be related to their taxonomic dominance in the Late Jurassic and Cretaceous.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

TRACKING DINOSAURS ALONG THE YUKON RIVER: A NEW DINOSAUR-DOMINATED ICHNOFOSSIL ASSEMBLAGE FROM THE MID-CRETACEOUS ARCTIC OF ALASKA

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Globally, only a handful of formations provide information on the diversity and distribution of dinosaurs from high paleolatitudes. Two of the best-known high latitude sites occur in Alaska: the Prince Creek Formation on the North Slope and the Cantwell Formation in Denali National Park and Preserve. While both of these localities record valuable information on terrestrial Arctic ecosystems from the very latest Cretaceous (Campanian–Maastrichtian), data from stratigraphically older sites have been largely absent. Recent fieldwork conducted by the University of Alaska Museum documents a diverse assemblage of dinosaur tracks along the Yukon River in west-central Alaska. The fossils occur in an undifferentiated, mid-Cretaceous (Albian–Cenomanian) sedimentary unit that crops out along a 200 kilometer river corridor. Discontinuous exposures in this area represent shallow marine prodelta, prograding shoreface/delta front and non-marine delta plain and coastal plain depositional environments. Non-marine sub-environments, which contain the majority of the dinosaur tracks, include meandering rivers, levees, crevasse splays, small lakes and ponds, coal swamps and floodplains. Paleomagnetic data indicate the basin was deposited above the paleo-Arctic Circle. Dinosaur tracks within the unit are common and are primarily preserved as natural casts, some of which preserve impressions of integument. A preliminary analysis of the ichnofossil assemblage reveals the presence of several track morphotypes, the most abundant of which are ornithopods, as well as ankylosaurian and potentially other ornithischian taxa. Small to medium-sized tridactyl theropods are also found, along with an unusual tetradactyl morphotype. Finally, we report the first documented occurrence of sauropod tracks in Alaska that likely represent the northernmost occurrence of the group in North America. To date, skeletal remains of dinosaurs and other vertebrates are unknown from this unit. However, a well-preserved paleobotanical assemblage co-occurs with the tracks. The new ichnofossil assemblage fills a major geographic and temporal gap in arctic ecosystems in the Cretaceous.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

NEW MATERIALS OF *PETROLACOSAURUS KANSENSIS* (DIAPSIDA: ARAEOSCELIDAE), THE EARLIEST KNOWN DIAPSID FROM THE UPPER PENNSYLVANIAN OF KANSAS, PROVIDE INSIGHT INTO EARLY TETRAPOD MORPHOLOGY AND LOCOMOTION

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The oldest known diapsid *Petrolacosaurus kansensis*, from the Late Pennsylvanian of Kansas, was first described on the basis of a single hind limb. A subsequent reevaluation employed nine poorly preserved, mostly juvenile specimens, including a partial skull preserved in palatal view. At that time, it was suggested that *Petrolacosaurus* was a primitive diapsid, but this identification was not generally accepted due to the lack of sufficient adult cranial material. Additional fragmentary skeletons were collected during the next two decades, including several better-preserved, mostly disarticulated partial skulls, making a more convincing diagnosis and a more complete description possible. Subsequent excavations have resulted in the collection of large numbers of blocks and the discovery of additional amniotes, including the synapsids *Haptodus, Ianthasaurus,* and *Ianthodon*, as well as other, yet to be described amniotes. Preparation of these blocks has also yielded a number of new specimens of *Petrolacosaurus*, including a nearly complete mature skeleton, providing an opportunity to analyze the anatomy and body proportions in individual specimens, as well as data for an examination of limb proportions in a limited ontogenetic sequence. For example, the new material confirms that *Petrolacosaurus* is distinct from most other early amniotes in having humeri and femora of similar lengths, although the former is much more gracile than the latter. In addition, the zeugopodia (radius, ulna, tibia, and fibula) are similar in length to their respective stylopodia (humerus, femur), suggesting that these proportions may be related to increased agility in this basal diapsid reptile. Interestingly, comparisons of long bone lengths and diameters in juvenile and adult specimens indicate that these parts of the skeleton grew in a fashion that cannot be differentiated from isometry, suggesting that no changes in locomotory strategies occurred during ontogeny.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

NEW SNAKES FROM THE OLIGOCENE OF THE FAYUM REGION OF EGYPT PROVIDE A FIRST GLIMPSE AT THE EOCENE-OLIGOCENE EXTINCTION IN AFRICA

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The Eocene marked an early high point in ophidian diversity, with many well documented faunas known from North America and Europe. This diversity declined precipitously through the latter part of the Eocene in North America and in the terminal Eocene extinction in Europe. Snakes in the Oligocene tended to be small and had morphology consistent with a fossorial lifestyle, but booids remained the dominant forms. Missing data in the fossil record of other continents means that the occurrence and timing of these extinctions are not known. In Africa, the Paleogene record for snakes is particularly poor, obscuring any large scale trends. Recent collections from several localities in the Eocene Birket Qarun Formation and the Eocene-Oligocene Jebel Qatrani Formation in the Fayum region of northern Egypt permit comparison of Eocene and Oligocene snakes from a geographically limited region.

The Fayum Eocene fauna from locality BQ-2 is largely similar in makeup to those known contemporaneously from elsewhere in the world. It includes the madtsoiid *Gigantophis*, the palaeophiid *Pterosphenus*, three booid-grade snakes, and two caenophidians. Of some note is the relative importance of caenophidian material (comprising 15% of the collection), but the most prevalent morphotypes are a medium-sized booid and *Pterosphenus*. In contrast, the Oligocene material includes only three morphotypes, all of which are booid-grade snakes. Unlike European and North American material, none of the Fayum Oligocene snakes show morphology typical of burrowing snakes; furthermore, one of the species was relatively large. Two of the Oligocene morphotypes are effectively indistinguishable from their counterparts in the Eocene, indicating survival across the boundary. Conspicuously absent as compared to the Eocene fauna are *Pterosphenus* (extinct worldwide at this time), *Gigantophis* (madtsoiids were restricted to Australia after the Eocene), and the caenophidian snakes. As in Europe and North America, the Fayum material shows a drop in overall numbers and diversity in the Oligocene versus the Eocene. However, it also reveals distinctly different ecology in northeast Africa versus Europe and North America, with no known fossorial snakes and one large species. Further explorations like this one at other localities will help to produce a fuller understanding of how the African snake fauna changed through time, and

clarify the origins of the modern assemblage. Funding was provided by the Leakey Foundation and National Science Foundation grants BCS-0819186 and BCS-0416164.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

REASSESSMENT OF ORNITHOMIMID MATERIAL FROM THE MILK RIVER FORMATION AND LOWER BELLY RIVER GROUP OF CANADA WITH IMPLICATIONS FOR ORNITHOMIMOSAUR PALEOBIOGEOGRAPHY

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Ornithomimids are among the most common theropod dinosaurs in the Upper Cretaceous Belly River and Edmonton groups of Alberta. Multiple articulated skeletons have been described from the Dinosaur Park and Horseshoe Canyon formations. The paleobiogeographic history of ornithomimids in the Late Cretaceous of Laramidia is poorly understood, with a long gap between the North American record of Early Cretaceous possible ornithomimosaurs and the well-known Late Cretaceous taxa. In Alberta, no articulated ornithomimid skeletons have been collected to date from the lower part (regressive phase) of the Belly River Group (Foremost and Oldman formations) or the older terrestrial dinosaur-bearing sediments of the Milk River Formation. Occurrences of ornithomimids in these units are based on identification of isolated bones and are largely unsubstantiated records in faunal lists, without verification. The only described specimen previously referred to Ornithomimidae from the Milk River Formation, a small pedal phalanx, differs from all known ornithomimid phalanges in the shape of its proximal and distal ends. It more closely resembles a pedal phalanx from a small, gracile-footed basal ornithopod in the combination of a well-defined, triangular hyperextensor pit on the dorsal surface with slightly asymmetrical distal condyles divided by a deep intercondylar groove. Additional material catalogued as Ornithomimidae from the Milk River, Foremost, and Oldman formations was reviewed in a thorough search of museum collections and databases, but much of the material examined (largely consisting of phalanges or phalanx fragments) could not be definitively referred to this clade. The presence of Ornithomimidae in the Oldman Formation is supported on the basis of pedal phalanges from the Dinosaur Provincial Park and South Saskatchewan River areas, including a characteristic straight, triangular pedal ungual. Given the intensive sampling in the Milk River and Foremost formations, and a similar biostratigraphic distribution reported for southern Laramidia (in Utah, ornithomimids are abundant in the Kaiparowits Formation, and unreported from the Wahweap Formation), it is suggested that the Late Cretaceous ornithomimid clade did not migrate into Laramidia until the beginning of the late Campanian. An ornithomimid ankle from the Dinosaur Park Formation displays a character state previously considered autapomorphic of *Qiupalong henanensis*, supporting the close relationship between this Asian taxon and the late Campanian ornithomimids of Alberta.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

PLESIADAPIFORM BIOGEOGRAPHY DURING THE PALEOGENE OF NORTH AMERICA

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Dispersal events played a significant role in shaping the evolutionary trajectories of plesiadapiform clades in North America during the Paleogene. The effect of geographic range on survivorship is a well-documented phenomenon in extant biota. This phenomenon is more difficult to study in the fossil record owing to preservation bias. However, plesiadapiforms are currently known from more than 600 localities in North America, representing about a two-fold increase over the last 20 years of exploration and publication. Here we examine patterns of geographic distribution on taxonomic survivorship at the family and superfamily (i.e., clade) level in North America plesiadapiforms. ArcGIS was used to calculate the minimum convex polygon associated with sets of coordinates for each family or clade per biochron. Generic diversity was estimated using data from the literature and museum records. At the family level, there is a positive correlation between geographic range and diversity for plesiadapids, carpolestids, and micromomyids, but not for picrodontids, paromomyids, palaechthonids, and microsyopids. For clades, there is a positive correlation between geographic range and diversity for Paromomyoidea and Plesiadapoidea, but not for Microsyopidae + Purgatoriidae. Diversity and range profiles were also examined to identify temporal offsets between range expansion and increases in diversity vs. a synchronous range expansion and diversity increase. Offsets are seen at the clade level at different points in the Paleogene, but not at the family level with the possible exception of the palaechthonids. Identification of patterns above the species level is important for understanding processes affecting taxonomic survivorship in plesiadapiforms during background periods and periods of increased turnover that occurred during the Paleogene in North America.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

ECOMORPHOLOGICAL VARIATION IN CAMELID POSTCRANIA FROM JUNTURA (CLARENDONIAN, ~9MA)

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Understanding the paleoecology of a region requires, in part, identifying its vertebrate fossils. Craniodental material usually provides the best basis for identification, but postcranial bones (e.g., astragali) are often preserved in greater abundance. Postcrania are abundant and relatively well-preserved in the Juntura fauna of eastern Oregon (Clarendonian, ~9Ma). Juntura is interesting as the only abundant Clarendonian-age fauna in Oregon's otherwise extensive Oligo–Miocene terrestrial record and one of a relatively small number of well-preserved faunas of this age across North America. While it has been well-described already, the most abundant large mammals in the Juntura fauna, the camelids, are currently identified only tentatively to genus level. We apply discriminant analysis to refine these previous camelid identifications, focusing on the abundance of metapodials. Discriminant analysis suggests the presence of four genera: *Hesperocamelus*, *Aepycamelus*, *Megatylopus*, and *Procamelus*. The Juntura camels show unusual scaling in multivariate space relative to the contemporaneous training set, however, suggesting that the Juntura fauna may have unsampled taxa or perhaps different ecotypes.

To clarify this issue, we also measured available camelid teeth and jaws from Juntura and contemporaneous faunas that show characters typical of both *Megatylopus* and *Procamelus*,but large size differences within both hypothesized genera. Our results suggest that there may be a previously unrecognized diversity of camels in this critical site, and furthermore that the many other sites where camels have been left unidentified (as is common in the Miocene of North America) may also conceal additional cryptic diversity. Our results also offer a potential for understanding the source of some of the confusing patterns of camel diversity; postcranial and cranial elements suggest different numbers of taxa, consistent with confounding effects of sexual dimorphism. Our findings improve the picture of mammalian diversity at Juntura, contributing to a clearer reconstruction of paleoecology in the Miocene of Oregon.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

LACK OF A PHYLOGENETIC SIGNAL IN THE OSTEOHISTOLOGY OF TEMNOSPONDYL PROPODIAL ELEMENTS

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Temnospondyl amphibians are a large and diverse group of early tetrapods, whose osteohistology has traditionally been examined in individual, taxon-specific studies. This analysis brings previous studies together to determine the amount of phylogenetic signal present in propodial bone microstructure across the temnospondyl tree of life. Propodials were selected for comparison in this analysis as they are the most widely represented skeletal element in temnospondyl paleohistologic studies. In addition to incorporating existing temnospondyl paleohistological literature, humeri of *Micropholis stowi* and *Lydekkerina huxleyi* from the Karoo Basin of South Africa (Katberg Formation) were sampled for paleohistological analysis. Diaphyseal bone histology of both taxa exhibits a convergence to fibrolamellar tissue and an absence of lines of arrested growth; additionally, medullary cavities free of trabeculae support a terrestrial lifestyle in both *Micropholis* and *Lydekkerina*. The presence of azonal tissue in *Micropholis* is unlike that of other dissorophoids or extant caudatans, suggesting an adaptation to local conditions in the Early Triassic of the Karoo Basin, as well as a complicated and understudied pattern of histological evolution in dissorophoids.

To assess bone microstructure evolution in the propodials of temnospondyls, paleohistology was described though five histological characters possessing discrete character states. The evolution of these histological characters was assessed using three independently derived broad-scale phylogenetic hypotheses of Temnospondyli. Results show a convergence towards sustained, non-cyclical growth and an absence of lines of arrested growth in the propodial diaphyses of all sampled Early Triassic temnospondyls. The optimization of histological traits on the three separate phylogenetic hypotheses is equally parsimonious between different topologies. Homoplasy among histological characters suggests that phylogenetic constraint in this group is overshadowed by developmental plasticity in bone microstructure, potentially due to environmental and biomechanical constraints.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

FOSSIL FISHES FROM THE JETMORE CHALK MEMBER OF THE UPPER CRETACEOUS GREENHORN LIMESTONE IN NORTH-CENTRAL KANSAS, U.S.A.

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The Jetmore Chalk Member of the Greenhorn Limestone is a Late Cretaceous rock unit deposited under the Western Interior Seaway in North America. The Jetmore Chalk, together with the overlying Pfeifer Shale Member of the Greenhorn Limestone, represents deposition during the maximum transgressive phase of the Greenhorn Cyclothem during the early Turonian. Whereas various fossil invertebrates are known from the Jetmore Chalk, the taxonomic composition of its vertebrate fauna is poorly known. Recently, remains of fossil fishes were recovered from a Jetmore Chalk locality in west-central Washington County, Kansas, U.S.A. through surface collecting in the field and acid treatment of weathered chalky rocks in the laboratory. Our study resulted in recovery of over 250 isolated teeth comprising a minimum of seven chondrichthyan taxa and nine osteichthyan taxa. They include: *Ptychodus* cf. *P. whipplei*, *Cardabiodon* sp., *Cretoxyrhina mantelli*, *Squalicorax* cf. *S. falcatus*, *S.* cf. *S. pawpawensis*, Scyliorhinidae indet., *Rhinobatos* sp., *Hadrodus* sp., Caturidae indet., Actinopterygii (non-teleostean) indet., Plethodidae indet., *Xiphactinus audax*, *Pachyrhizodus minimus*, Albulidae(?) indet., *Enchodus gladiolus*, and *E. shumardi.* Whereas the most common vertebrate fossils collected in our study are teeth of Caturidae indet., represented by slightly over 120 teeth, other fossil remains include nearly 100 isolated placoid scales of Elasmobranchii indet., numerous isolated vertebrae of various teleosts, and several small phosphatic pebbles thought to be coprolites of uncertain origins. The abundance of vertebrate remains by specimens and by taxa revealed through our study is rather surprising given that rocks of the Jetmore Chalk appear to be scarce or depauperate in the field. In particular, the large number of caturid teeth, as well as the discovery of scyliorhinid and *Rhinobatos* teeth from the Jetmore Chalk were not necessarily predicted prior to our study, indicating that there is still much to be learned about the paleoecology and evolution of the Late Cretaceous Western Interior Seaway of North America.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

THE UTILITY OF POSTCRANIAL BONES IN DISTINGUISHING TAXA AND SEXES IN MODERN ARTIODACTYLA AND THE IMPLICATIONS FOR PLACEMENT OF PALEOMERYCIDAE WITHIN ARTIODACTYLA.

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Historically, most descriptions of fossil and modern skeletal material have concentrated on cranial and dental material. Unfortunately, not all fossil localities yield adequate samples of craniodental remains, necessitating identification of taxa from postcranial material. In addition, postcrania offer the potential to diagnose genera, species, and even sexes in taxa that have poorly diagnostic dental material. In particular, a better understanding of postcranial morphological variation in extant artiodactyls should facilitate overall phylogenetic placement of the family Palaeomerycidae, as well as clarifying generic and specific diagnoses within the group. Originally considered a sister to Cervidae, later work on ankle morphology has suggested the palaeomerycids are instead sister to Camelidae. Adding confusion, the headgear of paleomerycids is more similar to the ossicones of giraffids than to the antlers of cervids. However, our morphometric comparison of cervids, bovids, camelids, antilocaprids, and palaeomerycids finds the astragalus, cubonavicular, and calcaneum to actually be most similar between cervids and palaeomerycids. Interestingly, this similarity holds true despite cervid postcrania having the greatest sexual size dimorphism of all modern artiodactyls sampled, with means varying by 5 to 10% between sexes. This dimorphism suggests the possibility of artificially inflated taxonomic diversity in the palaeomerycids from the misdiagnosis of different sexes as discrete species or even genera. This study underscores the utility of postcrania for diagnosing species. We found the cubonavicular to be the most useful for distinguishing among modern taxa in a discriminate function analysis, followed by the astragalus and calcaneum. This result is promising for application to paleontology as these compact and dense bones survive fluvial transport well and are common components of collections.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A REGIONAL APPROACH TO EAST AFRICAN EARLY MIOCENE PALEOBIOLOGY

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Early Miocene deposits in East Africa provide the richest evidence about the origin and early diversification of the hominoid clade. Yet, critical questions about the adaptive morphology and phylogeography of early apes and their catarrhine primate contemporaries cannot be answered from the perspective of any one fossil site. On the contrary, locality density, taxon diversity, depositional variation, and temporal depth in East Africa provide a unique opportunity for assessing broad patterns in biological evolution across both geographic and chronological ranges. For this reason, we established a research consortium designed to fully develop a regional geochronology, paleoecology, paleoenvironment, and biogeography of early Miocene fossil localities in East Africa (REACHE).

Here we report results from the first year of the REACHE project. New fossils from Karungu expand the catarrhine community from this locality, and include important new mammal species that inform our understanding of the paleoenvironment. Reconnaissance at the Napak volcano resulted in the discovery of new fossil localities, and recently discovered specimens from Moroto reveal new evidence for the locomotor behaviors of *Morotopithecus*. Preliminary work in the Tinderet region re-located most of the primary fossil sites and revealed several new ones, resulting in thirty new primate specimens. Likewise, Buluk produced more than 50 new fossil primates providing the most comprehensive evidence of cercopithecoid and hominoid sympatry. Discoveries at West Turkana document the first known skeleton of the enigmatic ape *Simiolus*. Together, these results greatly expand our knowledge of early Miocene catarrhine paleobiology, and lay the groundwork for important geochronologic, taphonomic, and paleoecological analyses in upcoming years. This work was funded by the National Science Foundation (BCS 1241807, 1241811, 1241812, 1241817, 1241918).

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE NON-MASSOSPONDYLID FAUNA OF THE UPPER ELLIOT AND CLARENS FORMATIONS (EARLY JURASSIC) OF SOUTH AFRICA

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Sauropod dinosaurs are justly famous for their redoubtable size, long geological reign, and unique physiology. Having evolved from semi-bipedal basal sauropodomorph ancestors sometime during the Triassic-Jurassic transition, by the Middle Jurassic sauropods were the dominant dinosaurian herbivores and, by sheer virtue of their size, were probably a driving force in shaping their own environment. However, prior to the dinosaurian explosion of the Middle Jurassic, surprisingly little is known of the early period of sauropod evolution.

This observation is especially remarkable given the comparative diversity of forms known from the latest Triassic that allude to the ancestral sauropod condition (e.g., *Antetonitrus, Lessemsaurus*, *Blikanasaurus*). In contrast, while the earliest Jurassic (pre-Toarcian) is represented by a plethora of taxa that are unambiguously non-sauropodan in both taxonomy and morphology (e.g., *Massospondylus*, *Seitaad*, *Lufengosaurus*), there is currently only a handful of similarly aged taxa of putative sauropod affinity, a designation that remains equivocal for most—if not all (e.g., *Chinshakiangosaurus*). Therefore, the recent discovery of two distinctly large-bodied, non-massospondylid sauropodomorph assemblages from the Early Jurassic Upper Elliot and Clarens formations of South Africa represents a much welcomed opportunity to add vital pieces to the puzzle of early sauropod evolution, as well as expanding upon our knowledge of the local-scale diversity of this region of southern Gondwana.

These assemblages are represented by a large, disarticulated bone-bed of hypothesized monospecificity (the Spion Kop sauropod quarry), and an articulated, mostly complete hind limb and tail of the largest animal yet recovered from Jurassic age rocks in southern Africa. We describe the anatomy of these new forms in comprehensive detail, exploring both their phylogenetic relationships and the functional implications of this material in regards to the important locomotory changes taking place at the sauropodomorph-sauropod transition. The taxonomic relationships of these new specimens are assessed cladistically, with both forms found to be of appreciable significance to our understanding of the nature of the evolutionary changes taking place within basal-most Sauropoda in the earliest Jurassic.

Symposium 5 (Saturday, November 8, 2014, 3:45 PM)

NATURAL TRAP CAVE: A MORPHOLOGICAL ASSESSMENT OF THE PLEISTOCENE TO HOLOCENE TRANSITION

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Natural Trap Cave, Wyoming (NTC) is an unparalleled fossil site that has been trapping animals for at least the last 50,000 years. It is unique not only because of the rich species diversity and abundance of Pleistocene megafauna fossils it contains, but also because it is the only locality known from the lower 48 states where it is possible to examine genetic variability in multiple species. The permanently cold and moist conditions at NTC have preserved ancient DNA and collagen molecules in the abundant fossils. Mitochondrial genome fragments from the extinct American lion (*Panthera atrox*), North American Pleistocene horses (*Equus* sp.), American cheetah (*Miracinonyx trumani*), and *Bison antiquus* have all been sequenced from this site, giving greater insight into the phylogenetic relationships of these species. In addition to giving genetic insight into extinct species, this site also offers a morphological comparison between the Pleistocene and the Holocene epochs. Many species found in this Pleistocene deposit also exist in the same geographic area in the Holocene (e.g., gray wolves, foxes, bison, etc.) and may show morphological changes from pre- to post-Pleistocene extinction that correlate with the major climatic, biotic and environmental changes that took place at this time. Using ecometrics—functional traits that correlate with an organism's environment—we examine several species from the Pleistocene from NTC and their extant counterparts from the same region to determine what, if any, morphological changes took place between the Pleistocene and the Recent; these three species include grey wolves (*Canis lupus*), pronghorn antelope (*Antilocapra americana*) and wolverines (*Gulo gulo*). We measured specimens from NTC (Pleistocene samples), and modern museum collections (Holocene samples), using linear (digital calipers) and 3D (MicroScribe) morphometrics. Results suggest that pronghorn and gray wolves have changed very little since the Pleistocene, but wolverines have gotten smaller, indicating a possible niche shift since the Pleistocene, which may have correlated with warming and drying climate in the Holocene and/or extinction of competitors, predators, or prey. Funded by a grant from Des Moines University and the National Geographic Society (NGS CRE 9479-14) to JAM.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

COMPARATIVE MORPHOLOGY AND VARIATION OF THE SNAKE PREFONTAL WITHIN VIPERINAE AND CROTALINAE AND THE APPLICATION TO MIOCENE SPECIMENS

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The venomous snakes within Viperidae include Azemiopinae, Viperinae, and Crotalinae. The earliest record of the family occurs in Eurasia in the late Oligocene. The robust structure of snake vertebrae and their abundance per animal permits these remains to be commonly preserved in the fossil record. Their occurrence in sedimentary units is often recognized even with the most casual of screen-washing methodologies. Lab technicians have come to easily distinguish these remains as belonging to snakes when sorting fossils, thus remains are selected for identification. Consequently, vertebrae are the predominant skeletal element when identifying genera and species of fossil snakes. Morphological characters on snake vertebrae are numerous. The ability to identify genera and species of snakes based solely on vertebral characters has varying levels of success and acceptance within the research community. North American researchers have concentrated on vertebral remains when analyzing fossil snake faunas. European researchers also have targeted vertebral remains but often include select cranial remains. These cranial remains have proven diagnostic to genera and even to species with varying success. A hindrance to using the various cranial elements for identification of fossil remains includes: 1) not having an adequate comparative skeleton collection of extant species; 2) complete morphological descriptions of extant taxa are lacking; 3) many cranial elements are not preserved in the fossil record (especially within older units); 4) lab personnel sorting bone from sediments do not recognize a number of the cranial elements, therefore specimens are not made available for identification.

Vertebrate remains are highly abundant at the Gray Fossil Site (GFS, Miocene-Pliocene, Hemphillian) Tennessee, USA. Select taxa from GFS indicate species similarity and dispersal events from Asia and Mexico. The recognition and recovery of cranial bones from GFS leads us to study the prefrontal of viperine snakes from the Western Hemisphere and Eurasia. Here we assess the morphological attributes and variation of the prefrontal from extant Eurasian Viperinae (5 genera) along with members of Crotalinae

from Asia (7 genera) and the Americas (11 genera). We examined a total of 170 total specimens.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

LAG DEPOSIT SOFT TISSUE PRESERVATION FROM A CRETACEOUS FISH

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Although visceral soft-tissue preservation is extremely rare, certain spiral fossils associated with the guts of non-teleost fishes have been known for 185 years. Whether they represent excreted fecal material (coprolites), intestinal contents (cololites), or the actual spiral intestines themselves (enterospirae) has been a subject of debate for almost as long. I will address two new specimens that shed light on this debate. These specimens were collected as float in Big Brook, New Jersey, a Late Cretaceous site famous for its abundance of non-teleost fossils (amiids, coelacanths, dipnoans, lepisosteids, acipenserids, and especially selachians, batoids, sclerorhynchids, and chimaeroids). Non-teleost fishes at Big Brook are represented by teeth, bone, cartilage, denticles, dorsal fin spines, and bromalites. The new specimens compare very well with the ordered morphology of some non-teleost fish intestines but less well with the more variable details of phosphatic spiral fossils common at Big Brook that are more confidently identified as fecal material (internal or external). Lag deposits are well-known for their accumulation of small hard parts but, because of their mechanism of deposition, soft-tissue preservation is very unexpected. Due to the obvious rarity of such preservation and the subtlety of the morphological details making them easy to dismiss as uninteresting, collectors are encouraged to take note of these exceptional fossils and add them to their search images.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A RE-EVALUATION OF CRANIAL ANATOMY OF THE DODO (*RAPHUS CUCULLATUS*) BASED ON TWO PREVIOUSLY UNDESCRIBED SPECIMENS

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We present a detailed treatment of the cranial morphology of two previously undescribed dodo (*Raphus cucullatus*) specimens, now in the collections of the Natural History Museum in Port Louis, Mauritius and the Durban Museum of Natural Science, South Africa. The specimens were collected around 1900 by Mauritian amateur naturalist Etienne Thirioux in caves near Le Pouce, Mauritius, and represent, respectively, the only known skeleton from a single individual (Port Louis) and a partial composite skeleton (Durban). Since all other known dodo skeletons are composite mounts of non-associated skeletal remains, the Thirioux skeletons are of great importance to our understanding of the dodo.

The Port Louis specimen has the most complete fossil dodo cranium known, whereas in the Durban specimen, the braincase and a portion of the mandible have undergone significant restoration. Dodo cranial morphology is characterized by a lengthening and heightening of the maxilla, a concomitant antero-posterior compression of the cranium and a dorsally expanded frontal region. There is no ossified nasal septum, and both specimens lack an ossified vomer. Although the orbital region forms a large part of the cranium, it is reduced in size relative to extant Columbiformes. The occipital region is flat, wide and oriented vertically. The foramen magnum and the occipital condyle are located in a posterior position on the skull. This arrangement is similar to that of the closely related Solitaire of Rodriguez, *Pezophaps solitaria*, but differs from extant Columbiformes, including the dodo's closest living relative, the Nicobar Pigeon (*Caloenas nicobarica*). In these columbids, the occipital region is more rounded and both the foramen magnum and occipital condyle are located ventrally. The fossa temporalis of the dodo is deep and narrow, and the quadratum is X-shaped. Both the mandibula and cranium are only gently curved dorso-ventrally. The mandibular rami are high and narrow, and contain only a single mandibular foramen. The medial mandibular process is large and triangular, and together with articulatory processes on the basitemporal plate, argues for a secondary articulation of the mandible with the basitemporal plate. Our study of the Thirioux specimens highlights the dodo's peculiar cranial morphology, which likely evolved in response to a more demanding and specialized lifestyle and feeding mechanism than previously appreciated.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

RECONSTRUCTING HOMININ ENVIRONMENTS: WHAT SPECIALIZED HERBIVORES TELL US ABOUT VEGETATION AND CLIMATE IN THE TURKANA BASIN

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Here we present a reconstruction of hominin environments of the Turkana basin from the late Miocene through Pleistocene in terms of climatic as well as vegetation parameters. We base our analysis on ecoprofiles (diet, body mass, and locomotion) of specialized herbivore taxa of the faunal communities recovered from each member. Our sample includes the mammal families Bovidae, Equidae, Giraffidae, and Rhinocerotidae. We assess ecological diversity and structure of fossil communities by several ecological variables. The fossil communities are compared with a recent reference sample to infer features of the habitats. The reference sample is based on recent specialized herbivore communities in 39 national parks associated with grassland and savannah biomes in sub-Saharan Africa. Based on the ecoprofiles of the taxa present in each national park, we distinguish four habitat categories, each one characterized by ecological diversity and structure of the communities on one hand and associated with specific climate and vegetation regimes on the other. The ecological diversity of the specialized herbivore community is estimated for each of the members east and west of Lake Turkana for the time from ~8 to 0.7 Ma ago. Compared to the present environment at Lake Turkana (mean annual temperature (MAT): 28.2 °C, annual precipitation (AP): 252 mm, vegetation density: 0.22, greenness: 0.11) during the Late Mio- through Pleistocene the climate was generally cooler and more humid; the vegetation density was higher by factor 3–4, greenness higher by up to factor of 7. Over time the climate and vegetation regime remained relatively stable in the oldest members (~8 to ~4 Ma). In the eastern part of the basin relatively stable conditions also persisted in the younger members (~3 to 1.3 Ma) (MAT: 25°C, AP: 750–900 mm). In contrast, the conditions were slightly more variable in the western part (MAT: 21 vs. 25 °C). After 1.3 Ma a notable shift towards drier climate (AP < 500 mm) with less vegetation cover is seen. At Kanapoi, the southernmost locality in the basin, we observed the highest precipitation (1300 mm) and greenness (0.76) compared to all other members. Our result raises the question: did a different climate regime prevail in the southern part of the basin? In summary, the climatic conditions could have supported seasonally flooded grassland, humid savannah and even forest like vegetation in the Late Mio- to Pleistocene. Funded by the German Research Foundation (SCHR 352/9-1) and supported by the Research Centre -Role of culture in early expansions of humans- (ROCEEH).

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

LOS ARROTUROS: NEW REPTILE TRACKSITE FROM THE MUSCHELKALK (MIDDLE TRIASSIC) OF PAREDES DE SIGÜENZA (GUADALAJARA PROVINCE, SPAIN)

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The new track locality belongs to the Cuesta del Castillo Formation (Ladinian in age), and it is included in the Muschelkalk facies (Middle Triassic). The tracksite surface (of about 1700 m^2) shows the impression of abundant isolated tracks and several quadrupedal trackways.

The pes prints are pentadactyl, with the digits I, II and III anteriorly oriented and showing similar lengths, although digit I could be slightly longer than the others. The digits are included within the footprint outline and only their ungual impressions are visible. Digit IV is shorter and oriented about 17° with respect to digit III. Digit V is the shortest one, and shows a clear lateral orientation of about 85° with respect to the longitudinal footprint axis. The heel surface is well developed; its proximal outline is rounded and, in general, well defined. The manus prints are shallow, poorly preserved, and much smaller than the pes prints. Only one of the tracks shows the presence of four digital impressions.

The trackways clearly shows a quadrupedal locomotion pattern. They are relatively narrow showing a high pace angle (about 160°) that suggests consistent locomotion, with the tracks oriented parallel respect to the longitudinal axis of the trackway. The shallow condition of almost all the manus tracks suggests the presence of a relatively firm and consistent substrate.

The general footprint morphology allows us to identify these tracks within the 'group' formed by the *Chirotherium-Isochirotherium-Brachychirotherium* ichnogenera. However, the Los Arroturos footprints show some differences, mainly related to the similar development of digits I, II and III, and only the impression of the distal ungual digital marks. These unique features suggest the need for further analyses in order to make a consistent proposal for the potential trackmaker.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

REVISITING THE PLEISTOCENE VERTEBRATE FAUNA OF AN NAFUD DESERT, NORTHWESTERN SAUDI ARABIA

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In the An Nafud desert in the northwestern part of Saudi Arabia, there are at least a dozen Quaternary lacustrine deposits exposed in basins enclosed by sand dunes. These deposits lay over an older sand dune system and were formed during wet and rainy seasons in the Pleistocene. These are lake sediments of a fresh water system, and are 2 to 15 meters thick. Lithologically, they are made of friable to semi friable white sand and sandstone (the ancient dune system), calcareous sandstone, siltstone, diatomite, and occasional dirycrust or caliches encrusting the tops of these beds. Three vertebrate fossils show a strong affinity to Pleistocene African mammalian communities.

Revisiting the area led to the discovery of more lake deposits that are restricted to the interdune system of An Nafud. Some of these lakes contain vertebrate faunas that were similar and synchronous with the previously known localities. However, our recent detailed stratigraphic examination of these deposits show that there are two major bone beds in two localities in An Nafud desert; the first bone bed in the bottom of the section has abundant cranial and postcranial artiodactyl remains, while the second (top) bone bed produced a wide range of vertebrates including reptiles (crocodilians and turtles), birds (abundant ostrich egg shells), and more mammalian taxa, such as proboscideans, artiodactyls (including hippos), and carnivores. Furthermore, one of the new localities (Tus ad-Diba locality) constitute the richest site in An Nafud desert. Our findings indicate that there are two major Pleistocene faunas that probably migrated to the An Nafud area on two separate wet events.

Fieldwork supported by the Saudi Geological Survey and King Saud University Mammals Research Chair.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

THE MAJOR TURNING POINT IN EUROPEAN RUMINANT EVOLUTION

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Nowadays, and during the entire Neogene, diversity of Ruminantia is mainly composed of species assigned to Pecora (ruminants possessing cranial appendages and four well-developed stomach chambers).However, during the Paleogene, the Tragulina (inermous ruminants with only three well-developed stomach chambers in extant representatives) were the most abundant, indicating a turnover in ruminant evolution at

the end of the Oligocene that has not been understood so far. Yet, the current reassessment of historical fossil ruminant material and new discoveries provide new insights in the evolution of European ruminants and the modality of the late Oligocene turnover.

Here I present results from detailed investigations, which allow for a more detailed stratigraphic assessment of the succession of latest Oligocene ruminant species. No less than 12 different species of ruminants from 10 different genera succeeded each other in Western Europe within a time span of 2.5 Ma (MP27 to MP30, appr. 25.5 Ma to appr. 23 Ma). Classical Oligocene species, mainly Tragulina (Tragulina: *Lophiomeryx* and several species of *Bachitherium*; Pecora: *Mosaicomeryx*), were adapted to wooded environments and were mainly leaf eaters. They disappeared at the end of MP27 or the early MP28. This corresponds to the appearance of Asiatic immigrants at the base of MP28 (Pecora: *Prodremotherium*, *Dremotherium* and *"Amphitragulus*"). In the context of the Latest Oligocene Warming, leading to climatic and environmental changes in Europe, these newcomers were adapted to more open environments (such as wooded savannah) and mixed feeding. At the end of MP28, this immigration led to a total renewal of the ruminant community. The Tragulina (Lophiomerycidae, Bachitheriidae) and stem Pecora gave way to more derived, but still without cranial appendages, stem and maybe crown Pecora (e.g., "*Amphitragulus*", *Babameryx*, *Dremotherium*). The disappearance of the Tragulina is probably linked to their direct competition with more derived ruminants having a more efficient metabolism in drier conditions and a better assimilation of less energetic food.This biological "crisis" is in correspondence with the newly described *Microbunodon* Event, also well observed in other organisms (charophyts, terrestrial plants, booids, micromammals, and other “ungulates”).

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

STABLE ISOTOPE ECOLOGY OF MIOCENE BOVIDS FROM NORTHERN GREECE AND THE APE/MONKEY TURNOVER IN THE BALKANS

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The Eurasian continent was home to a radiation of hominids during the Miocene. All of them were extinct at the end of the Miocene in Western Eurasia. In this study, we investigate the hypothesis of climate and vegetation changes at local scale along the Axios River, Greece, where the cercopithecid *Mesopithecus* replaced the hominid *Ouranopithecus* in the fossil record. Because they are herbivorous and were much more abundant than primates, bovids are preferred to primates to investigate the hypothesis of climate change in the Balkans.

By measuring the enamel carbon stable isotope ratios of bovids, we conclude that *Ouranopithecus* and *Mesopithecus* both evolved in pure C_3 environments. However, the large range of $\delta^{13}C$ values of apatite carbonate from bovids combined with their molar wear patterns preclude the presence of dense forested landscapes.

Oxygen isotope compositions of phosphate from bulk samples did not lead to detecting significant differences between-sites but between-species variations within each site. There are different factors that influence oxygen isotope composition. We especially discuss the rate of amelogenesis in regard to the high intra-tooth variations in $\delta^{18}O$, reflecting important amplitudes of seasonal variations in temperatures. Coldest monthly estimated temperatures are below 10°C and warmest monthly temperatures rose close to or above 20°C for the two time intervals. Climate with winter temperatures below 10°C for the cercopithecoids habitat are not actually unexpected because many monkeys today live in regions subjected to such harsh conditions. On the other hand, this picture sharply contrasts with the expected habitat for *Ouranopithecus* in regard to the present-day distribution of great apes. The late Miocene climate conditions are similar to the present-day situation in northern Greece, coherent with paleobotanical records but slightly different from climate models for the Eastern Mediterranean area that propose higher temperatures for winter and summer.

In summation, no significant change in climate has been detected before and after the extinction of *Ouranopithecus* along the Axios River. The absence of major climate change as *Mesopithecus* replaces *Ouranopithecus* in northern Greece was actually not so unexpected. Indeed, the recent discoveries of *Ouranopithecus*-like apes found together with typical Turolian mammals in Bulgaria and Turkey (without any sympatric species of monkeys, however) depict a less abrupt extinction for great apes in Eastern Mediterranean area.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

FROGS AND TOADS (LISSAMPHIBIA, ANURA) DURING THE END-CRETACEOUS MASS EXTINCTION: EVIDENCE FROM THE FOSSIL RECORD OF NORTHEASTERN MONTANA

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Modern anurans are environmentally sensitive tetrapods that often are viewed as bellwether taxa for the modern biodiversity crisis. As such, one would expect that anurans did not fare well during the Cretaceous-Paleogene (K-Pg) mass extinction ca. 66 million years ago. Previous analyses investigating salamander and albanerpetontid diversity dynamics leading up to and across the K-Pg boundary showed patterns of declining richness and evenness that correlate with the timing of multiple latest Cretaceous environmental perturbations (volcanism, climate change). Here, we document temporal richness patterns of fossil anurans from the same study system to provide a more comprehensive view of lissamphibian fossil assemblages across the K-Pg boundary.

We identified >200 maxillae and ilia from a temporally constrained stratigraphic sequence of 20 vertebrate microfossil assemblages in the Hell Creek and Tullock formations of Garfield County, Montana. Those fossil localities span approximately the last two million years of the Cretaceous and the first one million years of the Paleocene. From this dataset, we constructed biostratigraphic ranges for known anuran species (e.g., *Scotiophryne pustulosa*, cf. *Eopelobates* sp.) and for several unnamed morphotypes. We document several new occurrences for poorly understood anuran taxa including *Theatonius lancensis* and *Palaeobatrachus*? *occidentalis*. Our results show an increase in raw richness from up to nine species in the lower part of the Hell Creek Formation to up to 17 in the middle of the formation. Richness then declined to 10 species in the upper Hell Creek Formation, similar to levels in the lower Hell Creek Formation, and continued to decline leading up to the K-Pg boundary; however, losses were buffered by two new morphotype occurrences. Above the K-Pg boundary anuran fossils are extremely scarce despite intensive sampling from several highly productive vertebrate microfossil localities. The earliest Paleocene anurans occur in the lower middle Tullock Formation (?late Puercan 1 NALMA interval). This pattern of increasing anuran richness from the lower to middle Hell Creek Formation followed by a decline leading up to and across the K-Pg boundary mirrors the pattern of salamanders and albanerpetontids and suggests that anurans were similarly affected by the multiple environmental perturbations near the end Cretaceous. However, anurans suffered far greater extinction rates across the K-Pg boundary than salamanders did.

Technical Session II (Wednesday, November 5, 2014, 8:30 AM)

THE RECURRENT RECORD OF TERRESTRIAL ENVIRONMENTS IN THE LATE JURASSIC OF THE SWISS JURA MOUNTAINS: IMPLICATIONS FOR PALEOGEOGRAPHIC RECONSTRUCTIONS

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Until the first European dinosaur megatracksite was reported from Lommiswil (northerst Switzerland), the Late Jurassic carbonates of the Jura Mountains were thought to be completely marine. Since then, numerous terrestrial fossils and sedimentological features including over 50 dinosaur tracksites in tidal-flat deposits from many different stratigraphic levels spanning from the Oxfordian to the Berriasian were discovered.

The latest track discoveries are from the Middle Oxfordian Roeschenz Member, and they are so far the oldest dinosaur record known from the Jura Mountains. These tracks include both medium-sized theropod and sauropod tracks, and some of the latter were previously interpreted as tidal channels. Several localities contain ostracods, characeans. and lacustrine stromatolites which indicate the presence of freshwater on the Jura carbonate platform and possibly a persistent freshwater body over an extensive surface.

In the Swiss Jura Mountains, several stratigraphic levels have yielded bones of stegosaurs, pterosaurs, partial skeletons of ?diplodocid sauropods, teeth of megalosaurids, ceratosaurs, and dromaeosaurid theropods, and also land plants. The track record indicates the presence of small, intermediate. and large sauropods as well as those of baby sauropods. Theropod tracks include very small and slender forms (5 cm pes length) as well as medium- to very large-sized morphotypes (80 cm pes length). The stratigraphic levels correspond to some extent to those in the adjacent French Jura Mountains, where numerous tracksites with sauropod and theropod have been found over the last years.

This repeated terrestrial evidence is crucial for new paleogeographical reconstructions and the latest discoveries prove the coexistence of freshwater bodies and dinosaurs on the Jura carbonate platform. It shows that lacustrine and vast tidal flat environments were part of a larger, connected landmass, rather than of small islands. Linked to changes in sea-level due to excentric orbital cycles, the Jura carbonate platform repeatedly served as a migration corridor between the emergent Massif Central and the London Brabant Massif, and it was able to host large populations of dinosaurs.

Technical Session I (Wednesday, November 5, 2014, 8:00 AM)

COEVOLUTION OF THE SHOULDER AND KNEE IN UNGULATES: IMPLICATIONS FOR THE EVOLUTION OF LOCOMOTION AND STANDING

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Studies of postcranial morphology mostly focus on locomotion; however, most terrestrial animals allocate more of their activity budget to rest. The degree to which the skeleton is adapted to non-locomotory behaviors, such as passive standing, is uncertain. Horses are known to stand at rest for prolonged periods. The specialized morphologies of the equine shoulder and knee joints shunt forces from muscles to tendons and ligaments, preventing muscular fatigue. The equine passive stay apparatus (PSA) is identified osteologically by an enlarged intermediate tubercle within the intertubercular sulcus of the proximal humerus and an enlarged medial trochlear ridge on the patellar groove of the distal femur. Previously, we identified similar structures in various fossil taxa suggesting that PSAs evolved convergently.

Using an Immersion G2 Microscribe, we collected 3D landmarks on the proximal humeri and distal femora of 131 species of extant artiodactyls and perissodactyls. Structures suggestive of horse-like PSAs were found in bovids, cervids, giraffids, camelids, hippos, rhinos, and equids. The first principle components of the humerus and femur data relate strongly to the size of the intermediate tubercle of the proximal humerus and the medial trochlear ridge of the distal femur. For ruminants (n = 113 species), the first principal component scores of the humerus and femur are significantly correlated, and both are significantly correlated to body mass. However, non-ruminants tend to show less consistent results. For instance, the proximal humerus of camelids has a large intermediate tubercle, even though associated specializations in the distal femur are absent. Giraffids, in particular, show a degree of PSA development that exceeds other large mammals. Giraffes are not specialist gallopers, but like horses, allocate the majority of their activity budget to standing. Passive behaviors ought to be considered when studying evolutionary morphology. Comparison of limb morphology to the activity budgets of extant species may shed light on adaptation for non-locomotory behaviors and possibly facilitate inferences about activity budgets in extinct species.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

NEW BEST PRESERVED SPECIMENS OF *DISCOSAURISCUS PULCHERRIMUS* (SEYMOURIAMORPHA, DISCOSAURISCIDAE) FROM THE LOWER PERMIAN SEDIMENTS OF BOSKOVICE BASIN (CZECH REPUBLIC)

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The *Discosauriscus* clade belongs to the well-studied reptiliomorph tetrapods. This genus is known from the Lower Permian of Central and Western Europe (Germany, France, Czech Republic, Poland). *Discosauriscus* includes two species: *D. austriacus* (known on the basis of several hundreds specimens) and *D. pulcherrimus* (known on the basis of several tens of poorly-preserved specimens). New findings of four three-dimensionally preserved specimens of *D. pulcherrimus* originate from the Lower Permian of the Boskovice Basin (Czech Republic). Unfortunately, this species is very rare in this area (only five specimens were known prior to the new find). However, these four new specimens are the best-preserved individuals of this species yet recovered. For this reason, we took this opportunity to study all cranial and postcranial elements and make new observations. For example, the ridges located in the central region of the parasphenoid are described for the first time. A new reconstruction of the skull was produced.

Although, only nine specimens of *D. pulcherrimus* were found in Boskovice Basin, the individual variability of several characters can be clearly observed in these specimens. These characters are as follows: 1) intensity of ornamentation of dermal skull bones, 2) degree of development of lateral line system, 3) development of nasolacrimal duct, 4) arrangement of teeth on the pterygoids, 5) character of ornamentation of parasphenoid stem, and 6) shape of suborbital fenestra. The high individual variability is also observable in *D. austriacus*. Thus, all these new morphological data, including information on individual variability, provide an oportunity for the revision of the diagnostic characters on the basis of which both species of *Discosauriscus* were defined.

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Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

DINOSAUR TECTONICS-WHEN BIOMECHANICS MEET STRUCTURAL GEOLOGY

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A theropod dinosaur trackway from finely laminated interdune deposits of the Middle Jurassic eolian Entrada Sandstone shows a complex system of joints and faults created by the force exercised on the sediment during the time of contact between the trackmakers foot and the sediment.

Although in small scale, the structures of the faulted and folded sequence around the track are comparable to crustal-scale tectonics associated with plate tectonics and foreland fold-thrust belts.

By analyzing the structures in a structural geological perspective we are able to recreate in detail the timing and weight distribution in the dinosaur"s foot during the different phases of the walk.

Contrary to continent-continent collision, the observed dinosaur compression structures are linked directly to an extensional field in the front of the track that balances the compression towards the back. The extension and the associated compression are combined in a disk developed above an upward-concave, low-angle thrust established below the forepart of the dinosaur foot. In the touch-down to early kick-off phase, the downward and backward movement of the foot created a basin above the front of the disk. During the kick-off phase, the backward movement of the foot resulted in rotation and uplift of the rear part of the disk and further backward thrusting above a subhorizontal detachment fault. Forward dipping, fold-thrust ramps branched off from the detachment surface towards the back. In addition, a lower-order, imbricate fan may be developed at the rear end of the undertrack. The higher-order, central fold-thrust fan system is limited laterally by two strike-slip fault zones interpreted as lateral ramps limiting the central fan system. The backward movement declines across the strike-slip fault zones and reaches zero along splay faults towards the lateral margins of the undertrack. The inter-ramp segment matches the width of the dinosaur's foot which created the imbricate fan thrust system that extended to the far end of the undertrack.

The total length of the tectonic disturbance created by the dinosaur is up to three times that of the original footprint.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

NEW FOSSIL PANGOLIN SPECIMENS FROM THE EOCENE AND OLIGOCENE OF EGYPT

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The earliest fossil pangolins (Mammalia, Pholidota) are known from Laurasia during the middle Eocene in Europe, and the late Eocene in North America and China. The first Gondwanan record of the order is based on the recovery of two distal phalanges, from the early Oligocene Jebel Qatrani Formation in the Fayum, Egypt. Here we report on additional pangolin cranial and postcranial material from the Oligocene of the Fayum, as well as the first identification of a pangolin from the Fayum late Eocene Quarry L-41. The new Oligocene material consists of additional distal phalanges, a skull fragment, and a partial right femur. The material from L-41 is a single distal phalanx but its cleft morphology is distinctly pangolin.

Results of comparisons with other fossil and extant material indicate that the femur from the Fayum resembles other Paleogene pangolins in retaining a primitive mid-shaft position for the third trochanter. This condition is unlike that observed among modern pangolins, where the third trochanter is positioned more distally. Modern Asian and African pangolin lineages are quiet distinct morphologically, but when the modern forms arose and at what point the two lineages diverged is unknown. However, the fact that the new Fayum pangolins more closely resemble other Paleogene specimens rather than modern forms, suggests that modern pangolins must have arrived in Africa as a result of a subsequent, Neogene, invasion of the continent.

Although the L-41 pangolin is represented by only a distal phalanx, recovery of this element serves as an additional reference point for current arguments in Paleogene biogeography. Pangolins originated as part of a Laurasian fauna so their presence at L-41 is clear evidence for an immigrant taxon among endemic Fayum afrotheres. However, among laurasiatheres, the phyletic place of pangolins is unresolved. Morphologically, pangolins have been considered the sister group to palaeanodonts, a predominantly North American Paleocene–Eocene group of uncertain affinities. At the same time, molecular studies indicate that, among living forms, pangolins are most closely related to Carnivora. It is possible that pangolins are related to palaeanodonts, and that this group represents the sister taxon to carnivores, although these relationships may be distant with pangolins, palaeanodonts and Carnivora all potentially rooted among the Leptictida.

Technical Session X (Friday, November 7, 2014, 11:45 AM)

THE LAST MARCH OF THE PROBOSCIDEANS: CHANGES IN LANDSCAPE USE AND MOBILITY PRECEDING THE PLEISTOCENE MEGAFAUNAL EXTINCTION

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During widespread extinction events, changing patterns of species landscape use provide insight into the mechanisms and velocities of these biologically important periods. The terminal Pleistocene offers a fossil record with high enough spatial and temporal resolutions to test for millennial-scale changes in species landscape use and mobility prior to, and synchronous with, extinction. Two sources of data from fossil remains are useful for establishing past mobility: (1) geographic locality data, and (2) strontium isotope ratios ($^{87}Sr/^{86}Sr$). As rocks weather, Sr is released into overlying soils and surface waters, and subsequent incorporation of Sr into plants and animals occurs with little fractionation. Thus, organismal Sr ratios reflect the resources consumed during tissue formation. Matching organismal Sr ratios to local and regional geochemical signals historically required detailed sampling of local plants, animals, and water bodies, which complicated regional (or larger-scale) studies. Recently developed continental-scale Sr models offer new opportunities to reconstruct movement patterns of highly mobile organisms. Here, using a combination of spatially explicit (GIS) analysis and continental-scale Sr models, we develop an analytical framework to test for changes in megafaunal mobility prior to extinction. Our analyses focus on American mastodons (*Mammut americanum*) and Columbian mammoths (*Mammuthus columbi*). We assessed mobility using the difference between measured Sr ratios of the skeletal material and modeled values for the specimen's recovery location. To estimate movement magnitude, we identified regions of North America that matched skeletal Sr ratios and calculated great circle distances to those regions and least-cost paths using circuit theory. Results indicate mastodons and mammoths had significantly different geographic responses prior to extinction. Mammoths underwent a protracted and significant reduction in mobility following the Last Glacial Maximum ($p << 0.01$) with a rapid and unprecedented increase in mobility within the millennium preceding their extinction. In contrast, mastodons exhibit more consistent mobility patterns across the Pleistocene, including immediately prior to extinction. These results suggest that extinction pressures were geographically and/or taxonomically heterogeneous. Our analytical framework is conducive to a variety of geographic analyses of fossil data and future work will expand this study's taxonomic breadth.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A BIOGEOGRAPHIC ASSESSMENT OF INTERCONTINENTAL DISPERSALS IN ALLIGATORINAE

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Alligatorines are predominantly found in North America, but species have also been found in Europe and Asia with current phylogenetic estimates suggesting multiple dispersal events. The timing and path of these dispersals is of interest due to physiological restrictions limiting the dispersal ability of alligatorines. Possible dispersal paths to Europe and Asia are at high latitudes, so dispersals could only have taken place during warmer time periods. Intercontinental dispersals are further restricted because alligatorines are intolerant of salt water.

Here, we run a phylogenetic analysis of Alligatoroidea under maximum parsimony and assess biogeography in TreeFitter with the three continents as areas and direct connections between all three in accordance with the Bering and North Atlantic Land Bridges. Four Asian species (*Krabisuchus*, the Maoming alligator, *Alligator luicus*, and the extant *Alligator sinensis*) and three European species (*Arambourgia*, *Hassiacosuchus*, and *Caimanosuchus*) of alligatorines were included in this analysis. We recoded *Krabisuchus* following first-hand study of the material.

Arambourgia is in a clade with several North American taxa and represents one dispersal to Europe. The other European species fall as sister to one another, but in a basal polytomy with *Krabisuchus*, the Maoming alligator, and several North American species. While Alligatorinae is recovered as originating in North America, the number of dispersal events to Eurasia remains ambiguous and dependent on how trees are resolved. *Krabisuchus* is phylogenetically unstable due to its highly autapomorphic nature and the Maoming alligator is largely uncodable. Some trees suggest back-dispersals to North America. *Alligator luicus* and *Alligator sinensis* similarly fall into a polytomy with *Alligator olseni*, primarily because *A. luicus* is incompletely known, so the number and direction of dispersals here is also unclear.

In spite of the low resolution, our analysis still indicates at minimum one dispersal to Asia during the Miocene, and two to Eurasia during the Paleogene. Further research needs to be done to resolve the phylogeny and determine the exact number, timing, and direction of dispersals.

Symposium 4 (Friday, November 7, 2014, 11:45 AM)

SIMPLE METAMORPHOSIS IN THE TREMATOSAUROIDS

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It is increasingly clear that lissamphibian-type metamorphosis, comprising condensed ontogenetic change and structural remodeling, was present in the temnospondyl amphibian group Dissorophoidea. A simpler metamorphosis, restricted to condensed ontogenetic change, also appears to have developed in parallel within one clade of Triassic stereospondyl temnospondyls. The Trematosauroidea (Trematosauridae, Almasauridae, Metoposauridae and - on the stem - some Benthosuchidae) share a characteristic elongation of the skull table and hence the post-gape oropharyngeal region. This was not the product of simple allometric growth as found in basal stereospondylomorphs but produced by a growth spurt. This was previously demonstrated for the basal trematosauroid *Thoosuchus* and can be seen as a zone of characteristic 'stretched' ornament ('zone of intensive growth') on the skull-tables of most trematosauroids, although it may be lost in very old individuals where ornament has been remodeled. This growth spurt represents minimization of the intermediate condition between juvenile and adult feeding techniques in trematosauroids. It is suggested that most trematosauroids fed on small aquatic vertebrates throughout their lives. The juveniles with only slightly lengthened gapes may have been able to seize and manipulate fish not much smaller than themselves without suction being required. In contrast, the larger adults with elongate snouts with a more extended gape may also have fed on the same types of small vertebrate, impaling or damaging them with the longer jaws and then sucking them in from a greater distance. In the Late Triassic, the group diversified into lineages which did not elongate the snout but may still have fed on relatively small prey which required sucking in as the skull lengthened.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

NEW REMAINS OF MICROCHOERINAE (OMOMYIDAE, PRIMATES) FROM THE LATE EOCENE SITE OF SOSSÍS (NORTHEASTERN SPAIN) FOUND IN THE COLLECTIONS OF THE NATURHISTORISCHES MUSEUM BASEL

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The site of Sossís (late Eocene, Southern Pyrenees) has yielded a large number of vertebrate remains, representing the most significant Eocene assemblage from the Iberian Peninsula. All the primate material from this locality known to date was housed at the Institut Catalàde Paleontologia Miquel Crusafont (ICP). The first recovered material included scarce remains of *Adapis* cf. *parisiensis, Pseudoloris parvulus* and a large microchoerine referred to *Microchoerus erinaceus*. Later excavations led to the recovery of more material of these primates, currently under study, as well as some teeth that allowed the description of a fourth taxon, *Nievesia sossisensis*. Here we present new remains of primates from Sossís recently found in the collections of the Naturhistorisches Museum Basel (NMB). This material, including remains of *Pseudoloris* and *Microchoerus*, probably arrived in Basel as a result of collaboration which involved the exchange of fossils for comparisons. The material of *P. parvulus* consists of two m1-2, an M1-2, a P4 and a P2; this latter tooth is especially important since only one specimen was available until now from Sossís. The material of *Microchoerus* includes a fragment of mandible with m2 and m3, an M1-2, two M3 and a dental series with M1 to M3. The m2 has a small mesoconid and a single hypoconulid, the m3 shows a relatively short hypoconulid lobe; the isolated M1-2 has moderate-sized conules and lacks a mesostyle, but the M1 and M2 of the dental series show a very weak, crest-shaped mesostyle that is absent in most of the available teeth housed in the ICP. All these morphological traits, together with the smaller size, indicate that these specimens do not correspond to the species *M. erinaceus*. Further study of the whole sample from Sossís will surely allow providing a precise determination, most probably leading to the erection of a new species. The discovery of this additional material not only increases the sample size of two species of primates from Sossís, but also enables a better observation of their morphological and biometrical variability.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

DINOSAUR AND OTHER TETRAPOD TRACKS FROM THE LATE TRIASSIC-EARLY JURASSIC OF CENTRAL IRAN

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Dinosaur and other Mesozoic vertebrate body fossils are rare in Iran. However, their footprints are well documented in the northern (Alborz) and Central (Kerman Basin), Iran. These records have been restricted thus far to the Early-Middle Jurassic strata of Shemshak group. Here, we report on the first dinosaur and small tetrapod tracks from the Triassic-Jurassic boundary deposits of the Nayband Formation in the Tabas and Esfahan regions of Central Iran.

The Late Triassic across greater parts of Central Iran is made up of a thick, siliciclastic and in part carbonaceous succession called the Nayband Formation. In the vicinity of the Parvadeh coal mine in the Tabas area, well above the Rhaetian coal deposits, small tetrapod tracks have been discovered. They are 6 cm in length and width and are preserved as concave epirelief on the upper surface of a coarse sand/micro-conglomerate red bed. The digits vary in size from 3-4 cm and the interdigital angles are 40-50°. Despite some variations, these tracks are comparable to *Batrachopus*. *Batrachopus*, attributed to crocodylmorphs, mainly occurs in the Early Jurassic and also Late Triassic deposits of North America and Europe.

In the Shahreza region of the Esfahan area, among the predominantly dolomitic facies of Triassic age a small, siliciclastic, coal bearing unit is preserved. Here, a single, medium sized, tridactyl dinosaur track is recorded near an abandoned coal pit. The footprint is a convex hyporelief and has broad digits and an elongated heel mark. It is 10 cm long and about 12 cm wide. The interdigital angles are 35-45°. The macroflora associated with track bearing deposits provided Late Triassic (Rhaetian) elements. Despite its size, the track resembles *Eubrontes*, attributed to theropods. *Eubrontes* is widely recorded from the Late Triassic-Early Jurassic of North America, Europe, Africa and Australia. The discovered track also resembles *Anomoepus*, as they are closer in size and have morphological similarities. Several Late Triassic ichnogenera like *Eubrontes* and *Batrachopus* continue across the Triassic-Jurassic boundary, but *Anomoepus* first appears in the Early Jurassic. Based on paleobotanical evidence, we consider the studied tracks to be Late Triassic in age. Nevertheless, an earliest Jurassic age of these footprints cannot be dismissed unless their exact age is constrained. A Late Triassic age adds to the significance of these footprints, as they are the first record of these types of tetrapod tracks from the Asian continent. We thank NIOC and Uppsala University for funding of our field work.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE 3-FRONT MODEL: A DEVELOPMENTAL EXPLANATION OF LONG BONE DIAPHYSEAL HISTOLOGY OF SAUROPODA AND ITS APPLICATION TO OTHER DINOSAURS AND MAMMALS

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The bone histology of non-avian dinosaurs is informative for understanding many aspects of growth and development of these long-extinct animals. The rate of bone apposition and remodeling in the shaft of long bones appears to be accelerated in some groups and decelerated in others. Here we propose a developmental model to illustrate these fundamental aspects of long bone diaphyseal histology at different growth stages. We developed the model based on an ontogenetic series of long bones of the sauropod dinosaur *Apatosaurus*. The model describes the histology and microanatomy based on three fronts that move radially: the apposition front, the Haversian substitution front, and the resorption front. The 3-front model assumes a constant Haversian substitution rate while apposition and resorption decrease over time. Under these circumstances all changes to microstructure and histology result from relative changes in rates of apposition and resorption. We were able to apply the 3-front model for *Apatosaurus* to the sauropods *Giraffatitan*, *Camarasaurus*, and an indeterminate diplodocid from the Tendaguru beds. In addition, different 3-front models provided alternative developmental explanations for the distinct histologies and microstructures observed in the dwarf sauropods *Europasaurus* and *Magyarosaurus*, as well as the slower growing *Ampelosaurus*. The benefit of this model is that it is not limited to only Sauropoda, but it could be applied to a broad range of terrestrial amniote long bones and could provide unique insights into evolutionary patterns of bone development. Put into a phylogenetic framework, the comparison of 3-front models can inform us about evolutionary questions such as changes in body size and life history.

Symposium 1 (Wednesday, November 5, 2014, 11:45 AM)

ECOLOGICAL EVOLUTION IN AVES: TESTING EVOLUTIONARY MODELS AGAINST FOSSIL DATA

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Phylogenetic studies reveal much of the timing and subsequent diversification of clades, however extrapolations based on modern taxa only can be misleading if they are not constrained by fossil data. Based on dated phylogenies, Aves is thought to have diverged well before the first appearance of a crown bird in the fossil record. Modern ornithologists mistakenly conclude then, that phylogenetic methods applied to extant taxa yield superior results to methods based on the 'meager' fossil record of birds. However, the fossil record is the only empirical data available on what morphologies were realized within a given clade's history. Comparing the expectations of morphological evolution from extant taxa to the observed morphologies in the fossil record can highlight areas of disagreement where comparative models can be improved, and help better integrate fossil data into the comparative framework. To that end, I have compiled 22 morphological measurements from 604 extant genera (1375 specimens) and 337 fossil specimens of birds, with the fossils deriving primarily from the Jehol (125 Ma), Green River (52 Ma) and Messel (47 Ma) lagerstätten. I fit various models of morphological evolution (early burst, Ornstein-Uhlenbeck and Brownian motion with and without rate shifts) to the phylogeny of extant birds, and predicted how much morphological disparity is 'expected' in the Eocene intervals (52 and 47 Ma). The expected disparity based on extant-only taxa is significantly lower than the observed disparity in the Eocene lagerstätten. This suggests that the signal of constrained evolution through time (OU) being detected in the extant data is an artifact resulting from repeated small radiations and extinctions overprinting the more rapid early evolution of the clade. These empirical results based on fossil evidence agree strongly with simulation results which have shown early bursts of morphological evolution, commonly seen in the fossil record, are extremely difficult to detect in standard comparative datasets. These data also show that the morphological evolution of Aves occurred much more rapidly than is predicted from comparative analyses of extant taxa alone, highlighting the importance of incorporating fossil data in evolutionary studies, even for clades with a 'poor' fossil record.

Technical Session XIII (Friday, November 7, 2014, 2:15 PM)

CYCLOSTOME- AND CROWN GNATHOSTOME-LIKE CHARACTERS AMONG STEM GNATHOSTOMES AND CRITICAL TESTS OF COMPETING HYPOTHESES ABOUT JAW ORIGINS

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The origin of the jaw is a major transition that accounts for more than 99% of living vertebrate diversity. A long-standing challenge to discriminate among numerous hypotheses still remains, largely because the vast majority of jawless vertebrate lineages are extinct and generally poorly preserved. Reconstructions of these jawless stem gnathostomes have typically been modeled after cyclostomes (hagfish and lampreys). This practice complicates tracing and rooting gnathostome-like character states beyond the jaw origin. I identify skeletal correlates of soft tissues in the living cyclostomes and

gnathostomes, and use the Extant Phylogenetic Bracket method to test which crown-group characters likely occur in stem gnathostomes. This analysis focuses on derivatives of the mandibular arch and its peripheral structures in the premandibular, hyoid, and hypobranchial regions.

At the premandibular-mandibular interface, all jawless stem gnathostomes exhibit correlates for the cyclostome-like muscular upper lip, with some deviation toward gnathostome-like patterns in galeaspids. Osteostracans likely had an analogue of M. nasolingualis in hagfish. At the mandibular-hyoid interface, galeaspids have correlates of the velar attachment, whereas evidence for a velum is equivocal for osteostracans. Some heterostracans and pituriaspids developed conditions associated with the gnathostome-like hyomandibular pouch. At the mandibular-hypobranchial interface, no evidence exists for the gnathostome-like hypobranchial musculalature in jawless stem gnathostomes, and equivocal evidence for these muscles in antiarchs obscures whether the hypobranchial muscles (reconstructed for arthrodires) evolved around or well after the origin of the jaw. Synovial joints represent a gnathostome synapomorphy, whereas longitudinal tendons are a vertebrate synapomorphy. Taken together, these character distributions reject the existing jaw-origin hypotheses that invoke modification of a gill arch, gill arch-like ventilation structures, or a velum. The character distributions also contradict the Heterotopy Hypothesis, which proposes the formation of the trabecula cranii as a direct driver for the origin of the jaw.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

EVALUATION OF A PRIMITIVE TAPIROMORPH PERISSODACTYL FROM THE AKASAKI FORMATION, EARLY / MIDDLE EOCENE BOUNDARY, JAPAN

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A small tapiromorph from the middle part of the Akasaki Formation near the early/middle Eocene boundary (ca. 49 Ma) in the western part of Kyushu Island, Japan, was previously reported based only on a left maxillary fragment with two molariform teeth recognized as DP4 and M1. It was provisionally considered an isectolophid species potentially related to *Orientolophus* from the early Eocene of China or *Isectolophus* from the middle Eocene of Asia and North America. It is important to re-assess the taxonomy of the Akasaki species because tapiromorph perissodactyls play an important role in Eocene land mammal biochronology in East Asia. The mammal fauna from the Akasaki Formation, including trogosine tillodonts and derived coryphodonts, has been considered to represent an Arshantan age. Although it had not been completely prepared before, the Akasaki tapiromorph specimen now includes a right M3, a right upper canine, and a fragment of a limb bone from the same individual. The molariform teeth on the maxillary fragment can now be confidently identified as M1 and M2 based on careful examination using CT images and comparisons with the M3. The Akasaki tapiromorph is similar to *Orientolophus* and *Gandheralophus* from the early eocene of Pakistan in molar size but differs in having a more lophodont tooth form lacking para- and metaconules and having a smaller parastyle. These differences, plus reduced posterior cingula, ectocingula intermittent at paracones, and faintly lingually poitioned metacones on upper molars are generally considered to be derived (autapomorphic) conditions seen in ceratomorphs. These features make the Akasaki species easily discernible from early Eocene non-ceratomorph tapiromorphs from Asia, such as *Karagalax*, *Chowliia*, and *Homogalax*. It is also distinct from *Heptodon* from North America and early Eocene lophialetid *Minchenolestes* from China in having less flattened metacones and low proto- and metalophs. The Akasaki tapiromorph may represent a transitional form from the non-ceratomorph condition to a basal ceratomorph grade.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

PRELIMINARY EVALUATION OF SAUROPOD REMAINS FROM A NEW DINOSAUR BONE BED OF THE MORRISON FORMATION IN SOUTHEASTERN UTAH (USA)

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While extensive outcrops of the Morrison Formation exist in the southeastern corner of Utah, these dinosaur-bearing deposits have received minimal attention. We report on a new Morrison bone bed (Brushy Basin Member) from San Juan County that has yielded abundant remains of sauropods as well as more fragmentary fossils of theropods, ornithopods, and thyreophorans.

The 'Gnatalie quarry' (locality LACM 7683; Natural History Museum of Los Angeles County) contains the remains of at least two sauropod clades: two size-differentiated diplodocine specimens and a camarasauromorph. The morphology of the caudal vertebrae of the Diplodocinae specimens is similar to that of *Diplodocus,* with marked pneumaticity, a concave ventral face, and a sub-square cross-section. Additionally, like *Diplodocus*, the mid-caudals are antero-posteriorly long and the proximal caudals have well-developed 'wing-like' ribs. However, unlike *Diplodocus*, the largest individual from the Gnatalie quarry presents marked pneumaticity that extends to just the middle caudals, which have well-defined pleurocoels with rod-like struts dividing them. In *Diplodocus*, caudal vertebral pneumaticity is less extensive; the last pneumatized caudal vertebrae occupy an anterior position. In fact, caudal pneumaticity in the diplodocine from the Gnatalie quarry appears to be more extensive than in any other diplodocoid. Future analyses will be necessary to confirm whether this difference is of taxonomic significance or if it represents intraspecific variability with *Diplodocus*. The third individual is preliminarily interpreted as belonging to Camarasauromorpha, sharing with *Camarasaurus* the presence of spatulate teeth, anterior bifurcated dorsal spines, opisthocoelous posterior dorsals lacking a posterior centroparapophyseal lamina. Bridged chevrons with a robust distal end distinguish this sauropod from *Camarasaurus*.

A preliminary phylogenetic analysis supports the assignation of the Gnatalie quarry diplodocids to Diplodocinae; the analysis resolves these specimens as more derived than *Apatosaurus* and *Dinheirosaurus*. The camarasauromorph is considered as a camarasaurid closely related to the Upper Jurassic *Camarasaurus* and *Lourinhasaurus*. Additional collecting and analyses are necessary to determine whether the Gnatalie quarry assemblage is indeed different from the classic Morrison dinosaur quarries to the North. The discovery of the Gnatalie quarry provides information about the geographic variation of the dinosaur faunas from the Morrison Formation.

Technical Session XVI (Saturday, November 8, 2014, 11:45 AM)

THE SCALES OF A DEVONIAN TETRAPOD REVEALED BY SYNCHROTRON MICROTOMOGRAPHY: HISTOLOGICAL IMPLICATIONS FOR THE FISH–TETRAPOD TRANSITION

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Certain aspects of the fish–tetrapod transition are still incompletely known, especially those concerning the dermal skeleton, comprising certain skull bones, fin rays, and scales. Early tetrapods (limbed vertebrates) were extensively covered with dermal scales, inherited from their non-tetrapod sarcopterygian (lobe-finned fishes) ancestors. These scales were involved in fundamental aspects of their lifestyle and locomotion. The early evolution of tetrapods and their transition to land (or terrestrialization) induced important morphological and microstructural changes in the squamation. However, the evolutionary implications of these changes are still largely unexplored, mainly due to the lack of comparative data.

Here I report a thorough study on the scales of the early tetrapod *Tulerpeton curtum* from the Late Devonian of Russia (about 365 million years ago). *Tulerpeton* is one of the earliest representatives of limbed vertebrates known in substantial anatomical detail. The use of high-resolution phase-contrast synchrotron microtomography allowed us to perform the first highly detailed three-dimensional reconstruction of the scales of a Devonian tetrapod. The new data show that the scales of *Tulerpeton* share the same bone-tissue characteristics as those of the late Palaeozoic tetrapods. However, the microstructural differences between the scales of sarcopterygian fishes and tetrapods, as evidenced in *Tulerpeton*, probably arose rapidly during the Devonian in an aquatic environment and such differences were maintained and almost unmodified during the terrestrialization process of tetrapods.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A NEW TRIBOTHERE (MAMMALIA) FROM THE LATE SANTONIAN UPPER MILK RIVER FORMATION, ALBERTA

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The upper Milk River Formation (late Santonian-early Campanian), southern Alberta, Canada, has yielded diverse vertebrates, including fishes, amphibians, turtles, squamates, crocodilians, dinosaurs, and mammals. The mammals provided the initial basis for definition of the Aquilan NALMA; mammals of this age also occur in Utah. The published mammalian record from the Milk River Formation includes non-therians (eutriconodontids, multituberculates), pretribosphenic "symmetrodonts", and several therians of tribosphenic grade that are neither metatherians nor eutherians ("tribotheres", e.g., *Picopsis*, *Potamotelses*, unnamed gen. and sp. [UALVP 16269]). Here we describe a new Milk River tribothere based on isolated, but well-preserved upper and lower molars. The robust upper molars are asymmetrically triangular, with a long posteriorly oblique labial side; the stylar shelf is reduced opposite the paracone, becoming much wider posteriorly, with no ectoflexus. The ectocingulum bears small cuspules, but lacks a definitive stylocone. The paracone is much larger than the metacone, the preparacrista weak, the centrocrista stronger, and the postmetacrista a high, often deeply worn, shearing crest. The protocone is low, anteroposteriorly longer than wide, and lacks cingula. Conules are small, with variable internal 'wings.' The lower molars are longer than wide, with a narrow trigonid, open trigonid angle, and anteriorly placed paraconid. The high paracristid, with a pronounced carnassial notch, sheared against the specialized postmetacrista. The protoconid is a towering cusp, the paraconid and metaconid much smaller, and the distal metacristid is weak. The talonid is short and its basin deep; the hypoconulid is slightly nearer to the entoconid than to the hypoconid. The characters of these teeth are not metatherian or eutherian, but resemble those of the Milk River tribotheres *Picopsis*, UALVP 16269, and, to a less degree, *Potamotelses* in evolutionary grade. The molars of this new taxon are derived in their reduced anterior stylar shelf and stylocone accompanied by hyperdeveloped postvallum/prevallid shear, while remaining relatively primitive in a small protocone and conules, and retained distal metacristid.

Technical Session XIV (Saturday, November 8, 2014, 11:30 AM)

A NEW SPECIES-LEVEL PHYLOGENY OF THE ICHTHYOPTERYGIA AND ANALYSIS OF MACROEVOLUTIONARY TRENDS

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Two centuries of ichthyosaur research have revealed a great deal of information on the anatomy of ichthyosaurs. Recent research has put this in a systematic context using numerical phylogenetic methods, but many of these have only considered the group down to genus level, and many include a limited taxon sample. Here, I present new phylogenies for the Ichthyopterygia, coded to species level, and including every reasonably complete taxon. The data matrix comprises over 280 characters, built using a critical supermatrix methodology, coded for almost 100 taxa. Characters from these analyses were evaluated based on similarity, informativeness and exclusivity; reductive coding and non-additive binary coding methods were preferred. Character codings were derived mostly from published descriptions, focusing on type specimens where possible. Analysis was completed using several parsimony- and likelihood-based methods. These include the heuristic search, ratchet and drift functions in PAUP* and TNT, and Mk model Bayesian analysis in Mr Bayes. The phylogenies produced similar topologies from all methods, and in comparison to to previous studies, but several genera were found to be paraphyletic, such as *Ichthyosaurus* and *Stenopterygius*. Other subclades within the Ichthyopterygia were found to be well supported, and these mark transitions in several character states, for example Mixosauridae and Ophthalmosauridae. Bayesian analysis yielded poor resolution, except for clades supported by several characters. This suggests that the characters used are not all truly informative in a likelihood context: the higher resolution found in parsimony analyses may therefore be misleading. These new results show the

need to reappraise the taxonomy of several ichthyosaurian taxa, particularly within the Mixosauridae and several Liassic taxa, for example *Ichthyosaurus* and *Temnodontosaurus*. Despite this, these data allow preliminary analysis of large-scale trends within the evolution of the Ichthyopterygia. The group generally shows gradual acquisition of characters throughout its evolution, punctuated by times of rapid diversification, as marked by the best-supported clades. The combination of the new, comprehensive phylogeny and comparative analysis sheds new light on the key macroevolutionary models and phases in ichthyosaurian evolution.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

CROCODILE AND DINOSAUR TRACKS FROM THE LAS HOYAS FOSSIL LAGERSTÄTTE (LOWER CRETACEOUS, CUENCA PROVINCE, SPAIN)

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The fossil Lagerstätte of Las Hoyas has yielded a relatively rich and diverse assemblage of invertebrate trace fossils. In contrast, vertebrate tracks are scarcer but, in fact, they have been very important for the interpretation of the Las Hoyas paleoenvironment. The most abundant vertebrate ichnofossils from this site belong to the ichnospecies *Undichna unisulca*. It consists of incised grooves having the form of a single sinusoidal wave. These traces were tentatively identified as produced by pycnodontiform fishes.

Despite the paleoenvironmental conditions of Las Hoyas not appearing to be favorable for the preservation of large vertebrates, some notable dinosaur finds have been recorded (e.g., *Mantellisaurus, Pelecanimimus*, and *Concavenator*). This record was recently reinforced by the presence of a new theropod trackway. This trackway is formed of six tridactyl footprints showing acuminate digital marks, a V-shaped digit III, relatively narrow interdigital angles, and an asymmetrical general morphology. The trackway also shows peculiar track morphology: the footprints of the left side are clearly deformed and are shorter than the ones from the right side. Moreover, the trackway is also unusually wide. These features reveal the presence of a pathological theropod trackway.

The crocodile tracks also constitute an interesting record for the Las Hoyas fossil site. In addition to a previously described shallow crocodile trackway, some crocodile manus and pes tracks have recently been collected. This material consists of isolated tracks, and their general shape is well-enough preserved to allow us to infer the general morphology of the autopodia. Both dinosaurs and crocodiles seem to have been rather incidental fauna in the Las Hoyas aquatic ecosystem. This fact could be partially related to the substrate conditions, which were not well suited for terrestrial locomotion.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

SPHEROOLITHIDAE EGGSHELLS FROM THE EARLY CRETACEOUS OF EUROPE: IMPLICATIONS FOR THE EVOLUTION OF ORNITHISCHIAN REPRODUCTION

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Early Cretaceous Spheroolithidae eggshells have always been extremely scarce, unlike their putative egg layers, ornithopod dinosaurs, which are ubiquitous in Early Cretaceous ecosystems. This inconsistency between the oological and the osteological record puzzled the paleontologists who worked on Spanish Wealden outcrops for years, especially considering the diversity and abundance of eggshell fragments recovered from the microfossil bonebeds of the Iberian Chain. Particularly conspicuous are fragments previously described as '*Macroolithus*' *turolensis*, an oogenus of the oofamily Elongatoolithidae related to derived theropod dinosaurs (i.e., maniraptorans).

Here we re-examine the type material of *'Macroolithus' turolensis*, and reassign them to the oofamily Spheroolithidae on the basis of the lack of a squamatic ultrastructure and the presence of a prolatocanaliculate pore system and undulating extinction, typical of spheroolithid eggshells. The redescription of the holotype and the paratypes, together with the study of new materials from several early Barremian localities of the Maestrazgo Basin (Iberian Chain, northeastern Spain) has allowed us to recognize it as a new oogenus within of this oofamily.

Spheroolithidae eggshells have been attributed to hadrosaurid dinosaurs based on the association of *Maiasaura* hatchlings and *Spheroolithus* eggshells in the Late Cretaceous of North America. The new oogenus exhibits an acicular radial ultrastructure in the lower part of the shell units, which develops into a tabular radial ultrastructure in the upper part, giving the appearance of a two-layered eggshell in thin section that is not observed in SEM pictures. This feature fills the gap between the two-layered prismatic eggshell of ceratopsians and the prolatospherulitic ornithopod eggshell of hadrosaurids. No hadrosaurids are known in the Early Cretaceous of Europe, but iguanodontians are profuse in those ecosystems, being the most likely producers of these spheroolithid eggshells. This is the first time eggshell material has been successfully attributed to iguanodontians.

Technical Session XIV (Saturday, November 8, 2014, 8:00 AM)

EQ IN THE 21ST CENTURY: A REASSESSMENT OF NON-AVIAN DINOSAUR ENCEPHALIZATION QUOTIENT CALCULATIONS AND IMPLICATIONS FOR MODERN PALEONEUROLOGY

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Comparative, quantitative studies of vertebrate neuroanatomy often analyze the classic relationship between brain size and body size. As brains do not fossilize, inclusion of fossils in studies of relative brain size typically involves the Encephalization Quotient (EQ), a ratio of ″actual″ brain size (all or part of cranial endocast volume) to 'predicted' brain size (according to regressions calculated from extant taxa) after correcting for body size. The biological significance of EQ is often interpreted in the context of cognition (e.g., EQ >1 indicates greater-than-predicted 'intelligence' and the reverse for EQ <1). To account for grade shifts, workers calculate multiple EQ values per specimen using regression slopes derived from restricted taxonomic samples (e.g., for dinosaurs, Reptile EQ (REQ) and Bird EQ (BEQ)). Until now, no EQ-type calculations for dinosaurs have been performed using modern comparative methods. Here, REQs and BEQs for some dinosaurs (e.g., *Stegosaurus*, *Euoplocephalus*, *Hypacrosaurus*, *Pachyrhinosaurus*, *Diplodocus*, *Majungasaurus*, and *Troodon*) are revisited within a phylogenetic context. Using cranial endocasts extracted digitally from computed tomography (CT) data and the landmark-based approach Gross Anatomical Brain Region Approximation (GABRA), quantifiable 3D virtual brain models were constructed to restore actual brains. Regression equations were produced by analyzing log-transformed brain and body masses with phylogenetic generalized least squares regression (PGLS), incorporating tree structures from the literature. Tests (Pagel′s λ, Blomberg′s K) show strong phylogenetic signal for both 'reptile' and bird data, highlighting the importance of phylogenetic correction in determining 'predicted' brain values for dinosaurs prior to calculating REQ and BEQ. Newly-calculated, well-fit regression slope equations obtained from PGLS analyses indicate that previous slopes overestimated 'predicted' brain sizes, leading to underestimated REQ and BEQ values for dinosaurs. In birds, EQ correlates with cognition, social behavior, parental care, feeding behavior, and metabolic rate. New dinosaur EQs may shed light on dinosaur cognition and behavioral expression. However, as a whole-brain metric, EQ may mask changes in regional brain anatomy that inform how and why brains evolve. We recommend calculating EQ using phylogenetically-corrected regressions when appropriate and supplementing EQ with regional studies that may clarify evolutionary changes in overall brain size.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

ONTOGENY CHANGES EVERYTHING…BUT DOES A GROWTH TREND CHANGE?

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Although it is important in assessing paleo-biodiversity, classification of juvenile materials of extinct taxa is challenging because organisms often change their shape through ontogeny. However, if the nature of the growth trajectory is understood, it can be useful in identifying or distinguishing species. In this study, I tested whether allometric coefficients from multiple parts of the skulls of *Alligator mississipiensis* (Class: Reptilia) and *Marmota caligata* (Class: Mammalia) can be regarded as constant throughout growth. Skulls of different sizes (41 *A. mississipiensis* skulls ranging from 40 to 630 cm in length, and 111 *M. caligata* skulls, ranging from 6 to 11 cm in length) were used for the analysis. These skulls were categorized into three (in *A. mississipiensis*) and two (in *M. caligata*) size groups, and the allometric coefficients within each size group are compared against the allometric coefficients for all individuals of each species. In each species, the allometric coefficients of each size group are often statistically significantly different from the allometric coefficients calculated from all individuals. To understand the size of this difference, effect sizes (degrees of the differences) of the allometric coefficients are also calculated. The allometric coefficients for fenestrae or foramina have larger effect sizes than other lengths. The results show that although the growth trends may actually change through ontogeny, they remain within a certain range. Deviation from this range may indicate the compared specimens include more than one species.

Technical Session IV (Wednesday, November 5, 2014, 2:45 PM)

VARIATION AND VARIABILITY IN THE DEVELOPMENT OF THE SKELETON OF *MONODELPHIS DOMESTICA*: IMPLICATIONS FOR ASSESSING MATURITY IN EXTINCT AND EXTANT ORGANISMS

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Fossils provide insight into evolution that cannot be anticipated based solely on studies of extant organisms. Unfortunately, because the remains of extinct organisms are rare and incomplete, we have an imperfect understanding of their development and evolution. Evolutionary developmental biology (evo-devo) integrates both the developmental genetics of extant organisms and the ontogenetic and phylogenetic patterns in the fossil record to provide unique insight into the pattern and process of evolution. However, intraspecific variation in development is often overlooked in evo-devo studies because most methods for characterizing and comparing ontogenetic events do not take variation within populations into account. Quantifying ontogenetic variation is particularly important for interpreting patterns found in extinct organisms because sample sizes are often small and we cannot necessarily recognize intra- vs. interspecific variation. To fill this gap in methodology and knowledge, I used Ontogenetic Sequence Analysis (OSA), which quantifies developmental variation, to assess levels of variation and variability in the ontogeny of the skeleton of the marsupial *Monodelphis domestica*.

I evaluated 92 events during skeletal development using a sample of 35 cleared-and-stained (CS) specimens and 12 computed tomography (CT) datasets (spanning birth to 24 days). The analysis of CS and CT specimens recovered 5128 and 38 most parsimonious ontogenetic sequences, respectively; the difference in sequence number was related to sample size. Variability in the order of ontogenetic events was quantified for all events. The ossification of the interparietal was the most variable and those of a carpal and tarsal were the least variable events. From this analysis I was able to identify features that can approximate the maturity of specimens. Significantly greater levels of sequence variation were found than previously known, which demonstrates that intraspecific ontogenetic variation is important and should not be ignored. My results emphasize that methods such as OSA help to integrate ontogenetic variation into comparative developmental studies and can allow a greater understanding of developmental phenomena. These methods can be applied to other groups of vertebrates, including extinct taxa, but are limited by small sample sizes. My study also shows that, with careful study of developmental patterns, maturity can be assessed with confidence intervals for individual specimens, both extant and extinct.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

JUVENILE CRANIAL MATERIAL OF *AURORACERATOPS RUGOSUS* (CERATOPSIA: ORNITHISCHIA) AND IMPLICATIONS FOR THE PHYLOGENETIC PLACEMENT OF JUVENILE SPECIMENS

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Auroraceratops rugosus is currently known from over 80 individuals recovered from the Aptian-Albian deposits of the Yujingzi and Gongpoquan Basins, Gansu Province, Northwestern China. The material is often well-preserved, with associated and articulated skeletons common. Among the collection are several juvenile specimens, including a nearly complete skull. The juvenile skull has a basal skull length of 80 mm, compared to 170 mm in the holotype, indicating a considerably younger individual. As the specimen includes only an isolated skull, histological skeletochronology is not possible. The juvenile is referred to *Auroraceratops* based on the presence of some autapomorphies of the genus, including a dentary with a lateral tubercle near the contact with the surangular, a low tubercle on the ventral margin of the dentary near its mid-point, and a fungiform expansion of the lacrimal. The juveniles also share the plesiomorphic character of the absence of a surangular shelf with adult *Auroraceratops*. The juvenile lacks several autapomorphies, including inflated premaxillary teeth and the rugose texture of the jugal, dentary, and surangular. The primary differences between the juvenile and adult specimens are proportional, with relatively few changes attributable to discrete morphological characters. As in most juvenile amniotes, the eyes are relatively large and the tooth count and relative snout length are reduced.

The juvenile specimen was added to a new specimen-level dataset containing 71 specimens from 36 different species of basal neoceratopsians using 245 characters. The resulting matrix was subjected to a traditional parsimony analysis in TNT. Unexpectedly, the juvenile specimen clustered in a polytomy with many of the other specimens of *Auroraceratops*. This is in contrast to recent work finding that juvenile specimens typically appear in a more basal position than more somatically mature specimens of the same species. The clades used in previous work, Ceratopsidae and Hadrosauridae, include many species differentiated based on features which appear relatively late in ontogeny and may be related to age or sexual signalling. This analysis suggests that closer examination of less ornamented species may indicate that not all phylogenies are as strongly affected by ontogenetic changes.

Technical Session VI (Thursday, November 6, 2014, 9:30 AM)

PRIMATE BODY SIZE ACROSS THE PALEOCENE–EOCENE THERMAL MAXIMUM IN NORTH AMERICA

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The first appearance of several extant mammalian orders in North America (NA) at ~56 Ma coincides with the Paleocene–Eocene Thermal Maximum (PETM), an interval of rapid global warming of ~5–10° C. Two small-bodied euprimate genera (*Teilhardina* and *Cantius*) immigrated to NA during this time. Their fossils are found in the same screen-washed localities as microsyopid primates (*Niptomomys* and *Arctodontomys*), whose teeth suggest ecological similarities with those of the euprimate immigrants. PETM climate change should elicit similar morphological responses in ecologically similar but non-competing taxa, whereas it is expected to accentuate the effects of character displacement in competing taxa. Furthermore, if immigrant and endemic primates had significantly overlapping ecology, these groups should increase in size or shape disparity during the PETM to minimize competition. To test these hypotheses, we compared a large, stratigraphically resolved sample of log-transformed M1 and M2 areas of *Teilhardina* (n = 26), *Cantius* (n = 63), *Niptomomys* (n = 82), and *Arctodontomys* (n = 8) from the Early Eocene Wa-0 and Wa-1 intervals of the Cabin Fork area in the Bighorn Basin, Wyoming. We ran 10,000-iteration bootstrapped t-tests to correct for different sample sizes. We found that all four genera occupy non-overlapping tooth size ranges throughout the PETM and recovery, potentially indicating different ecologies for these taxa. Body sizes of Wa-0 microsyopids before and after the arrival of euprimates in NA are statistically indistinguishable, as are those of euprimates during Wa-0 compared to Wa-1. However, microsyopid body size increased significantly from Wa-0 (the PETM) to Wa-1 (the post-PETM recovery; $p < 0.005$ for both genera). Our results suggest that shifts toward larger body size occurred in endemic microsyopids, probably in response to climate change rather than the arrival of potential competitors, but not in the immigrant euprimates. Modern sympatric primate species frequently coexist by exploiting different food resources and occupying different forest height positions, which can have implications for body size. Our size data are consistent with such a relationship between Wa-0 to Wa-1 microsyopids and euprimates, and further indicate that non-overlapping sizes existed before the arrival of euprimates in the Bighorn Basin. Ongoing geometric morphometric analyses of dental and postcranial morphology will provide additional data to better characterize potential ecological responses to dramatic habitat change in these taxa.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

LATE MIOCENE-EARLY PLIOCENE COLUBRID SNAKES (SERPENTES: COLUBRIDAE) FROM TENNESSEE AND THEIR IMPLICATIONS FOR NORTH AMERICAN SNAKE EVOLUTION

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The Gray Fossil Site of eastern Tennessee is a late Hemphillian fossil locality in the southern Appalachian mountain region of eastern North America. Snakes make up a vital microfossil portion of the site's diverse herpetofauna, and members of the Colubridae are the most numerous snake fossils recovered. Colubrid fossils from the site consist of colubrines and natricines. Eight colubrid taxa have been identified from the site thus far, including three natricines (cf. *Neonatrix*, *Nerodia*, *Thamnophis*) and five colubrines (*Coluber*, *Pantherophis*, *Masticophis*, *Pituophis*, and a new colubrine). Non-thoracic vertebral material has also been identified and provide important taxonomic information. cf. *Neonatrix* and the new colubrine are the only extinct genera identified. If correctly identified, the *Neonatrix* fossils mark the first occurrence of this genus east of Nebraska. The new colubrine represents the only currently known endemic snake from the Gray Fossil Site. The absence of *Lampropeltis* and *Heterodon*, commonly present at other sites in mid-continental North America at this time, imply their evolution and migration from the Great Plains of the United States to the eastern and southeastern United States after the late Hemphillian. The Gray Fossil Site snake fauna is consistent with the hypothesis previously proposed that the Miocene was a time of transformation for the snake faunas of mid-continental and eastern North America. Boids were declining or completely absent from most of the United States by the late Hemphillian, as they are at the Gray Fossil Site, while colubrids and viperids were becoming more numerous, and modern genera were becoming more prevalent. The Gray Fossil Site represents a poorly-understood region of North America at a critical time in snake evolution, and further study may lead to a better understanding of the modern snake fauna present today in mid-continental and eastern North America.

Symposium 1 (Wednesday, November 5, 2014, 11:00 AM)

USING DEGRADATION EXPERIMENTS OF EXTANT FEATHERS TO ADDRESS THE PRESENCE OF MICROBODIES IN FOSSIL FEATHERS

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Elongate and round microbodies observed in fossil feathers were originally attributed to microbial overgrowth, in part because microbes are ubiquitous, resistant to degradation, and universally involved in the degradation of organic matter. A series of publications subsequently reinterpreted these microbodies as melanosomes, melanin-containing intracellular eukaryotic organelles endogenous to colored feathers. Based on this interpretation, whole-bird color, iridescence, physiological strategies, ecology and behavior have been proposed. To infer such a broad suite of traits, one hypothesis must first be disproven before advancing another. More than morphological similarities are required to support either hypothesis.

To test both the longevity of keratin in the fossil record and melanosome persistence in environmental conditions designed as taphonomic proxies, we report here the results of a 10-year degradation experiment. Feathers from a single freshly-killed Hungarian Partridge (*Perdix perdix*) were subjected to four environmental conditions. The four conditions were: 1) kept at room temperature (unaltered); 2) buried in saturated sand (Judith River Formation sand from dinosaur excavation) and incubated at 60°C for ~ 3 years, allowed to dry and kept buried at room temperature (wet burial); 3) buried in saturated sand, then baked at 350°C uninterrupted for 10 years (dry burial); and 4) the remaining feathers and whole bird carcass were buried in the same sand, placed in a drainage channel surrounded by rich peaty soil adjacent to a mountain pond (stream burial). Feathers, bones, and skin were completely degraded in the fourth condition; no data exist. Feathers from the other three conditions were subjected to TEM to observe changes in structure as well as melanosomes and immunohistochemistry to observe changes in anti-beta-keratin retrieval, and to determine if melanosomes are preserved. Data suggest there is no difference in epitope retrieval between the control (room temperature) and 60°C conditions, but signal is significantly reduced after 10 years at 350°C. Preliminary TEM data demonstrate no melanosomes in the latter condition, supporting the hypothesis that keratin feather components may outlast melanosome bodies, indicating the keratin preservation outlasted melanosome preservation.

Symposium 4 (Friday, November 7, 2014, 9:45 AM)

LIMB BONE MICROANATOMY OF THE MIDDLE TRIASSIC CAPITOSAURS FROM INDIA AND ITS PALEOBIOLOGICAL IMPLICATIONS

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Capitosaurs are the most abundant group of Triassic temnospondyls. In India, the Middle Triassic capitosaurs are known from the Denwa Formation of the Satpura Gondwana basin, and are represented by *Paracyclotosaurus crookshanki* and *Cherninia denwai*. These two taxa are known from the heterolithic sand-mud facies of the upper part and relatively lower part of the Denwa Formation, respectively. Osteohistological analysis is carried out in the present study based on multiple limb bones such as humerii, radii, ulnae, femora, tibiae and fibulae, which belonged to sub-adult and adult individuals as deduced from relative sizes. The analysis reveals a predominance of well vascularized fibrolamellar bone tissue in the cortices of the limb bones except for an adult humerus, femur and tibia. In the latter elements, the predominant cortical bone is nearly avascular lamellar zonal. In other limb bones, vascularity is high and the primary osteons are arranged in a laminar to sub-plexiform pattern. Site specific occurrence of radially arranged vascular channels is noted in the cortices. In general, limb bone microanatomy suggests rapid osteogenesis and fast growth during most of ontogeny, whereas growth was considerably reduced later in ontogeny. However, growth was continuous as indicated by the absence of growth rings in most of the limb bones examined. Only the tibia documents two lines of arrested growth. Fibrolamellar bone tissue reported from the Early Triassic trematosaurids and the Middle Triassic capitosaurs suggests that both these groups had fast initial growth as noted in many higher vertebrates. Inter-elemental histovariability is evident, which includes thickness of the cortices, differing bone tissue types, arrangement of the primary osteons, and extent of secondary reconstruction. A narrow compact cortex with well-differentiated medullary spongiosa suggests that the Indian capitosaurs, as evident in *Paracyclotosaurus*, suggests a high level of terrestriality. In contrast, an isolated adult femur possibly belonging to *Cherninia* shows very high vascularity, a narrow cortical compacta with large resorption cavities in the perimedullary region and absence of distinct demarcation between the cortex and medullary region,

thereby suggesting an amphibious habitat. Hence, differing life style adaptations for the Middle Triassic capitosaurs from India may be deduced from bone histology.

Technical Session VII (Thursday, November 6, 2014, 9:30 AM)

A NEW DUROPHAGOUS CROCODILE FROM THE LATE CRETACEOUS OF SUDAN

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The Late Cretaceous Wadi Milk Formation of northcentral Sudan is known to yield a diverse assemblage of micro- and macrovertebrates, but there has been no record of articulated skeletal material to date. Here we report on a new species of crocodyliform represented by an almost complete skull, which represents the first articulated vertebrate remains from this formation, and an isolated dentary from the same locality. The skull, which was discovered in 2011 at a previously unexplored locality near Jebel al Jammam (Humar basin), is almost 1 m in length and preserves all parts of the skull except for the premaxilla and the lower jaws. It is characterized by a wide but not overly deep cranium superfically similar to that of *Alligator*. The orbits are dorsally oriented, and the upper temporal fenestrae are comparatively small. The palate is virtually complete and well-preserved. The position of the internal choana is well posterior in the palate, similar to modern eusuchians. A notable derived feature is the possession of a distinctly bulbous dentition of varying size in both upper and lower jaws. Teeth in the anterior half of the jaws are very large, reaching approximately 20 mm in diameter, but remain bulbous and show a high degree of wear, suggesting hard-shelled prey.

Phylogenetic analyses using parsimony and Bayesian inference place the new taxon in a clade with other broad-snouted Cretaceous crocodyliforms from northern Africa, including *Aegisuchus* and *Aegyptosuchus*, suggesting crocodilian endemism in this region during the Late Cretaceous. The inclusion of the new taxon from Sudan collapses the monophyly of Notosuchia, and suggests mesoeucrocodylians form a variety of smaller clades that grade into neosuchians. The new crocodyliform from Sudan fills an important gap in our understanding of the Late Cretaceous diversity of this group in Africa, and underscores the potential of the eastern Sahara for important Mesozoic fossil discoveries.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

CONVERGENT EVOLUTION OF SECONDARY CRANIAL SYMMETRY IN ODONTOCETI (MAMMALIA, CETACEA): HOW AND WHY?

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Odontocetes (Mammalia, Cetacea) use echolocation in order to search for their prey, avoid predators, and navigate through their surrounding topography. Echolocation is accomplished by clicks that produce ultrasonic waves. Unlike most other vertebrates, odontocetes evolved cranial asymmetry accompanied with asymmetrical soft tissues for this special ability. Nevertheless, several linages of Odontoceti have secondarily obtained cranial symmetry. For example, extant phocoenids and *Pontoporia* share soft anatomical feature related to cranial symmetry: i.e., their left and right dorsal bursae which are fatty soft tissues associated with phonic lips and related echolocation clicks, are symmetrical. This morphology has been thought to be linked with their acoustic specialization. Namely, they produce narrow-band high frequency clicks (with a frequency above 100 kHz and the peak of the frequency of these clicks at about 130 kHz) and do not use whistles (a phonetic sound for intra-specific communication), unlike most other extant odontocetes. Most phocoenids and *Pontoporia* are less than 2 m in body length and do not form large pods. Consequently, they are exposed to high predation pressure. Narrow-band high frequency clicks and the absence of whistles in these species have been thought to represent an adaptation to avoid acoustic detection by their predator *Orcinus*, because *Orcinus* cannot detect such high frequency clicks. Even though some exceptions are present, cranial symmetry or weak asymmetry in extant odontocetes seems to be related to the presence of the symmetrical dorsal bursae and narrow-band high frequency clicks, which are adaptations to avoid predation that evolved in independent linages. The relationship between cranial symmetry and narrow-band high frequency clicks and the absence of whistle may be extrapolated to fossil taxa. In this study, I quantitatively assess degree of cranial asymmetry in both extant and extinct odontocetes. Then, I trace how secondary cranial asymmetry was evolved in Odontoceti on a phylogenetic tree. Furthermore, I test the hypothesis that narrow-band high frequency clicks and the absence of whistles in extant species are an adaptation to avoid passive listening of their predator *Orcinus* by the fossil record.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A FOUNDATION FOR BEST PRACTICES IN MITIGATION PALEONTOLOGY

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Mitigation paleontology focuses on the recovery and preservation of paleontological resources (fossils) that are threatened by ground disturbance associated with land and energy development projects. Mitigation includes the assessment of potential impacts and the development of measures to reduce or eliminate adverse impacts to scientifically important fossils, as well as the implementation of those measures. Despite several decades of steady progress with the development of standard procedures and regulatory guidelines for the assessment and mitigation of impacts, neither mitigation paleontologists nor the regulatory agencies that oversee their activities have been successful in developing industry-wide standard operating procedures. Best practices are methods and techniques that have consistently shown results superior to those achieved by other means, and are used as a benchmark for judging the adequacy of mitigation. They are a standard way of doing things that multiple organizations can adhere to, although they evolve and improve over time. In this paper we propose comprehensive and detailed best practices for the mitigation paleontology industry that fall into ten categories: (1) qualifications and permitting; (2) analyses of existing data; (3) research models and scientific context; (4) field data collection; (5) field surveys; (6) construction monitoring; (7) fossil salvage; (8) data management and reporting; (9) curation facilities; and (10) business ethics and scientific rigor. Our purpose, with input from the mitigation community, is to establish procedures that are successful in maintaining a rigorous scientific standard while promoting integrity in the industry in order to accomplish the common goal of paleontological resource preservation via impact mitigation.

Technical Session XV (Saturday, November 8, 2014, 8:45 AM)

ISLANDS ARE NOT CONTINENTS: PHYLOGENY AND BODY SIZE DRIVE UNIQUE EXTINCTION DYNAMICS OF CARIBBEAN MAMMALS

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The recent loss of insular diversity during the Holocene has made islands key targets for conservationists seeking to preserve hotspots of endemism. Prior to the latest Holocene (or Anthropocene), however, islands were refugia for megafaunal species. A disparity in mainland Pleistocene and island late Holocene extinction chronologies provides a natural framework to tease apart potential causal factors such as climatic change and the arrival of humans, which are largely decoupled on islands but contemporaneous on most continents. However, such comparisons must be made with caution. Insular communities are not just small continents. Their faunas are the result of unique evolutionary and ecological histories of islands, and thus, particular species may not adhere to the same models of community assembly and ecological diversity that mainland relatives experience.

We have assembled the most comprehensive database of all mammal species of the Caribbean (Quaternary to present). We reconstruct body sizes of extinct and extant species, constrain their phylogenetic placement and determine the timing of extinction by using radiocarbon or associational data. Our objective is to reveal the specific processes underlying extinction in this system and to compare patterns of extinction across single islands, island systems, and continents worldwide. We find that body size distributions of the Caribbean and other island systems deviate strongly from those found on either continental or single island systems in both pre- and post- Pleistocene extinction time bins. We find evidence for multiple pulses of extinction within the Caribbean associated with different extinction drivers, including two culturally distinct waves of human colonization, which have left strong imprints of size-biased extinction and phylogenetic signal in probability of persistence. Our results employ a conservation paleontological approach, linking studies of island biogeography in deeper time with studies of extant populations to provide a holistic perspective on the generation, maintenance, and erosion of mammalian diversity.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

EVOLUTIONARY TRENDS IN THE JAW APPARATUS OF ORNITHISCHIAN DINOSAURS

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Ornithischian jaw mechanisms have been investigated for over a century, with a majority of studies focusing on cranial musculoskeletal function of one or few taxa. In this study, various aspects of the ornithischian jaw apparatus are investigated to gain a comprehensive understanding of their diversity and evolution. Comparative observations of ornithischian craniomandibular material in all subclades are interpreted alongside jaw adductor muscle vectors and 2D lever arm methods for investigating relative bite forces. Morphological diversity in ornithischian jaw elements exists between subclades as well as among genera within a given subclade. The articulation of the neomorphic ornithischian predentary against the dentaries at the mandibular symphysis allows simultaneous independent mediolateral adduction or rotation of the mandibular corpora on both sides of the jaw. This mobility is supported by associated tooth row, coronoid process, and jaw joint morphologies. The predentary therefore inhibited symphyseal muscle force transfer, making 2D lever arm methods sufficient in giving an accurate reading of unilateral relative bite force. Lever arm analyses show major instances of overlap between taxa in the tooth positions in which there was high mechanical advantage. A relatively low bite force is seen across the tooth row among thyreophorans and a convergent transition occurs from a more evenly distributed bite force throughout the jaw in basal ornithopods and marginocephalians to a strong caudal bite force in hadrosaurids and ceratopsids. In all cases, both the heightening of the coronoid process and lowering of the jaw joint below the level of the tooth row aided in increased moment arm length and, therefore, mechanical advantage. Accordingly, M. adductor mandibulae externus muscle vector angles show repeated trends from a mid-range caudodorsal orientation in basal ornithischians and basal thyreophorans to a decrease in vector angles indicating more caudally oriented jaw movements convergently in other taxa (e.g., derived thyreophorans, basal ornithopods, lambeosaurines, pachycephalosaurs, and derived ceratopsids). The extensive amount of variation in muscle orientations as well as osteological traits in the ornithischian jaw apparatus suggest highly variable feeding mechanisms within subclades and convergent evolutionary trends toward greater overall mechanical advantage.

Technical Session XIV (Saturday, November 8, 2014, 10:45 AM)

OSTEOLOGY OF THE TYPE MATERIAL OF *MELANOROSAURUS READI*, A 'NEAR SAUROPOD' (DINOSAURIA: SAUROPODOMORPHA) FROM THE UPPER TRIASSIC LOWER ELLIOT FORMATION OF SOUTH AFRICA, AND THE STATUS OF REFERRED SPECIMENS

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The Late Triassic Norian stage was an important time in the radiation of sauropodomorph dinosaurs, when phylogenetically disparate taxa began to increasingly co-exist in time and space globally. A diversity of sauropodomorphs yielded from the lower Elliot Formation of southern Africa exemplify this, where six presently valid taxa and at least two unnamed forms represent variety in body size, cursoriality and postural gait, and probable feeding capacity. Accordingly, these provide key insights into the non-sauropod to sauropod evolutionary transition. Despite being founded on an accumulation of cursorily described postcranial elements, *Melanorosaurus readi* is presently the best-understood African Norian sauropodomorph due to two relatively complete specimens described and referred to it. However, the lack of a detailed osteological account of the type material renders the subsequent specimen referrals problematic, which may in future hinder proper assessment of any additional lower Elliot sauropodomorph materials.

Our survey of the type repository of *M. readi* (93 elements) demonstrates an abundance of extraneous fragmentary basal sauropodomorph specimens that were not part of the syntypes originally described. We show, via systematic preservational qualities, historical details, and osteological data, that these extraneous materials represent at least three additional unnamed sauropodomorphs. The revised lectotype and paralectotypes of *M. readi* allow for a differential diagnosis of the taxon, and bear several traits observable in the referred specimens: (1) primordial sacral II transverse processes with paired fossae; (2) unexpanded hyposphenal ridges present on proximal caudals; (3) an embayment on the distal end of fibula. Although still incomplete, sacral materials in the lecto-paralectotype suggest a four sacral vertebrae, as per both referred specimens.

A newly identified braincase is part of previously described referred material of *Melanorosaurus* that until now had only been known from postcranial elements. It exhibits (1) a partially separated vagal canal, (2) the near loss of the crista tuberalis, and (3) a relatively large and caudally tapering floccular recess, which are features shared with the neurocranium of a recently described complete skull of *Melanorosaurus*. Overall, and despite minor distinctions, an osteological revision of the type material of *M. readi*, in combination with the new braincase, seems to increase support for all these specimens belonging to one taxon.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

A NEW COPROLITE ASSEMBLAGE FROM THE UPPER OSAWA FORMATION (SPATHIAN), NORTHEASTERN JAPAN: MARINE FANAL DIVERSITY AFTER THE END-PERMIAN MASS EXTINCTION

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Lower Triassic marine deposits can potentially provide significant information on the diversity and trophic structure of marine ecosystems following the end-Permian mass extinction. Given the sparse body fossil record from the Lower Triassic, trace fossils may provide additional windows on paleo-ecosystems. Herein, we report a newly discovered coprolite assemblage from the upper Osawa Formation (Spathian, Lower Triassic) in the South Kitakami Terrane (SKT) of northeast Japan. The Osawa Formation yields macrofossil species including plant debris, bivalves, and brachiopods, in addition to small-sized ammonoids. However, regarding carnivorous animals of high trophic level, a hybodontid shark, a basal ichthyosaur *Utatsusaurus hataii*, and at least one non-*Utatsusaurus* ichthyosaur species have been reported. Geochemical analysis revealed that the coprolites are rich in phosphate and organic carbon, and poor in silicates, compared with the surrounding mudstone. Mode of the occurrence and geochemical signatures of the coprolites indicate that the fecal producers were not benthic sediment feeders, but were most likely nektonic animals. Bone inclusion suggests that carnivorous fish and/or marine reptiles, constituting the higher part of the food web, produced these specimens. Despite the low diversity of the known fossil nektonic assemblage from the Osawa Formation, the wide variety of coprolite sizes and shapes suggests that the fecal producers in the Early Triassic ocean of the SKT were more diverse in size and trophic level than predicted from the body fossil record.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE LATE CRETACEOUS ELASMOSAURIDAE (PLESIOSAURIA) FROM SHISHI-JIMA ISLAND, KAGOSHIMA, SOUTHWEST JAPAN

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A part of plesiosaurian fossil was found from the Goshoura Group, Shishi-jima Island, Kagoshima, southwestern Japan in February 2004 by Satoshi Utsunomiya. This plesiosaurian fossil is the first record from the Kyushu Area in the Inner Zone of southwest Japan. Almost of the Cretaceous plesiosaurian fossils in the Northwest Pacific region were found from the northeast Japanese Islands of Hokkaido and Honshu, and Sakhalin Island. The Educational Board of Azuma Town and Kochi University Research Team excavated reserved parts of this specimen and associated invertebrate fossils from May 2004 to January 2006. This specimen consisted of a left mandible, several vertebrae, ribs, fragments of girdle and limb bones.

The main morphological characters of this specimen are as follows. The teeth are conical and slender with ornamental ridges, the cervical vertebrae are relatively long, the cervical ribs are single-headed. These characters indicate that the specimen belongs to Superfamily Plesiosauroidea, Family Elasmosauridae.

Associated ammonite fossils referable to *Graysonites adkinsi* suggest that the specimen originates from a horizon that is early Cenomanian in age. This age indicates that this specimen is the oldest Cretaceous elasmosaurid recovered from the Japanese Islands.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

WAS *SMILODON FATALIS* A SLINKY CAT? PECTORAL AND PELVIC GIRDLE ADAPTATIONS ENHANCE STALKING CAPABILITIES OF THE AMBUSH PREDATOR FROM RANCHO LA BREA

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Mammalian carnivores are generally considered to belong either to the pursuit or ambush category. The prey capture requirements of these lifestyles differ, and specific behavioral strategies typify each carnivore group at the familial taxonomic level. For example, canids tend toward being pursuit predators that hunt in groups, while most felids specialize in ambush and hunt singly, although both specialize in capturing large-sized prey. The extinct saber-tooth, *Smilodon fatalis*, is considered to be an ambush predator because it is large-bodied, robustly muscled, and short-limbed, although no previously identified characters enhance *Smilodon's* abilities to engage in this style of prey capture. These adaptations have also been assumed to restrict the flexibility and range of movement of this sabercat because it is suggested that a sacrifice of flexibility is a required trade off as a means of acquiring increased strength to grasp and manipulate large-bodied prey. This study describes morphological adaptations that enhance the ability of *S. fatalis* individuals to move stealthily, derived from an analysis of the movement patterns created by unique pectoral and pelvic girdle features. Usually, in slinking cats, the posterodorsal aspect of the scapula and the anterodorsal aspect of the ilium project dorsal to the tips of the vertebral spinous processes. In *S. fatalis*, in contrast, truncated and modified scapular and ilial shapes allow this sabercat to show a lower crouching profile even when the fore- and hind limbs are flexed maximally, because the most dorsal margins of the shoulder and hip regions do not project dorsal to the vertebrae. This contrasts with the crouching profile of most other felids, including those of similar large body sizes, such as *Panthera leo,* in which the body regions that project most visibly above the potential cover offered by standing vegetation, such as that an ambush predator would use during a crouch, are the rounded shoulder and hip projections. Being able to flatten the body to a greater extent than can other cats of similar size allows *S. fatalis* to remain closer to the ground during a stalk, therefore enhancing the ability of this ambush predator to use even relatively low cover more effectively to hide its approach toward alert prey.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

REEVALUATION OF THE PHYLOGENETIC STATUS OF THE EUSUCHIAN CROCODILE *MUSTURZABALSUCHUS* FROM THE LATE CRETACEOUS OF SPAIN

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Musturzabalsuchus buffetauti, from the Campanian–Maastrichtian Laño locality (Condado de Treviño, Spain), is a poorly known representative of the European Late Cretaceous record of eusuchian crocodiles. The holotype is a left maxilla characterized by a marked curvilinear lateral profile with a mid-constriction, and other skull bones were designated as paratypes. Traditionally considered an alligatoroid, the status of this taxon remains uncertain and its relationships with other basal eusuchians from the Late Cretaceous of Europe, such as *Allodaposuchus* and related forms, are not clear. Alligatoroid affinities were based on two derived features: the presence of a pit in the rostrum for occlusion of the fourth mandibular tooth laterally placed behind the last teeth of the premaxilla and a foramen aëreum placed on the dorsal surface of the articular. The maxillary-premaxillary occlusal pit is found in other neosuchians, including *Theriosuchus, Susisuchus*, paralligatorids, hylaeochampsids, and *Allodaposuchus*. Moreover, whether the fourth dentary tooth occluded in a pit or a notch between the maxilla and the premaxilla of *Musturzabalsuchus* cannot be confirmed. The position of the foramen aëreum is an alligatoroid feature, but is also found in *Acynodon* and *Shamosuchus*. On the other hand, the mandibular bones from Laño lack the external mandibular fenestra found in all alligatorids. The fenestra is also absent in many non-eusuchian neosuchians, such as *Bernissartia* and some species of *Goniopholis,* and basal eusuchians such as *Iharkutosuchus*, *Acynodon* and specimens from Lo Hueco (Cuenca, Spain). In addition, *Musturzabalsuchus* shows many similarities with crocodyliform material described from Lo Hueco referable to *Allodaposuchus* or a close relative. Whether the holotype and referred specimens pertain to one species is unclear, but assuming they do, its inclusion on a phylogenetic analysis places *Musturzabalsuchus buffetauti* outside Crocodylia and closely related to *Allodaposuchus*.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

CT RECONSTRUCTION AND SYSTEMATIC POSITION OF THE ENIGMATIC DICYNODONT *PRODICYNODON BEAUFORTENSIS*

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Although great advances in resolving the alpha taxonomy of South African dicynodonts have been made in the past few decades, a variety of 'problem taxa' remain, mostly represented by small, poorly-preserved, and often partial skulls. One such taxon is the genus *Prodicynodon*, represented by two nominal species from the late Permian Beaufort Group: *P. pearstonensis* (the type) and *P. beaufortensis*, both known only from their respective holotypes. Both specimens are small (5 cm preserved length), poorly-prepared incomplete skulls with few visible characters. Previous authors have suggested that the *Prodicynodon* specimens represent juveniles of the aberrant dicynodont *Endothiodon*, a taxon characterized by the absence of tusks and reversal of the upper dentition to a long tooth row that includes premaxillary teeth. Here, we re-evaluate *P. beaufortensis* based on a computed tomographic (CT) scan of the type specimen. This scan has enabled accurate reconstruction of the palate and upper dentition, previously obscured in this specimen by the tightly-occluded lower jaw. Unlike *Endothiodon*, *P. beaufortensis* bears two small but distinct tusks. These tusks were still in the process of erupting, indicating that the *P. beaufortensis* holotype does represent a juvenile individual. The medial tooth row of *P. beaufortensis* is made up of four to five teeth

restricted to the maxilla, unlike *Endothiodon* with nine to eleven. In general, *P. beaufortensis* is most similar to the holotype of *Cryptocynodon simus*, another problematic taxon sometimes considered a juvenile *Endothiodon*. If *Prodicynodon* was a juvenile *Endothiodon*, the tusks would have to erupt and then be lost and the upper tooth row would have to expand dramatically during ontogeny. This possibility cannot be excluded at present due to the lack of a good growth series for *Endothiodon*, but this would represent a previously unknown developmental trajectory for a dicynodont. In addition, inclusion of *P. beaufortensis* in a recent and comprehensive phylogeny of anomodonts recovers it as the sister taxon to Therochelonia instead of Endothiodontia, with *Endothiodon* and *Pristerodon* forming successive outgroups.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A NEW, NEARLY-COMPLETE SKELETON OF AN EARLY-DIVERGING CROCODYLOMORPH FROM THE LATE TRIASSIC (LATE CARNIAN) OF NORTH AMERICA AND HIGH RATES OF MORPHOLOGICAL CHANGE PRIOR TO THE END-TRIASSIC EXTINCTION

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Crocodylomorpha, including extant Crocodylia and its extinct relatives, first appeared in the fossil record in the Late Triassic and quickly spread across Pangea. The early evolution of the clade is poorly understood because specimens of early crocodylomorphs are small and subject to preservational biases; therefore, they are generally rare in Late Triassic assemblages, and when found, they are almost always disarticulated partial skeletons. A new crocodylomorph from the Pekin Formation of the Upper Triassic Deep River Basin of North Carolina (North Carolina Museum of Natural Sciences [NCSM] 21722) is one of the earliest and most complete early-diverging crocodylomorphs found to date, as it is upper Carnian in age, and missing only the snout. The new specimen lies in nearly complete articulation and demonstrates that the small hands and relatively large feet of extant crocodylians were present in the earliest crocodylomorphs. The absence of clavicles in this specimen confirms that the clavicles were lost at the origin of Crocodylomorpha. Additionally, it shows that the ventral portion of the neck, parts of the pectoral girdle, and much of the lateral and ventral portion of the tail was surrounded by small osteoderms. This skeleton clarifies anatomical details of early crocodylomorphs from the Late Triassic of western North America. For example, our comparison of NCSM 21722 and the type specimen of *Hesperosuchus agilis* indicates that the latter represents a composite of animals. We placed the new specimen into a well sampled phylogeny consisting of early crocodylomorphs from the Triassic and Jurassic and proximate relatives (= loricatans). We found that the new specimen diverged near the base of Crocodylomorpha, but is not the earliest diverging crocodylomorph. These data demonstrate that the evolution of character states at and just within Crocodylomorpha were seemingly higher than other pseudosuchian clades during the Triassic, well before the end-Triassic extinction. Soon after the initial pulse of morphological change, the rate of evolution of character states diminished in the taxa present in the Jurassic. Once it appeared, the early crocodylomorph body plan (= sphenosuchians), typified by NCSM 21722, survived the end-Triassic mass extinction and persisted for 70 million years until disappearing at the end of the Jurassic.

Education and Outreach Poster Session (Poster displayed November 5 – 8)

APPLYING FLIPPED CLASSROOM TECHNIQUES IN THE DIGITAL AGE: HOW PODCASTS AND VIDEO CONFERENCING CAN CONNECT STUDENTS WITH SCIENTISTS

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Paleontology as an educational tool serves as a powerful introduction to evolution and earth history. Although it generates excitement as a subject, an adequate understanding of paleontology requires knowledge of biology and geology that is often lacking in a lay audience. This can make it difficult to present paleontological research as a rigorous and complex science without a lengthy lecture. To discuss and demonstrate paleontological methods, we have employed a dynamic method of connecting with science classes using video conferencing and a 'flipped classroom' technique. A flipped classroom assigns lecture-like material prior to class so students can independently cover a subject to gain a baseline level of understanding. Class time is then spent engaging the students in higher-level analysis and interaction. We opted to use this method to have in-depth discussions about paleontology with science classes. Students were assigned one or more paleontology-themed episodes from the Past Time podcast to provide background information and spark questions. We then lead a direct question and answer session, allowing students to pose their questions and generate new ones during the discussion. The live video connection was used to show fossil specimens and tour a museum collection to demonstrate the importance of collections, curation, and preparation in paleontology. This offered a unique glimpse into research and museums for students, and it also greatly reduced the time commitment and cost of outreach for scientists by eliminating travel. Feedback from participants indicated that they did not view the format as a hindrance, with many referring to the interaction as a "visit". Notably, they expressed excitement at the opportunity to speak directly to scientists rather than listen to a presentation. They were excited to see collections, fossil preparation, and research techniques, showing they understood paleontology as a multi-faceted field of research rather than the strictly fieldwork-based science presented in popular media. Our experience indicates that outreach using freely available digital tools can be part of an extremely valuable teaching opportunity that connects scientists with classrooms in areas with limited access to museums and to directly demonstrate research and curation techniques.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

CEMENTUM HISTOLOGY OFFERS A NEW PERSPECTIVE ON THE LIFE HISTORIES OF EARLY MAMMALS

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There is considerable interest in determining the physiology of early mammals, but basic life history variables such as lifespan and growth rate are unknown or poorly understood. All three principal mineralised tissues of the teeth; cementum, dentine, and enamel, record periodic incremental annuli which represent a chronological record of development. If unmodified by diagenesis, these form a permanent record of the growth of the teeth. Such annuli have been extensively studied in many extant mammalian taxa, and their relation to chronological age is well understood. We studied cementum annuli since cementum is the only dental hard tissue not to be resorbed through ontogeny, and so provides the most complete record of life history. Cementum is a collagenous tissue that anchors teeth within the alveoli against masticative forcing. It has been consistently shown in extant mammals to record seasonal changes in dietary quality and other intrinsic factors, through alternating dark/light bands of differing mineral density and structure. Our chosen taxon, *Morganucodon watsoni*, is one of the most basal and best known mammaliaformes. It is represented by thousands of teeth and dentary fragments, and also presents a rare opportunity to study a population-level sample of mammaliaform fossils. Using techniques to digitise thin section histological data, we removed much of the subjectivity underming previous cementum studies by analysing peaks and troughs in luminance values, rather than counting annuli. Using this quantitative approach we identified a maximum of five dark/light cementum annuli for a number of individuals within our *Morganucodon* sample. Validation of the circum-annular rhythm of cementum banding was achieved in extant mammalian ecological correlates of *Morganucodon* by utilising the same digital histology methods to compare cementum annuli with mandibular periosteal growth lines. Strong correlation between band counts of both tissues in extant taxa allowed the confident interpretation of a minimum lifespan estimate of five years for *Morganucodon*. This is the first absolute age estimate achieved for a Mesozoic mammal, forming a case study for the further analysis of mammaliaform cementum histology as an age indicator. Age estimation in mammaliaforms has an added importance in offering a relative estimate of metabolic rates when compared to estimated body mass. Such estimates have the potential to inform our understanding of the tempo of endothermic evolution across the early mammalian phylogeny.

Technical Sesssion XII (Friday, November 7, 2014, 3:00 PM)

TURTLE DIVERSITY IN THE MESOZOIC

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Turtles, tortoises, and terrapins are successful vertebrates that have endured for over 220 million years, having persisted through several major environmental perturbations including the formation of global hothouse conditions in the Late Cretaceous and Eocene (and associated cooling events), the end-Cretaceous mass extinction, and post-Eocene global cooling trends. Chelonians inhabit marine, freshwater, and terrestrial environments, are abundant as fossils, have a well-established taxonomy, and their habitat preferences are well understood, making them a model system for studying the responses of ectothermic vertebrates to long-term environmental change. However, few studies have attempted to document long-term trends in their species-richness and how this might be linked to sampling biases, biotic events, or environmental change.

Mesozoic chelonian occurrences were downloaded from the Paleobiology Database (PBDB) and augmented with other records. Raw diversity counts were based on a dataset comprising 1522 genus-level occurrences in 977 PBDB collections, and were analyzed to reduce noise resulting from uneven sampling and other biases (e.g., number of turtle-bearing formations or collections), using both subsampling (Shareholder Quorum Subsampling) and model-based approaches.

In general, chelonian richness increases through the Mesozoic and there is a strong relationship with sampling, but several features are shared between the raw, SQS, collections-corrected, and formations-corrected curves, including an extinction event in the Late Jurassic-earliest Cretaceous and a more marked extinction in the early Late Cretaceous. Additional features were detected in a subset of the analyses, such as a strong increase in richness in the Upper Cretaceous towards the Cretaceous-Paleogene (K-Pg) boundary, which is seen in raw richness curves and preserved in model-detrended curves, but is reversed in the SQS curves. This work represents the first attempt at understanding the global species-richness of chelonians through time and sets a baseline for understanding the ongoing radiation of Cenozoic turtles and the relationship between their species-richness and climate change.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A SIRENIAN FROM THE MAADI FORMATION (UPPER EOCENE) FROM THE CATACOMBS OF ANUBIS AT NORTH SAQQARA (EGYPT)

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The Saqqara Plateau area of Lower Egypt is well known for its archaeological sites, and less so for its geological and paleontological histories. Here we report on the first scientifically documented vertebrate fossils from the Saqqara region. Saqqara is the location of tombs belonging to early Egyptian officials and the site of Egypt's first pyramid (dating to c. 2650 B.C.). However, between c. 380 B.C. and the 1st Century A.D., Saqqara was also the location of an extensive series of subterranean catacombs for animals associated with particular deities. A project to investigate the Catacombs of Anubis, where some eight million dogs sacred to the god of Anubis were interred,

included a preliminary geological investigation, which revealed vertebrate fossils tentatively labelled as the 'Saqqara Sirenian', in the ceiling of one of the burial galleries.

The Saqqara region has been thought to be devoid of vertebrate fossil material and, although the Eocene sequence in the region is incompletely understood, the Catacombs of Anubis are cut into the Eocene Maadi Formation. On the Saqqara plateau, the Maadi Formation is represented by alternating grey marlstones and limestones with an average thickness of 0.5 m. Within the Catacombs, the fossil bearing marlstone, which is here up to 2.0 m in thickness, is argillaceous with a high smectite content, and contains abundant gypsum veins. These features distinguish it from the other marlstones within the Maadi Formation. The Eocene of Egypt is known from the multiple cetacean and sirenian genera of Wadi Al Hitan (better known as the Valley of the Whales) in the western desert of the Fayum region. Within the Eocene of Egypt there are three known genera of Sirenia—*Eosiren*, *Eotheroides*, and *Protosiren*—and yet the Saqqara Sirenian is not referable to any one of these genera. Taphonomically, the specimen appears to represent a whale fall assemblage consisting of numerous associated post-cranial (vertebrae, ribs, girdle) and possibly cranial (basicranium) elements.

Further palaeontological analysis will be undertaken, but due to the archaeological significance of the monument, it is unlikely that the fossils can be removed. This find represents a further example of the long history of interaction between ancient peoples and fossils. The paleontological significance of the Saqqara Sirenian is manifold: it represents the first vertebrate remains from the region, it extends and enhances the Egyptian sirenian fossil record, and this site has in one guise or another served as a vertebrate necropolis for millennia.

Technical Session II (Wednesday, November 5, 2014, 8:00 AM)

TETRAPOD TRACK RECORDS ACROSS THE TRIASSIC–JURASSIC BOUNDARY IN POLAND

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The Triassic–Jurassic boundary, about 201 million years ago, is one of the five largest mass extinction events in the Phanerozoic, associated with a loss of about 50% of flora and fauna genera in both marine and terrestrial environment. The Upper Triassic and Lower Jurassic terrestrial deposits of southern Poland preserve a spectacular record of tetrapod footprints. A comprehensive survey of 274 specimens of amphibians, reptiles, and early mammal tracks collected from 8 Upper Triassic and 17 Lower Jurassic localities spanning 7 successive stratigraphical stages (Carnian-Toarcian) were made. The analysis suggest that the abrupt change in ichnodiversity and turnover from the temnospondyl-archosaur-synapsid to dinosaur-dominated record cannot be explained simply by sampling effects but rather by extinction of numerous Late Triassic genera and families at the end of the period. This analysis also shows that large theropod dinosaurs rapidly increase their size just after the mass extinction interval in the earliest Jurassic and it was synchronous with the origin of large sauropodomorphs. This change in ichnofauna composition is indirectly associated with biogeochemical disturbances recorded in borehole material in Poland, which are attributed to volcanism activity in the Central Atlantic Magmatic Province. A series of periodic atmospheric loading by CO_2, CH_4, or alternatively by SO_2, sulphate aerosols, and toxic compounds is inferred to have caused series of rapid climatic reversals and resulting extinction of many less adapted forms at the end of Triassic. Appearance of highly-diversified dinosaur ichnofauna in the earliest Jurassic (early–middle Hettangian) strata indicates a rapid recovery and refill of ecological niches by saurischian and ornithischian dinosaurs. This study is part of a project financed by the Polish National Science Centre, granted on the basis of decision no. DEC-2012/06/M/ST10/00478.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

PALEOENVIRONMENTS OF BED II, OLDUVAI GORGE, TANZANIA

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The recovery and publication of large fossil assemblages from Olduvai Gorge in northern Tanzania has resulted in the site serving as an important biostratigraphic marker for evolutionary changes in East African faunal communities. Over two hundred taxa of vertebrate fauna were documented from Bed I through the Masek Beds, spanning 1.9 Ma–0.5 Ma. More recently, the ongoing Olduvai Geochronology and Archaeology Project (OGAP) has renewed excavations in several localities in Middle Bed II, including the HWK EE site (~1.7 Ma). This site contains a taxonomically diverse vertebrate assemblage that suggests a wooded grassland environment. This setting coincided with the development and preservation of paleolandscapes in the eastern paleobasin after the lowermost disconformity of Bed II.

Although the assemblage is dominated by grazing taxa (e.g., Alcelaphini, Antilopini, *Hipparion,* Equidae), the presence of crocodiles, Cercopithecidae, Hippopotamidae, Giraffidae, *Sivatherium*, and *Deinotherium*, along with geological evidence and intense land use by Oldowan hominins, suggests a paleoenvironmental setting influenced by wetland regimes, which is consistent with paleogeographical reconstructions of Lower and Middle Bed II times. This paleoenvironmental reconstruction is crucial for understanding the evolution of our ancestors during the time period immediately preceding the emergence of a new hominin species (*Homo erectus*), and the appearance of an improved new stone technology, the Acheulian.

We present the patterns of vertebrate faunal composition and provide interpretation for the paleoecological context of this critical transition in human evolution, which remain poorly understood.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

YPRESIAN MAMMALIAN LOCALITIES OF FOURNES, SAINT-EULALIE, AND AZILLANET (MINERVOIS, SOUTHERN FRANCE): REFINED BIOCHRONOLOGY BASED ON ORGANIC CARBON ISOTOPE CHEMOSTRATIGRAPHY

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The Minervois foreland basin (southern France) is characterized by continental Cenozoic deposits unconformably overlying Paleozoic levels of the Montagne Noire. This study deals with a ~290 meter thick composite lithological succession including three mammalian localities referred to successive mammal reference levels (Mammal Paleogene, MP): Fournes (MP7 in the lacustrine Ventenac Formation), Sainte-Eulalie (MP8+9, in the fluviatile Assignan Formation) and Azillanet (MP10, in the lacustrine Agel Formation). These faunas remain difficult to date due to the continental nature of the sediments, and the relative endemism of mammalian faunas in Southern Europe at the earliest Eocene. Carbon isotopes on the dispersed organic matter ($\delta^{13}C_{org}$) results highlight three major isotopic trends along the section: (1) progressive isotopic $\delta^{13}C_{org}$ values decrease from -23.7 ‰ to -28.2 ‰, clearly above the ETM1 (Eocene Thermal Maximum 1 or PETM; Paleocene-Eocene Thermal Maximum); (2) quite rapid increase from -28.2 ‰ to -24.9 ‰; and (3) very slow increase from -24.9 ‰ to -24.8 ‰. The carbon isotopic lightest values are observed within the Assignan Formation, and are attributed to the $\delta^{13}C$ minimum of the hyperthermals ETM2 (~53.7 Ma) and ETM3 (~52.5 Ma), also called "ETM2-ETM3 interval". Consequently, it can be assumed that the Fournes mammalian locality is located above the PETM (NP9b; Nannoplankton Paleogene) and below the ETM2-ETM3 interval (upper NP11–lower NP12), most probably early-middle NP11. It implies that: (1) the Fournes fauna is slightly younger than the reference MP7 level of Dormaal (NP9b); and (2) a very high sedimentation rate occurred during the lacustrine deposition of the Ventenac Formation (about 20 cm/ka). The Sainte-Eulalie mammalian locality (MP8+9) is included in the upper part of ETM2-ETM3 interval or just above it, suggesting a NP12 age. The Azillanet mammalian locality (MP10) is located above ETM2-ETM3 interval and could be middle Ypresian in age (middle NP12 - lower NP13). These results constitute a first step toward a global bio-chemo-stratigraphical framework of the early Eocene mammalian chronology in Europe.
This study has been partially funded by the project BR/121/A3/PALEURAFRICA of the Belgian Science Policy Office.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A THREE-DIMENSIONAL DIGITAL RECONSTRUCTION OF THE STEM AMNIOTE *OROBATES PAPSTI* (DIADECTIDAE) AS A PLATFORM FOR LOCOMOTOR INFERENCE

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Early tetrapod fossils of the Palaeozoic usually suffer from distortion and crushing. Preservation oftentimes also prohibits complete preparation from the surrounding matrix. While experts are able to identify and evaluate taxonomically, phylogenetically and often functionally significant structures, these fossils in general offer limited use for biomechanical studies. Here, I document the steps taken to digitally reconstruct the skeleton of a stem amniote on the basis of computed tomography and modeling. In the process, software was used to repair crushed bones and undistort the skeleton from diagenetic deformation. The final product is a complete skeletal representation of the *Orobates papsti* holotype specimen MNG 10181. All bones are watertight and are therefore available for 3D printing and physical mounting of the skeleton. It can be scaled and easily dispersed electronically. The digital reconstruction is used as a platform for biomechanical analyses ranging from body and segment mass estimation and analyses of the range of motion of numerous skeletal joints to complex simulations of locomotion. Fossil tracks that have been linked to *Orobates* as the trackmaker, as well as locomotor studies of extant sprawling tetrapods, are used to constrain these simulations in order to exclude unlikely postures and locomotor characteristics.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

REASSESSMENT OF CRANIAL ELEMENTS ASSIGNED TO THE FOSSIL SNAKE *CONIOPHIS PRECEDENS*, LATE CRETACEOUS, NORTH AMERICA

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Coniophis precedens is a snake from the Lancian of North America known primarily from numerous, isolated vertebrae. Morphologically similar vertebrae have been referred to the taxon (generically and specifically) from the early Cenomanian through the Eocene. However, there are only a few non-vertebral elements (isolated dentaries and maxillae from the Lance Formation) referred to *C. precedens*. The jaws were recently considered to represent a mix of primitive lizard-like, and advanced snake-like anatomical features; phylogenetic analysis of these characterizations reconstructed *C. precedens* as a primitive/transitional snake at the root of the ophidian clade. Reexamination of these specimens supports the identification of the dentary as that of a relatively advanced snake (single, large mental foramen; surangular embayment posteriorly; three-sided alveoli; sharply recurved teeth; ventral Meckelian fossa). Referral of the dentary to *C. precedens* is speculative since the only reference specimens for the taxon are isolated vertebrae; additionally, an isolated vertebra of a possible boiid is known from the contemporaneous Hell Creek Formation. Unlike the dentary, the maxilla specimens have a combination of anatomical features more consistent with referral to an advanced anguimorphan lizard rather than to a snake (e.g., lack of alveoli, basal nutrient foramen enclosed within dentine and enamel of tooth, only modest recurvature of tooth crowns, carinae on mesial and distal margins of tooth crowns, tall facial process, lack of anteriorly placed palatine process, well-developed premaxillary articulation). Reanalysis of a modified taxon character matrix where dentigerous elements were separated from the

vertebral elements, and where only the vertebral elements of *C. precedens* were treated as a valid terminal taxon, resulted in a non-basal phylogenetic position amongst snakes. During the Cenomanian there are numerous occurrences of relatively advanced fossil snakes from North America, Southern Europe, the Middle East, and North Africa. This diversity and distribution indicates a pre-Late Cretaceous origin of snakes.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

NEW DATA ON MORPHOLOGY OF THE BASISPHENOID COMPLEX IN SOME LATE MESOZOIC TURTLES OF ASIA

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A review of published and original data on morphology of the basisphenoid complex (basisphenoid plus adjacent bones and structures) in Late Mesozoic turtles of Asia revealed some previously unknown and/or overlooked details of its structure. The basisphenoid pits and ridges (structures on the ventral surface of the basisphenoid) were previously overlooked in a meiolaniform turtle *Mongolochelys efremovi* and xinjiangchelyids, in which they are situated near the posterior border of the basisphenoid. The interpterygoid vacuity, reported in some xinjiangchelyids (*Annemys* spp.), actually represents an underossified space between trabecules of the basisphenoid and should be better named the 'intertrabecular vacuity'. The basipterygoid processes were found in some lindholmemydids (*Lindholmemys elegans*) as well as in *Mongolochelys efremovi*, xinjiangchelyids, some macrobaenids/sinemydids and *Basilochelys macrobios*. *Oxemys gutta*, a problematic skull-based turtle taxon represented by a single basisphenoid from the Cenomanian of Uzbekistan, is unique among turtles in that the canals of the cerebral arteries in the basisphenoid are completely opened ventrally (while in all other turtles they are at least partially closed) and the basisphenoid rostrum is reduced. In other characters, *O. gutta*

demonstrates the greatest similarity with macrobaenids/sinemydids and lindholmemydids, but its certain systematic position remains unclear. In

general, morphology of the basisphenoid complex remains poorly known in Late Mesozoic turtles of Asia. In most taxa only the external morphology of this

complex (visible in a ventral view of the braincase) is known; details of its internal structure, which can be observed only on isolated basisphenoids, are

reported only for few species. The morphology of the basisphenoid complex remains completely unknown in bashuchelyids, sichuanchelyids, and sinochelyids. This study was supported by a grant of the Russian Scientific Fund.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

LINKING HYPOTHESIZED ARTIODACTYL KEY INNOVATIONS WITH MACROEVOLUTIONARY PATTERNS THROUGH TIME

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In modern faunas, even-toed ungulates are exceptionally diverse relative to other ungulates. Compared to the ecologically similar mammalian order Perissodactyla, Artiodactyla possesses nearly ten times higher species richness. This discrepancy has gradually increased over the Cenozoic, until a burst of artiodactyl speciation in the Pliocene. This study uses evolutionary modeling to test whether hypothesized artiodactyl key innovations (forestomach fermentation [FF] and thermoregulatory cranial vasculature [TCV]) have had a demonstrable effect in generating these contemporary diversity patterns. First, analyses were performed using only living taxa. Presence and absence of FF and TCV were mapped onto a complete, recently derived artiodactyl phylogeny. Trait-dependent log lineages through time (LASER, R 2.15.3), binary and multi-state trait dependent speciation and extinction (BiSSE, Mesquite 2.75; Diversitree, R 2.15.3), and evolutionary analysis of covariance models were simulated. Results show that diversification through time is not significantly different per trait, but that extinction probability is significantly lower for artiodactyls with TCV. The occurrence of FF and TCV are significantly correlated through time, such that 87% of artiodactyls possess both traits. Next, adding to the 10 extant families examined, patterns were sought in 16 families of extinct artiodactyls. A literature review was used to infer presence/absence of FF and osteological correlates were used for TCV. When all 26 clades are taken into consideration, only 8 families overlap in distribution of TCV and FF. By the Miocene, stem artiodactyls that possess neither trait are largely extinct. When log lineages through time are re-calculated incorporating extinct clades, artiodactyls with TCV diversify earlier and more rapidly. Major overlap in today's artiodactyl fauna suggests that these traits are significantly linked. It is possible that advanced TCV may be a prerequisite for FF, protecting the brain from the higher core temperatures sustained in support of fermentation.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

DEVELOPING A VIEW OF A SOUTHERN GONDWANAN FAUNAL PROVINCE: INFORMATION FROM THE MIDDLE CRETACEOUS OF CENTRAL AFRICA

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Although the Cretaceous vertebrate record from the Southern Hemisphere, and in particular the African continent, has improved dramatically over the past decade, large gaps still exist with regard to major regions of Gondwana and how faunal composition varies in both space and time. In an effort to address one of the regions (i.e., southern Africa) notably absent from the Gondwana-wide discussion, recent vertebrate discoveries from the middle Cretaceous Galula Formation in the Rukwa Rift Basin of southwestern Tanzania continue to reveal novel taxa pertaining to a number of terrestrial clades. Crocodyliforms are thus far represented by the small-bodied, heterodont notosuchian *Pakasuchus kapilimai* and the recently described large-bodied peirosaurid *Rukwasuchus yajabalijekundu*. Preliminary sister relationships for these taxa provide two biogeographic perspectives regarding middle Cretaceous Gondwanan faunas. *Pakasuchus* has been closely affiliated with the geographically proximate *Malawisuchus mwakasyungutiensis* from the middle Cretaceous of Malawi and a number of South American forms. By contrast, *Rukwasuchus* exhibits affinities with northern African, middle Cretaceous peirosaurids. Fieldwork conducted between 2010 and 2012 has more than doubled the number of crocodyliform taxa from the Galula Formation, with the discovery of three additional small-bodied forms. One form exhibits baurusuchid affinities including the presence of only 5 maxillary teeth, although other aspects of its cranial anatomy ally it with the genus *Araripesuchus*. This form awaits additional study, but further suggests gross faunal similarities with South American forms. Two additional novel, small-bodied taxa from the Galula Formation can be differentiated from *Pakasuchus* on the basis of both total tooth count and crown morphology. Overall, the faunal signal appears to differ from pene-contemporaneous deposits in northern Africa that also include a range of large-bodied megapredatory forms like the mahajungasuchid *Kaprosuchus,* the pholidosaurid *Sarcosuchus*, and potential derived eusuchians such as *Stomatosuchus* and *Aegisuchus*. The growing diversity of crocodyliforms from the middle Cretaceous Galula Formation of Tanzania mirrors that previously appreciated for Cretaceous deposits more generally among South American locales, suggesting the existence of a southern faunal province in western Gondwana.

Symposium 1 (Wednesday, November 5, 2014, 8:00 AM)

EARLIEST STAGES IN THE EVOLUTION OF THE MODERN AVIAN SKELETON: *ARCHAEOPTERYX* AND THE JEHOL AVIFAUNA COMPARED

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The only undisputed long bony-tailed bird is *Jeholornis* from the Early Cretaceous Jehol Biota in northeastern China. Typically resolved as more derived than *Archaeopteryx* and forming the sister taxon to Pygostylia, *Jeholornis* shows a number of major skeletal innovations relative to *Archaeopteryx*: its pectoral girdle is more advanced, with a curved scapula, narrow excavated furcula, moderately strut-like coracoid with procoracoid and lateral processes, and a large ossified sternum with a second pair of ossification centers. Descriptions of *Jeholornis* as having a 'mosaic' of primitive and advanced avian features are partly no longer supported in light of recent reinterpretations of the elongate tail as a derived feature that coevolved with its unique two-tail plumage, inferred to be more aerodynamic than the tail of *Archaeopteryx*. Among clades of basal birds, innovations are not across the board; Sapeornithiformes retain a primitive shoulder girdle with a short, axe-like coracoid and no sternum but have elongate wings and a reduced manus, whereas Confuciusornithiformes have the most primitive manus within Aves (metacarpal I proportionately long and robust) and a fused scapulocoracoid but have a beak, strut-like coracoid, and a well developed sternum. Basal enantiornithines have an even longer coracoid, narrow furcula with a distinct hypocleidium, sternum with low keel and lateral trabeculae, and an alula. Ornithuromorpha shows a clear departure from other basal birds with a more complete suite of derived features, typically having a U-shaped furcula, well-developed procoracoid process, curved and tapered scapula, rostrocaudally elongate sternum with large ventral keel and well developed intermediate trabeculae, small pygostyle, globe-shaped humeral head, fused compound bones, at least one large cnemial crest, and a primitive hypotarsus; features such as teeth and manual claws are also retained although a beak is present in some taxa. Ornithuromorpha also preserves evidence of an increasingly derived growth strategy, alimentary canal, and reproductive system relative to more basal clades, although some of these specializations also evolved independently in other groups (derived growth strategy in Confuciusornithiformes, derived alimentary canal in Sapeornithiformes); enantiornithines apparently remained primitive in all these aspects although by the time of deposition of the Jiufotang Formation they had further refined their flight apparatus, having evolved a reduced manus and more complex sternal morphologies.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

PALEODIET RECONSTRUCTION OF EARLY PLEISTOCENE EQUIDAE FROM KONSO, RIFT VALLEY, SOUTH ETHOPIA

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The Early Pleistocene Konso Formation is extensively exposed in the Konso area at the southernmost part of the Ganjuli graben of the Main Ethiopian Rift. The Konso Formation has yielded approximately 8000 identifiable fossil specimens of diverse vertebrate species, including the hominids *Homo erectus* and *Australopithecus boisei*, and abundant Acheulean stone tool assemblages. The age of the fossiliferous and artifact-bearing sediments of the Konso Formation range from ~1.95 to ~0.85 Ma.

We performed mesowear analysis on Equidae (*Hipparion* and *Equus*) cheek teeth found in the Konso Formation in order to evaluate equid diets.

The results of the mesowear analysis indicate that Hipparion and Equus of the Konso Formation were both grazers, but revealed a significant difference between the two genera. *Hipparion*, *Equus*, and 27 extant ungulates were compared in a hierarchical cluster analysis, and the results showed that *Hipparion* and *Ceratotherium simum* (white rhinoceros) are included in one cluster, while *Equus* and *Damaliscus lunatus* (topi) clustered together in another.

In this study, a significant difference was found between *Hipparion* and *Equus*, which suggests that *Hipparion* tended to be a more extreme grazer than *Equus*. This difference in dietary behavior might imply niche segregation in Equidae.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE IMPACT OF MODULARITY ON SIZE ESTIMATION OF SUCCESSIVE DIRE WOLF POPULATIONS AT RANCHO LA BREA, CALIFORNIA

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The Rancho La Brea tar pits are famous for their episodic accumulations of large numbers of fossils over short intervals in the Late Pleistocene. Carnivores are disproportionately represented in the deposits, and have formed the basis for several recent studies documenting evolution in response to climate change at La Brea. The most abundant carnivore is the dire wolf, *Canis dirus*. However, geometric morphometric studies on Rancho La Brean dire wolf crania and jaws have resulted in conflicting body size estimates. Statistically significant samples of both crania and jaws of the dire wolf were gathered from four pits: 61/67 (~13–14 ka), 13 (~17–18 ka), 2051 (~26 ka), and 91 (~28 ka). Landmark-based geometric morphometrics was employed, in three dimensions for crania and two dimensions for jaws. Extraction of centroid size yielded discordant patterns of jaw size and cranium size among pits. We hypothesized that this discordance might be due to modularity, because the jaw is part of the viscerocranial module and so grows with positive allometry. The cranium contains both the viscerocranial face and the neurocranial module, and the neurocranial module grows with negative allometry. In order to test the hypothesis that modularity was affecting size estimation, we used a dental size metric. Carnassial size is known to be a good predictor of body size in canids due to its functional importance, and we demonstrate that is scales isometrically in *Canis dirus*. Analyses on both the upper carnassial (P4) and the trigonid basin, or the shearing portion, of the lower carnassial (m1) show agreement in relative body size estimates. The wolves with the smallest 'natural' body size are in pit 2051, while pit 91 wolves have the largest mean body size. In summary, centroid size measures from crania and jaws are influenced by a complex mix of allometric responses acting differently on viscerocranial and neurocranial modules. Dire wolves move along the static allometry axis across pits, display significant size and shape neoteny in pits impacted by breakage and wear events, and show evolutionary responses to climate. Centroid size of the jaw is not a good size estimator due to strong positive allometry in the viscerocranial module and its corresponding vulnerability to neotenic effects. Centroid size of crania is a better size estimator because it crosses modules with opposing allometries. However, and counterintuitively, simple dental measures are the most robust size estimators due to their insulation from the neotenic effects of breakage and wear events.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

PALEOBIOGEOGRAPHY OF THE FIRST REPRESENTATIVES OF *MEGACRICETODON* (MAMMALIA, RODENTIA) DURING EARLY TO MIDDLE MIOCENE IN EUROPE

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The small mammal *Megacricetodon* is one of the most characteristic taxa of the European rodent faunas. It has been used profusely to propose biostratigaphic and biocronologic continental scales for the lower and middle Miocene of Europe, both for its broad geographic distribution and for its quick changes in size and morphology. The genus *Megacricetodon* appeared in Anatolia during MN3 (lower Miocene) dispersing throughout Europe during MN4. This early dispersion of the genus into Europe has never been fully understood due to systematic misinterpretations. Recent studies carried out on early representatives of *Megacricetodon* species from the main European continental basins demonstrated the existence of three major migration events involving different species groups. The earliest *Megacricetodon* migration event corresponds to the small-sized forms recorded from the earliest MN4 locality of Aliveri in the Evia island (Greece). This endemic Greek form evolved and dispersed through Komotini area (localities of Karidya I and II), Macedonia (Antonios), and Chios island (Thymiana section), during the middle Miocene. The second migration event corresponds to large-sized *Megacricetodon* forms from Central-European basins. The earliest representatives are from early MN4 localities in the Czech Republic. They are supposedly related to the *Megacricetodon bavaricus* group which earliest representatives from middle MN4 are: *Megacricetodon*. aff. *collongensis* from localities in Swiss and German Molasse, and *Megacricetodon bezianensis* from France. This group did not reach the Iberian Peninsula until middle MN5. Finally, the third event corresponds to the *Megacricetodon primitivus* lineage. This small-sized species is restricted to southwestern Europe, appearing in France (Gers basin) during MN4, although after *M. bezianensis*, and reaching the Iberian Peninsula in the latest MN4. The migration pattern shown by the early representatives of the genus *Megacricetodon* configure a paleobiogeographic framework on which there are three distinct forms that reach Europe in different migration waves, and with different main distribution areas. The earliest small-sized form, was endemic of the Greek area. The second large-sized form of *Megacricetodon* was mainly distributed in the Central-European basins. And the southwestern form was also small-sized, and endemic of the Iberian Peninsula and southern France.

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Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

AMONG THE RULING REPTILES: THE DIVERSE MICROVERTEBRATE ASSEMBLAGE OF THE HAYDEN QUARRY, GHOST RANCH, NM

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The Triassic Period was a transformative interval of environmental and biological change that encompassed the origin and initial diversification of today's most diverse and abundant vertebrates such as dinosaurs, mammals, lepidosaurs, lissamphibians, and neopterygian fish. However, most of these groups originated at small body size, and thus their early evolution is obscured by strong biases against fossilization and discovery. Therefore, species-rich Triassic microvertebrate localities with precise radioisotopic dates, although necessary for addressing long-standing evolutionary questions, are exceedingly rare. Because of its age (~212 Ma), the Hayden Quarry (HQ), from the Petrified Forest Member of the Chinle Formation, northern New Mexico, is in a unique position to fill such gaps. HQ sediments comprise a poorly-sorted debris-flow-like fluvial deposit, which increases the likelihood of smaller, more fragile components of the community making it into the fossil record. Vertebrate fossils at HQ are found in intraformational granule conglomerates interbedded with charcoal burned at high temperatures; microvertebrate material is found both in association with macrovertebrates as well as in finer-grained siltstone slightly higher in section. HQ microvertebrate fossils reveal a highly diverse aquatic and terrestrial community. The most abundant microvertebrate remains are actinopterygians, including numerous isolated scales, and rarer cranial elements and teeth. At least three major clades are represented, including redfieldiiforms, semionotiforms, and palaeonisciforms. Additionally, the assemblage preserves coelacanth cranial material and a diversity of freshwater chondrichthyans represented by teeth of *Reticulodus* and other hybodontiform taxa. A variety of archosauromorph teeth reflect the diverse archosauromorph macrovertebrate assemblage from HQ. In contrast, a high proportion of other microvertebrate tetrapod elements are assignable to the enigmatic diapsid clade Drepanosauridae. Other rarer specimens include tanystropheid vertebrae and jaw fragments with pleurodont dentition that may represent lepidosauromorphs. Taken as a whole, HQ is unusual in preserving one of the most diverse Late Triassic macrovertebrate assemblages associated with abundant and diverse microvertebrates, with particular bias toward small and otherwise rarely preserved taxa from this pivotal time interval.

Technical Session XVII (Saturday, November 8, 2014, 1:45 PM)

EXPLORING THE ROBUSTNESS OF PERMO–CARBONIFEROUS TERRESTRIAL COMMUNITIES: THE IMPORTANCE OF INSECT AND TETRAPOD HERBIVORES

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Terrestrial community structure in Permo-Carboniferous communities has previously been subdivided into three categories based on patterns of energy flow from primary producers to consumers. Type 1 communities rely on semiaquatic animals to transfer energy from aquatic producers to terrestrial animals. Type 2 communities receive energy directly from terrestrial producers with tetrapod herbivores transferring energy from terrestrial producers to higher level terrestrial consumers. Type 3 communities depend on insect herbivores to form the link between producers and consumers. Olson noted a transition between Type 2 communities in the early Permian to Type 2 communities in the late Permian associated with the diversification of tetrapod herbivores. We hypothesized that this replacement occurred because the food web structures of communities with tetrapod herbivores made them better able to resist perturbations that could potentially cause extinctions within the community. To test this hypothesis, we compiled food webs for five Permo–Carboniferous communities, three that fit the Type 2 classification (Upper Freeport Coal, Wellington Formation, Archer City Formation) and two that may represent early occurrences of Type 2 communities (Dolese Quarry, Bromacker Locality). We used a series of eight Permo–Triassic communities from the Karoo Basin that display a Type 2 structure for comparative purposes. When analyzed using the Cascading Extinctions on Graphs (CEG) model, the Archer City, Dolese, Bromacker, and Wellington communities display similar patterns of robustness to perturbations as the Permo–Triassic communities, but this is strongly dependent on how the insect fauna is treated. The Upper Freeport Coal community is less robust, but this reflects a difference in the partitioning of insect diversity among guilds and not a direct effect of the absence of tetrapod herbivores. Taken together, these results suggest that early Permian communities could have been as robust as later communities with greater tetrapod herbivore diversity, and that insects were key to providing this stability. Therefore, phylogenetic and ecological diversification of insects might have been a more significant event in the history of terrestrial communities than the diversification of tetrapod herbivores.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

THE COLORADO PLATEAU CORING PROJECT (CPCP): PROVIDING A PRECISE NUMERICAL TIMESCALE FOR TRIASSIC EARTH SYSTEM EVENTS AND PROCESSES

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The CPCP seeks to provide a rigorous geochronologic framework for the rich tetrapod assemblages of early Mesozoic strata of the American West, allowing time to be assessed at problem-appropriate resolution, and events, fossil occurrences, and environmental records to be temporally linked across geography and facies.

A major result of Phase 1 of the project is the drilling of three cores completed during December 2013 in Petrified Forest National Park, AZ with the goal of obtaining a complete Triassic section where superposition is unambiguous and the section is tied to a globally-exportable time scale using paleomagnetic polarity stratigraphy and high-resolution U-Pb zircon dates. Although zircon populations from sandstones analyzed thus far are complex because of redeposition, the Park is one of the few places in the world where there is a rich Triassic non-marine tetrapod record with an abundance of datable horizons.

Core 1A (520 m) from the northern part of the park recovered the lower Owl Rock Member (Mb) of the Chinle Formation (Fm) to the base of the formation (Late Triassic),

and all of the Moenkopi Fm (nominally Early and early Middle Triassic), terminating in the Permian Coconino Fm. Core 2A (80 m) and 2B (240 m) are from the southern part of the park and recovered the lower Sonsela Mb of the Chinle through to the top of the Coconino. The 2.5 in diameter cores sample the stratigraphy at a minimum average rate of 12 m/Ma and were drilled inclined from the vertical to maximize expression of the paleomagnetic reversal pattern.

The integrated Petrified Forest timescale, based on these cores, will make possible the registry of the massive amounts of surface data in the park and surrounding areas to regional and global processes and events. Specific questions these cores address include the following: (1) Was the largest identified medial Late Triassic biotic turnover synchronous with the giant Manicouagan impact? (2) Does the Newark Basin (eastern US) astronomically-calibrated record show a signal of the chaotic diffusion of the Solar System when tested by independent radioisotopic dates? (3) Are the cyclical climate cycles seen in Newark lake strata discernable in the predominantly fluvial Chinle, and did these cycles effect CO_2 by modulating weathering rates? 4) Were continental biotas of tropical Pangea radically different than those from higher latitudes despite the geographic contiguity and how does the new exportable timescale inform our understanding of existing biostratigraphic correlations?

Phase 1 of the CPCP is funded by NSF (SG&P/IF), and ICDP.

Technical Session XVII (Saturday, November 8, 2014, 4:00 PM)

UNDERSTANDING DENTAL GROWTH PATTERNS ACROSS THE CYNODONT TO MAMMALIAFORM TRANSITION

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The most basal member of the mammalian lineage to have a determinate pattern of growth is the Late Triassic-Early Jurassic mammaliaform, *Morganucodon*. However, other than bone histological studies, there has been relatively little quantifiable comparison of growth rates of more basal cynodonts with determinately growing mammaliaforms or indeterminately growing basal amniotes and diapsids. Determinate growth is linked with the evolution of key mammalian features such as diphyodonty, molar occlusion, lactation, and endothermy; hence, detailed investigation of cynodont growth is a crucial step in understanding the evolution of mammalian biology.

Histological techniques utilizing periodic enamel and dentine increments provide additional quantifiable measures of growth patterns, but have not previously been applied to cynodonts. We used polarized light microscopy to assess daily secretion rates of enamel and crown extension rates in histological thin sections of postcanines of three cynodonts (*Thrinaxodon*, *Scalenodon*, *Diademodon*), and compared these with measures from teeth of *Morganucodon,* and crown mammals and diapsids (e.g. *Canis*, *Crocodylus*). Laminations (incremental lines equivalent to daily prism cross-striations in mammalian enamel) were observed in all cynodont specimens, permitting quantification of daily secretion rates of enamel. These were reduced in cynodont enamel relative to comparably sized crown mammal teeth, and particularly low in *Morganucodon*. Crown extension rates were high in both diapsids and cynodonts (e.g. *Crocodylus*: 33.9 µm/day; *Thrinaxodon:* 104.2 µm/day); cynodont extension rates were at least twice those of comparable crown mammal teeth. Thus, in these animals, enamel is extended extremely rapidly in thin, 'sheath'-like layers. *Morganucodon*, in contrast, resembles most small non-hypsodont crown mammals in having a lower crown extension rate (7.8 µm/day).

Low daily secretion and crown extension rates indicate reduced secretory function and ameloblast differentiation rates in *Morganucodon* relative to cynodonts. Ameloblast activity may be at least partially linked to osteoblast function, suggesting that bone growth during molar formation is reduced. Lower dental growth rates may also have been permitted by the reduced, diphyodont replacement of *Morganucodon*. This is consistent with the hypothesis of determinate growth patterns in *Morganucodon*, while higher daily secretion rates and rapid crown extension accord with less determinate growth patterns in polyphyodont cynodonts.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

PALEOECOLOGY, PRESERVATIONAL ENVIRONMENT, AND PLEISTOCENE OCCURRENCE PATTERNS

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Online databases such as FAUNMAP, NOW, and the Paleobiology Database have revolutionized the study of large-scale paleobiological patterns. Nowhere is this truer than in paleoecology, as the occurrence data from these databases can be used to reconstruct shifts in ecological variables, such as abundance and geographic range through time, in many cases to test or strengthen projections of biotic responses to future climate change. Invaluable as these databases are, the degree to which the occurrence data they store reflect a true biological signal is an important consideration. To what extent have the patterns visible in these data been biased by geography, taphonomy, or sampling? Assuming that preservational environments are not uniformly distributed across landscapes and that different taxa are preserved at varying frequencies in these environments, it can be hypothesized that occurrence data will reflect the distribution of preservational environments rather than true taxon ranges or abundances. The Rancholabrean mammal record of western North America provides a natural laboratory for testing this hypothesis, not only because the region preserves a rich fossil record that has formed the basis for several studies in conservation paleobiology, but because it is environmentally heterogeneous. This test was conducted by using museum collection data to detect geographic biases in environmental distribution, to determine which taxa are preferentially preserved in which environments, and to predict how these biases are likely to affect data downloaded from FAUNMAP. The museum data confirm the two assumptions underlying the hypothesis: preservational environments are distributed nonrandomly across the region (e.g., the record of eastern Washington is dominated by loess deposits, while asphalt seeps appear only in southern California) and relative abundances of taxa vary between environments (e.g., muskrats are abundant in bog deposits, while the ground sloth *Nothrotheriops* is significantly more common in caves than in surface deposits). The occurrence data downloaded from FAUNMAP show regional variability in taxon abundance, but these differences do not conform to the predictions made based on environmental distribution. Further research will help determine whether this variability is the result of other forms of bias or whether it is shaped by ecological factors.

Symposium 3 (Friday, November 7, 2014, 10:30 AM)

EVALUATING THE PERFORMANCE OF NODE VERSUS TIP BASED FOSSIL CALIBRATION OF THE MOLECULAR CLOCK

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Molecular clocks have long usurped the role of palaeontology in establishing a timescale for evolutionary history. However, the introduction of Total Evidence Dating (TED), which incorporates fossil taxa directly in divergence time estimation as dated tips, rather than indirectly as dated nodes constraining the age of ancestors of living lineages, promises to deliver greater accuracy and precision. Unfortunately, such analyses performed to date have failed to transfer the lessons learned from dating fossils for node-calibration of molecular clocks. In most instances, individual fossils cannot be dated with any greater precision than can node-based calibrations. In accommodating these errors, it is not clear whether TED affords greater accuracy or precision than node-based calibration. We attempted to evaluate the performance of these competing approaches through analysis of both empirical and simulated data. Empirical work has centred on testing the convention that TED allows for higher precision estimates of divergence time. This has been achieved by re-analysing a well-known TED dataset for Hymenoptera, with the inclusion of a more realistic measure of chronological uncertainty in the construction of fossil tip calibrations. Our results demonstrate that TED may not necessarily provide more precise age estimates than node dating when established calibration design methodology is utilised. Simulated data has allowed us to test what effect the inclusion of increasing quantities of fossil morphological data exerts on the precision of divergence time estimates. Our approach builds on the infinite-sites theory for molecular dating which predicts that uncertainty in divergence time estimation can only be reduced through the inclusion of more precise time priors.

Our results suggest that TED is not a panacea for the perceived inaccuracy and imprecision of the molecular clock. Indeed, TED and traditional node-based calibration are not mutually incompatible and we suggest that a combination of node calibrated and TED approaches to divergence time estimation is the best approach to improving the accuracy and precision of evolutionary timescales.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

ANALYSIS OF A PECULIAR STRUCTURE OF THE PALATO-FACIAL ANATOMY OF THE EUROPEAN ZIPHODONT MESOEUCROCODILE *IBEROSUCHUS* (EOCENE, IBERIAN PENINSULA)

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The record of European sebecosuchian crocodiles is limited to a taxon from the Eocene of the Iberian Peninsula and southern France (*Iberosuchus*), and a second one from Germany (*Bergisuchus*). The material assignable to *Iberosuchus* comprises several specimens distributed among several Eocene basins in southwest Europe. *Iberosuchus macrodon* is known originally from fragmentary skull material from the Middle Eocene site of Vale Furado (Nazare, Portugal) and referred to Sebecosuchidae based on dental and cranial characters. The type specimen of *Iberosuchus* is composed only of a fragment of a rostrum (incomplete premaxillae, maxillae and nasals). This rostrum exhibits a combination of primitive features typical of Sebecosuchia (e.g. ziphodont teeth, narrow and high rostrum with vertical walls and anteriorly directed nares). However, the only feature that can be considered as autapomorphic on the *Iberosuchus* holotype is the anterior outline of a parasagittal palatal fenestra. A similar structure is present in several other crocodilyforms but, as can be seen in a specimen from the Eocene of Torsalet del Morral (Huesca Province), this structure is particularly complex in *Iberosuchus*. This premaxillo-maxillary structure consists of a deep and anteroposteriorly enlarged fossa with an anteriorly open fenestra communicating with the premaxillo-maxillary pneumatic cavities. In addition, the premaxillo-maxillary fossa presents tubular passages positioned anteriorly, posteriorly and laterally. This structure is present in all the specimens referred to *Iberosuchus* in which this portion of the secondary palate is accessible.

A computed tomography (CT) scan and 3D modelling of the premaxillo-maxillary structure of *Iberosuchus* allows for the detailed description of its inner anatomy and comparison with the pneumatic rostral cavities of other archosaurs. Finally, the results obtained offer new information to establish hypotheses about its glandular or pneumatic function.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

THE EVOLUTION OF FEEDING-RELATED CHARACTERS IN ANKYLOSAURS

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Oral food processing in ankylosaurs is generally thought to be a simple process characterized by pure orthal pulping with no or limited tooth-tooth contact. Recent studies on ankylosaurids (*Euoplocephalus*) and nodosaurids (*Hungarosaurus*), however, unambiguously revealed that the mode of feeding was more diverse among ankylosaurs, in some cases involving sophisticated dental occlusion and complex jaw mechanism. A detailed study of various feeding-related characters in ankylosaurs with well-preserved cranial material clearly demonstrates important craniodental changes in the evolution of the group. In basal forms (i.e. Middle Jurassic to Early Cretaceous nodosaurids from North America and Europe) the muzzle is quite narrow relative to the distance between the quadrate condyles, the tooth row is slightly curved both horizontally and vertically, premaxillary teeth are usually present, cingula are absent or weakly developed on the teeth, and the coronoid process is still low. Though well controlled tooth-tooth contact might have existed in some forms, complex jaw mechanism was still not present. In late Early Cretaceous nodosaurids of North America and Europe, the premaxillary teeth are still present, the cingulum is more pronounced, the attachment surfaces of cranial

adductors (e.g., pterygoid, coronoid process) are well developed, and the muzzle shape becomes more diverse. Only *Peloroplites* provides evidence for possible dental occlusion. In the distinct Asian lineage of ankylosaurids (examinable from Aptian to Maastrichtian), along with the development of a highly complex narial region, the narrow and elongate muzzle seen in basal forms became much wider in later species. Wear pattern indicates that tooth-tooth contact or any kind of complex jaw mechanism did not evolve among the Asian forms. Among the Late Cretaceous North American ankylosaurs, the muzzle became generally wide and diverse in shape, premaxillary teeth are absent, teeth bear massive cingula, and dental occlusion with specialized jaw mechanism evolved convergently among the nodosaurid and ankylosaurid lineages. By contrast, the European genera retained the narrow muzzle with premaxillary teeth but specialized jaw mechanism with well-controlled tooth-tooth contact also evolved convergently.

Symposium 2 (Thursday, November 6, 2014, 3:30 PM)

FORELIMB BIOMECHANICS OF *MUSSAURUS PATAGONICUS* (DINOSAURIA, SAUROPODOMORPHA): INSIGHTS FROM THREE DIMENSIONAL COMPUTER MODELING

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We present a three-dimensional (3D) reconstruction and biomechanical analysis of the forelimb of the basal sauropodomorph *Mussaurus patagonicus*, from the Late Triassic of southern Patagonia, Argentina. *Mussaurus* has been interpreted as more closely related to derived sauropodomorphs (i.e., Sauropodiformes) than to more basal forms (e.g., *Plateosaurus*). 3D data were acquired with a laser scanner, and 3ds Max software was used to estimate the positions and axes of the joints between bones and the ranges of motion (ROMs) of each joint. Finally, we integrated the whole forelimb into a musculoskeletal model in reasonably well-validated biomechanics software (SIMM), producing the first such complete model of an archosaur forelimb.

The musculoskeletal model includes a full range of degrees of freedom in joint rotation: flexion/extension, ab/adduction, and long-axis rotation, using joint morphology to estimate more realistic axes that could be non-orthogonal and not aligned to the world coordinate system or main body axes. Also, we reconstructed 28 muscle groups crossing the glenoid, elbow, and wrist joints. We used this model to estimate all major muscle moment arms about the main limb joints, varying limb orientation to quantify how these changed. Two forelimb models were analyzed, considering the two current hypotheses about antebrachium architecture to evaluate biomechanical differences between these: with manus pronation and with no pronation.

Our analysis of joint articulations indicates that the forelimb of *Mussaurus* was capable of similar ROMs for the gleno-humeral and phalangeal joints in both models, differing in the elbow and wrist joints, which produced different ROMs in each model. In this sense, the model with a pronated manus presented a larger elbow ROM due to a better fit of the radius to the cuboid fossa of the humerus. Wrist ROM, on the other hand was larger in the model with no pronation.

The antebrachium was not capable of active pronation, with minimal radial rotation against the ulna. The muscle moment arm data are important for addressing how *Mussaurus* used the forelimbs, testing hypotheses of forelimb function, such as locomotion, defense, grasping, and digging. We also present a comparative analysis of these moment arms against data from extant *Crocodylus* (as a rough approximation of plesiomorphic, quadrupedal musculoskeletal function), which illuminates numerous potential changes of muscle actions from basal archosaurs to bipedal - and then convergently quadrupedal - dinosaurs.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE SETTLEMENT OF THE AFRICAN FISH FAUNA

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A high level of endemicity (15 of the 48 families are endemic) and the presence of archaic fish are among the most striking features of the African freshwater ichthyofauna. The vast majority of the fishes are obligatory freshwater species, notably the numerous African members of the highly diversified group Otophysi (catfishes, carps, minnows and tetras) and the representatives of archaic and relict taxa such as the African lungfish *Protopterus*. Conversely, peripheral freshwater fish families are relatively poorly represented in African inland waters with generally relatively low specific diversity, and only a few of them include obligatory freshwater members. This typical pattern evidently results in a mix of species radiations and historical events of vicariance and invasion. On the base of the currently known fossil assemblages and of new material from the Eocene and Miocene of Libya, I will reconstruct the evolution of African freshwater fish faunas during the Tertiary and the establishment of the modern one to elucidate the main constraints that have shaped observed modern diversity.

The new fossils presented include some of the oldest members of modern genera such as the aba fish (*Gymnarchus* sp.), the catfish *Chrysichthys* sp., and the tiger fish (*Hydrocynus* sp.). These data and the review of the fossil record suggest that the settlement of the modern ichthyofauna in African freshwater occurred in the Eocene, which is much earlier than previously supposed. More precisely, on the basis of phylogeny, fossil record, modern distribution and habitat, I distinguish four types of fish, each type grouping taxa that share a common history and for which diversity was probably driven by similar environmental conditions. Indeed, geological events appear to greatly constrain the diversity pattern, particularly tectonics and related topographical modification and hydrographical divide. For instance, at the continental scale, the Burdigalian Afro-Eurasia collision allows invasion by several Asian fish such as cyprinids in the early Miocene. At a regional scale, the two main geological structures that participated to shape the hydrographical network in Africa, namely the Central African Shear zone and the East African rift system, appear as the main drivers for fish diversification and evolution. Moreover, some regions seem to have played a special role in the evolutionary history of certain taxa. Notably, the Great Lake Region seems to have acted as a refuge, at least for the lungfish *Protopterus* which suffered extinction threat during the Early Neogene.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE AXIAL FORMULA OF *ARISTONECTES QUIRIQUINENSIS* (PLESIOSAURIA, ELASMOSAURIDAE) AND ITS DIAGNOSTIC VALUE FOR ARISTONECTINES

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Three specimens (SGO.PV.94, 260, 957, Museo Nacional de Historia Natural, Santiago, Chile) from the Quiriquina Formation (late Maastrichtian) of central Chile allow us to describe most of the axial formula of the recently discovered species *Aristonectes quiriquinensis*. The total number of vertebrae reaches ~108 (43 cervicals, ~3 pectorals, 24 dorsals, ~3 sacrals, and 35 caudals). Fairly complete elasmosaur skeletons from North America have a variable number of cervicals (76 or less) but all they have a similar number of dorsal vertebrae (18-19). Among them are extreme long-necked forms with a total of 132 centra in the entire axial skeleton (*Albertonectes vanderveldei*), but there are also specimens reaching 109 (*Hydrotherosaurus alexandrae*). In addition, one fairly complete skeleton from the early Maastrichtian of New Zealand (CM Zfr 115) bears ~65 cervicals, 3 pectorals, 18 dorsals, 3 sacrals, and at least 20 preserved caudals, reaching a total of 109. This research shows that the total number of axial elements in *A. quiriquinensis* is similar to that found in other elasmosaurids (excluding *Elasmosaurus platyurus* and *A. vanderveldei* which have more than 130). On the other hand, *A. quiriquinensis* possesses broader and higher centra compared to typical elasmosaurids (e.g., North American forms), but the cranio-caudal length of each centrum is not proportionally enlarged, implying a comparatively lower VLI (Vertebral Length Index) that is distinctive for aristonectines. In summary, the robust aspect and shorter neck of *A. quiriquinensis* is caused by the presence of a larger axial skeleton with higher and broader centra, together with a shifting of the dorsal portion into the neck (commonly 18 centra in other elasmosaurids, but 23-24 in *A. quiriquinensis*). However, *A. quiriquinensis* retains a total number of centra which is common among elasmosaurids. This axial formula with ~45 cervicals and ~24 dorsals is partially verifiable on the early Maastrichtian species *Kaiwhekea katiki* from New Zealand, and could be diagnostic of the Aristonectinae. Finally, this research proposes the existence of three groups within the Elasmosauridae: The extreme long-necked forms (i.e., *E. platyurus*), the intermediate elasmosaurids (~108 axial elements, ~65 cervicals) and the aristonectines (~108 axial elements, ~45 cervicals, ~24 dorsals). This research was supported by the Antarctic Ring Project ACT-105, Conicyt-Chile.

Technical Session VII (Thursday, November 6, 2014, 11:30 AM)

EMPIRICAL TESTS OF WHETHER SPECIES RECOGNITION OR SEXUAL SELECTION IS A BETTER EXPLANATION OF 'BIZARRE STRUCTURES' IN DINOSAURS AND PTEROSAURS

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Much debate has raged about how to explain 'bizarre structures' in dinosaurs and pterosaurs (Ornithodira). Sexual selection is one hypothesis. However, sexual selection was explicitly defined as involving sexual dimorphism in features that attract mates or repel rivals. So, sexual dimorphism must first be established in taxa for which sexual selection is hypothesized. Lines of evidence that test these questions follow.

(1) To date, no reliable morphometric analysis has established dimorphism in any non-avian ornithodiran lineage. Reasons include poor sample sizes, poor stratigraphic or geographic control, and (2) no independent assessment of skeletochronology, which is critical because without knowledge of the actual age of the individual, it is not possible to compare ontogenetic stages, relative sizes, and degree of trait development with age. Hypothesized sexual 'differences' (not dimorphisms) among individuals often merely reflect age differences, because linear skeletal growth stops before mass increase (see 'robust' vs. 'gracile' forms). (3) Advocates of sexual selection often deny that sexual dimorphism is required for sexual selection, but they provide no other criteria for recognizing sexual selection. (4) Arguments against species recognition assert that it is not viable for extinct forms because there is little evidence for it in living groups; however, many extinct groups have no living homologues, and 'analogues' provide only weak arguments. (5) The lack of study of species recognition by neontologists is explained by the confounding effects of mating behavior, the context in which most taxa are studied. (6) The 'ontogenetic morphing hypothesis' applied to some dinosaurs is alleged to counter the hypothesis of species recognition because shape changes during life; however it actually weakens the sexual selection hypothesis and supports status recognition within species because, despite these ontogenetic changes, it is still impossible to discriminate genders. (7) Arguments about the 'cost' of 'bizarre structures' have never been quantified and are spurious given the success of the lineages. (8) Sexual selection is a small subcategory of a hierarchy of interactions that comprises species recognition, social selection, mate recognition, mate choice, mate competition, and sexual selection. Animals must first recognize conspecifics before mating and other social behaviors can occur. Conspicuous structures that vary non-directionally in clades and are not dimorphic reflect selection for species recognition.

Symposium 2 (Thursday, November 6, 2014, 1:45 PM)

ALL TIME GIANTS OF THE AIR: NEW APPROACHES TO CALCULATING THE LIMITS TO THE SIZE OF PTEROSAURS

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Cretaceous pterosaurs (azhdarchids, pteranodontids) are well known for giant wing spans, sometimes up to 10-12 metres: the size of small aircraft. Had these pterosaurs evolved to be as big as possible and was there a limit to their flight capabilities? Here, we present an analysis using aerodynamic design principles to determine the factors limiting pterosaur gigantism: an alternative approach to biologically based studies using allometric extrapolation techniques, either from birds (as extant analogues) or the pterosaur fossil record.

Based on information obtained largely from computed tomography (CT) scans (primarily of ornithocheirid specimens), we built a structural and aerodynamic computer model of a 6 m wingspan azhdarchid pterosaur, well within the size range where flight is

uncontroversial. Aerodynamic data was derived from wind tunnel tests on pterosaur wing shapes and mass estimates were made using the current consensus range. We then scaled our pterosaur model to wingspans of 9 m and 12 m, constrained only by the requirement to keep wing deflection in proportion. We then performed sensitivity analyses to determine which, if any, factors could have acted to limit the flight capabilities. Results show that under anaerobic muscle power even a 12 m wingspan pterosaur with a mass of 500 kg would be capable of gaining sufficient altitude to find lifting air or escape pursuit. Thus within the size range investigated, ability to achieve useful flight capability did not impose an upper limit on size. The aerodynamic constraints were also weak, so they were ineffective in defining clear limiting cases, which may account for the wide range of views expressed in previous studies.

Being capable in the air is not the whole story: in order to fly an animal must also be able to take-off and land. Due to the characteristics of the membrane wing, the likely landing speed for a 12 m pterosaur is within the range for large birds, so safe landings appear possible with robust azhdarchid hind limbs. The final hurdle is take-off. We applied a quadrupedal launch model that assumes hind limb and forelimb muscles all contribute to a ballistic takeoff. Tradeoffs between wing amplitude, launch height and launch speed were used to create a model that was iteratively optimized. As size increases, the range of feasible solutions becomes heavily constrained. At spans above 12 m there are no viable solutions due to the prohibitive forelimb muscle mass required, suggesting that takeoff performance limited giant pterosaurs to this size.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

SYSTEMATICS AND PHYLOGENY OF RHINOCEROTINI (MAMMALIA, RHINOCEROTIDAE)

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The tribe Rhinocerotini includes the extant rhinoceroses that are distributed in Southeast Asia and Africa. During the Neogene and Quaternary this tribe was widely distributed in Eurasia and Africa. The systematic revision of several specimens, currently housed in 36 institutions of Eurasia and North America, recognized at least 40 valid species belonging to Rhinocerotini. A cladistic analysis of 37 species based on 67 morphological characters was performed in order to identify the synapomorphies of the group and to clarify its inner phylogenetic relationships. A few species are scarcely documented by fossil remains and their inclusion in the cladistic analysis is problematic. Using the most complete taxon sampling ever for this group, we performed a maximum parsimony analysis in PAUP. Mapping the character states in the strict consensus tree (among 23 maximum parsimony trees), we found that the Tribe is supported by 7 unambiguous synapomorphies (US). The first dicotomy isolates the species *Lartetotherium sansaniense* and *Gaindatherium browni* based on 2 US. Two major clades are identified in the consensus tree. The first one is represented by the *Dicerorhinus* and *Rhinoceros-Punjabitherium* groups, the second clade is represented by *Paradiceros-Diceros-Ceratotherium* and relatives and "*Dihoplus*"- *Stephanorhinus-Coelodonta* groups. The *Dicerorhinus* clade (Dicerorhinina) is the sister group of the *Rhinoceros-Punjabitherium* clade (Rhinocerotina; supported by 5 US). A dicotomy separates the recent African rhinos and their relatives (Dicerotina; clade supported by 7 US) from the clade which includes the Eurasian late Miocene and Plio-Pleistocene rhinoceroses (Coelodontina; *"Dihoplus*"- *Stephanorhinus-Coelodonta* clade supported by 3 US). The five extant species in our analysis are placed in agreement with the most recent molecular analysis. The revision of Rhinocerotini and the new phylogenetic analysis suggest a close relationship between the Southeast Asian species, whereas Dicerotina is more closely related to Coelodontina. However, the inter-relationships between these clades and the early species of the tribe need to be more deeply investigated by adding other Miocene species (e.g., "Dicerorhinus" steinheimensis).

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

PALAEODIETARY RECONSTRUCTION OF EARLY MIDDLE PLEISTOCENE *URSUS DENINGERI* FROM WESTBURY-SUB-MENDIP (UK) THROUGH NOVEL APPLICATION OF MICROWEAR ANALYSIS

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The enamel microwear of select extant bear species is compared here with that of the extinct cave bear *Ursus deningeri* from a key early Middle Pleistocene site, Westbury-sub-Mendip (Somerset, UK). Mammalian dental wear studies allow examination of variation in microwear patterns that reflect the properties of food consumed, thereby shedding light on palaeodietary ecology. However, few studies have focused on the Ursidae, a family of carnivores that display extreme diversity in terms of adaptations to particular environments and/or modes of life. This is the first time that dental microwear analysis has been applied to extinct ursids from Britain in order to resolve their palaeodietary niches.

The enamel features were assessed via standard light stereomicroscopy at 35x magnification. First lower molar teeth (m1/carnassials) of adults were targeted, since this tooth combines bunodont cusps and a corresponding basin (talonid) associated with crushing actions, and shearing blades (trigonid), linked with slicing actions. Where this tooth was unavailable or poorly preserved, analogous teeth from the upper jaw, the upper fourth premolar (P4) and the upper first molar (M1) were used.

The results reveal that extant ursid species can be confidently separated into different parts of a dietary morphospace. The hypercarnivorous *Ursus maritimus* (polar bear) has the coarsest microwear features, characterized by more abundant pits than scratches. In contrast, the omnivorous *Helarctos malayanus* (sun bear) possesses more abundant scratches than pits, whereas *Ursus arctos* (brown bear) from Greece has almost even numbers of scratches and pits, reflecting a mixed diet. Crucially, differences in dietary morphospace are seen in *U. arctos* from different latitudes, thereby highlighting their potential to serve as proxies for fossil bears under different palaeoclimatic regimes.

Microwear results on *U. deningeri* reveal numerous scratches and pits together with many fine scratches and some gouge features. Plotting of large versus small pits in both extant species and *U. deningeri* suggests that the last occupied a position in dietary morphospace between the polar bear and sun bear with most individuals closer to sun bear. This suggests that the Westbury *U. deningeri* was primarily herbivorous but occasionally consumed hard foods. However, comparison with modern brown bears from different latitudes reveals interesting parallels with individuals from both Alaska and Greece, thereby indicating that a broad range of feeding preferences should be investigated.

Technical Session I (Wednesday, November 5, 2014, 11:30 AM)

TOOTHED MYSTICETE COCHLEAR MORPHOLOGY PROVIDES EVIDENCE FOR A GRADUAL SPECIALISATION TOWARD LOW FREQUENCY HEARING AND INABILITY TO ECHOLOCATE

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A fundamental difference between extant mysticetes (baleen whales) and odontocetes (toothed whales) is that mysticetes are specialised to hear low frequency sounds whilst odontocetes detect high frequency sounds used in echolocation. How the acoustic specializations of modern mysticetes originated and whether the earliest mysticetes were capable of detecting the ultrasonic sounds used in echolocation remains uncertain. Using synchrotron and microCT X-ray scanners, the internal structure of the periotics of the toothed mysticetes *Mammalodon*, Janjucetus, and an aetiocetid (cf. *Chonecetus*) were analysed and compared with those of extant mysticetes and odontocetes as well as archaeocetes and archaic Odontoceti (Xenorophidae). Early mysticetes possess several morphological adaptations for low frequency hearing such as increased number of cochlear turns and extension of the outer spiral lamina. Both mammalodontids and aetiocetids were adapted to hear low frequency sounds rather than high frequency sounds, displaying more similar morphologies to extant mysticetes than to odontocetes, making it unlikely that these early mysticetes were capable of detecting ultrasonic sounds. However, they do not possess the characteristic high cochlear radii ratio seen in modern baleen whales (a strong correlate of low frequency hearing). The combination of attributes possessed by early mysticetes suggest that the modern mysticete auditory bauplan did not evolve coincident with the divergence of Mysticeti and Odontoceti, but occurred at a later stage in the groups evolution, perhaps influenced by shifts in their feeding ecology.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE FIRST PLESIOSAURIAN REMAINS FROM THE EARLY BARREMIAN OF THE IBERIAN PENINSULA

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Plesiosaur material from the Early Cretaceous is poorly known, especially from the Northern Hemisphere. To date, only isolated vertebrae and teeth from the early Aptian and Albian-Cenomanian have been described from the Iberian Peninsula. Herein we describe some plesiosaur fossils from the Iberian Peninsula collected from several sites in the Blesa Formation (Teruel, Spain). The Blesa Formation was deposited in a coastal environment from the early Barremian. The fossil material consists on eight vertebrae: four cervical, one pectoral, one dorsal, one sacral and one caudal, as well as two teeth.

The centra of the vertebrae are preserved. They lack the neural spine and the apophysis. The centra are amphicoelous, shorter than high, and they have at least one pair of ventral/subventral foramina. Both teeth are slender, weakly curved and with eroded sharp apex. The first tooth is 52 mm long. The crown is 30 mm long and part of the root is broken off. The cross-section is oval, labiolingually compressed. It is ornamented with fine apicobasally oriented ridges. The ornamentation is on the whole crown, but it is more conspicuous on the lingual face. The second tooth is small and only the crown has been preserved (12 mm long). The cross-section is oval, labiolingually compressed. It is ornamented by fine apicobasally oriented ridges on the lingual surface.

The vertebrae can be assigned to Plesiosauria because of the presence of a pair of foramina on the ventral surface of the centra. The proportions of the cervical centra are commonly related to the length of the neck. All the centra are shorter then they are high or have subequal height and length. They are related to pliosauromorphs or closely related taxa. The undivided cervical rib facets are a shared character among derived plesiosaurs. The teeth can be related to the morphotype of piercing teeth common in many plesiosauroids.

These characters are apomorphies of different plesiosaurians and are hardly diagnostic. Therefore we assign this material to Plesiosauria indet. They are the first plesiosaurian fossils described from the early Barremian of the Iberian Peninsula, a period of time where plesiosaurs are poorly represented worldwide.

Technical Session XI (Friday, November 7, 2014, 2:30 PM)

STABLE ISOTOPIC AND MORPHOLOGICAL EVIDENCE FOR DIETARY EVOLUTION IN THE MAMMALIAN COMMUNITY OF EAST TURKANA, NORTHERN KENYA, BETWEEN 2 AND 1.4 MILLION YEARS AGO WITH PARTICULAR EMPHASIS ON THREE LARGE-BODIED PRIMATES

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In this study we combine stable isotopic and morphological data to investigate dietary evolution in eight genera and four tribes of mammals from the Upper Burgi, KBS, and Okote members of the Koobi Fora Formation in northern Kenya. These members span the period between 2 and 1.4 million years ago and are of particular interest because they document the last time that three large-bodied primate genera, *Theropithecus*,

Paranthropus, and *Homo*, coexisted within a single ecosystem. Although previous work has demonstrated that the prevalence of C_4 plant material increases through this period, we find: (1) the carbon isotopic signature of suids, hippopotamids, equids, and elephantids remain stable; (2) all of the bovid tribes analyzed become more depleted in carbon; and (3) *Theropithecus*, *Paranthropus*, and *Homo* become more enriched in carbon. This pattern suggests that, within this ecosystem, mammalian lineages adapted in different ways to changing environmental conditions. Morphologically, molar size in *Theropithecus* and *Paranthropus* increases significantly ($p < 0.05$) through this sequence, which implies a marked increase in the quantity of low-quality food resources ingested. This trend is not seen in *Homo*; molar size remains relatively stable ($p = 0.63$) through time. To determine if the morphological patterns in *Theropithecus*, *Paranthropus* and *Homo* potentially reflect competition for shared resources, we used two-dimensional geometric morphometric data to perform a character displacement analysis. Results suggest that the peculiar postcanine morphology of *Paranthropus* likely reflects adaptations that enabled the East African version of this taxon to occupy a distinct dietary niche during this period.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

COMPARISON OF THE ENDOCRANIAL MORPHOLOGY OF THE NODOSAURID *PAWPAWSAURUS* AND ANKYLOSAURIDS FROM NORTH AMERICA AND MONGOLIA, WITH COMMENTS ON THE PRESENCE OF THE FLOCCULUS IN THE BRAIN OF NON-THEROPOD DINOSAURS

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The cranial endocasts of *Pawpawsaurus*, a nodosaurid ankylosaur from the Lower Cretaceous of North America, and *Tarchia* and *Talarurus*, both ankylosaurids from the Upper Cretaceous of Mongolia, were studied using computed tomography (CT) scans. The goal of this study is the identification of evolutionary pattern change among the two ankylosaur families, and here we report the preliminary results. The general morphology of the brain and inner ear of the three taxa resembles that described for other ankylosaurs such as *Euoplocephalus* or *Sauropelta*. The development of the olfactory bulbs is similar in both families, and the elongated lagena indicates that hearing was probably an important sense. However, the brain has a more sigmoidal shape in nodosaurids, whereas ankylosaurids have less marked angles between hind-, mid-, and forebrains. Compared with *Pawpawsaurus*, the studied ankylosaurids have more laterally marked and expanded cerebral hemispheres. A remarkable trait is the presence of the flocculus in *Euoplocephalus* and *Tarchia*. The flocculus is not recognized in *Talarurus* and is absent in *Pawpawsaurus*, *Struthiosaurus*, *Sauropelta*, *Hungarosaurus*, *Panoplosaurus*, and an unnamed specimen from Japan, suggesting that its absence is characteristic of nodosaurids. Since recent studies on bird brain evolution state that the development of the flocculus is not just related with flight capabilities but with gaze stabilization, we suggest that its presence in quadrupedal non-theropod dinosaurs corresponds to capabilities related with fast movements of the head (feeding and/or defense behavior, and in the particular case of ankylosaurids, also related to the movement and stabilization required for the active use of a heavy club-tail).

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

ELASMOBRANCHII TEETH FROM THE LATE CARBONIFEROUS-EARLY PERMIAN ITARARE GROUP (PARANA BASIN), SOUTHERN BRAZIL

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The Itarare Group comprises an association of glacial-continental and glacial-marine facies, mainly composed by clastic lithologies that includes sandstones, diamictites and other conglomerates, rhythmites, mudstones, shales, and minor coal seams. This unit is considered to be of Late Carboniferous to Early Permian age, spanning from the Bashkirian/Moscovian to the Early Sakmarian. The present work specimens were collected in one facies of this lithostratigraphic unit, the 'Lontras Shale', that are known by its great fossil diversity that includes plants, invertebrates, ichnofossils and a diverse ichthyological fauna. The specimens corresponds to three isolated teeth collected in an outcrop near the Municipality of Mafra, coordinates 26°09'29.29"S, 49°48'51.95"W. The specimens belong to the following collections: Centro de Paleontologia of the Universidade do Contestado (CENPALEO-UNC), CP-142 and CP/E-2995; and in the paleontological collection of the Museu de Ciencias Naturais - Universidade Federal do Parana (MCN-SCB-UFPR), MCN.P. 1077. The specimen CP-142 shows a broad base 9 mm in length, with small basolabial and lingual torus projections. The oral portion of this base has a crown with five cusps. The median cusp is 9 mm in height, and is laterally flanked by four accessory cusplets (two on each side), two proximal and two distal, 3 mm and 1.5 mm in height, respectively. The central cusp is slightly lateral curved and compressed labiolingually, forming on the apical portion smooth lateral carinae. The surface of the teeth shows some longitudinal and discontinuous smooth cristae. The specimens CP/E-2995 and MCN.P.1077 are under preparation and present only one visible cusp that is strongly lingually curved. The specimen CP/E-2995 is approximately 8 mm in height with a broad base 7.5 mm long, while the specimen MCN.P.1077 (a,b) is 6 mm in height. The specimen CP-142 is preliminarily attributed to Cladodontomorphi incertae sedis with a symmoriform affinity, while the other two are only attributed to Elasmobranchii incertae sedis due to preliminary fossil preparation. The Symmoriformes are poorly known in the Brazilian territory, which increase the importance of these specimens and may contribute to understand the diversity of this group in Western Gondwana.

Technical Session VII (Thursday, November 6, 2014, 8:00 AM)

A NOVEL ARCHOSAUROMORPH FROM ANTARCTICA INCREASES SAURIAN DIVERSITY IN THE IMMEDIATE WAKE OF THE END-PERMIAN MASS EXTINCTION

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The lower Fremouw Formation of Antarctica provides a tantalizing look at a high-latitude vertebrate assemblage in the immediate aftermath of the end-Permian mass extinction. The Lower Triassic tetrapod assemblage of the lower Fremouw largely mirrors that of the more extensively sampled *Lystrosaurus* Assemblage Zone of the Karoo Basin of South Africa, though with important exceptions. Both areas share taxa of the extinction aftermath such as the dicynodonts *Myosaurus* and *Lystrosaurus*, the cynodont *Thrinaxodon*, eutherocephalians, and the parareptile *Procolophon*. Interestingly, the dicynodont *Kombuisia* and the reptile *Palacrodon* occur in the Fremouw before they are evidenced in the Karoo. The only archosauromorphs recognized from the lower Fremouw are *Prolacerta broomi* and fragmentary remains (AMNH 24262, a distal left humerus) of a much larger archosauriform with an estimated body length of over three meters.

During the austral summer of 2010-11, we collected a partially disarticulated postcranial skeleton of a small reptile, UWBM 95531, from lower Fremouw rocks at Graphite Peak that consists of cervical and dorsal vertebrae, ribs, a left humerus, and articulated pedes. An advanced ontogenetic stage is indicated by the complete fusion of the neural arches to their respective centra. Preliminary phylogenetic analyses of basal amniotes recover UWBM 95531 as an archosauromorph. UWBM 95531 can be differentiated from *Prolacerta* on the basis of several vertebral characters, including the absence of cervical and dorsal intercentra, absence of a ventral keel on the cervical centra, the shape of the cervical centra, and the presence of well-developed laminae between the zygapophyses and diapophyses. The distal humerus is less expanded in UWBM 95531 than in *Prolacerta*, though it is still asymmetrical with a large ectepicondyle. The distal end of AMNH 24262 is symmetrical and the humerus is far larger than UWBM 95531 (estimated at 212 mm vs. 59 mm), precluding their referral to the same taxon given the inferred ontogenetic stage of UWBM 95531. As a postcranial skeleton, UWBM 95531 adds important morphological data to analyses that aim to place fragmentary archosauromorph remains found in Permo-Triassic deposits into a phylogenetic context. Besides adding phylogenetic diversity to Archosauromorpha near the Permo-Triassic boundary, UWBM 95531 adds critical geographic and temporal information to the early expansion of the clade, and to Sauria as a whole. Work supported by NSF PLR-0838762, PLR-1146399.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

EARLY EVOLUTION OF TROODONTID DINOSAURS BASED ON INFORMATION FROM NEW AND OLD SPECIMENS

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Troodontidae is a family of bird-like dinosaurs resembling avians in both anatomy and ecology. Traditionally, Troodontidae is known as the sister group of Dromaeosauridae, and together they form the Deinonychosauria and the sister taxa to Avialae. However, recent discoveries of Late Jurassic paravians from Northeast China raised heated debates on the phylogeny and the monophyly of the troodontid family. This study examines two unnamed small troodontid taxa from the Lower Cretaceous of Mongolia, and revises the anatomy of multiple specimens of basal paravian dinosaurs, especially basal troodontids, including *Anchiornis*, *Sinovenator*, *Mei*, *Sinusonasus* and *Jinfengopteryx*. Careful study of these significant and well-preserved materials provides an opportunity to explore the phylogenetic history of troodontid taxa and the early radiation of Paraves. Phylogenetic analyses are conducted with the most updated information of coelurosaurians, especially maniraptorans, and under both maximum parsimony and maximum likelihood criteria. The preliminary results generally support the monophyly and the traditional phylogeny of troodontid dinosaurs. The Late Jurassic *Anchiornis* is recovered to form a monophyletic group with *Xiaotingia*. Although *Anchiornis* and *Xiaotingia* share some morphological similarities with *Archaeopteryx*, the current result favors *Anchiornis* and *Xiaotingia* as the most basal troodontids and as the sistergroup to other more derived Cretaceous troodontid dinosaurs. Cretaceous troodontids form a monophyletic group with solid support, with the clade of western Liaoning troodontids such as *Sinovenator*, *Sinusonasus* and *Mei* at its basalmost position. The unnamed Early Cretaceous Mongolian troodontids are relatively derived. Including new and revised information of these early troodontids into the analyses gives better phylogenetic resolution at the root of the paravian radiation. New synapomorphies are recognized from the cranial skeleton at multiple nodes within Troodontidae. Examination of character evolution on the current topology gives us deeper insights into the adaptive radiation at the early stage of Paraves, such as the origin of flight and the change of body size and diet.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

THE RODENT FOSSIL RECORD FROM THE MIOCENE OF THE MADRID BASIN (SPAIN): AN EXAMPLE OF CLIMATICALLY DRIVEN COMMUNITY EVOLUTIONARY PATTERNS.

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The Madrid basin is one of the main Cenozoic continental basins of the Iberian Peninsula. It stands out as having a rich Miocene mammal fossil record which expands over 5 million years. Its mammal record is especially well-represented and studied between 16 and 13.6 Ma. This study is focused on this well-sampled part that includes more than 30 mammal fossil associations. Taxonomical revision of the rodent material, from new and already known sites in the basin, combined with new stratigraphic

information, allow us to present an updated paleontological framework of the middle and upper Aragonian from the Madrid basin. The new information enabled us to establish the correspondence between local biostratigraphies and biochronologies proposed on different Spanish basins with the taxonomical and paleoecological patterns observed in Madrid, as well as the correlation of the latter with global paleoclimatic trends. The results indicate a clear correspondence between the Madrid local zonation and that from the Aragonian Type Area (Saragossa, Spain), despite differences in species richness (always lower in Madrid) and in taxonomic relative abundances. The main paleoecological changes in the small-mammal community from the Madrid basin correlate with the large climatic events and trends evidenced by the marine stable isotope record. The lower part of the Madrid faunal succession corresponds to the Miocene Climate Optimum. In this interval two local biozones are defined. The boundary between both zones is dated as 15.6 Ma and coincides with one large temperature shift of the Miocene, recognized in paleoclimatical reconstructions based on marine stable isotopes. The remaining faunal succession corresponds to the Middle Miocene Climate Transition that starts around 14.8 Ma, and represents an important global cooling trend. Along this last section of the Madrid succession, three major faunal changes can be recognized. The first one (starting around 14.4 Ma) could be related to a major stratigraphic discordance in the basin and represents a drop in rodent diversity. The second (around 14 Ma) shows an important increase in species richness, despite the fact that whole diversity keeps diminishing. The third, and most important, mammal change in the basin takes place around 13.8 Ma and correlates approximately with the major step in middle Miocene climate cooling detected at global scale.

This work was supported by the Spanish MINECO Project CGL2011-28877 and research group UCM 910607.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

A PHYLOGENETIC PERSPECTIVE OF THE AVIAN TROPHIC DIVERSIFICATION: INTEGRATING PALAEONTOLOGICAL AND NEONTOLOGICAL INFORMATION

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From their origin in the Middle Jurassic until the present, birds have undergone one of the most important evolutionary radiations among vertebrates, with the development of great species-level diversity and the occupation of a broad spectrum of ecological niches. Since dietary shifts involve a series of morphophysiological adjustments and reflect the use of the resources, diet represents a key ecological and evolutionary parameter to understand the history of bird clades. This study combines neontological and paleontological dietary information in a phylogenetic context, aiming the understanding the role of feeding habits in bird evolution and their potential relationship with past ecological and evolutionary events. Our findings point towards an omnivorous ancestral diet for the avian clade, which is consistent with dietary information, dental structure and life style of the first birds, such as *Archaeopteryx*. Our results also show dietary shifts in avian evolutionary history. Faunivores predominate in the avian history, while herbivorous lineages underwent adaptive radiations possibly related to transformation of ecosystems and their plant assemblages worldwide such as the development of the angiosperms during the Cretaceous or the development of grassy environments in the Oligocene. Faunivorous and herbivorous clades arose basically through diversification within lineages, while omnivores evolved due to transitions into the strategy. The capacity to specialize and generate new trophic niches allowed faunivores and herbivores to diversify more than omnivores. Nevertheless, despite this relatively low diversification, the omnivorous strategy appears to be key to the primary processes of bird radiation and fundamental in the evolutionary success of birds.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A NEW MIDDLE MIOCENE CONSERVAT-LAGERSTÄTTE IN THE TUGEN HILLS (CENTRAL KENYA, EAST AFRICAN RIFT VALLEY) REVEALS A UNIQUE RECORD OF FOSSIL HAPLOTILAPIINI (CICHLIDAE: PSEUDOCRENILABRINAE)

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African freshwater cichlids (Cichlidae: Pseudocrenilabrinae) provide one of today's best model systems for the study of adaptive radiation, because they exhibit an enormous diversity of trophic, ecological and behavioural adaptations. The Great Lakes of the East African Rift System are well known as hot spots of cichlid diversity, harboring more than 2000 modern cichlid species. However, a precise timetable for the evolutionary history of African cichlids remains to be established, because fossils are scarce, even from the Neogene and Pleistocene, and predominantly based on isolated teeth and bones, with few articulated specimens. Recent fieldwork in the Tugen Hills (Baringo County, Central Kenya Rift) has uncovered the new Middle Miocene (ca. 13-14 Ma) Conservat-Lagerstätte Kabchore, from which 70 extraordinarily well preserved cichlid specimens were recovered, eleven of them complete. Their assignment to the subclade of the Haplotilapiini is based on the presence of tricuspid teeth, and supported by the analysis of meristic characters in multivariate space based on a large dataset for extant Cichlidae (746 specimens). Three species can be discerned. One appears to be closely related to the comparatively 'old' tribe of the Etiini, based on the presence of two predorsal bones. The other two possess a single predorsal bone and may represent an extinct tribe close to the Oreochromini, based on meristic counts and osteological analyses. Strikingly, there is no hint that members of the East African Radiation (EAR) lineage are present, although such forms would be expected in Central Kenya at that time, according to time-calibrated molecular trees based on previous work. Sedimentological data from the new Conservat-Lagerstätte point to a short-time lacustrine period within a floodplain-dominated environment and some influence of volcanism. It can be assumed that, during the period when the Lagerstätte was formed, the river networks in the Central Kenya Rift were subjected to repeated remodeling due to active tectonic rifting, which was the major agent of environmental change. The absence of species indicative for seasonal aridity, such as killifishes, and the exclusive presence of Cichlidae suggest a tropical or subtropical perennial freshwater environment. We expect that our analysis of the fossil cichlids from Kabchore will be useful in providing a calibration point for new divergence-time estimates and will afford new insights into the evolutionary history of Africa's Cichlidae.

The research is funded by the German Research Foundation.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

TARSALS OF SESPEDECTINAE (EULIPOTYPHLYA, ERINACEOMORPHA) FROM THE MIDDLE EOCENE OF SOUTHERN CALIFORNIA

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Erinaceomorph eulipotyphlans are a diverse and frequently abundant component of many early Cenozoic faunas. Despite this, many aspects of the ecology and relationships of these taxa remain obscure due to a lack of definitive non-dental remains. Although clearly associated material is ideal for rectifying this situation, isolated postcranial remains can still be a valuable source of data when reassociations can be made with confidence.

Sespedectinae is a small clade of middle Eocene erinaceomorphs endemic to southern California. Isolated tarsals from several stratigraphic units in the San Diego area can be confidently assigned to all three sespedectine genera, *Crypholestes*, *Proterixoides*, and *Sespedectes*, based on patterns of size, morphology, and abundance. Tarsals of the three genera differ primarily in size and share a number of distinctive features. Calcanei share a medial expansion of the proximal end of the tuber, S-shaped ectal facet that is proximally concave and distally convex, large, dorsally oriented fibular facet, well-defined flexor groove on the ventral sustentaculum, and a prominent plantar tubercle that overhangs the cuboid facet distally. Astragali share a matching S-shaped ectal facet, moderately deep trochlea with medial and lateral ridges that are subequal in length, absence of an astragalar foramen, large lateral process, short, medially projecting astragalar necks, and ovoid, modestly oblique astragalar heads. Differences among the three genera are minor, particularly when intraspecific variation is considered. The most notable differences involve the calcaneal tuber, which is particularly robust in *Crypholestes* and elongate in *Proterixoides*.

Some features, most notably the S-shaped ectal facets, are consistent with a close relationship to extant erinaceids but substantial differences exist as well. In particular, the astragali of sespedectines lack the extreme elongation of the lateral trochlea that characterizes living and extinct erinaceids. At the same time sespedectine tarsals differ in several significant features from tarsals of other potential Eocene erinaceomorphs, including *Macrocranion* and *Zionodon*. In particular, both of the latter have uniformly curved ectal facets. There is little in the tarsal morphology of these taxa that indicates a close relationship to either the California forms or each other, suggesting that early erinaceomorphs may be an amalgamation of distantly related taxa sharing broad dental similarities.

Symposium 4 (Friday, November 7, 2014, 11:30 AM)

MINIATURIZATION, MORPHOLOGICAL CHANGE, AND ONTOGENY: A STUDY IN TEMNOSPONDYL AMPHIBIANS

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Miniaturization is a phylogenetic concept that has been defined as the evolution of extremely small adult size in a lineage. It does not simply imply a decrease in body size, but also involves structural modifications to maintain functional efficiency. Miniaturization is regarded as a key factor for the evolution of major clades. In particular, current hypotheses propose that at least one of the living amphibian groups originated from miniaturized dissorophoids, a clade of Permian temnospondyls. We analyzed the variation of adult cranial shape among miniaturized and non-miniaturized dissorophoid species in a phylogenetic context to identify patterns of morphological change in miniaturized forms. In addition, we also tested whether these evolutionary patterns resemble the ontogenetic patterns in *Micromelerpeton credneri*, a basal dissorophoid, in order to evaluate whether the miniaturized morphology resulted from paedomorphosis.

We collected linear and geometric mophometric data from skulls of adult dissorophoids and different ontogenetic stages of *M. credneri* and analyzed statistically their relationship with body size. For the interspecific analyses, we used phylogenetic comparative methods, which are suitable for dealing with the phylogenetic non-independence of data.

Two general results were obtained from the morphometric analyses: 1) Miniaturized dissorophoids present a distinctive cranial shape, even when the phylogenetic effects are taken into account. Among other features, they are characterized by proportionally reduced braincases and otic capsules. This contrasts with the pattern observed in miniaturized living amphibians, where these structures are remarkably enlarged due to nervous and sensory system constraints; 2) The interspecific allometric scaling of some characters (e.g., preorbital length) agrees with the ontogenetic growth patterns in *M. credneri* suggesting that these features are paedomorphic. However, this resemblance is not observed as a general rule.

In conclusion, the reduction of body size in temnospondyls led to quantifiable changes in skull shape, which cannot be completely explained by paedomorphosis. Future studies focused on the deviations from developmental truncation will probably shed light on the adaptive significance of structural changes and on functional constraints, which do no seem to be uniform between miniaturized forms of different clades.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

ON THE USE OF TWO-BLOCK PARTIAL LEAST SQUARES WITH LINEAR MEASUREMENTS FOR STUDYING INTEGRATION PATTERNS BETWEEN THE NEUROCRANIUM AND THE SPLANCHNOCRANIUM IN EXTANT HOMINOIDS AND EXTINCT HOMININS

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Many biological structures that interact in development and/or function tend to evolve in a concertedly fashion and thus become integrated forming modules. The two most prominent modules of the mammalian cranium are the cerebral capsule (i.e., the neurocranium) and the face (i.e., the splanchnocranium), as inferred from both developmental processes and functional reasons. The relative importance of both cranial complexes was estimated here by means of their relative sizes, which were measured in the five extant hominoid species and also in a huge sample of extinct hominins using six standard cranial measurements as proxies of the length, width, and height of each cranial module. Several two-block partial least-squares analyses (2B-PLS) were performed for adults of the extant and extinct species using size standardized and non-standardized variables, as well as pooled and non-pooled within-species correlation matrices. When no size standardization was performed, pooled and non pooled within-species analyses showed a common pattern of developmental integration for all living hominoid species, on the one hand, and very different patterns of evolutionary integration, on the other, in which each species exhibited a distinct relationship between the relative sizes of their modules. On the contrary, when cranial size was removed, ontogenetic and evolutionary integration run in the same direction, which indicates that the relative sizes of the splanchnocranium and the neurocranium relate inversely both within and between species. Australopiths, the extinct representatives of the genus *Homo* and the anatomical modern humans (AMH) seem to lie in a different trend than the great apes, although the pattern of covariation between their cranial modules is basically the same. This difference suggests that a great ape cannot reach the morphology of an AMH simply by increasing the size of its neurocranium. Similarly, an AMH cannot be transformed to the face/neurocranium proportions of an ape simply by reducing its neurocranium. We thank the Universidad de Malaga. Campus de Excelencia Internacional Andalucia Tech and the Ministerio de Ciencia e Innovacion (Ref. CGL2011-30334).

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

RELEVANCE OF THE MIOCENE *'TESTUDO' BOLIVARI* (CRYPTODIRA, TESTUDINOIDEA) TO UNDERSTANDING THE PHYLOGENETIC RELATIONSHIPS OF THE TESTUDINIDS FROM THE CENOZOIC OF EUROPE

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Testudinidae are terrestrial turtles currently living on several continents, including Europe. Fossil testudinids are known in Europe since the Eocene, with several taxa of medium size (from 0.3 to 0.7 m) recognized in the Paleogene record. The size of several European Neogene taxa was larger (between 1 and 2 m). These large testudinids were abundant and diverse, ranging from the early Miocene to the Pleistocene. Most of them are relatively poorly known. In addition, there is a nomenclatural gap at generic level, since the widely used assignment to the more primitive and smaller Eocene *Cheirogaster* cannot be sustained.

'*Testudo*' *bolivari* is the large European tortoise taxon with the most complex history. Although numerous specimens have been discovered from several Spanish sites at the beginning of the last century, the alleged destruction of the material and the absence of a detailed description of this taxon, hitherto lacking a diagnosis, hindered its proper inclusion in other studies. New material described after the 1970s has only added further complexity to the history of the taxon. The abundant classic material of *'T.*' *bolivari*, supposedly lost, has been relocated, identified by us and is described in detail for the first time, including some incompletely described specimens and many unpublished ones. In addition, the detailed revision of other previously analyzed specimens, coming from several Spanish middle and late Miocene sites, and the study of recently found specimens, let us properly define '*T.* ' *bolivari*. We propose a diagnosis, and identify a lectotype and paralectotypes. Due to the abundance of specimens, this study provides the first detailed documentation of the intraspecific variation and the sexual dimorphism of a European large tortoise taxon.

The comparison of '*T.* ' *bolivari* with the other Cenozoic and extant medium to large tortoises from Europe and Africa provides a major advance in the taxonomy of the European taxa. In this sense, a new hypothesis on the phylogenetic relationships among the involved taxa, most of them still not analyzed from a phylogenetic perspective, is proposed.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

TESTING OSTEOLOGICAL FEATURES FOR IDENTIFICATION OF SEX IN MODERN LIZARDS AND THEIR IMPLICATIONS FOR FOSSIL GROUPS

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Identification of the sex of a fossil organism is a difficult endeavor. The soft parts that would allow for easy sex identification are usually not preserved. For vertebrates this problem is even intensified by the generally low number of (complete) specimens per species. In this case, maximization of information from as few bones as possible is paramount. Previous studies proposed to use the position of the first haemal arch to identify sex. An additional suggestion was to use the position of the first vertebra with evidence for autotomy (in lepidosaurs, including lizards). Here, I tested the previously suggested features using 31 specimens of the Tiger Whiptail lizard (*Aspidoscelis tigris*: Teiidae). Both suggested criteria turned out to reflect intraspecific variation rather than sex, at least in *A. tigris*. Therefore, in an attempt to use different osteological criteria for the identification of sex in this species, I measured the width of the quadrate and width of the proximal end of the humerus. However, neither quadrate nor humerus showed a strong and unambiguous sex-based signal. Since macroscopic characters are seemingly uninformative, investigating differences in the growth rate of males and females from bone histological observations might prove to be more promising to shed light on differences in sex in groups that otherwise exhibit only minor sexual dimorphism. Identification of the sex in fossil organisms is important to accurately estimate the number of fossil species in a group and reconstruct paleoecosystems, as well as to better understand differences in the life history of male and female members of the same species.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A NEW LARGE BASAL SAUROPODOMORPH FROM THE EARLY JURASSIC UPPER ELLIOT FORMATION OF LESOTHO

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Recent fieldwork in the Upper Elliot Formation exposed near the village of Ha Noosi in the the Qacha's Nek District in Lesotho has yielded the sub-complete and articulated skeleton of a new basal sauropodomorph. The only missing elements are the caudal vertebrae, most of the pelvic girdle and the distal part of the right hind limb. An isolated femur of another individual and two partial disarticulated skeletons of the small *Massospondylus carinatus* have been found associated with this new specimen. The Ha Noosi locality is also known to have yielded the type specimen of the heterodontosaurid *Abrictosaurus consors*.

A detailed analysis of the skull combined with the large dimensions of the skeleton are sufficient to assume that the material represents a new species. The taxon displays the most elongated and dorsoventrally compressed skull known among basal sauropodomorphs from the Late Triassic and Early Jurassic. It can be distinguished from the other sauropodomorph genera of the Upper Elliot Formation based on several autapomorphies, including a bifid anterior process of the jugal. The new specimen is closer in size to Late Triassic forms such as *Antetonitrus*, *Melanorosaurus*, *Plateosaurus* or *Riojasaurus*. Only two other basal sauropodomorphs from the Early Jurassic have reached a large size: *Aardonyx* from South Africa and *Jingshanosaurus* from China. The steep dorsal process of the premaxilla observed in *Aardonyx* is absent in the Ha Noosi specimen. *Jingshanosaurus* clearly displays a dorsoventrally high skull with large external openings and comparatively thin bone bars separating the openings. This condition is not shared with the newly discovered Lesotho specimen. A large basal sauropodomorph is also known from the Upper Triassic Lower Elliot Formation bonebed of Maphutseng in Lesotho. One of the largest femora from Maphutseng has the same maximum length than the femur of the new taxon, but a robustness index shows that the Maphutseng femur is more robust.

In a preliminary phylogenetic study which was focused on the forelimb, the specimen was recovered in a polytomy among the basal sauropodomorphs *Coloradisaurus*, *Lufengosaurus*, *Massospondylus*, *Plateosaurus*, *Anchisaurus* and *Riojasaurus* (defined by some authors as 'Prosauropoda'). Moreover, when looking at discriminating characters among sauropodomorphs, the specimen appears to be closer to the basal condition. The new species described here is the most complete, well-preserved and articulated yet recovered, and could be a clue to understanding the evolution of sauropodomorph dinosaurs.

Technical Session XV (Saturday, November 8, 2014, 10:45 AM)

ASSESSING THE RELATIVE IMPORTANCE OF DIFFERENT CHARACTER PARTITIONS IN PHYLOGENETIC ANALYSES OF MAMMALS

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Taphonomic biases preferentially preserve hard parts, and thus characters associated with skeletal elements, during the fossilization process. Consequently, missing data associated with fossil taxa is not random, as is typically assumed in phylogenetic studies assessing the impact of including taxa with large numbers of unknown characters. A recent study simulating fossilization by selectively removing soft part characters found less phylogenetic signal and observed 'stem-ward slippage' in analyses that included only hard part characters. A range of vertebrate and invertebrate datasets were included however, and the present study examined more specifically how this observed phenomenon affects phylogenetic analyses of mammalian fossil taxa. Since many mammalian phylogenies rely predominantly on dental characters for largely incomplete fossil mammals this study also investigated the effects of using dental characters only in phylogenetic analyses.

This study used a node recovery test to assess the impact of fossilization filters on the phylogenetic resolution of an entire dataset. The taxon shift determined whether selectively replicating fossilization on a single taxon affects phylogenetic placement relative to the root. Although a loss of phylogenetic signal was predicted for both analyses, the node recovery test demonstrated that for mammalian taxa the inclusion of soft characters is significantly less important than including the hard part characters usually preserved in fossils (i.e., cranial, dental and postcranial characters) in contributing to phylogenetic resolution. Further, addition of soft characters may offer little to no improvements over using hard part characters only. Selectively 'fossilized' taxa were anticipated to change position closer to the root based on the prior study, however the taxon shift test did not support any systematic pattern.

In contrast, the 'dental character only' filter had a significantly negative impact on the resolution of nodes, suggesting that phylogenetic analyses should contain additional sources of characters whenever possible. Furthermore, taxon placement was significantly affected when scored for dental characters only, however no systematic trend of upward or downward movement was observed. Together, this suggests that paleontologists should exercise caution when using dental information only in their phylogenetic analyses, and when using fossil taxa known only from dentitions to calibrate molecular clock analyses.

Romer Prize Session (Thursday, November 6, 2014, 9:00 AM)

EXTINCTION AND BODY SIZE PATTERNS OF THE GIANT SHARK *CARCHAROCLES MEGALODON*

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Patterns and mechanisms of extinction of the largest shark ever known, *Carcharocles megalodon*, are poorly understood. Based on the extreme size, morphology and global distribution of their teeth, *C. megalodon* has been regarded as a cosmopolitan top predator. For that reason, it most likely played a key role in structuring the world's marine ecosystems. Consequently, its extinction potentially affected food webs and impacted ecosystems structure and function. In order to better understand the extinction mechanisms of *C. megalodon*, a fundamental first step is to know when it occurred. Furthermore, because body size is related with extinction risk, the study of *C. megalodon* size patterns will allow isolating potential causes of extinction. Here, the Optimal Linear Estimation, a novel method based on the temporal distribution the most recent occurrences of a species, is used to infer the time at which *C. megalodon* went extinct. In addition, body size estimates from a large sample of teeth from global collections are used to determine size changes through time. This is done by applying a variety of quantitative methods, including models of evolution. Results show that the time at which probabilistically *C. megalodon* should have gone extinct, was the Pliocene-Pleistocene boundary, ~2.5 Ma. Based on this new estimate, it becomes apparent that the extinction of *C. megalodon* coincides with the extinction of small-sized prey and the evolution of new competitors. Furthermore, the quantitative body size analyses suggest that *C. megalodon* maintained a stable size over time, and hence, evolutionary size-change was not a determining factor in its extinction. This research advances the understanding of the extinction of the largest predatory shark that ever lived. Nowadays, marine top predators are declining throughout the global ocean. Large sharks are particularly threatened as their extinction risk is higher than for most vertebrates. Understanding extinction mechanisms of *C. megalodon* and its impact on ancient food webs, therefore, could be informative to better comprehend modern ecosystems.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

THE RELATIONSHIP BETWEEN DIET AND BODY MASS IN MAMMALS

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Contemporary mammals are extraordinarily diverse, having adapted to fill almost all available ecological niches. In order to understand this successful radiation, special attention has been paid to the influences of different environments on mammalian evolution. Thus, various ecological variables have been explored in order to understand the successful radiation of mammals during the Cenozoic. Among them, diet and body mass have proven to be powerful paleoecological indicators.

In order to explore the relationship between these two variables, we built a database summarizing the dietary preferences of 139 species of terrestrial mammals and their average body mass. The dietary data were based on primary sources and consisted of volumetric percentages of stomach contents. We used a statistically-grounded classification scheme that emphasizes the primary resource in a given diet. Additionally, every species in our dataset was assigned a dietary diversity index by applying inverse-Simpson indices to stomach content percentages. The dietary diversity index indicates the degree of food mixing in the diet.

We observed a decrease in dietary diversity with increased body mass, which could be related to metabolic and nutritional tradeoffs. Our results also suggest that every dietary specialization has a specific optimum body mass range. Smaller mammals are mainly insectivores, granivores, or mixed feeders while bigger animals are usually herbivores and feed specifically on grasses and leaves. The medium size range is mostly composed of frugivorous species that inhabit tropical and subtropical rainforests**.** Thus, the near absence of medium-sized mammals in open environments can be linked to the decreasing density of fruit trees needed to support a pure frugivorous diet year-round. Specifically, seasonality and aridity will prevent species from specializing on a totally frugivorous diet in more open environments. These results are important because statistically tested dietary classifications can serve as powerful sources of information in paleoecology and paleoclimatology, helping, for example, to discriminate between seasonal and aseasonal environments.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

WAS *TAPEJARA WELLNHOFERI* (PTEROSAURIA, PTERODACTYLOIDEA) REALLY FRUGIVOROUS?

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Since the first description of complete skull material, tapejarine pterosaurs were regarded as frugivorous. This assumption was mostly based on preliminary morphofunctional observations and was never thoroughly tested. This unusual toothless pterosaur clade was, however, henceforth considered as not only frugivorous but as an important seed disperser, linked to the first radiation of the incipient angiosperms of that time. Alleged evidence supporting this specific feeding strategy was mainly based on the short rostrum and downturned, incompletely occluded jaws, which would serve as well-adapted tools for manipulating fleshy fruits. In addition, some workers draw attention to the temporal correspondence between tapejarine occurrences and dispersal events of early flowering plants. According to proponents of frugivorous tapejarines, good extant analogues for these animals would be birds belonging to the clade Bucerotidae (hornbills). In order to assess this issue and hypothesize possible feeding habits for tapejarines, we conducted a series of morphofunctional and ecological inferences for *Tapejara wellnhoferi*, the best known tapejarine, represented by several skulls and postcranial elements from the Romualdo Formation (?Albian) of the Araripe Basin, Brazil. Our approach was mainly focused on jaw musculature reconstruction, with its mechanical implications, as well as the recognition of possible permissive joints for intracranial movements. In addition, a survey of potential food resources among the fossil biota of the Crato and Romualdo Formations was made. The comparatively short rostrum of *Tapejara wellnhoferi*, allied to evidence for greater mechanical advantage of the quadrato-mandibular system amplifying the input force of the adductor musculature, and a skull constitution adapted for the dispersion of mechanical loads probably implies strong bite forces concentrated at the anteriormost region of the rostrum. This condition is very different from what is observed in hornbills, which have exceptionally long beaks and mostly akinetic skulls, but more similar to what is found in some seed-cracking finches, such as *Geospiza fortis*. Thus, the cranial constitution of *Tapejara wellnhoferi* shows more compatibility with a durophagous diet and, although eventual consumption of fleshy fruits is not discarded, its primary food resource would probably be hard items, such as *Araucaria* and other gymnosperm strobiles, or even mollusks, which are not unusual in the Crato and Romualdo formations.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

REPURPOSING THE PURPOSEFUL: RE-TRAINING FOSSIL PREPARATORS IN VERTEBRATE MOUNT DISMANTLING AND CONSERVATION

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The Smithsonian Institution National Museum of Natural History (NMNH) is undergoing the renovation and redesign of its nearly 31,000 square foot paleontology exhibit halls. In addition to many Smithsonian staff and contractors, museum volunteers serve an essential role in the dismantling and conservation of hundreds of mounted and bracketed fossil specimens previously on exhibit. Specimens allotted for volunteer work are not slated to return to public display. These specimens must be removed from their armature, repaired and conserved, and reincorporated into research collections both physically and in digital documentation.

NMNH Paleobiology volunteers have been educated and trained in many aspects of general paleontology, fossil preparation, and collections work through the NMNH Paleontology Training Program and/or a specialized 11-day preparation training course. Most volunteers perform fossil preparation activities in the publicly-viewable preparation lab called the FossiLab. A group of approximately 20 FossiLab volunteers have shifted from research-driven preparation projects to assist with the fossil hall renovation. The adjustment from their former tasks to their current ones was facilitated through a series of training sessions led by staff from the NMNH Paleobiology department and Vertebrate Paleontology Preparation Laboratory. This training incorporates hands-on specimen work with demonstrations in personal safety and protective equipment, documenting processes and materials used, and ways to resolve unique specimen issues through critical thinking. Volunteers work in a temporary FossiLab facility located in an interim NMNH paleontology exhibition, providing excellent opportunities to communicate with and educate public museum visitors. Overall content of training sessions was developed using professional fossil preparator core competencies as developed in 2012 through the Society of Vertebrate Paleontology Preparators Grant, as well as input and feedback from the participating volunteers. The materials and demonstrative setups produced for this training can be useful to other institutions training volunteers for similar tasks.

Training activities have resulted in the expansion of volunteer skill sets and competencies, allowing them to assist NMNH staff in the ongoing care of paleobiology collections and the fossil hall renovation project.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

TAIL FUNCTION IN OVIRAPTOROSAUR DINOSAURS: INSIGHTS FROM A 3D TAIL MODEL OF *CITIPATI OSMOLSKAE* (THEROPODA: OVIRAPTOROSAURIA)

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The oviraptorid dinosaur *Citipati osmolskae* (Theropoda: Oviraptorosauria) is known from brooding specimens and from MPC 100/978, an excellently preserved specimen with bones that are fully prepared from its host matrix. We present a detailed photogrammetric 3D model of the tail of MPC100/978 which was reconstructed from high-detail digital photographs using the software Agisoft Photoscan Pro 1.0. On the 3D model, the range of motion of the joints was modeled in Rhinoceros 5.0 by digitally manipulating the individual bone models with respect to each other. This was done both with and without intervertebral and zygapophyseal soft tissues which were inferred from the tail joints of modern crocodiles and birds. These data allowed us to quantitatively constrain tail mobility in *Citipati* for the first time. Using the Extant Phylogenetic Bracket approach we also produced detailed 3D models of the tail muscles including several variants of the M. caudofemoralis. Additionally, we determined the passive flexural resistance (stiffness) of the intervertebral tail joints using a Newtonian physics model based on lever and beam mechanics. As the most detailed model of an oviraptorosaur tail to date, our *Citipati* model can serve as a standard for unraveling tail function within this clade. Oviraptorosaur tails are suggested to have had a high degree of tail flexibility per unit of absolute tail length, based on their craniocaudally short and laterally broad prezygapophyses as well as their craniocaudally short centra, and large muscle volumes that presumably helped to actively stiffen or move them. Oviraptorosaur tails also had relatively high stiffness in their joints that passively supported it and enabled a range of muscular force vectors to be produced. These characteristics support the capability of the tail for bird-like display behaviors which involve the movement of the distal tail frond, as in *Caudipteryx* and *Similicaudipteryx*. In the context of this existing knowledge, our new tail model provides functional and morphological tail parameters, like mobility and muscle volume, that when compared to modern bird tails with observed display behaviors

allow us to appraise the plausibility of bird-like display behaviors in *Citipati*. Our methodological framework therefore has exciting potential applications in assessing tail function within theropods (including early birds) and other dinosaurs and vertebrates.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

REVEALING THE UNSEEN: COMPUTED MICRO TOMOGRAPHY SCANNING AND 3D RECONSTRUCTION OF A LOWER CRETACEOUS (BARREMIAN) SYMMETRODONT SKULL

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We present the 3D reconstruction of a partial skull of a zhangheotheriid symmetrodont from the Yixian Formation (Jehol Group) in Northeastern China. The exact locality of the three-dimensionally preserved specimen which is housed in the Yizhou Fossil & Geology Park (Guangxi, China), is not known. The right mandible including eight teeth, the right maxilla with two teeth and fragments of the cranium are preserved and were transferred to a plastic matrix during preparation. We used x-ray computed micro tomography (µCT) and virtual image rendering software (Avizo) to study and reconstruct the partial skull in detail. The anterior tip of the mandible including the incisors and the canine are not present as well as the dorsal tip of the mandible's coronoid process. The maxilla is almost complete with only the anterior tip missing and all teeth except for two broken molars are not preserved. Using the software Polyworks, broken and dislocated elements of the mandible, maxilla and teeth were reoriented and gaps were closed. The cranium is fragmentary and only a part of the right squamosal bone could be identified with certainty.

The dental formula is I? C1 P2 M4/i? c1 p3 m5. There is no indication for developing teeth inside the mandible or maxilla and deciduous teeth were not detected. According to the almost unworn teeth, the specimen is a young adult one.

Regarding the tooth morphology and shape of the mandible, the specimen can be attributed to Zhangheotheriidae. Three synapomorphies indicate that it is closer related to *Maotherium* than to *Zhangheotherium*. These are: (1) the position of the incisura mandibulae above the alveolar margin as in *Maotherium sinense*; (2) the anterior position of the dorso-posterior end of the coronoid process relative to the dentary condyle; and (3) the deep ectoflexus of the upper molars as in *M. sinense* and *Maotherium asiaticum*. Except for one lower molar position less the new specimen closely resembles *M. sinense*.

Symposium 3 (Friday, November 7, 2014, 9:00 AM)

EFFECTS OF NON-RANDOMLY DISTRIBUTED MISSING DATA IN PARSIMONY AND BAYESIAN ANALYSES

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The use of Bayesian analyses of paleontological data matrices has increased in recent years and the potential advantages of this approach have been advocated in the literature, such as statistical properties of the estimates and its natural integration with Bayesian molecular clock estimates. Sample cases have been discussed given they resulted in disparate topological results in comparison with parsimony analyses, such as the recently discussed phylogenetic position of *Archaeopteryx* and its affinities with basal avialans. All these applications of Bayesian phylogenetic analyses of morphological data are based on the assumption that all characters evolve through a homogeneous Markov model, the Mk model that is a generalization of the simplest model used for nucleotide substitutions (Jukes-Cantor model).

Despite the adequacy of this model for treating morphological data, paleontological datasets are characterized by the presence of abundant missing data. The distribution of missing data in paleontological data matrices is non-random, and is usually concentrated on highly incompletely scored taxa and highly incompletely scored characters. Recent studies using both empirical and simulated data matrices have shown that probability-based methods (including Bayesian analysis) can be affected by the presence of abundant missing entries. However, the impact of these problems for paleontological matrices has not been thoroughly studied yet.

Here I present a study on the effect that non-randomly distributed missing entries have on a set of empirical data matrices of morphological characters and assess the impact on the type and quantity of missing data for Bayesian analysis in comparison with parsimony analysis. The sensitivity of both methods is compared in terms of the topological results obtained under different regimes of quantity and distribution of missing entries, as well as on their support measures (posterior probabilities in Bayesian analysis and bootstrap frequencies for parsimony analysis). The results of these analyses show that both methods can be highly sensitive to the presence of non-randomly distributed missing entries, in particular for the case of highly incompletely scored taxa. However, a major difference in the results of both methods is found in the obtained support measures, which indicate an overestimation of credibility measures for the position of highly incomplete taxa in Bayesian analyses.

Technical Session IX (Thursday, November 6, 2014, 2:00 PM)

GEOLOGY AND PALEOECOLOGY OF A MARINE VERTEBRATE BONEBED FROM THE LOWER MAASTRICHTIAN OF ANGOLA

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A spatially and temporally restricted horizon at Bentiaba, Angola (14.3°S) preserves a concentration of skeletons and isolated elements representing sharks, rays, bony fish, at least three species of turtles, two species of plesiosaurs, at least five species of mosasaurs, and rare volant and terrestrial vertebrates. The concentration formed on a narrow continental shelf that evolved as a passive margin along transform faults associated with the opening of the South Atlantic. The locality formed at a paleolatitude of 24°S, predicted by paleomagnetic data, a latitude that falls today along the coast of northern Namibia, an area of intense upwelling along a hyperarid coastal desert. Massive bedding with no hummocky cross-bedding indicates deposition below storm wave-base. Sediment at the locality is an immature feldspathic sand, derived from nearby exposed granitic shield rocks, based on detrital zircon ages. Temporal control is provided by magnetostratigraphy and stable carbon isotope chemostratigraphy anchored by an Ar^{40}/Ar^{39}radiometric date on basalt, constraining the age of the deposit to chron C32n.1n, between 71.4 and 71.64 Ma. $\delta^{18}O$ analysis of bivalve shells indicates a water temperature of 18°C. Nearest neighbor distance between fossils peaks at 5 m (n=192, range = 0 to 35 m, mean = 8.487, σ = 6.475), and fossils lack linear orientation as in a strand or concentration by transport agent, but instead display a scattered distribution over the sea floor. Specimens vary in completeness and degree of scavenging, but none show evidence of prolonged exposure on the sea floor. The bonebed is attritional, evidenced by rare dinosaur and pterosaur elements in an otherwise marine assemblage. Gut contents, scavenging marks, and associated shed shark teeth indicate biological association due to feeding activities among marine species. Short time duration and taxonomic stability of the fauna indicates accumulation at ecological, as opposed evolutionary time scales. Tooth form, body-size disparity, and $\delta^{13}C$ values of tooth enamel indicate a variety of foraging areas and dietary niches. Relative abundance of taxa based on shed teeth and carcasses contrasted with $\delta^{13}C$ data shows the area was a foraging ground for diverse species, including the durophagous *Globidens phosphaticus*, small piscivorous forms such as *Halisaurus* sp. and '*Platecarpus*' *ptychodon*, and abundant *Prognathodon kianda*, which fed on other mosasaurs at the locality, while other taxa such as *Mosasaurus* sp. and two elasmosaurid species were transient opportunistic feeders in the area.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

SELECTION OR GEOGRAPHIC SORTING IN THE ESTABLISHMENT OF ECOMETRIC PATTERNS: INTRASPECIFIC VARIATION AND ENVIRONMENT IN CARNIVORAN ANKLE MORPHOLOGY

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Species distributions are influenced by geographic heterogeneity in environments: organisms must have traits appropriate for local conditions in order to persist. Arboreal limb specializations, for example, function well in wooded landscapes but not in open grasslands; consequently, locomotor morphology in mammalian carnivore assemblages is geographically correlated with vegetation cover at continental scales. The mechanisms by which such trait-based sorting arises are poorly understood. In principle, correlations between trait and environment can arise by three non-exclusive processes: (1) natural selection of local populations toward a local optimum; (2) geographic sorting of species into local environments compatible with their traits; (3) geographically selective extinction in environments that become incompatible with traits. The first process produces trait changes after exposure to a local environment, and it is therefore expected to generate intraspecific variation in the functional traits of species that are distributed across more than one environment. The other two processes sort species only into compatible environments and thus do not promote intraspecific trait heterogeneity.

We studied intraspecific variation in the locomotor morphology of the carnivoran calcaneum to determine whether local selection is likely to be a factor in species sorting. We collected data from five widespread modern species: *Canis latrans* (n = 117), *Urocyon cinereoargenteus* (n = 134), *Lynx rufus* (n = 46), *Mustela frenata* (n = 60), and *Procyon lotor* (n = 141). Intraspecific variation was compared to average ankle morphology in carnivoran assemblages across North America. The total variation within these species was, on average, about half as much as the variation among species (SD = 0.04 and 0.07 respectively). Ankle morphology differed regionally in *L. rufus* (p = 0.01) and marginally so in *P. lotor* (p =0.09) and *U. cinereoargenteus* (p = 0.08), but not in *C. latrans* (p = 0.96) or *M. frenata* (p = 0.53). In no species was there a significant correlation between intraspecific variation and variation in the average morphology in the assemblage. These data suggest, therefore, that ecometric sorting is a process that does not involve selection in local populations within species, but rather sorting of species as wholes. These results are consistent with previous data which suggested that geographic reorganization of species in the Quaternary has happened at a more rapid pace than evolutionary change in their morphology.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

TRACKING DINOSAURS ON THE ISLE OF WIGHT

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Dinosaur footprints have been reported from the Lower Cretaceous rocks of the Wessex Sub-basin of the Isle of Wight, England for over 150 years. In the past, documentation of both tracks and sites has been sporadic, and as a consequence the context of these ichnofossils is poorly understood. However, recent research has set out to record tracks and trackways using both traditional techniques and new methodologies including photogrammetry, which allow the accurate and permanent recording of tracks, trackways and sites as 3D data - ichnites that might otherwise be lost due to natural processes such as weathering, erosion, the action of the dynamic marine environment they are found in or human activity. Here we present a review of the dinosaurian ichnological resources of the Isle of Wight including the sites and ichnotaxa that can be found within the formations of the Wessex Sub-basin.

This research draws on data collected over several years from the Wealden outcrops at Compton and Brighstone Bays on the south-east coast of the island and at Yaverland on the west coast, and includes tracks from both the Wessex and Vectis Formations.

Tracks are found as both natural footcasts and concave epireliefs and range in size from very large (>60 cm) to small (~10 cm). Trackways are rarer but have been recorded at Hanover Point and Chilton Chine and analysis of these tracksites is presented here.

We also present the first report of the presence of the ornithopod ichnogenera *Caririchnium* and *Amblydactylus* in the English Wealden as well as the thyreophoran ichnogenus *Tetrapodosaurus*. Theropod and sauropod tracks are also reported but as yet remain unassigned, although the authors predict more ichnotaxa will be assigned in the future.

Comparison with other Lower Cretaceous ichnoassemblages is now possible, and early analysis shows differences in ichnotaxa from other Lower Cretaceous facies such as the Middle Purbeck Beds of Dorset, that are dominated by *Iguanodontipus* sp. These results have advanced our understanding of the unique dinosaurian ichnoassemblage of the Wessex Sub-basin and confirm the diversity of the dinosaurian fauna of Lower Cretaceous southern England.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

A NEW PHYLOGENY OF IGUANODONTIAN DINOSAURS

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The phylogeny of non-hadrosaurid iguanodontian dinosaurs is currently poorly resolved. This study seeks to find a well-supported phylogenetic tree for the group by adding more characters to those used in previous analyses, and by increasing outgroup coverage to the base of Ornithopoda. A matrix was compiled with 299 characters for 51 genera. Of these, 189 were culled from the literature, and 110 are novel characters. Before the addition of these new characters, the postcrania accounted for 45% of characters in the matrix. This meant that determining the phylogenetic placement of taxa known only from partial postcrania, such as *Cedrorestes*, *Planicoxa*, *Valdosaurus*, *Trinisaura*, *Iguanacolossus* and *Macrogryphosaurus* was difficult. As such, a majority of the new characters added represent the postcranial skeleton, bringing the portion of these characters up to 52%. Outgroup taxa in this analysis included 11 genera of basal ornithopods, and the tree was rooted on *Eocursor*.

A parsimony analysis was conducted in TNT using a new technology search of 10 000 random addition sequences with sectorial search, ratchet, drift, and tree fusing. This produced 49 most parsimonious trees. A strict consensus tree was calculated, which contained a large polytomy. Pruned consensus was used to determine which taxa acted as wild cards, and *Cedrorestes* and *Kangnasaurus* were removed from the consensus. Bremer support (BS) and bootstrap values were both calculated. While the bootstrap values for most nodes are low, Bremer supports indicate moderate to strong support for many nodes.

Several interesting features are found in this topology. *Tenontosaurus* is the most basal member of Rhabdodontidae (BS=3). There is also a monophyletic Dryosauridae, which includes *Dryosaurus*, *Dysalotosaurus*, *Trinisaura*, *Valdosaurus*, *Anabisetia, Macrogryphosaurus*, and *Planicoxa*. While the node containing *Dryosaurus* and *Dysalotosaurus* is well supported (BS=8), other nodes in this group have Bremer supports of one or two. While this support is low, the presence of *Trinisaura, Macrogryphosaurus*, and *Anabisetia* in this group indicates that dryosaurids may have survived until the Late Cretaceous in Gondwana. *Iguanacolossus* and *Equijubus* are found as sister taxa (BS=3), as are *Iguanodon* and *Mantellisaurus* (BS=3). The most basal hadrosauroids form a polytomy consisting of *Jinzhousaurus*, *Bolong*, *Altirhinus*, and a clade containing *Ouranosaurus* and *Hypselospinus* (BS=4). This project was supported by the Cosmos Club Foundation and by NSF grant EAR 0922187.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A REVISION OF THE LATE MESOZOIC CHIMAEROID GENUS *ELASMODECTES* (HOLOCEPHALI, CHIMAEROIDEI)

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Chimaeroid fishes of the genus *Elasmodectes* represent one of the more easily recognizable 'edaphodontids' from the Jurassic and Cretaceous. The genus is represented in the fossil record mainly by isolated small-sized dental plates bearing a number of 'archipelagic' tritors, which formed a thin cutting dentition. Isolated dorsal fin spines with a specific morphology (gracile and straight spine with costate antero-lateral walls), several naturally associated dentitions as well as more than a dozen of holomorphic specimens (Late Jurassic of Germany, Late Cretaceous of England) are also preserved.

A global revision of all nominal species and referred material of *Elasmodectes*, in both institutional and private collections (2007-2013) shows that the genus comprised between 5 and 7 species ranging from the Middle Jurassic (Aalenian) to Late Cretaceous (Maastrichtian): (1) *Elasmodectes* sp. (Aalenian of southwestern Germany); (2) *E. falcatus* (Bathonian of England); (3) *E. avitus* (Kimmeridgian and Tithonian of S.W. and S. Germany); (4) *E. secans* (Kimmeridgian of England and northwestern France; could be a junior synonym for *E. avitus*); (5) *E. kiprijanoffi* (Late Albian and Cenomanian of European Russia; Middle Albian of England; also found in the Cenomanian of Western Australia); (6) *E. willetti* (Cenomanian of England and Morocco); (7) '*Chimaera zangerli*' (Maastrichtian of Seymour Island, Antarctica).

As a result of this revision, *Elasmodectes* has been recorded for the first time from the Aalenian of southwestern Germany and the Antarctic chimaeroid ('*Chimaera zangerli*') was re-interpreted as terminal *Elasmodectes* species. The genus show low rates of evolution, stable morphology of the cutting dentition and ecology (? related to scavenging) during ca. 100 Ma *Elasmodectes* has evolved during Jurassic in Europe but reached a global distribution in the mid-Cretaceous (Europe, Australia). After the Cenomanian the genus was probably restricted to the Southern Hemisphere (Antarctica). Based on holomorphic specimens, *Elasmodectes* is interpreted as a small-sized chimaeroid with a maximum body length less then 50 cm and showing a couple of external characters unique for chimaeroids: large, bulky head with a short, centrally placed snout showing highly concentrated lateral line units; having specific dorsal fin spine, low second dorsal fin and a diphycercal tail. It represents a separate clade of chimaeroid fishes, distinct from the other 'edaphodontids'. This study was funded by RFBR grants 10-05- 00926 and 14-05-00828.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

HIGH SAUROPOD DIVERSITY IN THE EARLY LATE CRETACEOUS OF NORTHEAST AUSTRALIA IMPLIED BY A NEW SPECIES OF SAUROPOD FROM THE WINTON FORMATION (UPPERMOST ALBIAN-LOWER TURONIAN)

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Australian Cretaceous sauropods have become increasingly well-understood as a result of the recent redescription of the basal somphospondylan *Wintonotitan wattsi* and the lithostrotian titanosaur *Diamantinasaurus matildae*. A new sauropod, nicknamed 'Wade', has helped shed further light on the diversity of this clade in eastern Gondwana.

The preserved axial elements of 'Wade' are an incomplete cervical vertebra with ribs, eight dorsal vertebrae, dorsal ribs, an incomplete sacrum, and four caudal vertebrae. The cervical vertebra bears a mid-line keel on its ventral surface. However, the dorsal vertebrae lack the ventral keel set within a fossa observed in the dorsal vertebrae of *Diamantinasaurus*. All preserved dorsal centra are opisthocoelous, as in Macronaria. The neural spines are angled at 45° to the long axis of the centrum in the anterior-most vertebrae; this angle increases to nearly 90° in the posterior-most. The incomplete sacrum, comprising four vertebrae with sacral acetabular processes, exceeds 1 m in mediolateral width. The caudal vertebrae are amphiplatyan/amphicoelous, and the anterior-most possess shallow lateral pneumatic fossae, unlike those of *Wintonotitan*.

The preserved appendicular elements of 'Wade' are the left coracoid, both sternal plates, both incomplete humeri, the left radius, seven metacarpals with at least two phalanges, both pubes and ischia, and the left astragalus. The coracoid is robust, unlike that of *Diamantinasaurus*. The dorsoventrally thin but mediolaterally broad sternal plates lack the reniform shape seen in those of derived titanosaurs. The humerus is massive (mid-shaft circumference 580 mm, preserved length 1033 mm), with the deltopectoral crest not reaching the mid-length. The distal end of the radius was beveled relative to the long axis of the shaft, as in Titanosauriformes. The maximum length of metacarpal III, the longest in the manus, is 49% that of the radius, as in Macronaria. The pubes and ischia are fused, forming a huge sheet-like structure over 1 m wide mediolaterally. The posterolateral process of the ischium is less-developed than in *Wintonotitan*. The astragalus is taller proximodistally than either long anteroposteriorly or wide mediolaterally, differing markedly from that of *Diamantinasaurus*.

'Wade' indicates the presence of a third sauropod taxon in the Upper Cretaceous Winton Formation of northeast Australia. The co-existence of these sauropods could have been facilitated by dietary or environmental segregation. Additional material will be required to test this hypothesis.

Technical Session XVI (Saturday, November 8, 2014, 12:00 PM)

MANDIBULAR MECHANICS AND FEEDING ACROSS THE WATER-LAND TRANSITION: FINITE ELEMENT ANALYSIS OF THE EARLY TETRAPOD LOWER JAW

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The invasion of the land by vertebrates is a key moment in the history of life and necessitated dramatic skeletal evolution. Gradual changes in lower jaw morphology across the fish–tetrapod transition were initially ascribed to a stronger lower jaw and increased bite force, shifts in feeding strategy (suction vs. biting), or different constraints imposed by contrasting environments (aquatic vs. terrestrial). However, more recent work has suggested a disjunction between morphology and function in the lower jaws of early tetrapods. This study, which incorporates early tetrapod taxa from the Late Devonian to Early Triassic, investigates the mechanical behaviour of the lower jaw under feeding loads. CT scans were segmented to remove matrix, separate individual bones, sutures, and teeth, and retrodeformed to produce 3D finite element models of the lower jaws of *Eusthenopteron, Acanthostega, Greererpeton, Crassigyrinus, Megalocephalus,* and *Lydekkerina*. Models were scaled appropriately and simplified loads and constraints applied. Stress patterns and deformation regimes were compared to finite element models of the lower jaws of extant fish, including pike (*Esox*) and eel (*Anguilla*), and to *Alligator*. Deformation of the lower jaw (including eversion of the working-side tooth row and dorsal bending of the balancing-side jaw ramus) and the distribution of tensile and compressive stresses were similar across most taxa. However, higher stress occurred in the balancing-side ramus of more derived tetrapods, such as *Lydekkerina*, and in *Alligator*; in contrast, the working-side ramus of fish mandibles exhibited much higher stresses than the balancing-side ramus. These differences may reflect more efficient transfer of balancing-side muscle forces across the midline due to increasingly complex symphyseal morphology in later tetrapods compared to more basal forms, such as *Eusthenopteron*. Alternatively, lower stresses in the working-side ramus of later tetrapods may support the suggestion that morphological changes across the fish-tetrapod transition produced a stronger lower jaw better adapted for biting.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A NEW JEHOL MICRORAPTORINE WITH IMPLICATIONS FOR SECONDARY FEATHER LOSS IN *SINORNITHOSAURUS*

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Fossils from the Jehol Group (Early Cretaceous, Liaoning Province, China) have greatly contributed to our understanding of the morphology and diversity of Paraves (dromaeosaurs, troodontids, and avialians). However, many taxa are represented by only a few specimens of uncertain ontogenetic age. Without a thorough understanding of ontogeny, both evolutionary relationships and polarity of character states may be obscured. A specimen (Dalian Natural History Museum, D2933) of a new microraptorine dromaeosaur from the Jiufotang Formation (upper Jehol Group) possesses several autapomorphies, including more than 29 tail vertebrae, inclined pneumatic foramina on the dorsal vertebrae, and an unusually large coracoid fenestra. These, along with other features, demonstrate that it is a new taxon. Phylogenetic analysis shows D2933 to be sister to the larger microraptorine *Sinornithosaurus*. However, D2933 also shows many osteological markers of immaturity identified in other archosaurs. Skull elements, all visible neurocentral sutures, and proximal tarsals remain unfused. The porous surface texture of the cortical bone and poor ossification of long bone articular surfaces further supports an immature status. Histologic samples of the tibia, fibula, and humerus confirm that it was about one year old and still growing at death, but that growth had slowed. The presence of filamentous feathers, pennaceous feathers extending from the fore- and hind limbs, and two long plumes extending more than 12 cm beyond the caudal series indicates that growth of a variety of feather types preceded skeletal maturity and adult size. Histological analysis performed on *Sinornithosaurus haoiana* shows that it was relatively more mature than D2933, which agrees with its larger size and gross osteological maturity. Yet, *Sinornithosaurus* specimens show only branching filamentous feathers, which are thought to be a more basal feather state. Phylogenetic and ontogenetic constraints suggest that this simplified condition is a secondary loss of feathers, either as a feature of the genus, or as part of an ontogenetic loss of 'advanced' feather types in adults.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

PROBOSCIDEAN EXTINCTION CHRONOLOGY IN THE LATE QUATERNARY OF SOUTH AMERICA

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The megafauna extinction in South American was one of the most profound events, with the loss of 50 genera (~83%). Three orders disappeared (Notoungulata, Proboscidea, Litopterna), as did all large xenarthrans, but how this fits into global extinction is uncertain, mainly due to the lack of chronological resolution. In recent years there has been an increase in the number of radiocarbon datings at archaeological and paleontological sites, but this information varies greatly from area to area in South America, and few data can be considered to constitute a taxon date. The timing of gomphothere extinction is poorly established. Most dates only appears in biostratigraphic context and many reported ^{14}C dates do not meet the rigorous criteria for accepting dates. We evaluate the published radiocarbon dates and new radiocarbon dates in order to establish a more accurate 'extinction window' for the key taxa. These new dates are sufficiently robust to assess correspondences among last appearance records of megafauna, first appearance records of humans, and the Younger Dryas to Holocene climatic transition in South America. The dates suggest that gomphotheres become extinct in the Late Pleistocene, but the timing of extinction differed in each region. Several dates indicated that in many regions of South America, especially the Pampean region of Argentina and Uruguay, gomphotheres were already gone when the first humans arrived. Although gomphothere remains are present at Monte Verde (Chile) and other sites, they do not appear to have been important for human subsistence. Gomphotheres apparently survived until the end of the Pleistocene, but certainly those survivors were unique relict populations. Gomphothere extinction is driven more by climate and ecosystem changes than through human interactions.

Technical Session II (Wednesday, November 5, 2014, 8:15 AM)

RECENT VERTEBRATE FOSSIL DISCOVERIES FROM THE JURASSIC KOTA FORMATION OF INDIA

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In India, continental Jurassic strata are primarily known by the Kota Formation of Pranhita-Godavari valley. The Kota Formation is a sandstone, clay, mudstone, and siltstone sequence intercalated with two limestone horizons and is considered to be Early/Middle Jurassic in age. The limestone horizons of the Kota Formation have yielded semionotid, pholidophorid, and coelacanthid fish and stromatolites, whereas two near complete skeletons of sauropod dinosaurs were recovered from the clays underlying the limestone horizons. These clays have also yielded a symmetrodont mammal, ostracods, and charophytes. On the other hand, the mudstones and siltstones occurring intercalated with the limestone horizons produced a diversified microvertebrate fauna represented by freshwater sharks, an indeterminate anuran, two sphenodontian, one acrodont iguanian lizard, and five mammalian taxa. More recently, an eobaatarid multituberculate, the first from the Indian Mesozoic, was reported from the Kota Formation. Here we report additional microvertebrate fossils recovered from the Kota Formation by bulk screen-washing of the siltstones intercalated with the limestone bands of the Kota Formation. The new fauna includes several crocodilian, pterosaur, ornithischian, theropod dinosaur teeth, and six mammalian teeth. Preliminary identification indicates the presence of Atoposauridae crocodiles, two morphotypes of pterosaur teeth, three theropod dinosaur morphotypes resembling *Richardoestesia*-like, dromaeosaurid-like, and Velociraptorinae-like teeth, and ankylosaurid, scutellosaurid, and heterodontosaurid teeth which represent the only record of ornithischian dinosaurs from the Mesozoic rocks of India. Of the six new Kota mammalian teeth, two belong to the haramiyid family Theroteinidae and four represent peramurans. The haramiyid is being reported for the first time from the Kota Formation and the peramuran is likely the oldest record of this group from the former Gondwanaland. The present work demonstrated that the Jurassic vertebrate fauna of India is as diverse as contemporary faunas from Europe and Asia and included almost all the Jurassic mammalian groups present elsewhere.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

PLIOCENE MUSTELOID DIVERSITY AND PALEOECOLOGY AT HAGERMAN FOSSIL BEDS NATIONAL MONUMENT

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Since its discovery in 1928, the Hagerman Fossil Beds (Hagerman Fossil Beds National Monument, HAFO) have produced a rich and abundant Pliocene (4.2–3.4 Ma) carnivoran guild comprised of canids, felids, ursids, mephitids, and mustelids. In the HAFO collections (stored on site, National Park Service), mustelids dominate in terms of abundance and species richness. Seven mustelid species (six genera) were previously described from these deposits, but approximately 50% of the HAFO specimens can be ascribed to either the galicitine/gulonine, *Trigonictis* (*T. cooki* or *T. macrodon*)or the lutrine, *Satherium piscinarium*. Here, results from ongoing analysis of HAFO's musteloids, including previously identified and newly collected specimens, are presented. New data includes the first Blancan fisher, *Pekania* c.f. *P. pennanti,* and a large procyonid. The HAFO musteloid guild is ecologically diverse but with strong arboreal and semi-aquatic affinities. Taxa represent potential ancestors of species known today from tropical and coniferous forests and suggest a mixed lacustrine/riverine habitat with dense stands of trees. These specimens were collected from sites distributed across the monument's 4,351 acres allowing for landscape-scale analysis of changes in the spatio-temporal distribution, composition, and abundance of musteloids and of HAFO's changing landscapes during the Pliocene.

Symposium 2 (Thursday, November 6, 2014, 2:45 PM)

BIOMECHANICAL REASONS FOR DEVELOPING THE CHARACTERISTIC SHAPES OF RIBS AND RIBCAGES IN CURSORIAL MAMMALS

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The construction of the trunk wall is similar in all, even the oldest, tetrapods, and different from primarily aquatic vertebrates. This suggests the existence of powerful biomechanical constraints on morphological variability during evolution. Our basic hypothesis is that any morphological trait is determined by the biomechanical conditions. Here, the mode of biomechanical stress on the trunk is investigated in living hooved cursorials; the results can be and are applied to fossil forms.

The forces which act on an animal´s body reach their greatest values during locomotion and must be sustained to avoid fatal breakdowns. Footfall sequences, trackways, and accelerations show that supporting and accelerating the body upward is commonly performed by diagonal limbs. The muscle activities necessary during locomotion for sustaining the tensile stresses due to bending and torsion have been documented by electromyography. The anterior extremity is attached by muscles to the rib cage; therefore, the construction of the shoulder must be taken into consideration.

Anterior ribs I–VI are exposed to the compressive forces caused by torsion and the reaction forces of the serratus anterior and pectoralis profundus, by which the heavy torso is hung up at the supporting forelimbs. The nearly vertical direction and flat curvature of these ribs places the bones in line with compressive forces. In the transverse plane, compressive forces flow along the ribs to the vertebral column, where the eccentric attachment requires a bending resistant connection to the vertebrae, and an appropriate profile of the corpus costae. While the dorsal parts of ribs I–VI are under strong compressive and bending stress, their middle and ventral parts are exposed to longitudinal 'normal' forces parallel to the body wall, and less bending in the transverse plane. The more posterior ribs are outside the circle of forces which connect forelimbs and trunk. The reduced compressive forces along the ribs allows them to be more slender than the more cranial ribs, and to assume a more inclined direction and a curvature, which fits to the compressive forces derived from torsion. The cartilaginous parts of the ribs merge in the cranial direction and establish contact with the sternum. The 'rib angle' is mechanically characterized by the force flow in a plate, representing sternum and cartilaginous ribs, and supported by the series of bony ribs against the pull of the rectus abdominis. While the numbers of ribs vary, their morphometrical uniformity is in accordance with the mechanical stresses.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

TRACKING AUSTRALIAN PLEISTOCENE MEGAFAUNAL EXTINCTIONS THROUGH THE TROPICS

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The extinction of numerous large-bodied terrestrial vertebrates, or 'megafauna', during the Quaternary marked a major turning point in the evolution and emergence of modern ecosystems. In Australia, it is commonly argued that the majority of megafauna suffered extinction sometime around 40–50 ka, roughly coinciding in time with the earliest human inhabitants of the continent, and thus suggesting a causal link with the losses. However, a closer reading of the available geochronological datasets for the extinct forms shows that only ca. 15% of Pleistocene megafauna actually date younger than ca. 50 ka. Moreover, the vast majority of taxa cannot be placed within 10's to 100's of thousands of years prior to 50 ka. Many species lack firm dates of any kind, thus it is difficult, if not impossible, to determine the cause of their losses, and thus, test leading extinction hypotheses that require temporal coalescence between the last megafauna and earliest human inhabitants and/or climate change events. The problem is further

compounded by significant spatial bias, with the majority of dated megafaunal records restricted to southern Australia. Almost nothing is known about Pleistocene megafauna from the northern portion of the continent, especially in the tropics, the landing point of the first humans in Australia. Recent excavations in the tropical northeastern part of the continent have targeted the recovery of new fossil material with firm stratigraphic and taphonomic control. Several new megafaunal-bearing fossil deposits have been revealed, some of which are incredibly diverse and document a suite of both extinct and extant species. Numerous significant Pleistocene geographic range extensions have been identified for some megafauna, such as giant sthenurine (short-faced) kangaroos. The new records, some 1200 km further north than their previously known distribution, are not only significantly reshaping what we know about the spatial occurrence of Pleistocene megafauna, but more importantly highlight how poorly explored and sampled the tropics of Australia actually are. A rigorous U-series and optically stimulated luminescence dating program of the new fossil records have also revealed temporal range extensions for some forms, but have not yet provided evidence to suggest a concentrated extinction event of megafauna at 40–50 ka in the tropics, nor at any one time in the Pleistocene more broadly.

Technical Session XIV (Saturday, November 8, 2014, 9:45 AM)

A NEW HADROSAURID FROM APPALACHIA AND THE EVOLUTION OF THE FACIAL SKELETON IN DUCK-BILLED DINOSAURS

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During the Late Cretaceous, the Western Interior Seaway divided North America in two main landmasses: Laramidia to the west and Appalachia to the east. The fossil record for Laramidian hadrosauroid dinosaurs is remarkably rich, with no less than 30 recognized species. The record for Appalachia is much more sparse. Just three fragmentary monospecific genera are known: *Hadrosaurus* (Campanian of New Jersey), *Claosaurus* (late Coniacian of Kansas) and *Lophorhothon* (early Campanian of central Alabama). Here, we present a new genus and species of hadrosauroid from Appalachia that was collected from uppermost Santonian strata of the Mooreville Chalk in central Alabama. The only recovered specimen, MSC 7949, includes a nearly complete disarticulated skull. It is the most complete and best preserved Appalachian hadrosauroid, preserving diagnostic elements never before found in the other taxa from the region, and represents the first pre-Campanian non-lambeosaurine hadrosaurid known. The new taxon is characterized by a mosaic of plesiomorphic and derived characters in the context of Hadrosauroidea. Characters shared with basal hadrosauroids include a maxilla with short and sloping ectopterygoid shelf, caudally prominent jugal process, no more than one functional tooth per alveolus on the maxillary occlusal plane, jugal rostral process with shallow caudodorsal margin and medioventrally facing articular facet, a vertical dentary coronoid process with a poorly expanded apex, and tooth crowns with accessory ridges. Derived characters shared with members of Hadrosauridae include a circumnarial depression compartmentalized into three fossae (as in brachylophosaurins and *Edmontosaurus*), a thin everted premaxillary oral margin (as in *Gryposaurus*, *Prosaurolophus*, and *Saurolophus*), and a maxilla with a deep and rostrocaudally extensive rostrodorsal region with a steeply sloping premaxillary margin (as in *Gryposaurus*). This taxon differs from *Lophorhothon* in having a slender and crestless nasal whose caudodorsal margin is not invaded by the circumnarial depression. Maximum parsimony analysis places MSC 7949 within Hadrosauridae, as the sister taxon to Saurolophidae. The new taxon documents the acquisition of a derived circumnarial structure as early as the late Santonian. Notably this occurs prior to the evolution of the fully derived feeding apparatus that characterizes saurolophid hadrosaurids and before the split between the hollow-crested lambeosaurines and the solid-crested and unadorned saurolophines.

Technical Sesssion XII (Friday, November 7, 2014, 3:45 PM)

THE CRANIAL MORPHOLOGY OF DREPANOSAURS AND THE PERMO-TRIASSIC DIVERSIFICATION OF DIAPSID REPTILES

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Drepanosaurs are an enigmatic clade of Late Triassic diapsids from Europe and North America with superficially chameleon-like bauplans. The phylogenetic position of the group among diapsids is contentious. Most hypotheses suggest that drepanosaurs are basal archosauromorphs closely related to 'protorosaurs' (e.g., *Protorosaurus*, *Tanystropheus*). Other phylogenies place drepanosaurs as non-saurian diapsids, suggesting a substantially older origin for the lineage. Clarifying the phylogenetic position of drepanosaurs is important to understanding the degree of taxonomic diversification among diapsids prior to the Permo-Triassic Extinction (PTE).

The poor quality of the drepanosaur fossil record has hampered an understanding of their position. Nearly all drepanosaur skeletal material is badly distorted, and all described skulls are crushed such that phylogenetically important characters are obscured. A new drepanosaur specimen from the Late Triassic *Coelophysis* Quarry of New Mexico includes a partial, three-dimensionally preserved skull. The postorbital region of the skull, atlas-axis complex, and anterior cervical vertebrae are preserved in near-articulation. 3D reconstruction of micro computed tomography (CT) data allows the first detailed description of most drepanosaur skull bones. Many are surprisingly plesiomorphic (e.g., squamosal with massive descending process, quadrate lacking posterior concavity, occipital condyle with notochordal pit), sharing more in common with non-saurian diapsids than early archosauromorphs.

A phylogenetic analysis of 300 characters and 40 early diapsids supports the hypothesis that drepanosaurs fall outside of Sauria. This suggests a very long ghost lineage (~35 million years), extending well into the Late Permian. The results of this phylogeny suggest that both drepanosaurs and a number of early saurian lineages must have originated by the Late Permian. Although the fossil record suggests an enormous morphological diversification among saurians following the PTE, a great deal of taxonomic diversification among diapsids must also have occurred prior to the extinction.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

NOVEL INSIGHTS INTO EARLY NEUROANATOMICAL AND MORPHOLOGICAL EVOLUTION IN PENGUINS FROM NEW MATERIAL OF *WAIMANU* FROM THE PALEOCENE OF NEW ZEALAND

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The repeated evolution of wing-propelled diving in aquatic birds has served as a comparative system for examining both musculoskeletal and neuroanatomical change associated with the evolution of novel locomotor strategies. These aspects have been well studied in both extant and extinct species of penguins, owing partially to a robust fossil record. Described in 2006 from the Waipara Greensand, the Paleocene New Zealand taxon *Waimanu* represents the most basally divergent known lineage of penguins. As such, it is vital to investigating morphological and neuroanatomical evolution following the evolution of wing-propelled diving in penguins. We report on a specimen representing a new species of *Waimanu* from Waipara, consisting of a complete skull, mandibles, vertebrae, scapula, coracoid, tarsometatarsus, and partial pelvis. In addition, we report on three additional well-preserved partial skeletons referable to *Waimanu tuatahi* that provide a nearly complete representation of the osteology of one of the earliest known penguins.

Compared to named taxa of *Waimanu*, the new form is distinct in size and possesses shallower temporal fossae, a straight caudal margin of the quadrate otic process, a less ovoid scapular glenoid process, and a relatively more elongate tarsometatarsus. To examine the neuroanatomy of this taxon in comparison to previously described endocasts of penguins and other aquatic birds we reconstructed its cranial endocast. Some neuroanatomical features of *Waimanu* are shared with extant penguins and the previously described stem penguin *Paraptenodytes*, such as a laterally expanded telencephalon resulting in a 'heart-shaped' cerebrum, a lack of conspicuous cerebellar fissures, and the presence of prominent, posterolaterally directed floccular lobes that are separated from the cerebrum. However, several differences are also apparent, such as a less dorsally prominent wulst. Together, these new specimens paint a more detailed picture of late Paleocene penguin diversity and morphology close to the loss of flight in the penguin lineage. In addition, these data, when evaluated in a comparative context, have implications for the relative timing of neuroanatomical and musculoskeletal shifts in the evolution of wing propelled diving.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

MEDULLARY BONE IN THE MANDIBULAR SYMPHYSES OF A PTEROSAUR INDICATES A NON-REPRODUCTIVE ROLE

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Medullary bone is a special bone tissue forming on the endosteal surface of the medullary cavity in the bones of female birds prior to and during egg-laying to serve as a calcium reservoir for building the hard eggshell. Apart from birds, medullary bone was so far unambiguously identified only in some non-avian dinosaurs. Based on its physiological function in birds, the presence of medullary bone is considered a reliable indicator of a sexually mature female, and as such it is also used as an additional basis for the life history reconstructions of extinct animals. Here, we reveal the presence of a special bone tissue in the medullary cavities of the mandibular symphyses of the Late Cretaceous azhdarchid pterosaur, *Bakonydraco galaczi*, from Hungary. Apart from its unusual anatomical location, this bone tissue shows all microanatomical and histological characteristics of medullary bone as identified in other extinct taxa, and hence is referred to as medullary bone. This bone tissue was found in four out of seven sectioned mandibular symphyses. Surprisingly, the apparently fastest growing, smallest specimens, defined as juveniles, also possess medullary bone. Furthermore, medullary bone occurrence seems to correlate with neither the ontogenetic stage nor the size of the specimens. Our findings and the extremely thin-shelled eggs of pterosaurs suggest that, unlike in dinosaurs (including birds), the medullary bone tissue probably had a non-reproductive role in this pterosaur. The presumed non-reproductive significance and the anatomical location of medullary bone in *Bakonydraco* favor the evolutionary scenario of an independent appearance of this special bone tissue in dinosaurs and pterosaurs. Our results urge further investigations on the evolutionary origin, distribution, and possible functions of medullary bone-like tissues.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

GARBAGE IN, GARBAGE OUT, THE EFFECT OF IMMATURE AND OUTDATED TAXONOMY ON DATABASE COMPILATIONS OF NORTH AMERICAN MIOCENE LAND MAMMALS

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Large databases of paleontological data are widely used now, but the analyses of these data are only as good as the quality of the original data themselves. In many cases, these databases are grossly outdated, not only because of recent taxonomic revisions that eliminate oversplit taxa from the last century, but especially (in the case of Cenozoic North American mammals) because the taxonomy is not yet mature; there are many new genera and species in collections that have not yet been described. Checking the Paleobiology Database (PBDB) against the current taxonomy of the Palaeomerycidae, Moschidae, Rhinocerotidae, Tayassuidae, Brontotheriidae, and Merycoidodontidae shows that there are huge errors not only in invalid names and incorrect temporal and geographic ranges, but in many missing new taxa as well, even though the revised taxonomy of most of these families was published in 2005-2008 or earlier. The same problems plague major groups like the Camelidae, Antilocapridae, and Proboscidea, but

those taxonomic revisions are only just beginning. In short, the taxonomic and geographic data in the PBDB and older databases for most of the Miocene large land mammals of North America is so poor that any analysis of such data is premature at best. The only reliable way to use the PBDB is to already know the systematic details of any group that is the focus of a study. We should be cautious about accepting large datasets without some firsthand checking of the quality of the data.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE LAST RECORD OF GONIOPHOLIDIDAE: BIODIVERSITY AND PHYLOGENY OF THE ALBIAN CROCODYLOMORPHS OF TERUEL (SPAIN)

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Goniopholididae is a clade of crocodylomorphs known from the Late Jurassic and Early Cretaceous of Laurasia. Members of this clade are very abundant in the fossil record and their phylogenetic position as advanced neosuchians makes them very important to the study of crocodylomorph evolution and the origin of Eusuchia. However, since the description of the type genus *Goniopholis*, this genus has been used as a 'catch-all' taxon for a variety of species based on fragmentary or not phylogenetically tested material. In the last years a great review of the clade Goniopholididae has been carried out by several authors showing a more complex scenario than previously thought.

This study investigates the biodiversity and phylogenetic position of three specimens of Goniopholididae recovered in the lower Albian of two coal mines next to the localities of Arino and Andorra (Teruel, Spain). To assess their phylogenetic relationships within Goniopholididae, the type material of *Anteophthalmosuchus escuchae* and *Hulkepholis plotos*, and a new specimen of *Anteophthalmosuchus* cf. *A. escuchae* from Andorra have been included in a matrix consisting of 487 characters and 107 taxa with *Gracilisuchus* used as the outgroup taxon.

Our results indicate that the goniopholidid *Anteophthalmosuchus* cf. *A. escuchae* is closely related to *Anteophthalmosuchus escuchae* and may be the same species. Together they are the sister taxa of the clade formed by *Anteophthalmosuchus hooleyi* from the Valanginian of England and Dollo's unnamed goniopholidid from the Barremian-Aptian of Belgium. The clade form by *Anteophthalmosuchus* and Dollo's goniopholidid forms a polytomy with *Hulkepholis plotos* and *Hulkepholis willetti*, the latter from the Valanginian of England. All of them form the sister clade of the genus *Goniopholis*.

Our phylogenetic analysis shows that Goniopholididae is formed by a variety of basal taxa from Asia and North America, and two derived European clades. The first European clade includes three valid species of *Goniopholis* from the Late Jurassic-Early Cretaceous of England, Germany and Portugal; whereas the second clade is composed of the taxa *Anteophthalmosuchus* and *Hulkepholis* from the Early to middle Cretaceous of England, Belgium and Spain. The taxa from Teruel belong to the latter clade, being the last reliable record of Goniopholididae, which shows a higher diversity than previously thought.

Symposium 3 (Friday, November 7, 2014, 9:30 AM)

ORIGIN OF MAMMALS: MOLECULAR VERSUS MORPHOLOGICAL CLOCKS

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The origin of mammals has received a huge amount of attention in recent years, and has been the source of much debate. A particular controversy is that the vast majority of molecular-dated phylogenies place the origin of placentals within the Cretaceous, but no certifiable crown placental fossils are known until the Cenozoic. One way to investigate this issue is to perform a morphological-clock analysis that allows for the dating of nodes with the direct incorporation of fossils by using fossils as tip dates in phylogenies. These methods can then be directly compared to dates of placentals nodes from a traditional molecular-clock analysis of extant mammals and so elucidate how the incorporation of fossil data impact our understanding of the evolution of a major group of extant animals. Using a recently-published extensive morphological matrix of extinct and extant mammals allows for a direct comparison of ages of the origin of major clades of placental mammals to the largest molecular study of mammalian origins. Whilst a molecular date for the origin of placentals is around 90 Ma, the use of the morphological clock alone based on tip-dating pushes these results back further into the Mesozoic. These results have important implications for both how we understand the timing of mammalian evolution, and for how we employ the morphological clock.

Technical Session XVI (Saturday, November 8, 2014, 10:30 AM)

HISTOLOGY OF A PRIMITIVE OSTEICHTHYAN (*PSAROLEPIS ROMERI*) SHEDS LIGHT ON THE ORIGIN OF MONOTYPIC ENAMEL ON VERTEBRATE TEETH

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The great majority of extant vertebrates belong to the gnathostomes or jawed vertebrates, a group characterized by the presence of teeth. A typical tooth as seen in most extant tetrapods consists largely of dentine, covered with an enamel layer on the surface and with attachment bone at the base. Fossil data suggests that this type of tooth was already present in some of the earliest sarcopterygian fish such as *Onychodus* and *Youngolepis*, which also have monotypic enamel on dentine. By contrast, the stem osteichthyans *Lophosteus* and *Andreolepis* lack a hypermineralized covering on their teeth, a primitive condition also seen in placoderms (stem-group jawed vertebrates). Thus enamel on teeth must have first appeared in certain primitive osteichthyans crownward of *Andreolepis*. Here we examine the tooth histology of *Psarolepis*, a primitive osteichthyan from the Late Silurian and Early Devonian of South China, by making thin sections from a tooth-bearing premaxilla and lower jaw, in order to understand whether hypermineralized tissue had already appeared in this taxon. The sections show that *Psarolepis* teeth lack any hypermineralized tissue and are exclusively made of dentine, while other regions of dermal skeleton, including those immediately adjacent to the teeth, have a monotypic enamel layer on the top of cosmine - a characteristic tissue complex of early sarcopterygians. A remarkable feature is that the continuous enamel layer on the entire dermal skeleton of *Psarolepis* is only interrupted by the teeth without enamel. A direct comparison of the new data with *Lophosteus* and *Andreolepis* provides a novel view on the phylogenetic distribution of monotypic enamel in jawed vertebrates: it first appeared only on the body scales of *Andreolepis*, later on both scales and dermal bones of *Psarolepis* and finally on teeth of more derived sarcopterygians crownward of *Psarolepis*. Further examination of other primitive sarcopterygians such as *Meemannia* and *Styloichthys* may be able to pin down the origin of tooth enamel in jawed vertebrates.

Romer Prize Session (Thursday, November 6, 2014, 8:45 AM)

ORIGIN AND EARLY EVOLUTION OF SEA TURTLES

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One of the most intriguing questions in turtle systematics is the origin of sea turtles (Chelonioidea). Morphological analyses universally place them as basal cryptodires (hide-neck turtles) in contrast with molecular results. Moreover, there is no consensus among morphological phylogenies of whether pancryptodires evolved into highly adapted marine forms twice or only once. I addressed these questions through a careful anatomical review of key Cretaceous marine turtles and Mesozoic eucryptodires and by significant expansion of existing morphological datasets. Parsimony analysis robustly placed the extinct clade Protostegidae within crown sea turtles as sister to the extant leatherback turtle lineage (Dermochelyidae). This predates the divergence between extant hardshelled sea turtles (Cheloniidae) and leatherbacks by at least 30 million years relative to molecular clock estimates. The basal position of chelonioids among cryptodires is revealed to partly be an artifact of the unstable position and antiquity of pantrionychid softshell turtles coupled with the strong morphological signal linking certain Cretaceous pancryptodires to the stem of chelonioids. The results suggest that sea turtles descended from basal Laurasian freshwater eucryptodires sometime between the Late Jurassic and the Albian as part of a single marine radiation. Disparity analysis indicates that the early evolution of sea turtles was characterized by a peak in anatomical disparity in the Late Cretaceous that decreased in two steps during the Campano-Maastrichtian followed by conservative morphology throughout the Cenozoic. The phylogeny implies that large body size (~ 2 m) evolved at least twice independently, once in the Albian and once in the Campanian, but only among pandermochelyids. Both trends eventually culminated in true gigantism (~ 4 m). Limb articular surface morphology indicates that accelerated ontogenetic growth and high metabolic rate unique to extant leatherbacks evolved twice in Cretaceous pandermochelyids and was linked to the acquisition of large body size. Maximum body size was considerably limited compared to other marine reptiles, likely in correlation with the strictly oviparous reproduction of sea turtles and the associated constraint of the paddles during terrestrial locomotion.

Technical Session X (Friday, November 7, 2014, 9:15 AM)

NEWLY DISCOVERED MIOCENE PROBOSCIDEANS IN THE SOUTHERN LEVANT

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The evolutionary history of proboscideans is characterized by three successive events known as the Eocene radiation, the Miocene radiation and the Mio–Pliocene radiation. The highest taxonomic diversity in proboscideans occurred during the Miocene. Through study of the modes of dispersal of proboscidean species, we can theoretically reconstruct the routes along known geological land bridges by which dispersal took place. That in turn allows us to interpret the evidence of different proboscidean species from remote geographical regions in reconstructing paleogeography. The southern Levant is located on the route of dispersal in and out of Africa. New finds from Miocene localities reveal a rich faunal distribution, including various proboscideans. Proboscidean remains have been reported from several find-spots in the Golan Heights, the Negev, and the Arava Valley. In the Negev, fossilized mammals have been exposed in the Rotem and Yeroham Basins at three localities. At least two proboscideans have been indentified including *Prodeinotherium* sp. *Gomphotherium* or Ambelodintidae, together with other vertebrates. The taxa are mainly of African origin but there are also a few Eurasian as well as endemic elements in the record. These rich faunal remains suggest they existed within a wide variety of habitats of an early Miocene Age (Burdigalian). Recently, a mandible of a new proboscidean, *Gomphotherium*, has been discovered in sandy sediments of the Rotem Formation of the Hazeva Group near Ein Yahav in the Arava Valley. In spite of the spatio-temporal position of the Negev sites as crucial for interpreting initiation of biotic exchange between the Afro-Arabian and Eurasian realms. Intensive tectonic activity and erosion post-dating the Miocene Hazeva Group has removed most of the sediments of that group, leaving only thick sections sheltered in Grabens, therefore localities with fauna are quite rare. Synchronic and diachronic changes in the fossil proboscidean record of the southern Levant, species morphological characteristics, diet preferences, and species turnover is analyzed within their geological and geomorphological contexts in order to reconstruct past environments.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

DISCOVERY OF A NEW GENUS OF A LONG-SNOUTED BEAKED WHALE FROM THE LATE MIOCENE GRAM FORMATION IN DENMARK

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A subcomplete skull and some postcranial elements of a beaked whale (Odontoceti, Ziphiidae) have been found in the upper Miocene Gram formation (10 Ma). This is the first occurrence of this family in Denmark.

The specimen is related to the genus *Messapicetus* due to its elongated rostrum and its shallow prenarial basin margined by strips of maxilla. However, it is considered as a new genus because of its two pairs of mandibular tusks, the large pentagonal nasals on

the vertex, a wider contact between the premaxillary crests and the nasals, the absence of a tympanic spine, and the presence of a strong ventral concavity on the rostrum involving the maxillae.

Preliminary phylogenetic analysis places it with *Beneziphius*, *Messapicetus*, and *Ziphirostrum* in the *Messapicetus* clade and confirms its basal position. *Ninoziphius* is still considered to be the most basal Ziphiid found. The oral apparatus of the specimen, although less specialized than in extant Ziphiids, is showing clear specializations to suction feeding, more than in *Ninoziphius* and might explain the differential tooth wear observed.

Several sexually dimorphic characters on extant Ziphiids and the fossil species *Messapicetus gregarius*, are present in the Gram specimen. It may indicate the specimen was a male. However, the debated function of these structures in the ziphiid fossil species and the absence of other fossils from this species do not permit us to confirm its sex.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

ECOLOGICAL DIVERSITY OF AN EOCENE NORTH AMERICAN OMOMYID PRIMATE: SEASONALITY OR COMPETITION?

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Omomys carteri is an omomyid primate from the middle Eocene of North America. Since its discovery, numerous fossil specimens belonging to this taxon have been described including both cranial and post-cranial remains. This primate is small-bodied (approximately 230 g), nocturnal, and most probably insectivorous. Diet is a parameter which can be highly variable, as potential food sources vary in spatial distribution and availability over time. In this study, the dietary range of *Omomys carteri* is assessed using low magnification dental microwear analysis on isolated teeth from the Powder Wash Quarry locality (early Bridgerian) in Utah. The comparative database for this study is comprised of 182 specimens and 15 species of living lemurs, lorises, galagos, and tarsiers. Of the 116 total number of specimens studied, 89 showed distinctive microwear patterns. Data analysis was carried out using Discriminant Function Analysis on several independent variables (number of pits, scratches, scratch length and number of wide pits, and long scratches).

The results indicate two different dietary types among the specimens from Powder Wash Quarry : 41 specimens show a diet based on fruit and 48 show a diet based on insects and gums. Results show no overlap between these two dietary groupings. Such a distinction between two different diets in a same sample is indeed unusual. Several hypotheses could explain these results. One possibility could be that the sample represents two taxa rather than one. However, no morphological differences can be discerned between the two groups. Another possibility could also be sexual dimorphism. Indeed, extreme dietary differences between males and females of the same species are known in extant primates such as cercopithecids, although none have been observed in small-bodied species. A third hypothesis is that the sample represents multiple seasons and *Omomys* shifted its diet according to the season and available resources. However, in this scenario, a gradual shift from a fruit-based diet to an insect- and gum- based one should be able to be observed, which the data do not seem to show. Primates also change their diet according to competition for available resources. *Omomys lloydi*, similarly nocturnal, is also present in the Powder Wash locality. Microwear results indicate a highly insectivorous diet. The two different dietary groupings present for *Omomys carteri* could therefore also represent a dietary shift under competitive pressures.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

HOW FAT WAS THE DODO? THE FIRST MASS ESTIMATE FROM DIGITAL BODY RECONSTRUCTION BASED ON A COMPLETE SKELETON OF *RAPHUS CUCULLATUS*

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The mass of the dodo, a large extinct flightless columbid once endemic to the island of Mauritius, has been a topic of debate for more than a century. The ambiguity caused by the lack of complete remains, and the paucity of dependable historical sources from the intervening decades between the dodo′s discovery and extinction, have been further confounded by a range of different mass estimates derived from scale models and scaling equations applied to disarticulated fossil limb bones from the Mare aux Songes Lagerstätte. Here we report the results of the first estimate of dodo mass based on digital body reconstruction using the only known and still undescribed fossil skeleton of a single individual bird, the Thirioux dodo from the Mauritius Natural History Museum in Port Louis. The mounted Port Louis Thirioux skeleton was scanned with a Konica Minolta Range7 laser surface scanner at a point cloud density of approximately 100 µm. Subsequently, the digital skeleton was segmented and repositioned in an anatomically accurate position using the 3-D editing software package Geomagic Design X. Based upon muscle reconstruction and soft tissue arrangement, and using the 3-D modeling software package Autodesk Maya, two independent minimum threshold (skinny) and maximum threshold (fat) body outlines were reconstructed. Body outlines were subsequently reimported into Geomagic in order to determine model volume and center of mass. The volume of the reconstructed pulmonary system was subtracted from the whole model volume. The volume range represented by the skinny and fat models spans 12.5 to 20 liters. Whereas the 20-liter dodo model is certainly obese, the leg muscle mass on the skinny models is so atrophied that it almost certainly represents a non-viable morphology. Using a conservative relative density of 0.865 kg m^{-3}, we find an absolute minimum mass of 10.8 kg. Using a higher relative density for the fat dodo of 0.970 kg m^{-3}, we compute a maximum model mass of 19.4 kg. Although these values are lower than some of the highest mass estimates derived from historic sources, they are higher than several of the recent mass estimates derived from limb bone scaling equations. Improved estimates for dodo mass and center of gravity are important for future analyses of the biomechanics of dodo locomotion.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

PHYLOGENETIC AND ECOLOGICAL CORRELATES OF INNER EAR MORPHOLOGY AND ONTOGENY IN PINNIPEDS (MAMMALIA, CARNIVORA)

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Pinnipeds are caniform carnivorans secondarily adapted to an aquatic environment, with fossils such as the late Oligocene *Enaliarctos* providing important evidence on the early evolution of this clade. Ecology and locomotor performance on land and in water differs markedly among the three extant families (Phocidae, Otariidae, and Odobenidae), and understanding the ecology and degree of land-dependency of fossil species is crucial to reconstructing this major transition. While most studies of pinnipeds have focused on cranial, dental, and postcranial traits, the inner ear provides key information on hearing and locomotor ecology. The cochlea and semicircular canals (SCC) of the inner ear are well studied in living mammal species, and as the petrosal is well preserved in fossils, study of these elements could help reconstructing the phylogeny and ecology of fossil specimens.

Skulls from fetal to adult specimens of 13 species of living pinnipeds were CT scanned and 3D reconstructions were made of the SSC and cochlea. The holotype skull of Miocene-Pliocene monachine phocid *Acrophoca* was also scanned and the cochlea was reconstructed. Three sets of size-corrected measurements were analyzed with principal components analyses (PCA): all measurements, SSC measurements only, and cochlear measurements only. In all PCAs, the first component separated the three families with no overlap.

Adding younger ontogenetic stages to the PCAs revealed divergent routes of ontogenetic direction, with no consistent pattern within or across families. Addition of *Acrophoca* to the cochlea PCA showed that this specimen was consistently closest to *Leptonyctes weddelli,* a deep diving monachine.

Phylogenetic least-squares regressions of adult-only size-corrected log inner ear measurements and PC scores against 17 ecological and life history variables found significant correlations of PC scores with latitude (PC1-all), mean diving depth (PC3-all, and PC3-cochlea), and temperature (PC1-SSC). Measurements of the anterior SSC were significantly correlated with temperature and gestation, while latitude, growth rate, and mean diving depth were significantly correlated with cochlear measurements. Although no relationships were significant following a Bonferroni correction, the correlation between cochlear measurements and diving depth and the similarity of *Acrophoca* to *L. weddelli* in most aspects of cochlear morphology suggest that this extinct phocid may have also achieved moderate to deep diving depths.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

CRANIOMANDIBULAR ONTOGENY IN NONAVIAN THEROPOD DINOSAURS: INSIGHTS FROM THE ABELISAURID *MAJUNGASAURUS CRENATISSIMUS*

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Abelisauroidea represents the most diverse group of nonavian theropod dinosaurs from Gondwanan landmasses during the Cretaceous, including forms that spanned from small to large body sizes and presumably occupied a range of niches. This group, particularly the less inclusive Abelisauridae, is characterized by high, short, and broad skulls and a robust cervical skeleton, a suite of features thought to provide increased resistance to mechanical loads during feeding. As most abelisaurids are established on individual specimens, our knowledge of the ontogenetic development of typical abelisaurid morphology remains somewhat rudimentary. Recent finds of numerous new partial-to-complete and size-diverse skulls of *Majungasaurus crenatissimus* provide an opportunity for examining cranial ontogeny within Abelisauridae. We employed two-dimensional geometric morphometrics to evaluate ontogenetic changes in associated or articulated skulls representing a partial growth series, in order to assess patterns of shape change in cranial morphology through ontogeny.

Ontogentic shape change of various cranial elements is found to contribute differentially to overall cranial shape in *Majungasaurus crenatissimus*. The high and short skull morphology in adults resulted from three major components of shape change over the size range examined, including (1) increases in the dorsoventral dimension of the lacrimal process of the jugal, (2) decreases in the size of the orbit, and (3) increases in the dorsoventral dimension of the posterior half of the skull due to the increase in height of the squamosal process of the postorbital and the quadrate process of the quadratojugal. As a whole, the height of the skull and the interlocking of elements both increase through growth.

These observations indicate that the adult cranial morphology of *Majungasaurus crenatissimus* results from modifications of skull shape over an individual′s life span. Thus, craniomandibular biomechanics and function likely shifted through ontogeny as well. These findings suggest that juvenile and adult *Majungasaurus* individuals may have occupied different ecological niches and favored different prey, as has been hypothesized for some other large-bodied theropods (e.g., *Tyrannosaurus rex*).

Symposium 1 (Wednesday, November 5, 2014, 8:30 AM)

NEW INFORMATION ON THE THEROPOD DINOSAURS FROM THE LATE JURASSIC LITHOGRAPHIC LIMESTONES OF SOUTHERN GERMANY

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The lithographic limestones of southern Germany have long been known for their excellently preserved fossils. Terrestrial vertebrates are rare components of the fauna of these marine units, but a number of taxa have been described. Dinosaurs are so far only represented by theropods, which include four different genera: *Sciurumimus*, *Juravenator*, *Compsognathus*, and *Archaeopteryx*. *Sciurumimus* and *Juravenator* are only known from single, probably early post-hatchling individuals of very similar size and proportions; both are from the upper Kimmeridgian Painten Formation. Nevertheless, the two taxa differ in numerous anatomical details, indicating that they are not closely related. *Sciurumimus* shows characters of basal tetanurans, such as a medially closed maxillary fenestra and a broad groove below the occipital condyle, but differs from coelurosaurs in many plesiomorphic features, indicating that it is a non-coelurosaurian tetanuran. *Juravenator* has so far been considered to be a basal coelurosaur, but new observations on the skeleton reveal a number of characters shared with basal theropods, such as the presence of a posterior pleurocoel in the cervical vertebrae, a lateral brevis shelf that is continuous with the supraacetabular crest and a well-developed antitrochanter in the pelvis, which might challenge this idea. Interpreting the phylogenetic position of these two taxa is hampered by our poor understanding of early theropod ontogeny and the potential role of paedomorphosis in the evolution of coelurosaurs. *Compsognathus*, first described in 1861, is also known from a single juvenile individual. Recently discovered casts show that the specimen is better preserved than first described and provide new data on its morphology, indicating that it is not the same taxon as the French *Compsognathus*. *Archaeopteryx* is known from 12 skeletal specimens, most of which are from the lower Tithonian Solnhofen Formation and thus slightly younger than the other theropods, although one specimen has recently been found in the uppermost part of the Painten Formation, and one specimen is from the Moernsheim Formation, overlying the Solnhofen Formation. New studies and new specimens have helped clarify some controversial issues of the anatomy of this taxon, such as the great similarity of the braincase with that of dromaeosaurids and the presence of a closed postorbital bar. The taxonomy of *Archaeopteryx* is still debated, but the genus can be shown to be monophyletic with some certainty and includes probably at least three, and as many as four to five species.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

BONE DEGRADATION IN A LATE TRIASSIC RHYNCHOSAUR: SIGNATURES OF FUNGAL EROSION?

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Microscopic examination of several limb bones of a Late Triassic rhynchosaur from the Tiki Formation of the Rewa Gondwana basin, India shows considerable bone degradation in the form of extensive network of microtunnels. These microtunnels are of two types. Type I is long, thin, and intruding into the bone tissue through the peripheral cortical bone wall that dichotomously branches out at a distance from the cortical periphery resulting in a reticular pattern in the inner cortex with an overprint on the earlier bone tissue structures. It can penetrate the lines of arrested growth and annuli, and may extend to the medullary cavity. Type II is short, thick, predominantly associated with vascular channels, and more concentrated in the perimedullary region. The uniformity of the tunnels in terms of thickness, regular periphery, bifurcation, growth line penetration, consistency in orientation within cortical tissue in accordance to the destruction of histological integrity of the bone discard the possibility of their origin as micro-fissures. Such tunnels, with definite organization and inter-relationship with the vascular channels and bone fibrils, often showing high-angle cross-cutting relationships with arrested growth lines can only result from microbial activity, which is the principal agent of initial bone degradation. Both types of microtunnels show distinctive birefringence under polarized light suggesting that they contain crystals of calcite within the borings. These branched tunnels are identified as the microborings imparted by fungus based on site-specific occurrence of the interconnected tunnels, and their intruding relationship with the growth rings. The Tiki rhynchosaurs had undergone catastrophic mass mortality by entrapment in mud and drowning during flash floods. The carcasses were subjected to decomposition during which microbial attack played an important role under favorable warm, moist and well oxygenated environmental conditions. It resulted in extensive bone damage including loss of collagen from the bone matrix and destruction of the vascular channels. The degree of dissolution of bone matrices increased with recharging of fresh water from repeated flash floods, and this in turn increased the microbial alteration.

Symposium 2 (Thursday, November 6, 2014, 2:15 PM)

ECOMORPHOLOGICAL AND FUNCTIONAL VARIATION IN THE THEROPOD DINOSAUR MANDIBLE

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Ecomorphological variation can be used as a proxy for variation in feeding ecology in extinct animals, where behavior cannot be directly observed. Biomechanical analysis, pioneered in dinosaurs by R. McNeill Alexander, is also employed to infer ecological niche occupation in extinct organisms. Whether inferences from ecomorphology are congruent with inferences of feeding behavior from biomechanical analysis is unclear. Here we use Geometric Morphometrics (GMM) and biomechanical metrics to discern the variation in mandibular shape and function in non-avian theropod dinosaur taxa. We estimate the mechanical advantage (MA) of each jaw (ratio between in-lever to out-lever of the jaw) and a measure of resistance to bending, both linked to feeding performance and ecology in extant taxa. Six two-dimensional landmarks and 50 semilandmarks were used to capture the variation in jaw shape in 103 taxa. We focused upon the lower jaw to minimise the influence of non-feeding structures found in the cranium (sensory organs, possible display structures) on jaw shape and hence feeding signal. After Procrustes superimposition and Principal Component Analysis performed in PAST, MorphoJ and R, we find that the largest proportion of variation is explained by changes in jaw robustness (mandibular length and depth), with a change in the relative size of coronoid process playing a key role. Oviraptorids are morphologically and biomechanically distinct to all other taxa in the analysis (NPMANOVA, $p<0.05$) and contribute disproportionately to overall disparity. There is some partitioning of taxa based on feeding ecology, with supposed omnivorous and herbivorous taxa occupying statistically distinct regions of morphospace from carnivorous taxa (NPMANOVA, $p<0.05$). When the data is partitioned into six time bins, morphological disparity (sum of variance) increases from the Late Triassic to the Late Cretaceous, with a rapid increase from the Late Jurassic onwards, linked to the diversification of Maniraptora. However we find there is limited congruence between the pattern of morphological variation and variation in biomechanical metrics, suggesting that jaw shape does not fully capture the biomechanical performance of the non-avian theropod dinosaur jaw.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

SUBSTRATE PROPERTIES AND FOOT ANATOMY: TWO OF THE VARIABLES CONTROLLING DINOSAUR TRACK MORPHOLOGY

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Vertebrate track morphology is determined by three factors: anatomy of the track maker's foot, distal limb dynamics, and substrate conditions. We present two dinosaur tracksites from the Iberian Peninsula in which we attempt to assess the independent contributions of substrate and foot motion to 3D track morphology. The El Frontal tracksite (Lower Cretaceous, Soria) contains multiple trackways in which track morphology substantially changes across the exposed surface. Given that foot anatomy must remain constant within a trackway, and that consistent stride lengths do not indicate any significant alteration of limb motion, we attribute this morphological change to variations in substrate consistency. We used 3D digitization techniques to record and quantify the morphological variation present within and between trackways. The trackways exemplify how individual track morphology, and consequently potential ichnotaxon assignment, can vary considerably even when produced by a single track maker in a small area. The El Barranco de La Canal tracksite (Lower Cretaceous, La Rioja) offers a different view of track variability in which sediment consistency appears uniform throughout the trackway (i.e. displacement rims and other features are constant), stride lengths indicate no change in gross limb motions, yet impressions of the left and right feet appear to consistently differ in interdigital angle and digit lengths. Our study discusses two examples in which foot anatomy and limb dynamics remain constant, and yet track morphology alters. The tracks at the El Frontal tracksite present a continuum of track morphologies and geometries produced by a gradient of substrate consistencies, and the extremes of this continuum would, if found separately, be classed as different ichnospecies or even ichnogenera. The El Barranco de La Canal case underscores how, given a seemingly consistent substrate and stride length, tracks can still occupy a wide range of morphospace due to additional factors, potentially adhesion of substrate to the feet which alters the contact area between footfalls.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

ALL THE BETTER TO SEE YOU WITH: REUNITING *OPHTHALMOSAURUS ICENICUS* SPECIMENS AT THE AMERICAN MUSEUM OF NATURAL HISTORY

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Maintenance of paleontological collections is critical if the collections are to remain useful to the scientists that study them and significant to the institutions that preserve them. Yet collections are not static. Specimens travel to other institutions, suffer damage or are mislaid, mislabeled or misnumbered.

How do we stay ahead of the chaos? Keeping good records (correspondence, archival materials, histories) is crucial, but the most important tool may be the inventory. By conducting inventories, problems are discovered and resolved before becoming major conundrums, and while most issues are settled quickly, the occasional puzzle invites a closer look.

Recently we discovered some anomalies in the organization, labeling and descriptions of several marine reptile specimens in the museum"s collection. To untangle this, we began by ordering the vertebrae of one of the specimens. By then comparing features such as size, shape, texture, color, staining and finish of the elements, we were able to complete the sequence with vertebra that were otherwise unlabeled, unassigned or mislabeled. The suspected mingling of specimen numbers led to a broader comparison of the two animals: both are *Ophthalmosaurus icenicus* and both were discovered in the Oxfordian near Peterborough, England. Significantly, one specimen has a forelimb and a hind limb; the other has the opposite pair, and the mounts are identical. Finally, they are similar in color, shape, texture and size, and there is no apparent overlap of elements in the two specimens.

Although AMNH received one specimen from the British Museum of Natural History and the other in exchange with Tübingen, we believe that most elements of these two specimens are from a single individual. Researching the history of collecting at the Peterborough clay pits and the distribution of those finds to BMNH and Tübingen is intriguing, and supports the possibility. Correspondence, both archival and current, with several institutions may provide additional support as well as answers to lingering questions: were the specimens collected and/or distributed separately or did one of those institutions split them? And if so, what were the circumstances that led to their reunion at the AMNH?

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

ADVANCES IN GEOSPATIAL DATA COLLECTION FOR PALEOBIOLOGY

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The increasing volume of paleontological data presents several challenges. First, data are often collected by individual investigators or small research teams that invest resources in field collection and lack additional resources for digital data management. As a result, in the age of expanding global information infrastructures, it remains difficult to get digital access to specimen-level occurrence information and there is a growing risk that critical specimen provenience data may be lost. Second, the use of localities as the method for recording the spatial provenience of fossils risks aggregating data, temporally and spatially, in a manner that may not be suitable for analysis. Third, the disparate and compartmentalized nature of these collections is a barrier to synthetic, big-picture analyses of the fossil record.

This paper argues that the solution to these challenges is the deployment of GPS-GIS based field data collection systems that record data about each item directly into spatial databases as they are collected or observed. This system greatly improves data integrity by capturing ephemeral contextual data into a stable database format that can be archived and shared better than paper field notes or excel spreadsheets. It provides analytical precision and flexibility by efficiently recording the spatial and stratigraphic context of individual items rather than aggregating items into paleontological localities, and spatial databases promote standardized data collection and rapid dissemination of the data.

Historically, localities were used as a way to record the spatial and stratigraphic location of fossils, but advances in GPS and GIS technology now make it feasible to record the spatial location, along with other key attributes about an item, in the field as it is collected. This paper presents working examples of field collection workflows using mobile data recorders and smart phones. These workflows build upon existing data standards, such as Dublin Core and Darwin Core, to facilitate the design and integration of data sources across projects. These workflows include migrating data to and from mobile devices, collecting data in the field with mobile devices and developing data repositories that can be accessed from multiple computer programs such as ArcGIS, QGIS, R, DBVIS, or web browsers, depending on the need of the investigator.

Technical Session XI (Friday, November 7, 2014, 3:45 PM)

COMMUNITY RESOURCE PARTITIONING IN AFRICAN BOVIDAE (MAMMALIA, ARTIODACTYLA): NICHE OVERLAP AND RESOURCE DIVERSIFICATION THROUGH TIME

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Modern tribes of Bovidae appeared in Africa by the end of the Miocene, having arrived from Asia. The family diversified extensively during the Plio–Pleistocene, and tribal adaptations have often been used to reconstruct past environments. In particular, the dietary adaptations of modern bovid taxa of a particular tribe are often automatically attributed to fossil taxa from that same tribe, implying that bovid communities remained static (depending on habitat) through time. That is, it could be assumed that woodland bovid dwellers, for example, maintained the same resource partitioning structure throughout the Plio–Pleistocene.

We have examined the feeding morphology of modern and fossil taxa to reveal trophic capabilities, using ecomorphological analyses of a number of mandibular measurements and hypsodonty indices. We compared these results with previously collected carbon isotope values to evaluate dietary capability versus actual diet, as bovid tribes consume either solely C_3 or C_4 plants, or for some tribes, combinations of both types. Finally, we used principal components analysis (PCA) applied to the available trophic data, both morphological and chemical, to examine resource partitioning and niche overlap. We compiled these trophic data on bovids from 102 modern African communities and four fossil communities of different time periods: Langebaanweg, South Africa (5.2 Ma), Hadar, Ethiopia (3.5–2.95 Ma; 2.3 Ma), Makapansgat, South Africa (~2.8 Ma), and Ledi-Geraru, Ethiopia (2.8–2.4 Ma). The eastern African localities encompass 15 different time intervals on which we based community structure. Results show that fossil bovids which exhibited morphology that would enable the eating of grass or both grass and browse (dicot plants) often had solely C_3 trophic signals indicating that they were not eating what was expected. It appears that resource partitioning in the past differed from that of bovids in modern localities, with fossil taxa seeming to have more overlap in diet. Finally, we note that some fossil taxa have no modern analog in terms of dietary capability.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

ECOMORPHOLOGY OF WHITE-TAILED DEER CALCANEA DURING THE MIDDLE TO LATE HOLOCENE OF CENTRAL NORTH AMERICA

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White-tailed deer (*Odocoileus virginianus*) are the oldest members of New World deer (Capreolinae) and occupy the majority of North America and the northern part of South America. Being a generalist species, they thrive in almost all herbivourous habitat types except for deserts and areas with deep snow. This study uses geometric morphometric shape analysis to explore the change in shape and size of the calcaneum over time and between paleo-habitat types. Deer remains were obtained from archaeological sites thoughout central North America from sites ranging from 8 ka to 500 years. Three dimensional data was collected on the calcaneus using a 3D digitizer.

The sample includes modern white-tailed deer and mule deer (*Odocoileus hemionus*) that were used to establish the degree of variation between closed-adapted and open-adapted respectably. The archaeological samples were collected from sites that were known to have had paleo-habitat conditions appropriate to test for open and closed habitats. Calcaneal shape and size was explored using Principal Components Analysis (PCA), Canonical Variates Analysis (CVA) and Discriminant Function Analysis (DFA) on Generalized Procrustes-aligned variables. The first principal component (PC1), accounting for 23% of the variance in the analysis ($p < 0.05$), separates mule deer from white-tailed deer, CVA found the variables to be significantly different (Wilks' Lambda = 0.6338) and DFA was significant, correctly classified 98.4% of the individuals (Hotelling's = 318.78). In the analysis of modern and the mid Holocene sample, accounted for 14.65% of the variance ($p < 0.05$), CVA found the variables to be significantly different Wilks' Lambda = 0.2499) and DFA was significant, correctly classified 86.5% of the individuals (Hotelling's = 111.69). In removing size, little difference was observed.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

EVOLUTION AND MORPHOLOGY OF THE PATELLAR SESAMOID IN LEPIDOSAURIAN REPTILES (SQUAMATA AND RHYNCHOCEPHALIA)

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Sesamoids are bones that develop within tendons as they pass over joints. The patella is generally the most familiar of these, due to its large size and wide taxonomic distribution. Postulated functions include increasing the mechanical advantage of muscle through larger joint moment arms and protecting the tendon from compressive forces as it bends around the joints. Squamates tend to have a large number of sesamoid bones, whereas they are almost absent in other closely related groups (e.g., crocodylians, testudines, non-avian dinosaurs), despite the advantages they might confer.

The patella has evolved independently in squamate lizards, mammals and birds. However, the origin(s) and evolution of the patella within each linage are unclear. Previous work suggests the squamate patella is inherited from their common ancestor, but its existence in the rhynchocephalian sister group and hence its ancestral presence in Lepidosauria has not been seriously investigated.

Our study combines multiple lines of evidence from lepidosaurian knee joints to reconstruct the evolution of the patella within this clade. Patellar presence is seen in certain exceptionally preserved fossil squamates but not convincingly reported in any known fossil rhynchocephalian or stem-lepidosaur postcrania. However, the patella is very small and may be less ossified than the limb bones, making it hard to detect and vulnerable to loss. In fossils, absence of evidence does not necessarily equate to evidence of absence.

Using micro-computed tomography scans of extant material, we have found the first evidence of an ossified patella in tuatara (*Sphenodon punctatus*); the only extant representative of Rhynchocephalia. The structure seems formed of several fused centres of ossification in the main knee extensor tendon, overlying the distal femur. Comparative gross and microscopic anatomical data from squamates (e.g., *Iguana, Varanus, Tiliqua, Chlamydosaurus, Chamaeleo*) shows it to correspond with the patella in morphology, apparent composition and location.

Thus we suggest that the patella in lepidosaurs is a homologous structure, originating once in Lepidosauria. The smaller size of the patella in *Sphenodon* and Mesozoic squamates hints at secondary enlargement in some modern squamate lineages, whilst there was secondary loss in other taxa. However, fossil evidence from stem lepidosaurs and early rhynchocephalians is critical in testing our evolutionary hypothesis - so far, clear evidence only comes from well-preserved taxa within Squamata.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

THE EVOLUTIONARY HISTORY OF GOBIOIDS FROM A PALAEONTOLOGICAL PERSPECTIVE

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Gobioids are small benthic fishes that constitute one of the largest suborders of teleost fishes, with about 2200 extant species. Their systematic interpretation at the family level was initially based on characteristic suites of morphological characters and has, more recently, been largely confirmed by studies using molecular data. Most studies agree in assuming that Rhyacichthyidae + Odontobutidae represent basal groups and are sister to all other clades. The next split probably separated the Eleotridae from Butidae + Gobiidae, and the split between the Butidae and Gobiidae then followed. Since many teleost groups emerged in the Late Cretaceous, a Late Cretaceous age has also been suggested for the origin of the Gobioidei. It has generally been assumed that divergence of the Eleotridae occurred around the Cretaceous-Paleogene boundary, that Gobiidae and Butidae separated in the early Eocene and that diversification within the former also began in the early Eocene. One major argument for this scenario was the reported presence of abundant gobiid-like fossil otoliths in the upper Eocene Barton Clay (England). However, in light of a critical review of the fossil record, the previously postulated divergence ages all appear too old. Contrary to previous interpretations, the oldest records of fossil gobioids do not relate to the Gobiidae, but rather to the Odontobutidae and Eleotridae. Moreover, all other previously described gobioid fossils from the Eocene and early Oligocene, whether based on skeletons or otoliths, appear more closely related to the Eleotridae and Butidae than to the Gobiidae. In particular, the so-called typical gobiid otoliths from the upper Eocene Barton Clay, to which most previous interpretations of the temporal diversification of the Gobiidae have referred, are not in fact represented in these sediments. We propose here that the divergence of the Butidae and Gobiidae took place near the Eocene-to-Oligocene transition rather than in the early Eocene, and may have been related to paleogeographical and ecological changes associated with the global fall in sea level at that time. Furthermore, we assume that the grand radiation of the Gobiidae did not take place prior to the early Miocene and may have been related to the emergence of new habitats in the course of the closure of the Tethys. In conclusion, a careful re-examination of the known fossil gobioids is required to better understand the temporal diversification, zoogeography and evolutionary history of the gobioids and contemporary gobioid diversity.

Symposium 4 (Friday, November 7, 2014, 10:45 AM)

DIVERSITY AND DISPARITY OF DISSOROPHOID TEMNOSPONDYLS AT THE LOWER PERMIAN DOLESE QUARRY NEAR RICHARDS SPUR, OKLAHOMA

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The Dolese Brothers limestone quarry preserves the greatest dissorophoid taxic diversity of any Paleozoic locality, and includes the amphibamids *Doleserpeton*, *Pasawioops*, and *Tersomius*, the dissorophids *Cacops morrisi*, *C. woehri*, *Dissorophus,* and *Aspidosaurus*, and the trematopid *Acheloma*. In addition, at least one other amphibamid, a dissorophid, and two new trematopid taxa remain to be described.

Richards Spur appears to have been a natural trap that preserved an unusually high species-level diversity, making this locality an ideal model system for investigating terrestrial community structure during the Paleozoic. Taxonomic diversity can be examined through traditional species counts, leading to results that are clearly related to biodiversity. However, this kind of method only measures the minimum number of taxa at any particular time or place, provides no insight into community interactions, and is generally a poor measure of ecological diversity.

Based on previous observations that tooth morphology correlates with feeding ecology, we undertake an extensive morphometric analysis of variation in tooth shape and size within a phylogenetic framework. In order to understand the ecological diversity present at Richards Spur, we quantified variation in tooth morphology along the entire tooth row of the 20 taxa that have well preserved, complete maxillae. Metrics of tooth shape were then combined with other morphometric data, including tooth size, number, and tooth row length. Morphological diversity (i.e., disparity) was calculated based on the results of a principal component analysis, and comparisons were made between the three major vertebrate clades present at Richards Spur: Dissorophoidea, Lepospondyli, and Amniota. The results reveal that dissorophoids exhibit the highest disparity in body size, but relatively low diversity in tooth morphology, whereas disparity in amniotes is largely related to tooth shape. These results suggest important ecological differences early in terrestrial tetrapod evolution. Dissorophoid dental morphology appears to be highly conserved, and as a result ecological variation was achieved through changes in body size. Body size also varied in amniotes, but the latter exhibit a wide range of dental morphologies, suggesting greater variation in feeding strategies and possible novel niche space adoptions. This difference in ecological diversity may have played a major role in the subsequent success of amniotes.

Technical Sesssion XII (Friday, November 7, 2014, 2:00 PM)

INFERRING THE PHYSIOLOGY OF *CAPTORHINUS AGUTI* (REPTILIA: CAPTORHINIDAE) FROM HISTOLOGICAL DATA OF LONG BONES AND TEETH

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Studies of paleohistology have greatly increased our understanding of the physiology, ecology, and growth of extinct vertebrates. In this study, the growth patterns of *Captorhinus aguti*, a common Early Permian amniote, is assessed and its physiology is inferred from growth lines in limb bones and teeth. Most previous histological growth studies have focused on dinosaurs and other Mesozoic reptiles; this study is the first to examine growth patterns during the earliest stages of terrestrial vertebrate evolution, a critical period of early amniote diversification. Twenty *C. aguti* femora (ranging in length from 20 mm to 31 mm) were thin-sectioned at mid-diaphysis and compared to thin sections of the tibiae and humeri of *C. aguti*, as well as limb bones of *C. magnus*, *Varanops*, and a temnospondyl, all collected from the Dolese Quarry in Oklahoma, a locality that is rich in Early Permian (Sakmarian) terrestrial vertebrates. Lines of arrested growth (LAGs) were not observed in any of the *Captorhinus* sections, but were present in the other taxa.

There are three possible explanations for the absence of LAGs in *Captorhinus*: 1) the femora sampled were from juveniles and thus were too young to have preserved any LAGs; 2) *Captorhinus* were short-lived r-strategists that did not live longer than one year and thus did not live long enough to lay down any LAGs; or 3) *Captorhinus* were active, had a high metabolic rate, and were continuously growing and/or capable of remodeling their bones quickly, preventing any LAGs from developing. The first explanation can be discarded because cross-sections show evidence of bone structure found only in adult bone. To determine which of the other two explanations is the most probable, the lines of von Ebner were counted from thin sections of *C. aguti* teeth to approximate the minimum age of the specimens from the replacement rate of teeth. A conservative estimate indicates that individual teeth from larger individuals are at least one year old, suggesting that *Captorhinus* did live longer than a single season and should have LAGs. Based on these results, we conclude that *Captorhinus* was not short-lived and the absence of LAGs implies that it had an unusually high metabolic rate for an early amniote. These findings advance our understanding of the physiology of *Captorhinus*, a key representative of the earliest stages of amniote evolution.

Technical Session XVI (Saturday, November 8, 2014, 8:15 AM)

A NEW CARBONIFEROUS CHONDRICHTHYAN FROM THE DERBYSHIRE LIMESTONE, UK.

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The Carboniferous Limestone of the Derbyshire Peak District is well known for chondrichthyan teeth which range in size from microfossil to collector-prized hand specimens of six to eight cm. Recent work reveals the presence of beds in two localities bearing preserved cartilage. Here we show a chondrichthyan preserved in one of these localities and prepared digitally with computed tomography (CT) scans. The individual is preserved in 3D with some fracturing of the cartilage but little apparent distortion. The neurocranium, palatoquadrate and Meckelian cartilage are all partially preserved with sixteen near in situ teeth.

The Peak District chondrichthyan is identified as symmoriiform based on the morphology of the multicusped teeth and as symmoriid based on the relatively large size of the teeth. Several characters identify this individual as a new taxon including a short, deep and robust palatoquadrate ramus with very few dental indentations along the oral margin. The dental indentations are sub-triangular in shape and tilt posteriorly. Two deep grooves on the ethmoid flange of the palatoquadrate ramus facilitate articulation with the ethmoid region of the braincase. The orbital and basicranial regions are partially preserved and allow the reconstruction of part of the inner ear and endocranial cavity, and the likely arrangement of nerves and blood vessels.

Recent developments in the field have reinforced the reality that symmoriiforms, and possibly Palaeozoic chondrichthyans in general, possessed anatomy distinct from their modern-day counterparts. This relatively large and well-preserved chondrichthyan adds to the continually-widening diversity and disparity found within the symmoriiform sharks and expands the geographic extent of exceptionally preserved body fossils, previously concentrated in North America and Scotland, to England.

Technical Session XVI (Saturday, November 8, 2014, 11:15 AM)

FIRST ARTICULATED COELACANTH FISH (SARCOPTERYGII: ACTINISTIA) FROM THE PALAEOZOIC OF SOUTH AMERICA (BRAZIL)

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The late Palaeozoic ichthyofaunas of western Gondwana are very poorly known. Among sarcopterygians, only dipnoan tooth plates and coelacanth scales have been figured previously. Articulated coelacanths from the Permian of Uruguay have been mentioned in the literature, but remain undescribed. Here, we report on a new coelacanth fish, the first articulated actinistian specimen from the Permian of Brazil. This specimen was found in pinkish sandstone deposits at the Pedra de Fogo Formation type-locality in the state of Maranhao, in north-eastern Brazil. This site has also yielded dipnoan tooth plates, scales of ray-finned fishes, xenacanth and eugeneodontid shark teeth, petalodontids, spiral coprolites, and fragmentary remains of the temnospondyl *Prionosuchus*. The coelacanth specimen remains partly embedded in rock matrix and has been micro-computed tomography and neutron scanned. The partly articulated skull and post-cranium are exposed in dorsal view. The posterior part of the trunk is not preserved, but it is estimated that the fish was approximately 200 mm long, smaller than the average *Latimeria* at birth. The exposed areas and reconstructed 3D images show parts of the skull roof, snout, lower jaw, shoulder girdles, a supra-ocular/tectal series with six bones, viscerocranium elements, neural spines, dermal scales, a few fin rays and dorsal fin plate. The parietonasal and postparietal shields show the same proportions as in *Axelrodichthys* from the Araripe Basin, but the bones are thinner and lack the coarse ornamentation typical of mawsoniids. There are two pairs of parietals and one pair of postparietals. The skull roof bones are ornamented with fine short ridges often associated with small pores; there are three pairs of nasals. The exposed areas of the dermal scales show approximately 14 sub-parallel ridges of equal breath. The specimen may be a juvenile and possibly the first non-mawsoniid coelacanth from South America. The new fossil adds to the diversity of the vertebrate fauna from the Pedra de Fogo Formation in the central area of the Parnaiba Basin, where a shallow-marine/coastal fauna is predominant, in contrast with more continental/fresh water vertebrate assemblages found in the northeast margin of the basin.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

INSULAR VERTEBRATE RESPONSE TO AN EXTREME DROUGHT AT 4.2 KA: INTERDISCIPLINARY EVIDENCE FROM A DODO VERTEBRATE CONCENTRATION-LAGERSTÄTTEN IN MAURITIUS.

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Mare aux Songes (MAS), a coastal marsh on Mauritius, contains one of the richest subfossil accumulations on any volcanic island. A multitaxic bone bed up to 0.5 m thick, set in a peaty matrix, the MAS contains 40 vertebrate species dominated by two species of giant tortoise and dodo remains. Radiocarbon dating indicates more than 750,000 vertebrate individuals accumulated on two hectares ca. 4200 years ago within a 150 year interval. Emerging fresh groundwater at MAS formed a climatically sensitive water hole that attracted diverse fauna and flora. Alkalic and low salinity groundwater percolating through calcareous substrate and anaerobic conditions led to excellent preservation of bone, chitin, and plant remains. Histological and SEM analysis indicate absence of microbiological decay, confirming anaerobic conditions, though evidence for micro-cracking, pyrite formation, and iron oxide formation was also found. The latter are evidence for pyrite oxidation, suggesting incidental subaerial exposure of the bones. Carbon and nitrogen stable isotope ratios reveal a terrestrial C_3 plant-based diet for the main vertebrates and different dietary preferences for the tortoises. Their wide range in $\delta^{15}N$ ratios also suggests adaptation to extreme drought. Bone analyses indicates significant size differences in giant tortoise species. Collagen fingerprinting using ZooMS aided in distinguishing giant tortoise species so far indistinguishable. The majority of dodo bones exhibited globally were excavated from MAS in the 18th and 19th century, reveal a higher degree of taphofacies variation than the bones we excavated. Historical research shows earlier excavations were located in a different sub-basin with a

diachronic bone bed. Pollen, non-pollen palynomorphs and micro charcoal from the MAS indicate extreme drought events generated by the onset of the El Niño climate system, which led to the desiccation of the fresh water hole. Incomplete (< 6%) and disarticulated skeletons confirm post mortem transport and loss of pneumatic and lighter bone specimens. Diatoms indicate shallow, hypertrophic and saline conditions, associated with vertebrate facies and carcass decay. Spores of cyanobacteria and other traces suggest water poisoning associated with high temperatures, hyperthropism, and saline conditions. In spite of extreme high death rates (> 40 individuals / m^2 in < 150 years) all species contained in the MAS survived on Mauritius until human colonisation in the 17th century, after which, in two centuries, 50% of the vertebrates became extinct.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

INCISOR GROWTH AND WEAR RATES INFERRED FROM PERIRADICULAR BANDING SUPPORT A MORTAR AND PESTLE FUNCTION FOR GIANT BEAVER INCISORS

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Periradicular bands are incremental structures seen on the external dentin surfaces of rodent incisors. These structures reflect circadian developmental rhythms in dentin formation. Measurements of increments located between these bands along the longitudinal axis of incisors can be used to infer the eruption and wear rates. In this study, average eruptive growth rates were calculated for incisors representing 4 beaver taxa. The fossil specimens included 13 *Dipoides* incisors, 6 *Procastoroides* incisors, and 11 *Castoroides* incisors. Forty Recent *Castor canadensis* incisors were examined for comparison. Distances between all periradicular bands were measured in sequence in all 70 teeth (= 6000 incremental measurements) and the average growth rates and inferred wear rates determined. Despite large differences in overall incisor size among the fossil rodents, average growth rates for all individual specimens fell within the range of rates found among the *C. canadensis* specimens. These results indicate the absence of a linear relationship between incisor growth rates and rodent body size. The growth rates of *C. canadensis* and *Dipoides* followed a pattern typical for rodents: lower incisors grew significantly faster than upper incisors. However, a surprising finding was that the upper incisors of *Procastoroides* and *Castoroides* grew faster than their lowers, a relationship presently undocumented for any other rodent species. In most rodents, upper incisors are used as an anchor while lower incisors are used for the gnawing power stroke. This system subjects the lowers to higher rates of wear during gnawing than the uppers, and necessitates the lowers growing faster to counter their greater wear. Higher upper incisor growth rates, relative to those in the lower incisors, in giant beavers (*Procastoroides* and *Castoroides*) suggest their incisor use differed mechanically from that typical of rodents. The inferred wear rates, in conjunction with gross wear patterns and reconstructed jaw musculature, support a hypothesis of giant beaver upper incisors functioning like a mortar with lowers functioning like a pestle.

Technical Session X (Friday, November 7, 2014, 9:00 AM)

A NEW EARLY MIOCENE PARAHIPPINE (MAMMALIA, EQUIDAE) FROM THE PANAMA CANAL AREA, CENTRAL AMERICA

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The fossil record of horses in North America is one of the best documented examples of evolution in a modern mammalian clade. Although taxonomically complex, the late Oligocene–early Miocene tridactyl parahippines marked the appearance of two related innovations in horse evolution—the inception of hypsodonty and tooth crowns coated with cementum. As traditionally envisioned, parahippines are evolutionary intermediaries between brachydont taxa lacking cementum (e.g., *Miohippus*, *Anchitherium*) and fully hypsodont taxa with cementum (e.g., *Merychippus* sensu lato, Hipparionini, and Equini). Newly discovered parahippine fossils from the late Arikareean (~21 Ma) Las Cascadas fossil assemblage, Panama Canal basin, include a partial skeleton and several associated isolated dentitions of a small and incipiently hypsodont parahippine lacking cementum (P2–M3 length, ca. 83 mm; mesostyle height of very slightly worn M1 is ca. 8.9 mm). Although more hypsodont than the similarly sized, early Arikareean *"Parahippus" pristinus* from South Dakota (P2–M3 length: 77.5 mm), the Panamanian parahippine also exhibits a shallow preorbital fossa with a very narrow preorbital bar, variably present crochets on upper cheek teeth, and metalophs consistently reaching the ectoloph. It differs from *Archaeohippus* in having more hypsodont cheek teeth with reduced cingulae, strongly developed metastylids separated from the metaconid by a well-marked groove, a larger m3 hypoconulid, and shallower preorbital fossa. In addition to the lack of cementum and its mesodont dentition, the new species differs from more progressive Hemingfordian species of *"Parahippus* " (such as *"P". leonensis*) in the variable presence of crochets. Results of a cladistic analysis of 18 late Oligocene–early Miocene equids scored for 84 characters suggest that the new Panamanian species is nested within the genus *"Parahippus* ". Interpreted autapomorphies (e.g., very elongate symphysis and narrow muzzle, and proportionally shortened and more robust metapodials) suggest that the new species inhabited forested areas of Panama during the earliest Miocene after a rapid colonization of recently emerged volcanic terrains. The apparent absence of mesodont parahippines in the younger (Hemingfordian) Centenario Fauna in Panama also suggests that, unlike higher latitudes parahippines, they did not persist in the New World tropics where mammalian communities were dominated by browsers with brachydont teeth, typical of more closed forest habitats with restricted input of volcanic products.

Technical Session XI (Friday, November 7, 2014, 3:30 PM)

EVOLUTION OF TOOTH WEAR AND DIET OF RHINOCEROTIDAE DURING THE QUATERNARY IN WESTERN EUROPE

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In the last few decades, dietary ecological reconstructions have been used as powerful tools for gaining insight into local and global environmental trends. Ungulate tooth mesowear and microwear studies in particular serve as useful proxies for demonstrating the existence of geographical and/or temporal variability in diet and vegetation structure. Improvements in these techniques reveal patterns involving Quaternary vegetation and climatic structure as well as aspects of niche utilization.

Pleistocene Rhinocerotidae from about 20 Pleistocene localities in Western Europe spanning the last 2.6 million years were sampled. The low-crowned *Stephanorhinus etruscus* from two early Pleistocene localities showed dominant browsing feeding habits. In the late early and Middle Pleistocene, *Stephanorhinus hundsheimensis*, like its possible parent species *S. etruscus*, shows a browsing and mixed diet. The Merck"s rhinoceros, *Stephanorhinus kirchbergensis*, and the narrow-nosed rhinoceros, *S. hemitoechus*, co-occurring during the Middle Pleistocene, show different diets which indicate niche partitioning between the two species. According to mesowear and microwear patterns, *S. kirchbergensis* was a browser or mixed feeder, which is supported by its longer limbs and brachydont teeth indicating more browsing habits. In contrast, *S. hemitoechus* samples indicate grazing and mixed feeding, a result supported by short and broad limb bones that suggest graviportal locomotion and higher hypsodonty, both indicating an adaptation to more open habitats than *S. etruscus* or *S. hundsheimensis*. These two species also show a high dietary flexibility. Finally, the Late Pleistocene wooly rhinoceros, *Coelodonta antiquitatis*, appears here as a pure grazer.

Results indicate a greater plasticity in dietary behavior among forms with similar tooth crown heights and morphology than previously supposed. These results suggest that increased crown height is most likely an adaptation allowing species to expand their dietary breadth. That is, crown height augmentation may serve as a mechanism to allow a species to exploit new habitats and to expand its niche but not necessarily to shift exclusively to a new dietary regime.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

NEW INSIGHTS INTO THE PALEOBIOLOGY OF THE CRYPTOCLIDID PLESIOSAURS FROM THE UPPER JURASSIC AGARDHFJELLET FORMATION OF SVALBARD

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Boreal Late Jurassic to Early Cretaceous marine ecosystems are poorly known in part because of their inaccessibility and lack of stratigraphic control. In particular, articulated remains of fossil marine reptiles are rarely described from high latitudes compared to lower latitude regions. Since 2004, our intensive fieldwork in the Upper Jurassic Slottsmøya Member Lagerstätte of the Agardhfjellet Formation (Svalbard, Norway) has yielded abundant plesiosauroid and ichthyosaur remains that are associated with a rich invertebrate fauna. The Slottsmøya Member spans approximately 12 million years and is preserved as a 70 meter thick sequence of marine shallow-shelf grey shales and siltstones. With up to 20 excavated specimens of plesiosauroids, five specimens to date have been described as representing four endemic cryptoclidid plesiosaur taxa (*Spitrasaurus larseni, Spitrasaurus wensaasi, Djupedalia engeri* and *Colymbosaurus svalbardensis*).

The Slottsmøya endemic cryptoclidid plesiosaurs show unique morphological characters; including a column of three or more preaxial accessory ossicles, high cervical vertebrae count, highly reduced epipodials compared to other cryptoclidid taxa and proximodistally extended femora, relative to humeri. These traits were previously only known from juvenile specimens.

Here we present the largest and first adult specimen excavated from this region, from which we confirm the reported unique morphology from the described juvenile specimens and add important new information on the paleobiology of this clade. The specimen preserves four partially articulated paddles, most of the pectoral girdle, both ilia and series of caudal, dorsal and cervical vertebrae including the atlas-axis. Computed tomography (CT) scans were used to better interpret elements of the skeleton, and yield evidence of pathology from predation or infection in the Slottsmøya Member cryptoclidids. Our results indicate that the plesiosauroids of this region were species rich and give us further insight into the diverse ecological network of the Boreal Slottsmøya Member ecosystem.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A NEW TOOTHED PTERANODONTOID (PTEROSAURIA, PTERODACTYLOIDEA) FROM THE JIUFOTANG FORMATION (LOWER CRETACEOUS, APTIAN) OF CHINA

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Pteranodontoids comprise a diverse and cosmopolitan clade of Cretaceous pterosaurs. In the Jiufotang Formation (Lower Cretaceous, Aptian) of eastern China, they are represented only by dsungaripteroids, including the edentulous azhdarchoids, istiodactylids and two anhanguerians, *Liaoningopterus* and *Guidraco*. Here we describe a new pterosaur from this unit that represents a new species of toothed pteranodontoid. The specimen IVPP V15549 is composed of a partial skull and mandible lacking a portion of the rostrum and symphysis. It shows the usual flattened condition observed in Jiufotang specimens. The skull is seen mostly in right lateral view and some bones are dislocated from their original positions. The mandible is almost complete and shows part of the symphysis and the rami. The overall morphology (e.g., shape of the skull, number of

teeth and interalveolar spacing) is consistent with other toothed pteranodontoids but shows some features indicating that this is a new taxon. The orbit is more ventrally positioned than in other pteranodontoids, with the ventral margin almost level with the nasoantorbital fenestra, which is regarded an autapomorphy of the new species. Neither premaxillae nor mandible have median sagittal crests, as is typical of anhanguerids such as *Liaoningopterus*. The lacrimal process of the jugal is vertically oriented and thin, differing from the broad condition of *Liaoningopterus* and *Guidraco*. IVPP V15549 has gently curved teeth, with crowns either smaller or about the same size as the roots and lacking the laterally compressed triangular condition of istiodactylids, excluding the new taxon from that clade. Dental features also distinguish it from the two known anhanguerians from the Jiufotang Formation. *Liaoningopterus* has very enlarged upper anterior teeth, a premaxillary crest that begins near the tip of the rostrum, and a dentary crest, features absent in IVPP V15549. *Guidraco* has very peculiar thin and elongate upper anterior teeth which are also absent in the new specimen. From the older Yixian Formation, *Haopterus* has teeth that are overall similar, but with a constriction between crown and root, absent in IVPP V15549. Therefore, the specimen is clearly representative of a new species, increasing the pterodactyloid diversity from the Jiufotang Formation. This study was supported by National Basic Research Program of China, the Hundred Talents Project of CAS, FAPERJ, CNPq, and FAPES.

Technical Session I (Wednesday, November 5, 2014, 8:15 AM)

NEW EVIDENCE OF EARLY CERVIDS AND PHYLOGENETIC IMPLICATIONS

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The early evolution of cervids comprises a variety of early and middle Miocene stem forms which have been interpreted to represent different lineages with one or two leading to crown cervids. It has been traced back to the early Miocene via a fossil record of antlers or antler-like appendages, being supraorbital outgrowths of the frontals, having branched proximal ends and documenting a cycle of shedding and regeneration. Based on different antler morphologies, several contemporaneous genera of an age between 20 and 18 Ma of exclusive European origin have been established. Principal morphological differences, dichotomously forked and multipointed, accompanied by histological differences have given ground for discussions on a radiation of stem cervids and as well on the potential exclusion of the multipointed species for the benefit of a sister taxon Lagomerycidae.

Among those first antler-bearing ruminants the dichotomously forked have been separated into antlers without (*Procervulus*) and with burr (*Acteocemas*). Although the first is known by many specimens from Western and Central Europe, the knowledge of the latter has been mainly based on the type specimen. Yet recently, a pair of antlers on a skull roof has been unearthed in Switzerland, in association with teeth and some postcranial bones, from a well-dated geological section showing the same morphology as the type of *Acteocemas*. This finding is the most exactly dated early cervid record so far and does not only confirm the occurrence of *Acteocemas* in the early Miocene, but sets the early occurrence of at least two different simultaneous dichotomously forked stem lineages (Procervulinae, Dicrocerinae) on a more stable basis.

Here we present the new *Acteocemas* specimens for the first time and outline the biostratigraphic framework of the dawn of antler-bearing ruminants as well as morphological diversity and implied hypotheses on character evolution and phylogenetic lineages. Moreover, we demonstrate the current evidence of an early cervid radiation and subsequent changes in higher level systematics in case the last common ancestor of crown cervids will turn out to be a stem member with a more recent root, as recently hypothesized in molecular phylogenetics. In this context, we highlight critical connections of calibration points in molecular clock calculations and morphology.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

RECOVERY FROM THE LATE PERMIAN MASS EXTINCTION: NEW INSIGHTS FROM A NEGLECTED EARLY TRIASSIC FISH FAUNA FROM THE SALT RANGE (PAKISTAN, NEOTETHYS REALM)

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The study of diversity patterns across stratigraphic successions deposited after mass extinction events allows in-depth examination of biotic recovery dynamics. Previous studies on the recovery from the Late Permian mass extinction, the largest of its kind, predominantly focused on marine invertebrates and terrestrial vertebrates, but knowledge about patterns in fishes (Chondrichthyes, Osteichthyes) is still incomplete due to a lack of studies of Early Triassic faunas. The fossiliferous Permian-Triassic successions of the Salt Range and Surghar Range in northern Pakistan have been intensively studied during the last two centuries. Research especially concentrated on invertebrates, the palynoflora, and geochemistry, but fish fossils and even a few tetrapod remains have also been documented from marine deposits of Late Permian and Early Triassic age.

Ichthyoliths (chondrichthyan and osteichthyan teeth and scales) from mixed siliciclastic-carbonate shelf deposits of the Mianwali Formation (Early Triassic) within the Salt Range were first described in the 19th century. During the 20th century, several publications reported of additional fish material from the Early Triassic of the Salt Range, but almost no taxonomic studies on fishes have been performed since the early works. Here we present preliminary results of our investigations on chondrichthyan teeth from the Mianwali Formation. They were obtained through acid dissolution of bed-controlled rock samples of earliest Early Triassic (Griesbachian substage) to late Early Triassic age (Spathian substage). The chondrichthyan fauna of the Mianwali formation includes hybodontoids but also neoselachians. During recent years, it has been shown that the Early Triassic was a time of severe climatic upheavals associated with extinctions and turnovers. Thanks to a high-resolution biostratigraphic framework provided by ammonoids and conodonts, the new material from northern Pakistan allows detailed study of ichthyofaunal changes and a direct correlation with various climatic proxies, leading towards a better understanding of the recovery dynamics of fishes in the wake of the Late Permian mass extinction event.

Technical Session XIV (Saturday, November 8, 2014, 9:15 AM)

ICHNOLOGICAL EVIDENCE FOR DIVERSE PEDAL POSTURES IN ORNITHOPODAN DINOSAURS

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Evolutionary transitions involving changes in pedal posture may also lead to changes in associated soft-tissue structures of the pes. For extinct taxa, pedal posture can be gleaned in part from osteological evidence, augmented by ichnological data. Two different pedal postures have previously been proposed for ornithopodan dinosaurs: a digitigrade posture where the metatarsodigital joint is in close proximity to the plantar surface; and a subunguligrade posture where the metatarsodigital joint is permanently elevated. These postures have been linked to plesiomorphic (non-hadrosaurid) and derived (hadrosaurid) ornithopodan body fossil taxa, respectively. However, ichnological data suggest that the majority of ornithopodan taxa were digitigrade, with tracks typically displaying prominent metatarsodigital pad impressions, including those attributed to hadrosaurids. We propose that the information from both the osteological and the ichnological evidence indicates there are distinct skeletal and functional pedal postures within Ornithopoda. The likely plesiomorphic condition for ornithopods is a pedal posture that is both skeletally and functionally digitigrade, while the derived hadrosaurid posture is skeletally subunguligrade but functionally digitigrade. The hadrosaurid-like pedal posture was not limited to hadrosaurids, but may also have been present in some basal hadrosauriforms as well as in some basal Ankylopollexia. The latter possibility indicates that the hadrosauroid-like postural configuration may have evolved independently among different clades. Tracks assigned to the ichnogenus *Wintonopus* indicate that some small- to medium-bodied ornithopodan trackmakers had permanently elevated metatarsodigital joints but without an associated plantar (metatarsodigital) pad. The suggested pedal posture of these trackmakers is skeletally and functionally subunguligrade, a posture that was previously unrecognized for ornithopodans. By integrating osteological data with soft-tissue data derived from tracks, we find evidence for multiple transformational pathways within Ornithopoda that mirror the attainment of derived postures in extant lineages.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

PRESENCE OF ALBANERPETONTIDAE (LISSAMPHIBIA) FROM THE 'EL GALLO FORMATION' (LATE CAMPANIAN), BAJA CALIFORNIA, MEXICO

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Albanerpetontidae is an extinct clade of small-bodied, salamander-like lissamphibians, known from Middle Jurassic-Neogene localities. It includes four genera. In North America it is represented by *Albanerpeton* which includes five named and one unnamed species from Early Cretaceous to late Paleocene localities occurring along the Western Interior Seaway of southern Alberta and Saskatchewan, Canada, southward into United States reaching Texas.

Previous paleontological work in the 'El Gallo Formation', near El Rosario, Baja California, focused on the recovery of dinosaur remains; however a probable record of *Scotiophryne* and the presence of indeterminate amphibians were noted by previous authors. In 2004, a collaborative research project was initiated to continue paleontological fieldwork, with an emphasis toward screenwashing for the recovery of microvertebrates, and as a result remains of amphibians were found. The material was collected from two microsites and includes fragments of one maxilla, four dentaries, and one premaxilla, all of them bearing teeth. The teeth are pleurodont, chisel-like, non pedicellate and labiolingually compressed. One of the dentaries has an external nutritive foramen, low dental parapet, and a shallow, gutter-like subdental shelf anteriorly. All these characters are present in the members of the family Albanerpetontidae. Unfortunately, the material is too fragmentary to secure a generic identification, but most of the teeth are tricuspid suggesting that they belong to *Albanerpeton*. The lack of ornamentation in one dentary and the maxilla is reminiscent of *A. nexosus* described from Santonian-Maastrichtian faunas in North America, although these specimens are larger. One dentary is distinguished because the teeth are gracile and they are not tricuspid, but the dentary shows the diagnostic characters of Albanerpetontidae.

This is the first occurrence of Albanerpetontidae in the 'El Gallo Formation', Baja California, and its presence is important because it extends the geographic distribution of the family during the late Campanian, not only to the South but also to the Pacific Coast.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

VERTEBRATES FROM THE KIMMERIDGIAN (LATE JURASSIC) OF BRUNN, SOUTHERN GERMANY: THE OLDEST VERTEBRATE FAUNA FROM THE SOLNHOFEN ARCHIPELAGO

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Brunn (Oberpfalz, Bavaria) is one of the easternmost localities within the famous Solnhofen archipelago. The fossiliferous layers represent finely laminated limestones that were deposited in a small depocenter called the Pfraundorf-Heitzenhofener basin. The locality is especially noteworthy for representing the oldest fauna of the Solnhofen archipelago, having been dated in the *subeumela* subzone of the *beckeri* ammonite zone of the Late Kimmeridgian. The limestones of Brunn are especially rich in invertebrates, but numerous vertebrate specimens have also been found. Only a few of the fossils of Brunn have been scientifically analyzed as of yet—the only vertebrates published being the rhamphorhynchid pterosaur *Bellubrunnus rothgaengeri* and the pachycormiform

actinopterygian *Orthocormus roeperi*. The vertebrates from Brunn are exceptionally well preserved in respect to their completeness and remarkable state of articulation. Among them, fishes are the most abundant fossils. Apart from the pachycormiform *O. roeperi*, one shark, one coelacanth, three halecomorphs, two macrosemiids, one pycnodont, one aspidorhynchid, and at least six teleost taxa have been identified so far. With the exception of *O. roeperi*, which is only known from a single specimen, no endemic fish has been identified so far in the locality of Brunn; taxa identified to the species level are also present in the other Kimmeridgian or probably Kimmeridgian lagerstaette of central Europe (Kelheim, Ettling, and Painten in Germany and Cerin in France), or have wider stratigraphic distribution like the teleost *Tharsis dubius*. As in all localities of the Solnhofen archipelago, tetrapod remains are much less common. Groups recorded so far include turtles (*"Aplax oberndorferi"*, probably a juvenile of *Eurysternum*), a possibly atoposaurid crocodyliform, the pterosaur *Bellubrunnus*, and other fragmentary pterosaur remains, and rhynchocephalian lepidosaurs. The latter are the best-represented tetrapod group, with four complete skeletons having been found so far, and include at least two new taxa, as well as an early juvenile attributable to *Homoeosaurus*. The tetrapod fauna thus seems to demonstrate more endemism than the fish fauna, which might be expected in terrestrial vertebrates from an insular setting, where island speciation might have been common.

Technical Session VIII (Thursday, November 6, 2014, 2:15 PM)

EARLY EOCENE CAMBAYTHERES FROM INDO-PAKISTAN ARE THE SISTER GROUP OF PERISSODACTYLS

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Cambaytherium, *Nakusia*, and *Kalitherium* are closely related early Eocene mammals from the Indo-Pakistan region that have been assigned to Perissodactyla (Laurasiatheria) or Anthracobunidae. The latter have been variously considered artiodactyls or perissodactyls, but more recently are usually placed at the base of the order Proboscidea or of the more inclusive Tethytheria (Afrotheria). We present new evidence from the dentition, skull, and postcranial skeleton of *Cambaytherium*, from Gujarat, India (ca. 54.5 Ma), that cambaytheres occupy a pivotal position as the sister taxon of Perissodactyla.

Cambaytherium was more robust than basal perissodactyls such as *"Hyracotherium"* and *Homogalax*, and had a body mass of ~25-27 kg based on humeral, radial, and dental regressions. Perissodactyl synapomorphies include a transverse nasal-frontal suture, twinned molar metaconids, and an astragalus with deeply grooved trochlea and a saddle-shaped navicular facet. Like perissodactyls, cambaytheres are mesaxonic and have hoof-like unguals and a cursorially-adapted skeleton. Plesiomorphic traits compared to basal perissodactyls include bunodont molars with large conules and almost no hint of bilophodonty, unmolarized premolars, sacrum with four vertebrae, humerus with distally extensive pectoral crest and distal articulation lacking a capitular tail, distal radius without discrete scaphoid and lunate fossae, femur with low greater trochanter, calcaneus robust and wide with rounded ectal facet, astragalus wide with moderately long neck and vestigial astragalar foramen, navicular and cuboid short and wide, metapodials short and robust, and Mc I and Mt V present. In most or all of these traits cambaytheres are intermediate between phenacodontid condylarths and perissodactyls but closer to the latter.

Our phylogenetic analyses place cambaytheres just outside perissodactyls, and place anthracobunids among primitive perissodactyls. However, similarities between cambaytheres and anthracobunids suggest that they are closely related, and future discovery of skeletal material of anthracobunids will provide a test of this hypothesis. Our results indicate that Anthracobunidae are not Proboscidea or tethytheres, and suggest that the origin of Perissodactyla may have taken place on the drifting Indian plate. How the progenitors of perissodactyls reached India is more problematic but might have involved land connections with Afro-Arabia during the Paleocene.

Field work and research supported by the National Geographic Society.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

ECOLOGICAL AND PHYSIOLOGICAL IMPLICATIONS OF VERTEBRAL PATHOLOGY IN MOSASAURS

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Three forms of pathology are routinely noted in the vertebrae of mosasaurs: shark bites, avascular necrosis and fusion, in addition to isolated reports of what was thought to represent tumors. Grooves on vertebrae evidence shark bites, while associated new bone formation allows recognition of predation. The former is common; the latter, relatively rare but provides insights into behavior of both the mosasaur and its attacker. Recognition of diving disease in mosasaurs was based upon identification of a specific associated pathology, avascular necrosis. The devitalized bone typically becomes necrotic (and lucent to x-rays), secondary to loss of vascular supply. The resultant loss of mechanical integrity makes the surface susceptible to compression stresses across the shoulder and hip joint, respectively. The resultant damaged bone can no longer resist the normal stresses across the joint and partly collapses, producing a visible subsidence zone. Avascular necrosis was invariably present in *Platecarpus, Tylosaurus, Mosasaurus, Plioplatecarpus, Prognathodon, Hainosaurus* and an Antarctic mosasaur, and invariably absent from *Clidastes, Ectenosaurus, Globidens, Halisaurus* and *Kolposaurus*. Fused mosasaur vertebrae are attributable to reactive bone from trauma and infection (e.g., related to trauma of shark bites) and perhaps to splinting or to a disease documented in contemporary varanids. It would appear that fusion through vertebral centra occurs whenever motion is lost at that segment. However, there is another form of fusion through the outer layers of what was once presumed to have been an intervertebral disk, as has been documented in contemporary *Varanus*. Isolated suggestion of tumors is a more complex subject. The previous suggestion of osteoma must be rejected on the basis of apparent lesion size and location. The only other recognized 'tumor' has been called an osteoma, but its size complicates histologic examination to assure it is not simply a hamartoma, as human skull so-called osteoma have been now reclassified.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

BOVIDAE (MAMMALIA, ARTIODACTYLA) FROM THE PLIO–PLEISTOCENE BUSIDIMA FORMATION OF HADAR, AFAR REGIONAL STATE, ETHIOPIA, AND THE EVOLUTION, PALEOECOLOGY, AND BIOGEOGRAPHY OF BOVID FAUNAS AT HADAR CA. 3.4 TO 2.3 MA.

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Bovidae from the Busidima Formation at Hadar in northeast Ethiopia, ca. 2.3 to 1 Ma, are described. The assemblage is comprised of immigrant taxa common to the Omo-Turkana Basin but previously unrecorded from the Afar, including *Beatragus antiquus* and *Tragelaphus gaudryi*. This is in contrast to the older sediments of the Hadar Formation, ca. 3.4 to 2.9 Ma, which are characterized by a great diversity of endemic taxa. The bovid assemblage from the Busidima Formation suggests relatively open habitats, as alcelaphins and antilopins are most common, a pattern that contrasts with the older Hadar Formation which is comprised primarily of taxa suggesting wooded and well-watered habitats, such as Tragelaphini and Reduncini. We hypothesize that climatic change and the expansion of grassland ecosystems near the Plio–Pleistocene boundary fragmented stable, local habitats that persisted in the Afar and Omo-Turkana Basins prior to this time, and that these changes ultimately drove the dispersal of Omo-Turkana taxa northward before 2.3 Ma. These events culminated in the relatively low levels of endemism observed in East African bovid faunas during the early Pleistocene, with many common taxa shared across sites spanning northern Tanzania through northeast Ethiopia.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

***ARAGOSAURUS ISCHIATICUS*: NEW FOSSIL REMAINS FROM LAS ZABACHERAS SITE (GALVE, TERUEL, SPAIN)**

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Aragosaurus ischiaticus was the first dinosaur to be named in Spain. This dinosaur came to light from associated postcranial remains yielded at the Las Zabacheras site, which is located 150 m north of Galve village in Teruel Province (north-eastern Spain). Las Zabacheras site represents a deltaic sediment complex in the Villar del Arzobispo Formation with Tithonian-Berriasian (latest Jurassic-earliest Cretaceous) age. The site has been excavated by several paleontological teams who have found different bones, all of them belonging to the same specimen. At the end of 1950s it was presented for the first time in the local media. It was excavated again and defined in the 1980s by a team led by JL Sanz. Now in 2014, a new team of paleontologists from the Fundacion Conjunto Paleontologico de Teruel-Dinopolis and Universidad Autonoma de Madrid are revisiting Las Zabacheras. The main problem is that the area has been used as a dumpsite during the last decades. However, after removing rubble more than 4 meters in depth we have gained access to the layer with fossils and thus recover a historical site. At the moment, the new anatomical elements consist of two middle chevrons, a right sternal plate and a left tibia. This research has confirmed that another left sternal from the municipality of Galve collection belongs to the same *Aragosaurus* specimen for various reasons: it comes from the same site, it is symmetric to the right sternal we have just recovered and it is characterized by similar preservation. Chevrons are opened proximally with the facets very close. The complete chevron has a short haemal canal depth similar to the middle chevrons of *Aragosaurus*. The sternal is elliptical in outline, elongate and gracile. The medial border of the sternal is slightly convex with rugosities, while the lateral one is straight with a smooth surface. The tibia is a straight bone with the proximal end compressed mediolaterally. At the cranial margin of the proximal section stands the cnemial crest, which is craniolaterally projected. These new data and phylogenetic analyses support the view that *Aragosaurus* is a basal macronarian sauropod, lying outside of Titanosauriformes. *Aragosaurus* is one of the four genera of sauropods recovered from the Villar del Arzobispo Formation, making the latter an important contributor to our understanding of Late Jurassic sauropod diversity alongside the well-known contemporaneous faunas of the African Tendaguru Formation and the North American Morrison Formation.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

TAPHONOMY OF THE ORNITHOMIMOSAUR DINOSAUR HERD FROM THE EARLY CRETACEOUS LIGNITIC BONE BED OF ANGEAC-CHARENTE (FRANCE)

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Through the systematic excavations conducted by our team since 2010 in the quarry of Angeac-Charente, a large number of vertebrate fossils, including dinosaur, crocodile and turtle remains, have been recovered. To date, the fossiliferous lignitic bone bed has yielded more than 3000 bones or teeth excavated from a surface of 230 m^2. Nearly half of the collected bones (1380) belong to a new ornithomimosaurian taxon. Most of the bones of the ornithomimosaur are found isolated. They can be cracked and broken, but their external surface and 3D aspect are well preserved, allowing observation of fine anatomical structures (muscle insertions), and traces produced during taphonomic processes.

Preliminary taphonomic works allow us to characterize the bonebed. The latter shows a wide range of fossil size, a high diversity of vertebrate taxa and is dominated by the new species of ornithomimosaur. The various taphonomic signatures observed on bones (cracking, fracturing, erosion and marks) underlines the complexity of the depositional history, showing a mixture of bone concentrating influences: ecological, biological and physical.

Ornithomimosaurs are represented by at least 20 individuals, based on the minimum number of tibiae, unearthed from a surface of about 100 m^2. Close proximity of ornithomimosaurian remains, homogeneous age-profile, absence of hydraulic sorting of elements depending on Voorhies groups and uniform preservation of unweathered and unabraded ornithomimosaurian bones indicate a catastrophic mass-mortality occurrence rather than attritional accumulation of bones. In-situ breakage pattern, skeletal completeness analysis, rarity of tooth marks and abundance of scratch marks on bone surfaces suggest an intense trampling of the ornithomimosaurian remains, at the origin of skeletal disarticulation, as well as displacements, cracking and fracturing of bones. The chronology of these taphonomic signatures on ornithomimosaurian bones and results of a trample experiment in Angeac sediments, realized during summer 2013 field campaign, support this assumption.

The 20 ornithomimosaurs are arranged into six distinct age classes, from juveniles to sub-adults. This indicates that they probably belonged to a juvenile-dominated multi-year herd, as in modern ostriches. This kind of gregarious habit has been previously reported for other ornithomimosaurian species, as *Sinornithomimus dongi* from the Upper Cretaceous of China.

Technical Session XIII (Friday, November 7, 2014, 2:45 PM)

DENTAL EVOLUTION READ IN TOOTH AND JAW

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Theories on the evolution of teeth and tooth replacement in jawed vertebrates have been based largely on chondrichthyans, because they constitute the sister lineage to all other crown-gnathostomes, and because their comparatively simple structure fulfills expectations. However, living chondrichthyans are a mosaic of secondary specializations resulting in simplification of morphology that, without consideration of stem-chondrichthyans and, indeed, stem-gnathostomes, provide a poor guide to ancestral gnathostome conditions.

We employed digital, non-destructive methods including synchrotron X-ray tomographic microscopy (SRXTM), to determine sclerochronology in order to elucidate the pattern of tooth development and replacement in stem-gnathostomes, stem-chondrichthyans and both stem- and crown-osteichthyans.

Taking this broader approach, it is clear that teeth evolved long before the first crown-gnathostomes since they are present in placoderms, an array of sister lineages to crown-gnathostomes. Here, teeth are replaced but not shed, arranged in two or more rows. Evidently, the files of shed and replacement teeth are a specialization of chondrichthyans, not a primitive condition for jawed vertebrates. However, tooth whorls, comprised of teeth that are replaced but not shed, may be a component of the dentition that is primitive to crown-gnathostomes.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

EGGS AND EGGSHELLS OF CROCODYLOMORPHA FROM THE LATE JURASSIC OF PORTUGAL

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The Lourinha Formation, cropping out on the western shore of Portugal, dated from the Late Kimmeridgian to latest Tithonian-earliest Berriasian, has produced an extensive record of fossil vertebrates, including nine localities with nests, eggs and embryos. In four of these localities, Paimogo N and S, Casal da Rola and Peralta, several thinner eggshell fragments were recovered associated with dinosaur egg material. Besides the fragments, 3 partial eggs were found. In a fifth locality, in Cambelas, a nest with 13 mostly well-preserved eggs was recovered. On average, these eggs are 42 mm long and 26 mm wide. Preliminary observations suggested a crocodilian affiliation based on eggshell features such as tabular ultrastructure, wedge-shaped shell units and triangular blocky extinction. We found that, excluding the small nest, all the samples exhibit a clear, outer diagenetic layer (DL) with recrystallized and secondary calcite. The typical crocodiloid ultrastructure and shell units are present, although faint and not always clearly defined; strong sub-horizontal fracturing precludes a more extensive description. No ultrastructure is observable in the nest sample. The presence of basal plate group knobs on the inner eggshell surface is also diagnostic. Three layers can be differentiated in three of the samples, with an inner or mammillary layer corresponding to the dark basal knobs, a middle layer characterized by the presence of the tabular ultrastructure, and an outer layer, below the DL, distinguishable from the middle layer by a darker thin band. Furthermore, all the samples show the distinct triangular blocky alternating extinction. The thicknesses range between 163 µm and 392 µm, which is consistent with values for fossil crocodiloid eggshells. The density of the mammillae is very similar to what is observable in extant eggshells, as are the pores, with long, straight canals. Moreover, the ellipsoid shape of the eggs is typically crocodilian, even though such shape is shared with some dinosaur eggs. Thus, this analysis allows us to ascribe it to the oofamily Krokolithidae, making them the oldest crocodylomorph eggs known so far, as well as the best record for eggs of non-crocodylian crocodylomorphs. Based on the morphological characters, we tentatively assign it to the oogenus *Krokolithes*. The structure of crocodilian eggshells is very conservative and has seemingly remained unchanged since at least the Late Jurassic.

Symposium 4 (Friday, November 7, 2014, 8:15 AM)

THE DVINOSAUR *KOURERPETON*, AND A NEW ANALYSIS OF RELATIONSHIPS AND EVOLUTIONARY RATES IN PALAEOZOIC TEMNOSPONDYLS

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The anatomy of the temnospondyl *Kourerpeton bradyi* (probably originating from the San Angelo Formation, Texas) is reviewed in conjunction with a new cladistic analysis of (chiefly) Palaeozoic temnospondyls. Notable features of *Kourerpeton* include the small postfrontals (albeit these are comparatively larger and more elongate than those of tupilakosaurids), broad polygonal postorbitals, a shallow squamosal embayment, and absence of an incisure along the distal portion of the pterygoid quadrate ramus. *Kourerpeton* is nested within dvinosaurs, in an apical position relative to trimerorhachids, eobrachyopids, and dvinosaurids and as a sister taxon to tupilakosaurids. Reassessment of *Kourerpeton* prompted a re-analysis of the large-scale relationships of Palaeozoic temnospondyls. Dvinosaurs and a clade consisting of eryopoids plus basal archegosauriforms compete for their placement as the second earliest diverging radiation at a post-edopoid level of temnospondyl organization. A study of rates of character change reveals significantly high rates in the most apical regions of most temnospondyl clades (an exception is represented by edopoids) as well as along the internal branches that connect such radiations. Rates tend to decrease significantly within certain branches in dissorophoids (e.g. branch leading to amphibamids) and in dvinosaurs (e.g. post-eobrachyopid taxa).

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

MACROSCOPIC TOOTH WEAR AND DIETS OF EXTANT AND FOSSIL XENARTHRANS (MAMMALIA, XENARTHRA)

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Xenarthra is one of the major superorders of placental mammals. It comprises a major group of the large terrestrial mammal fauna in South America during the Cenozoic and in North America during the Pleistocene. Understanding dietary paleoecology of Xenarthra would provide information not only about the dietary adaptations of the species but also about how their diets have varied according to changing resources and environmental conditions. The usually simple and reduced tooth morphology of the xenarthrans, lacking enamel, has rendered dietary analyses based on their fossil teeth challenging. In particular, the problem is analyzing paleodiets of xenarthrans using a consistent methodology which would give results comparable to mammals with other kinds of tooth morphologies. We introduce a new method based on macroscopic tooth wear morphology easily applicable for fossil and extant xenarthran teeth. Relief on the occlusal surface of xenarthran teeth forms during the tooth wear as a result of uneven wear of harder dental materials (durodentin) and softer dental materials (vasodentin). The wear-resistant durodentin edges of the teeth wear down more heavily as a result of abrasive food materials (for example grass), causing lower relief of the tooth surface. The new method is similar to mesowear analysis and it is based on measuring the relief of the worn molariform teeth of xenarthrans as antero-posterior angles by placing the tip of the angle at the bottom of worn vasodentin valleys and the sides of the angle as tangent to durodentin edges of the teeth. The wider the measured angles are, the lower the worn tooth relief is, which indicates an increasingly abrasive diet. This method gives consistent, comparable information about the relief of the worn tooth surface regardless of differences in the primary morphology of the teeth. We have previously successfully applied this method for dietary analysis of proboscideans. The results based on our angle-based method of recording tooth surface relief correlate with dietary analyses based on stable isotopes from xenarthran teeth. This work was funded by the Finnish Doctoral Program in Geology and the Waldemar von Frenckells Stiftelse.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

THE LATE CENOZOIC PROBOSCIDEANS OF MYANMAR: A REAPPRAISAL.

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Paleontological expeditions of the Irrawaddy sediments and the Freshwater Pegu Beds, as well as reappraisal of the collections of proboscidean fossils housed in museums and universities in Myanmar, sheds new light on the Neogene

The Freshwater Pegu Beds yields a small sized gomphothere, besides a small deinothere comparable with *Prodeinotherium pentapotaminae* from the lower Siwalik of India and Pakistan. This gomphothere, represented by isolated teeth showing amebelodont traits such as symmetric pretrite trefoil and presence of posttrite conules, appears to be endemic to Indochina.

Irrawaddy sediments yields *Sinomastodon*, *Anancus* and various stegodontids. The materials of *Sinomastodon* from both the Upper of Myanmar and those from Nakhon Ratchasima province, Northeast Thailand include both the derived and primitive morphotypes, suggesting that this genus has been present in Indochina since the late Miocene. A left gomphothere intermediate molar (NHM m15594) and a right m3 (NMMP-KU-IR 0441)housed in the Natural History Museum, London and the University of Yangon, respectively, represent an anancine that exhibits primitive cusp arrangement and can be compared with *A. perimensis* from India.

The Lower Irrawaddy and possibly the Freshwater Pegu Beds yield a primitive stegodontid of tetralophodont grade, *Stegolophod latidens*, and the upper Irrawaddy yields derived *Stegolophodon stegodontoides* and an unnamed species of primitive *Stegodon*. These materials appear to represent an evolutionary transition between the two genera of the family Stegodontidae. Numerous stegodont molars from the Upper Irrawaddy show the spectrum of dental evolution of the genus *Stegodon,* and the types of *S. elephantoides* and *S. insignis birmanicuscan* can be placed in this spectrum. A *Stegodon* skull from the Upper Irrawaddy exhibits a quite dissimilar morphology to previously known *Stegodon* crania from other regions of Asia and suggests that the stegodont molars from the Irrawaddy sediments represent a new species of the genus. A

small M3 (NMM-PB1) housed in the University of Yangon is similar to a set of upper and lower large stegodontoid molar from Nakhon Ratchasima in having a reduced central conule on both pretrite and posttrite half lophids. They may represent the small and large species of the same stegolophodont clade.

Technical Session X (Friday, November 7, 2014, 10:15 AM)

BLOOD IS THICKER THAN WATER: REPLACEMENT PATTERNS IN EURASIAN FELIFORM CARNIVORES

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Recent studies have indicated that relatedness, speciation rates, and dietary specialization have varying influences on evolutionary dynamics within different Cenozoic mammal orders and families. The New and Old Worlds (NOW) database of fossil mammals contains extensive information on Cenozoic (65 Ma-recent) land mammal taxa and localities. A key strength of the NOW database is that, in addition to the locality-taxon data, the taxa are recorded with their ecomorphological properties. In our study, novel supertree phylogenies of the carnivoran families Felidae, Barbourofelidae, and Hyaenidae (suborder Feliformia), NOW database data, Cenozoic climate/environmental proxies, and new phylogenetic comparative and range-overlap methods were used to explore macro-evolutionary questions relating to replacement patterns of Cenozoic mammals. Results for Eurasian mammal localities and taxa indicate that the importance of relatedness in taxon replacement varies among clades and between time intervals. In most cases, replacement was more likely by closely related taxa than by distantly related taxa. However, in the subfamily Felinae the pattern was the opposite; distantly related taxa were more likely to take over ranges lost during the whole duration of each taxon. Additionally, even though there was a strong signal for phylogenetic relatedness playing a role in replacement over the studied time interval as a whole (European mammal stages MN1-MQ18, approximately 24-0.85 Ma), during times of considerable environmental change and faunal turnover, e.g. the Vallesian crisis at 9.5 Ma and the end-Miocene collapse of the Pikermian biome at 5.3 Ma, the role of relatedness is diminished.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

EVIDENCE FROM THE CLOUD FOREST: MATTHIESSEN SPECIMEN OF *PURUSSAURUS* FROM THE LATE MIDDLE MIOCENE OF PERUVIAN AMAZONIA

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Peter Matthiessen in his classic of 1961 "The Cloud Forest", detailed the discovery of a one-hundred-kilogram 'giant mandible' in a creek bank of the Mapuya River, Peruvian Amazonia. He canoed with the heavy fossil for around 300 km down the Ucayali River to Pucallpa city where the specimen was retained in the police station and subsequently lost for more than three decades. In 1997, the fossil was recovered by the Ucayali Regional Government and stored at the Museo Regional de Pucallpa (MRP).

The fossil specimen (MRP 19), is a snout preserved anterior to the suborbital fenestrae, and presents a broad, deep, and heavily-sculpted rostrum and large external naris, both diagnostic features of the giant caiman *Purussaurus*. Stratigraphy and paleontology of the *Purussaurus*-bearing outcrops at the Mapuya River and surrounding areas of the Fitzcarrald Arch concur to assign a late middle Miocene age to this assemblage based on high faunal similarity with the La Venta mammals of Colombia. However, MRP 19 more closely resembles late Miocene species of *Purussaurus* from Acre (Brazil; *P. brasiliensis*) and Urumaco (Venezuela; *P. mirandai*) than the coeval species from La Venta (*P. neivensis*), in having short V-shaped nasals, a postnarial fossa, and huge size. Nonetheless, the unique features of MRP 19 were only revealed after removing the hard matrix of the dorsal surface of the rostrum. The narial opening is capacious and elongated, but it only reached posteriorly the level of the fifth maxillary alveolus, whereas in the late Miocene species it reached the eighth alveolus level. Behind the narial opening and fossa, the dorsal surface between both rostral canthi is not longitudinally depressed. This region is relatively flat in *P. neivensis* but deeply depressed in the younger species. Ventrally, the vomer is exposed behind the premaxillary-maxillary suture, as we suspect is characteristic for the genus *Purussaurus*. Within the maxillary dental series, all *Purussaurus* specimens known show unambiguously that the third alveolus is slightly bigger than the fourth, a unique feature among caimanines.

During the late middle Miocene, the Fitzcarrald *Purussaurus* and *P. neivensis* inhabited different areas of the vast Pebas System, a complex of mega-wetlands that covered most northwestern South America. By the late Miocene, strong Andean uplift divided the 'pan-Amazonian' region and further favored allopatric speciation of *Purussaurus* within the newly born Orinoquia and Amazonia basins.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

FIRST RECORD OF THE GENUS *HYPOSAURUS* (CROCODYLIFORMES: DYROSAUIDAE) FROM THE LATE CRETACEOUS OF SUDAN

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The Late Cretaceous ?Campanian-Maastrichtian Shendi Formation of Sudan is known to yield remains of fossil vertebrates, but in comparison to other, contemporaneous formations from Sudan the unit has remained largely unstudied. Here we report on new dyrosaurid crocodyliform material from this formation that represents the first record of the genus *Hyposaurus* from this formation, and potentially the oldest known occurrence of this taxon. The material consists of an incomplete, associated skull that includes a partial mandible, a posterior portion of the upper jaw, and a fused frontal complex, all belonging to a single individual. The partial mandible preserves five alveoli in both dentaries, with the eighth alveolus being the largest. The alveoli are laterally oriented and circular in shape, with their raised borders projecting dorsally. The preserved portion of the upper jaw includes a partial posterior maxilla, which is dorsomedially separated from its complement by the nasal and the anterior lacrimal process. The comparatively wide frontal preserves the interorbital and the interfenestral portions and shows a distinct ornamentation on its dorsal surface. Taken together, these features support an assignment of the material to *Hyposaurus*. This assignment is additionally supported by the elliptical shape of the mandibular symphysis, which is wider than high, unlike other dyrosaurid taxa, as well as the overall flat shape of the mandible. The occurrence of *Hyposaurus* in the Shendi Formation represents the first record of this genus from the Late Cretaceous of Africa, and extends its temporal range back into the Campanian (and possibly earlier), pending revised dating of the Shendi Formation. While this occurrence in the Late Cretaceous of Sudan supports previous hypotheses of an African origin of *Hyposaurus*, more complete material is needed for evaluating these hypotheses in a phylogenetic framework.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

THE EARLY CRETACEOUS DINOSAURIAN ICHNOFAUNA OF THE BROOME SANDSTONE FROM THE WALMADANY AREA (JAMES PRICE POINT) OF THE DAMPIER PENINSULA, WESTERN AUSTRALIA

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The Early Cretaceous (Valanginian to Barremian) Broome Sandstone of the Dampier Peninsula, Western Australia, has often been touted as having one of the most diverse dinosaurian ichnofaunas in the world. Yet with the exception of tracks assigned to the theropodan ichnotaxon *Megalosauropus broomensis*, and more recent work on the preservational characteristics of sauropodan tracks, descriptive accounts of the types of dinosaurian tracks that occur in the Broome Sandstone have been limited, with reports ranging from 6-16 different ichnotaxa. As such, the overall scientific significance of the ichnofauna has remained enigmatic.

At the request of Goolarabooloo Traditional Custodians, over 300 hours of ichnological survey work was undertaken on the 25 km stretch of coastline in the vicinity of Walmadany (James Price Point) over a three year period from 2011 to 2013. 48 discrete tracksites were identified, containing upward of 20 track types referable to theropodan, sauropodan, ornithopodan and thyreophoran trackmakers. Around half of the track types can be formally assigned to known and new ichnotaxa, while the remainder represent informal but distinctive morphotypes. All the tracksites in this part of the Dampier Peninsula occur in the same type of horizon, and the level of diversity of the main track types is comparable across areas where the tracksites are concentrated. The overall diversity of the dinosaurian ichnofauna in the Broome Sandstone is unparalleled in Australia, and even globally. In addition to being the primary record of non-avian dinosaurs in the western half of Australia, this ichnofauna provides our only detailed glimpse of Australia's dinosaurian fauna during the first half of the Early Cretaceous. It indicates that the general composition of Australia's mid-Cretaceous dinosaurian fauna was already in place by the Valanginian to Barremian. Both sauropods and ornithopods were diverse and abundant, and thyreophorans were the only type of quadrupedal ornithischian. Notable is the presence of large-bodied theropods, the immense size of some of the sauropods, the high diversity of ornithopods, including large-bodied forms reminiscent of hadrosauroids, and the high diversity and abundance of thyreophorans, among which were probable stegosaurians.

Technical Session XIII (Friday, November 7, 2014, 3:00 PM)

ECOLOGICALLY DRIVEN 'COPE'S RULE' SIZE INCREASES IN DEVONIAN FISHES REVERSED BY END-DEVONIAN MASS EXTINCTION

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Body size has a profound effect on all aspects of vertebrate ecology and biodiversity, including extinction risk, prey choice, and generation times. Evidence for active, large-scale body size trends, such as 'Cope's rule' (long-term coordinated increases) and the 'Lilliput effect' (short-term reduction after mass extinction) is limited for early vertebrates. It has been hypothesized that observed Devonian size increases were abiotically-driven and correlated with oxygen levels, but this was based on incomplete data. We analyzed a new, comprehensive database of over 1100 Devonian-Mississippian (419-323 Ma) vertebrate body sizes to track change during a critical interval in early fish and tetrapod evolution. We found coordinated 'Cope's rule'-type increases in median, mean, maximum and minimum vertebrate body sizes over the entire Devonian. This occurred at all levels of global diversity, involving jawed and jawless fishes, fresh and saltwater ecosystems, and classes and genera, but was unrelated to either oxygen or temperature changes. These size trends were abruptly stopped by the end-Devonian Hangenberg extinction (359 Ma), marked by loss of most Devonian gains. In terms of size, Mississippian ecosystems more closely resembled the earliest Devonian, with bimodal distributions involving a small-sized/r-selected new majority of ray-finned and cartilaginous fishes (Actinopterygii and Chondrichthyes) and fewer larger-sized/K-selected dead clades (e.g. the acanthodian *Gyracanthus*). The dominant 'Lilliput' fish fauna remained biased toward smaller sizes over the Mississippian while large-bodied aquatic lineages became scarcer, suggesting high-level selection for small taxa. Likewise, the sizes of doomed Devonian jawless fish lineages, static early on, dramatically increased alongside the numerical rise and increased ecological complexity of jawed fishes, continuing this trend even as their numbers subsequently declined. Thus, long-term size change in early fishes appears to have occurred under active selection driven by ecological interactions, with direction dependent on initial conditions. In both the

Devonian and Mississippian, vertebrate size trends ramped up and continued long after the establishment of feeding morphologies, suggesting that dietary diversification preceded size changes at global scales.

Technical Session X (Friday, November 7, 2014, 9:30 AM)

FILLING THE CENOZOIC GAP: MIOCENE BATS FROM NOSY MAKAMBY, MADAGASCAR

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The near total lack of Cenozoic terrestrial fossils has inhibited direct testing of biogeographic hypotheses regarding the origin and evolution of Madagascar's unique fauna. The extant bat fauna of Madagascar includes 49 species, but the published fossil record consists of only 11 Late Pleistocene/Holocene species. Bats are thought to have arrived on the island through multiple dispersal events, largely after the mid-Miocene. We report here a collection of bat fossils recovered from Miocene sediments on the island of Nosy Makamby, northwestern Madagascar. Fossiliferous deposits consist of medium to coarse sandstones representing a coastal plain/near-shore marine environment. The palaeoecological setting was likely similar to the warm tropical environment interpreted for Riversleigh, a mid to late Cenozoic locality in Australia that is rich in bats. Fossils were extracted using acetic acid preparation techniques and include jaws, partial limb bones, and isolated teeth. Tooth morphology most closely resembles that of *Hipposideros* (Hipposideridae) based on the dental formula, small upper premolar shifted lateral in the toothrow, and distinctive morphology of P_2. *Hipposideros* is widely distributed throughout the Old World tropics, including *H. commersoni*, currently the largest extant microchiropteran bat in Madagascar. Subfossil *H. commersoni* has been described from Madagascar, as well as the larger extinct *H. besaoka*. Some of the Nosy Makamby Miocene specimens exceed both modern *H. commersoni* and subfossil *H. besaoka* in size, suggesting that they may represent a new species. The Nosy Makamby specimens represent the earliest record of fossil bats in Madagascar and the first non-marine fossils from within the island's 80 million year fossil gap (virtually no fossil vertebrates are known from the later Cretaceous to the sub-Recent). A better understanding of this faunal assemblage has great potential to help reconstruct the biogeographic history of Malagasy bats, and demonstrates the potential for recovering small fossils from nearshore marine sediments. These types of localities may currently represent the best opportunity to elucidate how, when, and from where the ancestors of Madagascar's modern animals arrived.

Symposium 4 (Friday, November 7, 2014, 9:15 AM)

TEMNOSPONDYL LIMB-BONE PALEOHISTOLOGY REVEALS A GREAT RANGE OF EVOLUTIONARY ADAPTIONS TO VARIOUS ENVIRONMENTS

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Temnospondyls form a speciose group of tetrapods comprising 198 genera, spanning more than 200 million years (Lower Carboniferous-Lower Cretaceous). They form abundant components of vertebrate faunas worldwide and existed in extremely different environments. In an attempt to explain their evolutionary success, we apply paleohistology to a range of well-preserved temnospondyl taxa.

Bone histology has been widely used within extant vertebrates to provide information on growth rate, metabolism and life history traits. This histological database has become an invaluable comparative source for paleobiologists. Based on the current knowledge of bony microstructures, we are able to reconstruct formerly inaccessible paleobiological aspects in selected temnospondyls and display a great range of their adaptative strategies.

The study of three time-averaged paleopopulations of the branchiosaurid *Apateon* from different localities of the Saar-Nahe Basin in Germany showed that they apparently adjusted their metabolic activity to local conditions. Their limb bone histology shows a different number of annual growth marks depending on environmental parameters that each paleopopulation was exposed to. Conceivably, metabolic flexibility permitted *Apateon* to exist at various elevations within the Variscan orogen. Different heterochronic patterns between these same paleopopulations explain their ability to cope with hypoxic conditions and other unfavorable water properties, existing in lakes in which other vertebrates were absent.

The paleohistological study of the plagiosaur *Gerrothorax*, present in a wide range of habitats from the Germanic Basin, suggests that growth rate, age at maturity, and life span were all subject to broad variation in different paleopopulations. *Gerrothorax* is further peculiar in exhibiting an extreme morphological stasis, spanning some 35 million years during the Triassic. This wide reaction norm permitted adjustment to fluctuating conditions such as salinity and level of nutrients, making *Gerrothorax* an abundant pioneer taxon among aquatic tetrapods. The enhanced plasticity of some temnospondyls could explain their long persistence, especially that of stereospondyls in Inner Asia and Australia.

Technical Session IV (Wednesday, November 5, 2014, 2:00 PM)

NEW FOSSIL MAMMALS FROM THE NORTHERN NEOTROPICS (URUMACO, VENEZUELA; CASTILLETES, COLOMBIA) AND THEIR SIGNIFICANCE FOR THE LATITUDINAL GRADIENT IN DIVERSITY AND THE GREAT AMERICAN BIOTIC INTERCHANGE

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The Great American Biotic Interchange (GABI) refers to the faunal exchange between North and South America around the time of closure of the Central American Seaway, an event that modified the mammal fauna of both continents. Current hypotheses about diversity dynamics during this event have been mostly based on data from temperate sites. We present new data from the Urumaco sequence in Venezuela and from new sites at the Guajira Peninsula, northeastern Colombia, which together comprise a series of faunas from the early Miocene to the early Pliocene. Due to their age and geographical location, they serve to characterize the Neotropical mammal community before and after GABI′s migrational intervals. Studies of taxonomic groups involve teams of researchers. In Urumaco the greatest diversity of mammals is in the xenarthrans, with at least 20 species of Mylodontids, Megalonychids, Megatherines, Glyptodontids, Pampatherids, and Dasypodids. Some species provide insights into the re-ingression from North America, taxonomic affinities with megalonychids otherwise present in the Caribbean islands, and the record in these northern latitudes of 'basal' forms recorded in earlier deposits of higher latitudes. Among rodents, the revision of both new dental and postcranial remains and their variation revealed that several species must have existed, including *Phoberomys pattersoni*, *Eumegamys* sp., and *Neoepiblema* sp. Among the ″meridiungulata″, cranial remains of toxodonts suggest the presence of forms with plesiomorphic features unexpected for animals at this geological age. Astrapotheres include cranial remains from Castilletes representing the oldest record of Uruguaytheriinae in the tropics, whereas materials from the Urumaco sequence are postcranials which provide insights into locomotory style. The oldest procyonid carnivores from the northern neotropics are recorded based on dental remains, from Castilletes and Urumaco (San Gregorio Fm.). We complement field data by compiling and analyzing the composition of late Neogene mammal assemblages in the Americas by computing the percentage of both native and migrational faunas across a latitudinal gradient. Migrations started in the late Miocene (~10 Ma), but most exchange occurred after the early Pliocene (~5 Ma). In tropical South America migrants are first recorded in the Pliocene. In temperate South America, there are records of North American migrants during the late Miocene and Pliocene, but it is not until the Pleistocene when migrants became common

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A PNEUMATIC CAVITY IN AN *ALAMOSAURUS* PUBIS: THE FIRST EVIDENCE OF PUBIC PNEUMATICITY IN SAUROPODOMORPHS AND THE IMPLICATIONS OF PELVIC PNEUMATICITY IN NEOSAUROPODS

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LACM (Natural History Museum of Los Angeles County) 156591, a nearly complete sauropod left pubis, was recovered from the Naaishobito Member of the Ojo Alamo Formation of the Bisti/De-Na-Zin Wilderness, New Mexico (USA). *Alamosaurus* is thus far the only titanosaur recognized from the Upper Cretaceous strata in North America, so it is likely that these remains pertain to *Alamosaurus sanjuanensis* or a related species. The bone has a maximum proximo-distal length of 1210 mm and a proximal width of 840 mm; the iliac and ischiadic peduncles, and most of the shaft, are complete.

A large, triangular, distally-directed cavity, 35 mm long and 17 mm wide, pierces the ventral rim of the oval-shaped obturator foramen. Several sets of high-resolution computed tomography (CT) scans were taken of the cavity (pixel size of 0.5 mm). The cavity penetrates distally for approximately 27 mm before merging into a complex of small spaces within the bone. It is not presently clear whether these spaces are pneumatic camellae or large marrow-filled trabecular spaces. The margins of the cavity are smooth, finished bone, and the cavity itself was obscured by matrix and only discovered during preparation; it is not an artifact of breakage or preparation, and there is no evidence of pathology. Several lines of evidence suggest the cavity is pneumatic: large neurovascular foramina in the vertebrae of whales and ungulates are subcircular and connect to vascular canals that run through the bone. This cavity is triangular and does not connect to any persistent canals in the bone; it is similar to deep, non-ramifying pneumatic fossae in sacral vertebrae of *Haplocanthosaurus*. Also, primary neurovascular foramina in bones tend to be conserved; the absence of similar cavities in other sauropods is more consistent with the inherent variability of pneumaticity. Finally, the presence of this cavity inside the obturator foramen is consistent with the tendency of pneumatic diverticula in birds to follow neurovascular bundles.

This is the first instance of pneumatic invasion of the pubis in a sauropodomorph. The pelvic elements of birds are pneumatized by diverticula that surround the acetabulum. Pneumatization of the ilia in many derived neosauropods, the ischia in the rebbachisaurid *Tataouinea*, and now this pubis of *Alamosaurus*, suggest that similar pelvic diverticula were present in neosauropods. This discovery adds to an expanding body of evidence showing that pneumatic diverticula like those of birds were both taxonomically and anatomically widespread in non-avian saurischians.

Technical Session VIII (Thursday, November 6, 2014, 3:00 PM)

PROBOSCIDEANS FROM THE LATE EOCENE BIRKET QARUN FORMATION OF NORTHERN EGYPT, AND THEIR BIOCHRONOLOGICAL IMPLICATIONS

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Recent fieldwork in the late Eocene (ca. 37 Ma) Birket Qarun (BQ) Formation (Fm) of Fayum, Egypt yielded a wealth of the oldest-known moerithere fossils and more rare remains of barytheres. The semi-aquatic adaptations of these odd-shaped proboscideans are anatomically and ecologically convergent on those of hippos, sirenians, and desmostylians. Moeritheres are well documented from the late Eocene Qasr el Sagha Fm. and late Eocene–early Oligocene Jebel el Qatrani Fm of the Fayum, allocated conventionally to the time-successive species *M. lyonsi* and *M. trigodon*, respectively. *Moeritherium* is also documented primarily by isolated teeth from the Priabonian site of Bir el Ater, Algeria (*M. chehbeurameuri*) and the Evaporite and Idam Units, Dur At-Talah (DAT), Libya. These units, originally calibrated to the late Eocene–early Oligocene, were more recently hypothesized to be late middle Eocene (Bartonian) in age,

suggesting that DAT was the locus of the oldest anthropoid radiation in Africa. Support for this interpretation was offered by cursory biochronological interpretation of the proboscideans from the site.

Detailed comparative analysis of DAT and BQ moeritheres was undertaken based on cheek tooth dimensions and occlusal features (e.g., crescentoid and tritoloph(id) development, number of conelets) and indicates that moeritheres evolved very conservatively; BQ moeritheres are most similar to *M. lyonsi*; and the modest sample of DAT moerithere teeth, nearly all from the Idam Unit, are larger than and morphologically dissimilar to those from Bir el Ater, and are generally more derived than those of BQ and reminiscent of *M. trigodon* teeth. The numerous DAT remains of barytheres resemble those of *Barytherium grave* from the Qasr el Sagha Fm. and the barytheres from BQ; a small barythere-like taxon, *Arcanotherium savagei*, is known only from DAT and therefore has limited biochronological value; palaeomastodonts from DAT are elsewhere limited to Oligocene occurrences. These observations indicate that the proboscidean fossils of DAT provide better evidence for a Priabonian–Rupelian than Bartonian age for the site, as originally determined. This project was supported by NSF Grants BCS-0819186 to E.S. and BCS-0416164 to E. Simons and E.S., and by the Leakey Foundation.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

TWO GOOD NEIGHBORS: NICHE PARTITIONING IN MIOCENE RHINOS (RHINOCEROTIDAE, PERRISODACTLYA) FROM THE IBERIAN PENINSULA

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Rhinoceros remains from the new Late Aragonian (Middle Miocene) locality of M-407 Rotonda (Tagus Basin, central Spain) represent two taxa: *Alicornops simorrense* and *Lartetotherium sansaniense*. These two species are commonly found together in the Upper Aragonian and Lower Vallesian deposits of Western Europe. In order to unravel the biotic preferences of *A. simorrense* and *L. sansaniense*, a multiproxy reconstruction based on morphological comparison of both cranial and postcranial remains and tooth enamel stable isotope analyses has been performed. Isotopic results (*A. simorrense*: $\delta^{13}C = -11.2\pm0.4‰$, $\delta^{18}O = 29.5\pm1.2‰$; *L. sansaniense*: $\delta^{13}C = -9.1\pm1.1‰$, $\delta^{18}O = 30.0\pm1.3‰$) show enamel $\delta^{13}C$ values indicative of C_3 vegetation since Iberian continental ecosystems during the late Aragonian were dominated by these plants. The similarity of tooth enamel $\delta^{18}O$ values point to ingestion of water with a similar isotopic value. Lower $\delta^{13}C$ values shown by *A. simorrense* suggest feeding in woodland or mesic C_3 grassland. Additionally, the more folded enamel pattern observed in *A. simorrense* suggests processing more abrasive items (grit, dust, wooden parts, and/or soil ingestion if consuming subterranean resources). *A. simorrense*'s shorter limbs and occiput orientation support a consumption of resources close to the ground. Sexual dimorphism observed in tooth morphology suggests a gregarious behavior. Higher $\delta^{13}C$ values observed in *L. sansaniense* suggest ingestion of vegetation from woodland-mesic C_3 grassland and open woodland-xeric C_3 grassland. Long and slender limbs point to a cursorial behavior and therefore, occupation of more open environments.

Morphological and isotope data of rhinoceros enamel presented here indicate occupation of different ecological niches. Sympatry between *A. simorrense* and *L. sansaniense* was facilitated by resource and habitat partitioning as indicated by isotopic and morphological results with the former incorporating more abrasive dietary resources from wetter areas (e.g., marsh, riparian forest) and the later consuming leafy parts from more open areas.

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Technical Session X (Friday, November 7, 2014, 8:15 AM)

DIFFERENTIAL RATES OF EVOLUTION WITHIN HIGHLY FOSSORIAL MOLES (TALPINAE) CONSTRAIN TRAJECTORIES AND EVOLUTIONARY ALLOMETRIES OF HUMERAL MORPHOLOGY

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The subfamily Talpinae includes two tribes, Talpini and Scalopini, whose most recent common ancestor traces back to the late Eocene. Both a North American and Eurasian origin have been proposed for this clade. During the Neogene, Talpinae spread across all the Paleartic. One of the most investigated skeletal elements is the humerus, as it is particularly well-preserved and abundant in the fossil record. The humeral morphology of the entire subfamily is highly modified and adapted for complex tunnel digging. However, the two tribes still show morphological differences mainly related to the teres tubercle, the bicipital tunnel, and the pectoral crest. Here we used 2D geometric morphometrics to assess for the first time the humeral morphological disparity and evolution of Talpinae by comparing all extant and extinct species for which at least one complete humerus is known. We built a synthetic phylogeny including a total of 53 species, i.e., 19 Scalopini and 34 Talpini, that was entered in comparative analyses to test explicit hypotheses about their rates of evolution. When performing ANOVA and MANOVA for size and shape, we found non-significant and significant differences among Talpini and Scalopini respectively. The phylogenetic versions of these analyses returned non significant results thus indicating a strong phylogenetic conservativism for the two tribes. A neat negative shift in morphological evolutionary rate was found in correspondence of derived Late Miocene *Talpa* spp. This evidence stressed the differences in morphological evolutionary rates between Talpini and Scalopini. Significant evolutionary allometries were found in both tribes showing different multivariate slopes, even when controlling for phylogeny through phylogenetic ANCOVA. An ontogenetic convergence test on evolutionary allometric trajectories suggests a significant convergence between the two trajectories, with the Scalopini humeral morphology more related to size than that of Talpini. Evolutionary trajectories traced on the phylogenetic tree using ancestral state reconstruction highlighted that Talpini followed a significant phenotypic channeling while the Scalopini tribe showed no relationships between phenotype and time during their evolution. In conclusion, we found differences in evolutionary rates and disparity between clades that appear very similar and highly constrained by the same adaptation, thus suggesting different evolutionary canalizations in the humeral morphology of Talpini and Scalopini.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

THE EFFECT OF SAMPLING EFFORT ON MAMMALIAN PALEODIVERSITY: THE FOSSIL RECORD OF LARGE AND SMALL MAMMALS COMPARED

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Patterns of faunal turnover and diversity dynamics through geologic time are central topics in paleobiology. These patterns are usually addressed by counts of fossil taxa preserved in each time period, which allows for the construction of paleodiversity curves. Analyses of such curves can provide important macroevolutionary clues for events such as adaptive radiations or mass extinctions. However, studies based on raw counts of taxa assume that the recorded diversity is representative of the underlying pattern of biotic evolution. In this study, we quantify sampling effects on the diversity curves of large (> 5 kg) and small (<5 kg) mammals from the Cenozoic of North America as a first step to statistically compare their taxic dynamics. We used numbers of sampled localities and raw counts of genera per time unit as proxies of sampling effort and diversity, respectively. A series of correlation analyses were performed between both variables. Raw and detrended data (for time series) were used in both parametric and non-parametric tests. All correlation analyses were highly significant for both groups of mammals. Subsequently, the sampling and biological signals contained in the mammalian fossil record were decoupled by estimating diversity peaks and troughs that departed significantly from expected values as a result of differences in sampling effort. Our results indicate that major diversity fluctuations represent genuine excursions from the proxy-biased model, and therefore, illustrate diversity changes independent of sampling. Therefore, when sampling biases were accounted for, it was possible to perform a comparison between the macroevolutionary dynamics of the large and small mammals. The sampling-corrected diversity curves of both groups showed a close association between their dynamics, with similar drops or increases in diversity during the same time intervals. However, important differences could also be noted. The most intriguing of them is perhaps a different pattern of rise in diversity during the early Paleocene between small and large mammals. Future studies will allow us to assess if the diversity dynamics of the small mammals were influenced by major climatic and environmental events in the same fashion as in the large mammals.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

REVISITING SIZE TRENDS IN EARLY STEM BIRDS

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Evolutionary trends for body size change in basal Mesozoic birds have been addressed in several studies with disparate results obtained. Furthermore, these studies used femoral length (FL) as a proxy of body size, even though this variable can be an inaccurate estimator of overall body size due to ecological adaptations.

In this work we compiled a dataset of osteological measurements from 44 specimens within 30 Mesozoic avian species, which belong to stem taxa Archaeopterygidae, Jeholornithidae, Confuciusornithidae, Sapeornithidae, Enantiornithes, and basal Ornithuromorpha. Body mass (BM) was estimated for each individual by means of multiple regressions (MR) from limb variables. One MR equation was specifically derived for each taxon. Furthermore, we constructed a cladogram with calibrated branch lengths in millions of years. The presence of phylogenetic signal for BM and FL was tested comparing the square length of the tree with that of 10 000 trees generated by random permutation of the position of terminal taxa, while tree topology and branch length were held constant. Weighted square change parsimony was used to reconstruct ancestral states. The values obtained were regressed on node height, in order to test for the presence of evolutionary trends. Five analyses were performed, one per monophyletic taxon: Aves, Pygostylia, Ornithothoraces, Enantiornithes and stem-Ornithuromorpha. Phylogenetic signal was found for the three most basal clades, but it was not significant for enantiornithines and ornithuromorphs. The estimations of BM and FL provided similar results: a significant trend to reducing size was found in the clade Aves, but not in the other monophyletic taxa.

The results obtained indicate that the trend to miniaturization known to be ancestral for Paraves (i.e., the clade that includes Aves, Troodontidae and Dromaeosauridae) was continued in Aves as far as the clade Pygostylia. Meanwhile, increase in size variation within Pygostylia was a diffusive phenomenon, as it did not show a clear trend. The acquisition of some traits in short-tailed birds (i.e., Pygostylia) that improved their flight ability allowed them to radiate diffusively over two orders of magnitude of size variation (from ~40 g to ~1 kg). An explanatory hypothesis for the observed model of size decrease in basal birds could be related to selective pressures associated with flight requirements. From the Pygostylia node onwards, when basic flight skills were achieved, other selective pressures might have appeared.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

LATE TRIASSIC DOCKUM DINOSAUROMORPHS: NEW LIGHT ON THE ORIGIN AND EARLY EVOLUTION OF DINOSAURS

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Early dinosaurs became globally distributed during the Late Triassic in the Pangaean world, but their origin and early evolution have been debated over a century. Argentina has been traditionally considered as a center for the origin of dinosaurs because of close temporal associations of dinosaur ancestors such as *Lagerpeton* and *Marasuchus* from the Middle Triassic Chanares Formation with the early dinosaurs such as *Eoraptor* and *Herrerasaurus* in the overlying Upper Triassic Ischigualasto Formation. In recent years, a new group of quadrupedal herbivorous dinosauromorphs such as silesaurids are gaining importance as the sister group of dinosaurs. As a result the role of *Marasuchus* and other allied forms from South America in questions involving the immediate ancestors of dinosaurs has been considerably diminished. Moreover, recent cladistic analyses placed lagerpetids as basal dinosauromorphs. With the new realignment of dinosauromorph phylogeny, the Chinle-Dockum Basin appears to be a crucial locality to trace the early evolution of dinosauromorphs, starting with the basal forms (i.e. *Dromomeron*), then silesaurids (i.e. *Technosaurus*), and finally the basal theropods such as herrerasaurids and neotheropods. Despite the poor fossil content of the lower part of the Chinle Formation, the stratigraphically equivalent portion of the Dockum Group (i.e. Tecovas Formation) provides fragmentary but more diverse and richer dinosauromorph fauna. There is now adequate material from the Dockum Group to evaluate the affinity of those dinosauromorphs and their successive evolution to early dinosaurs because both dinosaurs and their precursors had lived together within a close temporal sequence during the Late Triassic, similar to those of South America. In this context, North America may equal in importance to South America in the emergence of early dinosaurs. Although the different composition of these two American faunas might be a result of a geographic and/or climatic barrier which existed along the future Central Atlantic Magmatic Province, dinosauromorphs as well as other terrestrial pseudosuchians were able to cross this barrier, in contrast to the phytosaurs and metoposaurs which were semi-aquatic vertebrates.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

ESTIMATING BODY MASS IN TERRESTRIAL BIPEDS

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Body mass has been shown to significantly influence physiology, ontogeny, biomechanics and ecology of biological organisms. In paleontological studies, it is not possible to directly determine body mass; rather, an accurate method for estimating body mass from skeletal measures is required. Ornithopods, theropods and extinct flightless avians are all terrestrial bipeds. It is reasonable to look for a modern analog among extant terrestrial bipeds. Extant flightless avians are numerous and diverse; every order contains at least one flightless taxon. Surprisingly, flightless avians have not been considered when looking for skeletal correlates to body mass.

This study examined 13 skeletal measures in three avian groups: primarily flightless terrestrial species (8 species, n=32), secondarily flightless terrestrial species (9 species, n=73), and nearly flightless terrestrial species (25 species, n=132). The best skeletal measures for estimating body mass in each group were determined by the coefficient of correlation determination of ordinary least squares regression and percent prediction error. The results show that in nearly flightless and secondarily flightless terrestrial species, forelimb measurements provide the best skeletal measures for estimating body mass; specifically, the maximum diameter of the humeral articulation facet of the coracoid. These results are similar to what has previously been found in volant avians. Interestingly, the forelimb girdles of many of these taxa resemble volant avians morphologically, including those that have strongly keeled sterna. In primarily flightless terrestrial taxa, on the other hand, the best skeletal measure for estimating body mass is the maximum length of the tibiotarsus. This is generally similar to what has previously been found in some (mainly quadrupedal) mammals, in that the maximum length of the tibia has been shown to be the best skeletal correlate for estimating body mass.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

TOOTH REPLACEMENT OF THE SAUROPOD DINOSAUR *TORNIERIA AFRICANA* FROM TENDAGURU (LATE JURASSIC, TANZANIA)

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The Late Jurassic (Tithonian) Tendaguru Formation of Tanzania offers one of the richest sauropod faunas known, including the diplodocid *Tornieria africana*. The material from Tendaguru treated in this study includes the left and right premaxilla and incomplete left maxilla of *Tornieria africana*.

CT scanning of the three separate tooth bearing bones of the upper jaw allow a secure reconstruction of its tooth replacement pattern. In the premaxilla, four replacement teeth are present in each of the four tooth families. The maxilla bears ten alveoli, with the number of replacement teeth decreasing from four to two per tooth family. Replacement rates can be calculated to around 96 to 162 days for the premaxillary teeth of *T. africana*, which confirms the presence of rather high tooth replacement rates in Diplodocoidea. The rostral most teeth in *T. africana* were probably used for food procurement, whereas the more caudally positioned teeth served only as a guide and boundary within the mouth opening.

These findings are in agreement with the reconstructions of *Torniera* as a selective mid-height browser, which corresponds well with the recovered vegetation dominated by woody browse in the Tendaguru Hill area.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

PALEOHISTOLOGY OF *SUSISUCHUS ANATOCEPS* (CROCODYLOMORPHA, NEOSUCHIA) AND COMMENTS ON GROWTH STRATEGIES AND LIFESTYLE

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Susisuchus anatoceps is considered to be an advanced neosuchian crocodile lying outside Eusuchia, and is associated with the transition between these two clades. The specimen MPSC R1136, referred to *Susisuchus anatoceps,* was collected in the deposits of the Crato Formation (Aptian of the Araripe Basin) in fieldwork carried out in a limestone quarry (Idemar quarry) located in Nova Olinda, in northeastern Brazil. The specimen MPSC R 1163 is a partially articulated postcranial skeleton comprising cervical and dorsal vertebrae, bones of the pectoral girdle including the right forelimb, and osteoderms from the dorsal shield. The excellent preservation of the microstructure of these bones allows, besides simple morphological description, a way to obtain information about the growth rate and life history strategies of *Susisuchus anatoceps*. For this work, thin sections of the right rib and radius were used to produce the histological slides. The radius cross-section exhibited a huge cortex with 14 lines of arrested growth (LAGs), a few scattered vascular canals and primary osteons. No evidence of spongiosa tissue was observed. Few secondary osteons were observed either. In the rib, the spongiosa is present, but secondary osteons were absent, indicating that the remodeling process was active in this specimen. The cortex is not as thick as in the radius and exhibits four LAGs; the others may have been lost by resorption. Few vascular canals and primary osteons are present. Both sampled bones show a high osteocyte density and there is no evidence of an external fundamental system (EFS). Based on the observed data, *Susisuchus anatoceps* has a slow-growing microstructural pattern, as is expected of crocodiles. The high number of LAGs indicates that this animal experienced times of drought, aestivation, or other environmental stressors during its lifetime. It was an adult animal, based on the number of LAGs and remodeling processes observed in the radius and the rib, respectively. This animal was still actively growing based on the absence of the EFS layer that is only present when the animal reaches its upper growth. The reason why rib shows spongiosa bone and the radius a thick cortex, probably pachyostosis, could be related to buoyancy and swimming specialties already known for this semi-aquatic group. Although preliminary, this is the first paleohistological information of the advanced neosuchians in South America.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

THREE NEW ORNITHOPOD TAXA FROM THE EARLY CRETACEOUS (APTIAN -- ALBIAN) CEDAR MOUNTAIN FORMATION OF EASTERN UTAH, U.S.A., AND THE SHIFT TO THE ORNITHISCHIAN-DOMINATED FAUNA OF THE CRETACEOUS

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Recent excavations in the Cedar Mountain Formation of eastern Utah have yielded three new taxa of iguanodont dinosaurs. The best represented of these ornithopods, found in the lower half of the Yellow Cat Member, is from the Blane II Quarry in a largely disarticulated bone-bed with close associations between elements. This genus is represented by four individuals. There are two morphs, differentiated by notable differences in length of cervical neural spines. This iguanodont is closely related to *Hippodraco scutodens*, also from the Yellow Cat Member, but differs in having longer frontals, a tall lacrimal, a scapular spine running along the superior edge, a robust deltopectoral crest, and metatarsal IV the same length as metatarsal II.

Two other new taxa were collected from the Ashley II Quarry in the Poison Strip Sandstone Member. The large one is massive. It is 25% larger than *Iguanacolossus fortis* from the same formation, and compares closely in size to the European *Iguanodon bernissartensis* and to the Nigerian *Lurdusaurus arenatus*, but the new taxon is less derived. It consists of an articulated neck, maxilla, teeth, scapulocoracoid, partial pubis, distal femur, and ribs. Phylogenetically, it is closely related to *'Iguanodon' ottingeri*, although this new taxon lacks tall dorsal spines. A pelvis of a third new iguanodont was discovered in the same quarry, one meter higher than the large taxon. The ilia are most similar to *Cedrorestes crichtoni* from just below the Poison Strip Sandstone. The ilium of this new taxon differs from *Cedrorestes* in that the ischiatic peduncle extends as low as the pubic peduncle and the ilium lacks a medio-lateral expansion of the dorso-caudal edge.

These finds suggest that the basal stratigraphic sequence package of the Cedar Mountain Formation (consisting of the Yellow Cat, Poison Strip, and Buckhorn Conglomerate members) is characterized by a diverse ornithopod fauna, indicating that the shift from the sauropod-dominated Late Jurassic fauna to the ornithischian-dominated Late Cretaceous faunas was already underway by the Aptian in western North America.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

SEPARATED BY CENTURIES: THE REMARKABLE RE-DISCOVERY OF THE ENORMOUS LATE CRETACEOUS MARINE TURTLE *ATLANTOCHELYS MORTONI*

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Atlantochelys mortoni was erected based entirely on the proximal portion of a right humerus (ANSP 9234) which was found in New Jersey, U.S.A., during the early 19th century. This single partial element has remained the only known bone representing the taxon - until now. In 2012, the distal portion of a chelonian humerus (NJSM GP23438)

was discovered in the brooks of Monmouth County, New Jersey. Subsequent comparison with the type specimen of *A. mortoni* confirms that the new element is actually the distal portion of the same bone. The reunited portions reveal a complete thalassic-type humerus that is 527 mm long, with maximum widths at the proximal and distal epiphyses measuring 178 and 194 mm, respectively. The length of the humerus suggests a turtle that was three meters long in life, confirming that *A. mortoni* is one of the largest turtles ever to exist. The diaphysis is nearly cylindrical as well as curiously and distinctly narrow (66 mm minimum diameter) relative to its length; more so than any other known chelonian. The specimen exhibits an open ectepicondylar groove rather than a canal, although this may be a result of weathering. There are numerous shallow, subparallel grooves, mostly on the proximal portion, which are interpreted as tooth marks created by scavenging sharks. Two massive and similar cheloniid ilia from the Maastrichtian Navesink Formation of New Jersey cannot, as yet, be assigned to a genus. A left ilium (MAPS A1216a) is 222 mm long and 125.5 mm wide at the proximal end, whereas a right ilium (NJSM GP11884) is 222 mm long and approximately 124 mm wide proximally. The size and proportions of these elements suggest not only that they belong to sea turtles as large as *A. mortoni*, but also that they belong to advanced cheloniids, including *Corsochelys*.

With the discovery of NJSM GP2343, the type locality of *Atlantochelys mortoni* within Monmouth County, New Jersey is now known. The complete specimen is believed to have originated in the Campanian Mount Laurel Formation before being eroded, fractured, and the two portions separated during the Pleistocene or Holocene, and finally reinterred in alluvium. The nearly two-century interval between the field discoveries of two portions of the same bone is believed to be the longest on record.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

HEAD POSTURE IN THE WOOLLY RHINOCEROS

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As a member of the Eurasian Pleistocene megafauna, the woolly rhinoceros (*Coelodonta antiquitatis*) was well adapted to the glacial period. Mummies found near Starunia (Western Ukraine), are giving us a much better view on this species than skeletal remains would allow. Horns and several other preserved soft tissues (e.g., muscles, skin, and hair) provide information on special behavior. For example, the abraded anterior side of the anterior horns reflects the active removal of snow cover to feed on cereals and wormwoods underneath. As a consequence of feeding on low vegetation, the head is held downward and the occiput is inclined backwards. This is also the case in the extant white rhinoceros, which is a pure grazer in African grasslands. An opposite inclination of the occiput (a forward inclination) and a horizontal head posture is found in the extant Javan rhinoceros, which is a pure browser in Asiatic wet forests. These taxa represent the two extremes among extant rhinoceroses concerning feeding strategy, occipital skull shape, and head posture, although there are more differences existing.

Fragmentary skulls with preserved petrosal bones have been scanned using micro computed tomography to determine the habitual head posture of the extinct woolly rhinoceros. Digital reconstruction of the bony labyrinth of the inner ear made the position of the three semicircular canals visible. In mammals, the lateral (or horizontal) canal is said to be held almost horizontal in the habitual head posture. Under this assumption, the head posture of the woolly rhinoceros was reconstructed and compared to extant species. As a result, the habitual head-down posture for the woolly rhinoceros can be verified. This head posture is comparable to that of the white rhinoceros and lies within the range of the examined specimens of this extant species. Beside the head posture, both species share additional characters like a large anterior and a smaller posterior horn, and the same dental formula with no incisors, no canines, three premolars, and three molars. In comparison, the Javan rhinoceros resembles a more primitive state in rhinoceros evolution, with one small nasal horn, four premolars, and existing incisors, which are also used for fighting. These differences are most probably linked to the feeding strategies, and therefore to the different head postures. This research received support from the SYNTHESYS Project http://www.synthesys.info/ which is financed by European Community Research Infrastructure Action under the FP7 "Capacities" Program.

Symposium 4 (Friday, November 7, 2014, 12:00 PM)

THE EARLY TRIASSIC MARINE BIOTIC RECOVERY FROM A PREDATOR'S PERSPECTIVE

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Several times in the geological past, life on Earth was severely affected by global catastrophic events, known as mass extinctions. Furthermore, the recovery dynamics of large predators provide a key for evaluation of the pattern and tempo of ecosystem recovery because predators are interpreted to react most sensitively to environmental turbulences.

Following the end-Permian event 252 million years ago, the most severe mass extinction ever, the paradigm persists that the recovery of oceanic ecosystems was prolonged, lasting up to 8 or 9 million years into the Middle Triassic (Anisian). Accordingly, the ecological or trophic 'pyramid' was assumed to recover step by step bottom upwards, with producers recovering before consumers and at last the apex predators. We conducted a survey of the global distribution and body size spectra of Early Triassic and Middle Triassic marine predatory vertebrates (cartilaginous and bony fishes, amphibians and reptiles) to elucidate diversity and trophic structure in marine ecosystems after the end-Permian event. The body size survey was done by compiling maximum standard lengths for bony fishes and some cartilaginous fishes (n=218 taxa), and total size (estimates) for the tetrapods (n=41 taxa). The data revealed that many species were globally distributed and that the taxonomic composition of the faunas was well balanced whereas, on the other hand, there was no indication for species dominance as would be indicative for disaster taxa. Furthermore, the data indicated that there was no truncation of food chains to the lower levels in the marine realm, but the food chains were already topped by large predators very early in the aftermath of the end-Permian mass extinction (from the Griesbachian onwards). Furthermore, no significant size increase in predators is observable from the Early to the Middle Triassic. Two major faunal community changes occurred around the end-Permian mass extinction however: the first one from fish-dominated to fish/amphibian-dominated communities across the mass extinction event and a second one from fish/amphibian-dominated to fish/reptile-dominated systems about two million years later in conjunction with another extinction event (the end-Smithian crisis). Both extinctions can be linked to massive volcanic eruptions and ensuing global climatic changes.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

DESCRIPTION OF A LOWER MORRISON FORMATION DINOSAUR QUARRY FROM SOUTH-WESTERN MONTANA

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While receiving less scientific attention than the more publicized formations in the state, the Morrison Formation (latest Oxfordian-early Tithonian) of Montana represents an overlooked Mesozoic ecosystem. These Montanan localities largely appear to be equivalent to the upper portion of the Salt Wash Member (Kimmeridgian), and the vertebrate fauna resembles typical Morrison assemblages - at least three sauropod species, one stegosaurian, and one allosauroid theropod. However one unusual feature in marked contrast to typical Morrison localities is the sheer abundance of immature sauropod material. One site from south central Montana represents a bone bed of over fifteen individual diplodocids (maximum femur length 120 cm). Another site, designated the O"Hair quarries, represents five immature sauropods belonging to the genera *Diplodocus* and *Apatosaurus* (the majority under two-thirds adult body length), and one individual of the theropod *Allosaurus*. The O"Hair locality exhibits a normal graded sequence containing alternating well cemented mudstone and fine grained, well cemented sandstone facies approximately 1-2 meters in thickness. The presence of mud rip-up clasts, cross-bedding, and other sedimentary structures within these facies are interpreted as representing a channel bar within a north flowing anastomosing fluvial system. Skeletal remains near the sediment interfaces exhibit abrasion and rounded edges (consistent with Fiorillo"s abrasion Stage 2), along with sub-horizontal orientation which are all taphonomically consistent with channel-lag deposits. This interpreted depositional history indicates that unlike more typical or famed Morrison localities, such as Dinosaur National Monument or Cleveland-Lloyd Dinosaur Quarry, the O"Hair quarries do not appear to represent mass catastrophic death assemblages, and are therefore representative of a more natural environmental depiction.

Technical Session VI (Thursday, November 6, 2014, 8:00 AM)

INTERPRETATION OF BURROWING BEHAVIOR FROM INCISOR MORPHOLOGY OF FOSSORIAL RODENTS

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The incisor morphology of burrowing rodents was evaluated with the goal of interpreting behavior in fossil rodents. Burrowing rodents utilize one or more of the following behaviors to excavate: scratch-digging using the manual claws, chisel-tooth digging using the incisors to scrape soil, and head-lift digging using the head and incisors in a twisting fashion to break soil free. The length, width, eruption length (length from alveolus to incisor tip), wear facet length, wear facet angle, and procumbency angle were measured in modern rodents for which burrowing behavior is documented and some fossil rodents previously interpreted as burrowers. There is a significant correlation between burrowing behavior and the following parameters: wear facet length: eruption length, wear facet angle, and procumbency angle. There is no statistically significant relationship between burrowing behavior and the length or width of the incisors; however, the widest incisors occurred in head-lift digging taxa whereas the narrowest incisors occurred in chisel-tooth digging taxa. A combination of these characters define incisor morphotypes that characterize certain burrowing behaviors, such as thin, procumbent incisors with short, curved wear facets characterizing chisel-tooth diggers. These different morphologies, therefore, easily distinguish non-tooth (scratch) diggers and tooth (head-lift and chisel-tooth) diggers in the absence of any post-cranial skeletal material and finely discriminate between head-lift and chisel-tooth behaviors based on incisor morphology alone. Evidence suggests that specialized tooth digging evolved in rodents in the late Oligocene and Miocene. Among palaeocastorine beavers, the euhapsines specialized in head-lift digging whereas the remaining palaeocastorines specialized in chisel-tooth digging. Mylagaulids were adapted to head-lift digging. These results agree for the most part with previously published reports but further refine interpretations of ancient burrowing behavior.

Romer Prize Session (Thursday, November 6, 2014, 8:30 AM)

ACCELERATING OUR UNDERSTANDING OF THE INNER EAR OF SAUROPODOMORPHA: FIRST GLOBAL, STATISTICAL ANALYSIS OF SEMICIRCULAR CANALS OF DIPLODOCID AND MACRONARIAN DINOSAURS AND ITS IMPLICATION FOR NECK-POSTURE

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The extraordinarily long neck of sauropods is unique among terrestrial vertebrates, and as such, questions arise as to how it functioned. For instance, the mechanisms that allowed sauropods to cope with the angular acceleration that occurs during neck movement are not fully understood. The vestibular system of the inner ear is an important sensory system in all vertebrates, providing primary information about movement and balance. Thus, studying the inner ear of Sauropodomorpha may provide insights into head and neck movement.

This study is the first broad morphometric assessment of the inner ear, specifically the semicircular canals, of sauropodomorphs. Thirty specimens from Africa, America, Asia, and Europe were scanned using computed tomography (CT), and 3D renderings were generated, which were then used to measure the dimensions of the semicircular canals. The radius of curvature of the anterior semicircular canal (ASC) is disproportionately large, while the radius of curvature is extremely small in the lateral

semicircular canal (LSC) of Sauropodomorpha. However, the LSC is very thick, with a trend to ever increasing thickness in sauropodomorph phylogeny. Furthermore, semicircular canal size in basal sauropodomorphs and in macronarian sauropods can be compared with that of extant animals, when corrected for body mass; Diplodocoidea on the other hand show disproportionately small semicircular canals. The size ratio of ASC to LSC and relative canal thickness are different in different sauropodomorph clades. In addition to varying ratios there are also allometric differences in semicircular canal dimensions: while the ratio of the ASC to LSC vary greatly throughout Sauropodomorpha, the ratio of the posterior semicircular canal (PSC) to LSC remains fairly constant.

The allometric variation of the semicircular canals suggests different sauropod clades may have had different habitual neck postures, with different browsing heights, and different feeding envelopes. Hence, this study provides a new method to assist and test research on the neck posture of Sauropodomorpha based on osteological features. Further research may contribute to the controversial issue of low-browsing versus high-browsing in Sauropodomorpha.

Symposium 5 (Saturday, November 8, 2014, 2:45 PM)

FROM TEETH TO GENES: INTEGRATING FOSSIL AND MOLECULAR DATA TO UNDERSTAND MODES AND RATES OF TRAIT EVOLUTION

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Ecometric traits (e.g. locomotion, diet, thermoregulation, etc.) allow the quantitative study of the relationship of organisms to their environment. As environments, climates, and ecosystems change, the responses of organisms are mediated through these traits. Here, we focus on the evolutionary dynamics of carnivoran ecometric traits, namely locomotor types and body size. Patterns of trait change have traditionally been studied using data from the fossil record, but recent advances in molecular phylogenetics have created opportunities for inferring ancestral character states and estimating the modes and rates of trait evolution from phylogenetic hypotheses of extant organisms. However, using only extant taxa discards potentially useful information from fossils and in the worst case may be misleading—in particular if extinction rates have been high and directional selection has acted. In this case, extant species provide an incomplete sample of the phenotypic space for the evolution of the group as a whole.

We integrate data from both extant and extinct members of the carnivoran superfamily Musteloidea, a group that has diversified extensively in a range of habitats throughout the Northern Hemisphere within the past 30 Ma. Specifically, we build a total-evidence phylogeny that combines molecular data for 73 of the 85 extant taxa together with morphological information for 86 extinct taxa and highlight the impact of employing total-evidence or extant-only phylogenies in evaluating modes and rates of evolution of ecomorphological traits in relation to past environmental changes.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

***ASPIDORHYNCHUS SANZENBACHERI* FROM THE UPPER JURASSIC PLATTENKALKS OF SOUTHERN GERMANY**

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The species *Aspidorhynchus sanzenbacheri* is one of three currently valid *Aspidorhynchus* species from the Late Jurassic paleoarchipelago of Solnhofen in Southern Germany. The species is only known from the locality of Ettling, famous for the exceptional preservation of fossil fishes. A first, short anatomical description of the species was published in 2009. In a recent paper, a differential diagnosis of the species was proposed. *A. sanzenbacheri* differs in several features from the other German species, including the short and curved rostrum, the praeoperculum forming an angle of more than 90°, embracing the ventral thickened margin of the quadrate and only 17-18 principal caudal fin rays. Since the first description of the species, several new excellently preserved specimens of *A. sanzenbacheri* were found in the quarry of Ettling. Based on the new specimens in the collection of the Jura-Museum Eichstätt, a thorough revision and complete anatomical redescription of the species was possible. Further diagnostic anatomical features were found during this study, like the presence of an articular bone and the fusion of the parietal and dermopterotic bones in all specimens. Additionally, a well preserved juvenile specimen provided information about the ontogenetic development of *A. sanzenbacheri*. Like the other German species, *A. sanzenbacheri* presents very high intraspecific morphological variation in several features, including the ornamentation of the skull roof bones, the number of extrascapular bones, the number of ventral scale rows and the form and size of the supramaxilla. *A. sanzenbacheri* is endemic to the locality of Ettling. Therefore, the polymorphism observed in adults of *A. sanzenbacheri* was probably not due to environmental influences, but it was rather the consequence of random genetic plasticity.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

INFUNDIBULA AND ENAMEL ISLETS IN RODENT HYPSODONT MOLARIFORMS

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Many herbivorous mammals, e.g., rodents, possess rooted hypsodont cheek teeth with infundibula, occurring as enamel islets on the occlusal surface. These islets often arise from enamel folds. Morphology of the enamel islets (e.g., length and angles of the shearing blades) yields information about their function during the chewing process. Nevertheless knowledge about the variability of the islets as well as ontogenetic changes of the occlusal surface and its function is still scarce.

High-resolution computed tomography (μCT) enables us to investigate the morphology of infundibula and leads to a better understanding of main functional characters such as the length and orientation of enamel ridges that function as shearing blades. Based on 3D reconstructions and hypothetical future occlusal surfaces, the rooted hypsodont cheek teeth of five extant and one extinct rodent species were studied.

Shearing blade angles in all investigated specimens are concentrated around certain values, with differences in the upper and lower jaw (e.g., in *Cuniculus paca* 91° in upper, 85° in lower jaw), giving information on the orientation of the shearing blades during the chewing process. The main angle does not significantly change with progressive wear, but the orientation of the angles becomes less concentrated.

The length of the shearing blades remains constant (e.g., *Castor* sp., *Cuniculus paca*, *Mylagaulus elassos*) or reduces continuously (e.g., *Dasyprocta azarae*, *Hystrix* sp.). This seems to be dependent on the disappearance of infundibula, and not on the increase in the number of enamel islets occurring when infundibula split up apically.

Though splitting of infundibula does not have any influence on the length of the shearing blades, it occurs frequently and with great variability. Despite the variability, particular infundibula often split in every tooth position in the upper or lower jaw respectively, but these infundibula differ in different species. This may indicate a genetic source rather than morphological. Additionally, in lower molariforms infundibula split more often than in uppers. A high individual variability could be detected in the fossil rodent *Mylagaulus elassos*, where more than one specimen was investigated. Despite the high variability, infundibula are never fused apically.

The occurrence of infundibula enables the presence of shearing blades even in latest wear stages in hypsodont teeth. In contrast, fewer growing molariforms possess enamel islets due to the problems of mineralizing isolated structures in ewer growing teeth.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

NEW RECORDS OF THE SABER-TOOTHED CAT *MEGANTEREON* (FELIDAE, MACHAIRODONTINAE) FROM EARLY PLEISTOCENE CAVES IN GUANGXI, SOUTH CHINA

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Here we describe two new machairodont records from the early Pleistocene of Guangxi, South China. These specimens are represented by a complete left dentary and right m1 from Yanliang Cave (~2.0 Ma), and a relatively complete cranium and partial right dentary from Sabertooth Cave (~1.0 Ma). Both cave sites are dated using mammalian biochronology, as well as relative elevation of the cave deposits. Specimens are identified as the saber-toothed cat *Megantereon* based on cranial, mandibular, and/or dental characters. Our review of this genus indicates that species level taxonomy is problematic, contentious, and in need of further revision. The Yanliang fossils represent the smallest known *Megantereon* from Asia. Overall size and dental proportions align this specimen with *M. whitei*, a taxon previously unknown from China or eastern Asia. However, the Yanliang cat clearly lacks the characteristic p3 root morphology and p3-p4 diastema of *M. whitei*. Thus far, our comparative analysis of the *Megantereon* from Sabertooth Cave has focused on the lower jaw and dentition. This specimen is unusual compared to other *Megantereon*, specifically the p4 width to length ratio. In summation, new *Megantereon* specimens from China further demonstrate variation and uncertainty in the evolutionary history of the genus, and the need for a systematic revision that focuses on discrete morphological characters.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

IS THE *HOMO ERECTUS* HOLOTYPE FROM TRINIL A COMPOSITE, OR NOT?

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The potentially composite nature of the type lot of *Homo erectus*, comprising a skull cap (lectotype), a femur, and a molar (paralectotypes), all found at Trinil (Indonesia), has raised controversy ever since its publication. The debate centers on the question of whether or not the more ‘ape-like’ skull cap of the famous fossil really belongs to the same taxon—and perhaps even to the same individual—as the much more ‘human-like’ femur.

Questions have been raised on the collecting practices employed at the time, and it has been suggested that the femur could have been collected from a more recent stratum.

We performed semi-quantitative XRF-analyses on the *Homo erectus* type femur and skull cap, the additional *Homo erectus* femora from Trinil, and associated vertebrate fauna from Trinil and Kedung Brubus. This allowed us to determine that the skull cap and the femur can reliably be binned in the same specific elemental composition profile, which allows us to independently confirm that they share the same taphonomic and diagenetic history indicating a similar stratigraphic position.

The wide range of fossils from different locations at Java in the Dubois Collection at Naturalis is a treasure trove that is currently yielding unexpected and exciting new insights. Reliable and irrefutable provenancing of the studied fossils, particularly the *Homo erectus* holotype material, is essential.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

RECONSTRUCTING DENTAL FUNCTION AND MASTICATION IN TRITYLODONTIDS (SYNAPSIDA, CYNODONTIA) WITH IMPLICATIONS FOR DIETARY COMPOSITION

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The small- to medium-sized non-mammalian synapsid tritylodontids possess several derived mammal-like characters, of which multi-rooted, multi-cusped molariform teeth with precise occlusion are the most remarkable. Spanning the Late Triassic to late Early Cretaceous, tritylodontids developed a palinal (backward) power stroke in mastication. Such a chewing pattern is also found in mammaliaforms (haramiyids) and mammals (multituberculates and gondwanatheres), but is not known from therians. All groups with a palinal power stroke share enlarged incisors, long diastemata and multicuspid molariforms. Tritylodontids are considered to have been herbivorous based on their distinctive tooth morphology and palinal mastication. Their molariforms bear longitudinal cusp rows with sharp anterior-facing blades in the uppers and posterior-facing in the lowers. Minor differences between taxa exist including crown shape and cusp height and number. *Oligokyphus* has ovoid teeth with lesser cusp height but more cusps, whereas the larger *Kayentatherium* and *Xenocretosuchus* have rectangular crowned teeth with steep and high, but fewer cusps. Reconstruction of the mastication movement involves: (1) uplift of the lower jaw; (2) interlocking of the tooth rows; (3) backward movement of the lower jaw half a tooth length; and (4) jaw opening. Virtual chewing analysis applied to moderately worn molariforms reveals large confluent occlusal contacts, even in the grooves between the cusp rows in *Oligokyphus* during mastication, whereas in *Kayentatherium* and *Xenocretosuchus* the main contact areas occur along the steep blades of the cusps. Chewing simulation suggests mainly a cutting function in the larger taxa but incorporating a crushing component in the smaller taxa. Light-optic microwear and surface texture analysis revealed low abrasiveness of food items for the target tritylodontid species. Tooth wear patterns accord with the assumed predominantly herbivorous diet. However, the larger species ingested somewhat more abrasive food than the smaller taxa. Low values of root-mean-square roughness (*Sa*), peak density (*Spd*), and material volume (*Vm*) signify softer, heterogeneous plant components with moderate cuticle thickness, such as fronds or leaflets, shoots, herbs, or lichens. Simulated chewing movements and dental surface characters reveal that smaller tritylodontid taxa may have been opportunistic feeders with at least a seasonally dependent diet of plants and soft-bodied animals, whereas larger taxa were almost exclusively herbivorous.

Technical Session XIV (Saturday, November 8, 2014, 12:00 PM)

PHYLOGENY AND POSITED DIMORPHISM OF POLYCOTYLID PLESIOSAURS, NEW INFORMATION FROM A NEARLY COMPLETE SKELETON OF *POLYCOTYLUS LATIPINNIS* FROM THE NIOBRARA FORMATION (EARLY CAMPANIAN) OF SOUTH DAKOTA, UNITED STATES

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Polycotylus latipinnis is an enigmatic member of the Polycotylidae. The holotype specimen (AMNH 1735, USNM 27678) is weakly diagnostic and prompted designation of a paratype (YPM 1125). Researchers have affirmed congeneric comparison of the holotype and paratype specimens, and a suite of post-cranial characters is used to identify *Polycotylus*, including: 1) 26 cervicals; 2) vertebral centra amphicoelus and short (length/width ratio ~ 0.55), dorsals with compressed walls; 3) chevrons set equally on adjacent caudals; 4) ischia elongate; 5) ilia strongly recurved and laterally compressed with reduced sacral end; 6) propodials remarkably expanded posterodistally with four distinct facets for epipodials, fifth epipodial may be present; 7) metapodials exceptionally short, phalanges subquadrate. Characters 3 and 7 are equivocal and present in other taxa. Other characters employed include scapulae with an expanded ventral ramus and a straight dorsal process, pubes indented on the antero-lateral border, and coracoids with postero-medial extensions.

In 1990 an articulated, nearly complete polycotylid skeleton (SDSM 23020) was excavated from the upper Niobrara Formation (Early Campanian) of South Dakota. Surmised to be *P. latipinnis*, formal description has languished pending preparation. The specimen possesses minimally 23 cervicals, short vertebrae and the strongly recurved ilia and elongate ischia of *P. latipinnis*. The complete skull reveals: 1) central plate of pterygoid long and straight; 2) anterior parasphenoid ossification projects into anterior interpterygoid vacuity; 3) short temporal fenestrae and tall sagittal crest; 4) angulars and splenials extend to near midpoint of symphysis; 5) robust teeth with subtle carinae, and striae prominent on lingual face. Cladistic analysis indicates that *Polycotylus* is a derived polycotylid that retains (or regains) a 'primitive' cervical count.

Dimorphism and live birth is documented in basal sauropterygians, and a polycotylid specimen was recently described as a gravid female (LACM 129639). I hypothesize that dimorphism attributable to live birth should be evident in plesiosaurs. No single element of the polycotylid skeleton exhibits such marked variation as the ilium. Ilium morphology is complex; involving shaft recurvature and roundness, and marked differences of the acetabular and sacral ends. I speculate that the characteristic ilium of *Polycotylus* is attributable to gender, and historical taxonomy of polycotylids may confuse dimorphism with speciation.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

CT SCAN OF THE BERLIN SPECIMEN OF *ARCHAEOPTERYX* AND POTENTIAL USES OF THE ACQUIRED DATA

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The Berlin specimen is the most complete and beautiful of all known *Archaeopteryx* specimens. A computed tomography (CT) scan of this specimen was produced with the medical CT scanner Aquilion CX with the aim to gain as much volume data as possible from the slab. Although the resolution of the scan is not high enough to cover all anatomical details preserved, the preparation of several regions of the specimen as 3D data are of particular interest, allowing visualization of all preserved bone surfaces. In particular, regions of the wings and the leg have potential to yield new and more detailed 3D data, whereas the vertebral column and the skull separate very poorly from the sediment. The CT scan allows measurements to be taken from the scan data instead from the original specimen, protecting the latter from possible damage.

The data captured by a CT scanner consists of varying attenuation values describing the density levels of the specimen. At the 3D lab the volumetric dataset is subject to image processing in various software packages (Avizo, VG Studio Max) to obtain a differentiated representation of the anatomy of the specimen. The fossil and the embedding rock are separated very carefully during the ensuing segmentation process. The data reconstruction and postprocessing is required to obtain data files that are suitable for 3D manufacturing techniques.

Provided that the generation of qualitatively appropriate 3D models of some bones from the CT scan is possible, these would serve as a basis for future scientific studies, both on a comparative anatomical and a functional morphological scale, thereby allowing a more complete description of the Berlin specimen of *Archaeopteryx*. Increased precision of the CT scans would allow further quality improvement and new measurements.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

MORPHOLOGICAL SHAPE DIVERSIFICATION AND EVOLUTIONARY HISTORY OF THE BONY LABYRINTH IN AELUROID CARNIVORA (MAMMALIA, FERAE)

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Carnivora represents one of the largest size ranges of any mammalian order, and additionally the most outstanding case of convergent evolution for similar ecomorphological adaptations in the radiation of mammals. Despite the extensive research, the phylogeny and evolution of cat-like aeluroids is still poorly understood because of unambiguous character traits when different morphological units (e.g., skull, teeth, postcranial skeleton) are considered. At the beginning of the Neogene, the radiation of felids is inferred from dental evidence in the stem-group felid *Proailurus* sp. and the closely related *Pseudaelurus* sp. However, investigating teeth is tracing evolutionary pathways by which ecomorphological convergence takes place. Therefore, we are focusing on conservative morphological trends of the bony labyrinth within the petrosal bone by using non-invasive micro-CT approaches. In this study, we are reconstructing temporal transitions across two-dimensional trait spaces of 3D data in *Proailurus lemanensis* (Quercy, Bach, U. Eocene/L.Oligocene), *Styriofelis turnauensis* (Petersbuch, MN3), *Pseudaelurus quadridentatus* (Petersbuch, MN6) and representatives of all additional aeluroid families (Viverridae, Felidae, Herpestidae, Hyaenidae, and Nandiniidae). Selected taxa of mustelids were used as outgroup. We performed geometric morphometric analyses of 3D landmarks that capture the overall shape of the vestibular system to assess evolutionary traits of the bony labyrinth in aeluroids and a principal components analysis with eigenanalysis. Results show that major taxonomic groups can be differentiated suggesting phylogenetic structures in the morphometric data. Hypothetical ancestral morphologies employing squared-change parsimony was used to map a phylogenetic hypothesis of aeluroid interrelationships onto the constructed morphospace. Our study indicates that the bony labyrinth represents an important morphological trait complex in shaping changes and transitions in the evolutionary history of felids and aeluroids, respectively.

Symposium 1 (Wednesday, November 5, 2014, 10:30 AM)

POSTCRANIAL SKELETAL PNEUMATICITY IN *ARCHAEOPTERYX*

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The presence of postcranial pneumaticity is well demonstrated for numerous non-avian theropods. It might have been organized in a pattern similar to the avian respiratory system that is dominated by caudally positioned abdominal and thoracic air sacs involved in the ventilation of the dorsally fixed parabronchial lungs. From the available fossil record we may assume that a specialized and highly efficient respiratory system appeared early in the evolution of theropods and was likely further elaborated in maniraptorans. The indirect evidence of the non-avialan theropod respiratory system including air sacs stems from morphological traces left on the bone surfaces interfacing with air sacs. Whereas pneumatic patterns of vertebrae are informative about axial extension of the cervical air sacs, the skeletal sources for reconstruction of the clavicular, thoracic and abdominal air sacs are much more limited. However, the lack of intraosseous pneumaticity in topographically contiguous bones does not argue for the absence of the air sacs.

The pneumatic character of vertebrae and appendicular bones of *Archaeopteryx* was reported by several authors, however no consensus about the topographic organization and spatial extension of these pneumatic structures has yet been reached. Only few air sac-related pneumatic foramina/recesses and some ambiguous implications may enable us to correlate between the presence of air sacs and distribution of postcranial

pneumaticity. The first part of this study will detail current evidence for extra- and intraosseous pneumatic characters of *Archaeopteryx*. As it is likely to assume that *Archaeopteryx* might have had a respiratory system comprising air sacs, biomechanical factors have to be considered as alternative explanations for the absence of intraosseous pneumaticity in some postcranial regions of *Archaeopteryx*. We suggest that these factors may include: 1) structures that reinforced functional integrity of the vertebral column including intervertebral articulations and zygapophyses; 2) insertion sites that provide information regarding how the axial musculature was organized; and 3) locomotor patterns.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

MOLAR FORM AND FUNCTION OF THE LATE JURASSIC STEM-ZATHERIAN *NANOLESTES* (MAMMALIA)

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The molars of *Nanolestes drescherae* from the Late Jurassic of Portugal exhibit the basal condition of the zatherian morphotype: a triangular primary trigon, a prominent paracone, a less developed metacone as well as the absence of a protocone in the upper cheek teeth, a three-cusped trigonid, and a single-cusped talonid in the lower. Worn teeth show exposed dentine areas on the tips of the cusps and also along the crests. The nearly vertical walls of trigon and trigonid have sporadic scratches, but clearly defined enamel facets were not identified. Intensive attrition is evident in the parastylar groove and the hypoflexid, reflecting high precision of intercuspation. Detailed analysis of the complementary shapes of these structures informs us about the chewing pathway, forming a guiding system for the occluding protoconid, and respectively the paracone.

During occlusion, the protoconid enters the parastylar groove buccally and then slides upwards and lingually at an angle of about 45°. Subsequently, the paracone enters the lingual portion of the hypoflexid. The potential enamel shear-cutting edges of primary trigon and trigonid are closed at this moment of the chewing cycle. It follows a further upwards and lingually directed movement of the lower jaw until the paraconid reaches the lingual end of the parastyle.

Food items are pierced and fixed by a multiplicity of pointed cusps, followed by stretching of the material during lateral movement. This movement shifts the steep paraconid to a more lingual position, where the space between the antagonistic molars is wider than buccally, allowing further closing, and respectively intercuspation of the teeth. No differentiation of phases was observed and the power stroke ends without a definable central occlusion.

As in dryolestids, the molar pattern of *Nanolestes* is dominated by alternating triangles (primary trigon and trigonid). The lower jaw conducts a lateral movement during occlusion, guided by the parastylar groove and the hypoflexid. Enamel facets, indicating a precise shear-cutting action, as they are visible in dryolestids and other stem-zatherians such as *Amphibetulimus*, *Arguimus*, or *Palaeoxonodon*,were not observed in *Nanolestes*.

In contrast to pretribosphenids, in basal Tribosphenida, the parastylar groove and the hypoflexid are part of a more complex occlusal system and lost their exclusive guiding function. The power stroke of tribosphenic molars is defined by a point of centric occlusion and the differentiation of the chewing movement in two phases.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

TWO REMARKABLE FOSSIL ASSEMBLAGES INFORM OUR UNDERSTANDING OF VOLANT MARINE BIRD EVOLUTION IN THE ZEALANDIAN PALEOGENE AND NEOGENE

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During the evolution of marine birds, the Southern Hemisphere and the Pacific have clearly played a crucial role. Due to its position in the southern Pacific Ocean and its links with the Antarctic nowhere is more vital than Zealandia (the continental fragment that now contains New Zealand) in understanding marine bird evolution. Whilst penguins are well known in the New Zealand Tertiary, the published record of volant marine birds is minimal with only a couple of bony toothed birds (Pelagornithidae) fossils described. Here we detail new records of bony-toothed birds (Pelagornithidae), albatross (Diomedidae) and petrels (Procellaridae) from Late Miocene of Zealandia. We also discuss an enigmatic volant waterbird from the New Zealand Paleocene that fundamentally alters our ideas about the evolution and biogeography of New Zealand's marine avifauna and gives us a new insight into the timing of evolution of waterbirds worldwide. We discuss the paleo-environment of New Zealand during these two crucial epochs and discuss how radical changes in climate, currents and biogeography that occurred during these two time periods may have affected the evolution of seabirds worldwide.

Technical Session XIII (Friday, November 7, 2014, 2:00 PM)

AN EARLY DEVONIAN ATELEASPIDID OSTEOSTRACAN (JAWLESS VERTEBRATE) FROM THE NORTHWEST TERRITORIES, CANADA, HAD POLYODONTODE, DENTICULATED SCALES RESEMBLING THOSE OF SOME PALEOZOIC GNATHOSTOMES

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The oldest known articulated fossils of jawed vertebrates (Gnathostomata) are from the Silurian, while some Ordovician fossils have been identified as gnathostomes based on scales resembling those of later chondrichthyans. Chondrichthyan features of the scales include small (micromeric) size, the presence of a neck between base and crown, and polyodontode construction (composed of multiple tooth-like elements). The supposed gnathostome scales from the Ordovician have been identified primarily on gross morphological characters (listed above) due to poor histological preservation. We report here that scales with several of these traits have been found on the articulated body of a new osteostracan from the late Lochkovian (Early Devonian) Man on the Hill locality, Northwest Territories, Canada. Similar to Paleozoic chondrichthyan scales, the new osteostracan scales are micromeric and polyodontode; however, no neck is present. These scales differ significantly from the mesomeric scales of other osteostracans. Thin sections of scales from a referred specimen show each denticle with a pulp cavity, a crown of dentine with no enameloid, and a base of laminar tissue. Presence of several of the supposed chondrichthyan characters in an undoubted jawless vertebrate cautions against attributing scales with similar traits to the Gnathostomata. However, the new osteostracan scales differ from chondrichthyan scales in the absence of a neck between crown and base and in the absence of enameloid in the crown. The new osteostracan is a derived member of the Ateleaspididae, a family considered relatively basal in recent phylogenies of the Osteostraci. The presence of such scales in a bottom-dwelling, presumably slow-swimming osteostracan suggests that the original function may not have been drag reduction during fast locomotion as has been previously proposed.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A MORPHOMETRIC ASSESSMENT OF PLEISTOCENE HORSE METAPODIALS ACROSS WESTERN NORTH AMERICA

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Horses (*Equus* spp.) are among the most widely distributed and abundant large mammals recovered from Late Pleistocene faunas in North America. Classical morphological treatments, largely based on cranial and dental characters, have been used to define numerous (> 60) Pleistocene horse species across the continent. In contrast, recent analyses of ancient mitochondrial DNA have suggested that most Late Pleistocene Holarctic horses can be grouped into a well-supported clade of true caballine horses, which also includes domestics. These studies propose that this clade showed extraordinary anatomical plasticity as a result of adaptations to different paleoenvironments. The only exception revealed in these analyses was the genetically distinct but poorly understood New World ‘stilt-legged‘ (NWSL) horses, which were endemic to North America rather than being related to Old World hemionines.

Paleontologically, combining all North American Pleistocene caballine horses into a single species based on mitochondrial DNA is problematic, and fails to account for the actual patterns of variation observed in the fossil record of *Equus*. Some morphospecies exhibit relatively consistent size and anatomical characters across a broad geographic range and through prolonged periods of geologic time, showing no evidence of environment-induced morphological plasticity. Alternatively, many single localities accommodate multiple discrete metric groupings of *Equus*.

In order to better reconcile morphological and molecular datasets, an improved understanding of the range of morphological variability in Pleistocene *Equus* is needed. To this end, we utilized the largest sample of metapodials of Late Pleistocene horses yet investigated (n = 716), using fossils that span the latitudinal breadth of western North America, to examine statistical patterns of morphological variability in *Equus*.

Qualitative assessment of principal components analysis supports at least 3 distinct groups. The coefficient of variation (CV) within species for morphological measurements of NWSL horses ranges from 3.5 to 6.7 but is most often close to 4, within a reasonable range for intraspecific variation. Within posited species of non-NWSL horses (e.g., *Equus scotti*, *E. “occidentalis“*, and *E. conversidens*), CV shows a similar range (generally between 2 and 7), similarly suggesting discrete species. In contrast, CV for all specimens taken from given geographic regions tends to be higher (9.1 to 14.9), supporting the potential presence of multiple species.

Technical Session VI (Thursday, November 6, 2014, 11:45 AM)

DEVELOPMENTAL AND EVOLUTIONARY CRANIAL INTEGRATION IN EXTANT GREAT APES

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Attainment of adult brain and cranial shape is the result of ontogenetic dynamic coupling at the structural level, a process that is necessarily integrated across both developmental and evolutionary time. Accordingly, modifications to patterns of integration provide a mechanism enabling the evolution of novel adult morphologies. In the *Homo* lineage, cranial evolution has been marked by an overall increase in brain size in conjunction with gnathic reduction: parallel trends that might have arisen due to changes in the pattern and degree of integration. Using virtual endocasts generated by segmenting CT scans of dried crania, we have previously shown that extant hominoids share a pattern of endocranial shape change development following the eruption of the deciduous dentition. We hypothesize that this shared pattern of endocranial development is driven by integration between the endocranium and the splanchnocranium via the cranial base.

To determine to what degree integration between the endocranium and the splanchnocranium is shared among extant great ape species, we characterized the interspecific patterns and degrees of cranial developmental and evolutionary integration in an ontogenetic cross-sectional sample of *Pan* (n = 56), *Gorilla* (n = 65), and *Pongo* (n = 72). Using three-dimensional geometric morphometrics, shape information was captured of ectocrania (574 landmarks and semilandmarks) and matching virtual endocasts (309 landmarks and semilandmarks). Following Procrustes superimposition, partial least squares analysis was used to quantify the patterns and degrees of integration. Our partial least squares results indicate that while variation exists in the degree of integration between taxa and across ontogeny, extant great apes share a pattern of ontogenetic covariation. This overarching pattern of morphological developmental integration in extant great apes suggests that this is an ancestral integration pattern and thus provides a model for estimating cranial covariation in the primate fossil record.

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Technical Session VIII (Thursday, November 6, 2014, 2:00 PM)

TESTING THE LINK BETWEEN CLIMATE CHANGE AND MAMMALIAN FAUNAL TURNOVER DURING THE EARLY PALEOCENE WITH A NEW STABLE ISOTOPE RECORD FROM THE SAN JUAN BASIN, NEW MEXICO

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The San Juan Basin of New Mexico preserves the most complete record of early Paleocene mammal evolution in North America, spanning the Puercan and Torrejonian land-mammal ages. Faunal turnover is extreme in parts of this record, raising the question of whether these faunal changes resulted from extrinsic factors, such as climate or environmental change, or from intrinsic factors such as rapid rates of evolution or competition among taxa to fill newly opened ecological niches following the K–Pg mass extinction. To test this problem we construct stable carbon and oxygen isotope stratigraphies from mammalian tooth enamel to use as proxies for environmental and climate change, respectively. The longest isotope record is from the closely related periptychid "condylarths," *Carsioptychus* and *Periptychus*, and spans eight local biostratigraphic zones (Pu2–3, To1–To6; not to be confused with biochrons). Isotopes were also sampled from the "condylarth" *Tetraclaenodon*, spanning most of the Torrejonian (To2–To6). We evaluate faunal turnover at the species level taking into consideration possible biases from unequal interval durations, sample size, and species richness. We correct for sample size, which was the only factor significantly correlated with origination or extinction rates. Results indicate that origination rates far outpace extinction rates with strong peaks of origination in the late Torrejonian (To5 and To6). The stable isotope record indicates stability in carbon and oxygen values through most of the record with two exceptions in the late Torrejonian: a significant increase in $\delta^{13}C$ values in *Tetraclaenodon* from To4 to To5, and a significant increase in $\delta^{18}O$ values in *Periptychus* from To5 to To6. In both cases, however, covariation of values does not occur between these taxa. $\delta^{13}C$ values in *Tetraclaenodon* are significantly correlated with faunal origination rates, although the sample is small (n = 5), suggesting that $\delta^{13}C$ values in *Tetraclaenodon* may be reflecting underlying environmental changes. However, $\delta^{18}O$ values, which serve as a climate proxy, are not correlated with turnover metrics in either *Tetraclaenodon* or *Periptychus*. Thus, there is no clear correlation between climate and faunal change in the San Juan Basin, and preliminary results suggest that mammalian turnover resulted primarily from intrinsic factors and/or immigration. Future efforts will focus on temperature estimates from San Juan Basin floras and expanding the stable isotope record to include additional taxa to better resolve the climate and isotopic records.

Symposium 2 (Thursday, November 6, 2014, 3:45 PM)

THE APPLICATIONS OF EVOLUTIONARY ROBOTICS TO RECONSTRUCTING LOCOMOTION IN EXTINCT ANIMALS

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Models are important tools to aid our understanding of the locomotor capabilities of extinct vertebrates. More recently, by using direct fossil evidence combined with our knowledge of comparative anatomy, we have been able to construct extremely high biofidelity models of the musculoskeletal system. Furthermore, by using computational techniques borrowed from mechanical engineering and robotics, we can produce predictive, evolutionary robotic simulations based on these models that can demonstrate the locomotor capabilities of the extinct animals. However most vertebrates have extremely rich locomotor repertoires even though they may use very stereotypical gaits most of the time. The difficulty is then deciding which of this potentially vast range of possible locomotor patterns are the ones that are commonly employed in any given situation. This problem is generally overcome using optimisation goals such as maximising speed or minimising the energetic cost of transport to choose between multiple possible gait patterns. Whilst this approach works well with relatively simple models, and is entirely suitable for solving hypothesis driven research questions, it is increasingly clear that with complex 3D models, it often does not produce gait kinematics that closely match those expected from comparative studies on living animals. One likely reason for this mismatch is that in reality animals are not trying to optimise a single global parameter but instead need to produce a gait that balances multiple constraints on performance, economy, skeletal loading, and balance. In this paper we demonstrate this phenomenon in a range of single goal simulations of vertebrate locomotion (bipedal and quadrupedal dinosaurs and primates) and show how the inclusion of a more realistic set of goals is able to produce simulations with a much closer kinematic match to extant vertebrates whilst still maintaining high levels of performance and/or economy. We would therefore suggest that having high levels of biorealism in the anatomy and physiology in a simulation is insufficient for generating good kinematic estimations for extinct vertebrates. Our simulations suggest that it is also necessary to have a realistic set of goals to allow the optimisation system to choose correctly among the many possible alternatives but that considerably more work is needed in the area of optimisation goals if we are to make best use of these simulation techniques.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

NESTING SITE PREFERENCE IN THE LATEST CRETACEOUS DINOSAURS FROM SOUTHWESTERN EUROPE

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In extant amniotes, the selection of nesting site often results in a nonrandom environmental distribution. This behavior is widespread and plays an important adaptive and ecological role, but also has strong evolutionary implications. To date, the nesting site selection in dinosaurs is inferred on the basis of the apparent recurrence of certain types of dinosaurs eggs in certain environments. However, this correlation has never been statistically tested. The southwestern European region is known for producing one of the largest records of Late Cretaceous dinosaur eggs in the world, and therefore offers a unique opportunity for testing nest site selection in this clade. Based on literature and first hand observations, we constructed a database containing 358 egg occurrences distributed in 344 egg-bearing localities. The age, the egg type, the primary environment (inland or coastal), and the secondary environment (fluvial, paralic or coastal) are specified for each site. We tested the relationship between different egg types and certain environments by using statistical chi-squared analyses. The results of the first chi-squared test found a nonrandom distribution of all dinosaur eggs within the primary paleoenvironments. In the second test, considering secondary environments, we found that sauropod eggs (Megaloolithidae) and theropod eggs (Prismatoolithidae) show a positive and statistically significant association with fluvial environments. In contrast, the number of hadrosaurid nesting sites (Spheroolithidae) is still low and this prevents a statistically significant association with any sub-environment. However, abundance counts suggest a preference for paralic environments (e.g., swamp, marsh, marginal lagoons). The spatial distribution of the nesting areas may reflect complex ecological interactions between the latest Cretaceous dinosaur faunas in southwestern Europe, especially within herbivores, with the aim to avoid ecological competition during nesting periods. As occurs in many extant reptile and bird species, the selection of the nesting site by dinosaurs could also be constrained by finding an environment with optimal incubation conditions that ensures offspring success and avoids the pressure of predators.

Education and Outreach Poster Session (Poster displayed November 5 – 8)

A CALL TO ACTION: A REPORT ON THE NEW NATIONAL INITIATIVE FOR GALVANIZING CHANGE IN UNDERGRADUATE LIFE SCIENCE EDUCATIONAL PRACTICES IN THE UNITED STATES

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Recently, an innovative group of program officers from the National Science Foundation (NSF), Howard Hughes Medical Institute (HHMI), and the National Institutes of Health (NIH) began a historic and unprecedented collaborative effort known as the Partnership for Undergraduate Life Sciences Education (PULSE). This community of scientists is dedicated to department-level implementation of recommendations put forth in the 2011 Vision and Change in Undergraduate Biology Education: A Call to Action Report that advocated for a focus on newly defined core concepts and core competencies necessary for biology literacy in undergraduate life science education. Forty Vision and Change Fellows were appointed to spearhead this intensive new national initiative and to develop strategies for transforming how life sciences are taught in the United States. Three Fellows report here on the role of the Fellows as well as the establishment of PULSE working groups and projects, faculty networks and resources, on-going regional partnerships and conferences, a departmental ambassador program, and available curricular and assessment toolkits developed to support faculty, departments, and institutions in moving along the change spectrum for adopting Vision and Change recommendations. A new national initiative for certifying life science departments at various levels of expertise will be delineated as well as the standardized rubric which will be used for assessing specific departments and institutions as they strive to adopt these national recommendations for change and to attain various levels of departmental certification.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

THE EFFECT OF INSULAR DWARFISM ON DIETARY NICHE OCCUPATION IN PYGMY MAMMOTHS FROM THE CHANNEL ISLANDS OF CALIFORNIA

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Tooth wear studies have proven very adept at elucidating paleodietary and environmental trends at both local and global levels. Microwear analysis in particular has been shown to be quite useful in revealing dietary behavioral differences in taxa with similar or even virtually identical gross tooth morphologies, though relatively few studies have focused on proboscidean microwear. We used dental microwear analysis to study a large sample of pygmy mammoths (*Mammuthus exilis*) from the Channel Islands of California (mostly from Santa Rosa Island) and compared our results to those of extant ungulates, proboscideans, and mainland fossil mammoths and mastodons from North America and Europe. Microwear features such as enamel pits and scratches were identified and quantified using a stereomicroscope at 35 times magnification by a single observer. Results show that the raw scratch distribution of *M. exilis* is narrower than what is seen in the modern elephants *Loxodonta africana* and *Elephas maximus* and skewed toward the low scratch browsing range of extant browsing ungulates. Average scratch and pit results for *M. exilis* are nearly identical to those of *Loxodonta cyclotis* and distinctive from *L. africana* and *E. maximus*. Interestingly, results are more similar to those found in prior studies for the American mastodon (*Mammut americanum*) than those found in extant elephants or the extinct Columbian mammoths studied here, including *Mammuthus columbi,* the likely mainland ancestor of *M. exilis*. Our results clearly show a shift in mammoth dietary niche occupation as mainland mammoths colonized the Channel Islands. It appears that *M. exilis* narrowed its dietary breadth from that of its mainland ancestor and became more specialized on browsing on leaves and twigs rather than the more typical mammoth pattern of switching between browse and grass. These results are consistent with the Pleistocene vegetation history of the Channel Islands whereby extensive coastal conifer forests were available during the last glacial, as well as *Pinus* stands and extensive sage scrub vegetation.

Symposium 4 (Friday, November 7, 2014, 9:00 AM)

PATTERN OF TEMNOSPONDYL DISTRIBUTION DURING TRIASSIC AND THE PROBLEM OF USING THEM FOR GLOBAL CORRELATION

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Temnospondyls, a diverse clade of extinct amphibians, lived mostly in non-marine water bodies from the Carboniferous to Cretaceous Periods. They are global in their occurrences during Triassic and can be divided into three broad groups having different skull outlines. One group had a triangular skull with posteriorly placed orbits, the second had a long snout and the third had a deep occiput and parabolic skull. The first is mostly represented by 'capitosauroids' or 'mastodonsauroids', the second by trematosauroids, including metoposaurids, and the third by plagiosaurids, brachyopids and chigutisaurids. All three types show great disparity within groups. They have local stratigraphic ranges even relative to similar taxa. This phenomenon is related to factors like the time and route of migration of different temnospondyls, the associated fauna, niche partitioning and sharing, local geological backdrops, local sea-level change during a specific geologic time, prevailing paleoclimate, conditions of deposition of the host rocks, replacement of faunal elements and extinction events. The Early Triassic fauna of India, Australia, Antarctica and Greenland are dominated by the temnospondyls with triangular skulls. They had a number of taxa at the same stratigraphic level and lived in partitioned niches. This is not very common in Late Triassic. In Late Triassic, the migration route and time of occurrences of Laurasian metoposaurids and southern chigutisaurids remain enigmatic. The metoposaurids persisted until the Norian in North America but never crossed the Carnian-Norian boundary in India or in Morocco. In all of these areas, metoposaurs thrived with the semi-aquatic phytosaurs. Conversely, chigutisaurids are known from the Early Triassic of Australia, from Carnian deposits in South America and the Norian of India. They are found again in the Cretaceous Period in Australia. Another parabolic skull-bearing form, the plagiosaurids, are found from the Early Triassic of India and Australia while in Europe and Greenland they are mostly restricted in the Late Triassic. Geologically, local Gondwanan basins had different tectonic histories during Triassic and correlation is difficult. The Triassic was also a time of global sealevel regression and seasonality in climate. Lastly, the Triassic non-marine successions are not continuous throughout the world. Hence, background information should be critically appraised before using temnospondyls as a tool for global biostratigraphic correlations.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

THE MORPHOLOGY AND INTERNAL ANATOMY OF THE FROZEN MUMMY OF THE EXTINCT STEPPE BISON, *BISON PRISCUS*,FROM YAKUTIA, RUSSIA

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The frozen mummy of the Yukagir Bison identified as *Bison priscus* comes from the Chukchalakh Lake shore of the northern Yana-Indigirka Lowland, Eastern Siberia. It is a male about 4-4.5 years old and has an accelerator mass spectrometry (AMS) radiocarbon date of about 9,300 years BP. The specimen represents the most complete mummy among known records of this extinct species: Blue Babe, Dome Creek and Fairbanks Creek Bison from Alaska; Tsiigehtchic from Northwest Territories, Canada; and Indigirka, Anyuy, Chukotka Bison, and Batagai Baby Bison from Eastern Siberia.

A necropsy was conducted in 2014 to examine topography, anatomy, and state of the inner organs' preservation, overall health condition, presence of parasites, cause of death, and to compare it with extinct and extant *Bison* and *Bos* taxa.

The mummy possessed completely preserved inner organs, but some of them were not identified. The organs were removed in four separate parts for the detailed study, tissue sampling, and preservation. The brain represents the first record for the species that appears to be complete. It has shrunken to about 36% of its original neurocranial volume, which is more than reported for the woolly mammoth Yuka (55%) from the Eastern Siberia. The brain retained olfactory bulbs, optical and trigeminal nerves, medulla oblongata, and the upper part of spinal cord.

Some torso organs, including trachea, heart with pericardium and large blood vessels, stomach, and penis, appeared to be close to normal sizes. Other inner organs (or their parts), such as the brain, tricuspid and bicuspid heart valves, pulmonary and aorta semilunar valves, papillary muscles, small blood vessels, esophagus, lungs, liver, rumen papillae, reticular crests and cells, omasal laminae, intestines (jejunum, ileum, colon, ampulla recti, cecum and rectum), and left testicle were significantly shrunk.

The trachea and lungs didn”t contain foreign objects. The esophagus and rectum were free from food remnants. The rumen and reticulum were filled with vegetation mass containing shrub and tree brunches and roots, while the jejunum contained some chyme.

The general topography of the Yukagir Bison corresponds to *Bison* and *Bos*, but morphology (i.e. reticulum), sizes, and volumes of some organs are largely due to the body's mummification for thousands of years in permafrost conditions. No visible parasites in the examined organs, pathological tissues, or injury were revealed. The lack of visible subcutaneous fat in the abdomen and neck areas indicates that starvation might have caused the animal”s death.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

MORPHOFUNCTIONAL EVOLUTION OF THE HUMERUS IN THE AVIAN LINEAGE

SERRANO, Francisco, Universidad de Málaga, Málaga, Spain; PALMQVIST, Paul, Universidad de Málaga, Málaga, Spain; MARTIN-SERRA, Alberto, Universidad de Malaga, Malaga, Spain; SANZ, José Luis, Universidad Autónoma de Madrid, Madrid, Spain

We have explored shape variation in the avian arm using a sample of 469 individuals from 155 living species of flying members of the crown group Neognathae, distributed within 22 orders, and 37 fossil specimens from 26 species of stem-taxa Aves and two of Deinonychosauria. Five variables were measured in the humerus: total length (HL), diameter at midshaft (HD), length of the deltopectoral crest (dcL), length of bicipital crest (bcL) and length of the major axis of the humeral head (Hh). Principal components analysis (PCA) was performed with the five variables size-standardized. The first principal component (PC1) accounts for nearly 50% of the total variance and shows an allometric change in bone robustness: small birds have more robust humeri than large ones. The second component (>27% of explained variation) reveals a shape change in the proximal epiphysis between stem taxa and modern taxa: compared to Mesozoic birds, neognaths show humeri with longer bcL and Hh, and shorter dcL. Finally, the third component (>13% of variance) describes a variation in the length of the proximal epiphysis with respect to overall humeral size.

Three cladograms were constructed: (1) the first includes stem and crown taxa and has branches of unit length; (2) the tree for stem bird fossils has branch length calibrated in millions of years; and (3) the cladogram for modern neognaths has branches calibrated in molecular distances. Weighted square change parsimony was used to reconstruct ancestral states for each PC and the values obtained were regressed against node height in order to test for the presence of evolutionary trends. Only the crown group showed a significant trend in the degree of robustness (i.e., PC1), which increased within the clade probably as a result of passerine diversification. The enlargement of the bcL and the Hh relative to the dcL (i.e., PC2) showed a 'saltational' transition from stem to crown birds. Finally, although the morphological change of PC3 showed a slight decrease in Aves, no trends within each group were found. In summary, our results suggest that the shape of the avian humerus has been primarily modeled by size-related changes in bone robustness, although humeral shape also relates to stresses supported during flight. Furthermore, a drastic change in the proximal epiphysis occurred from stem birds to modern ones, increasing the development of the bicipital crest and the humeral head. This resulted in a larger origin for the biceps muscle and a more developed joint surface with the shoulder, which indicates an improvement of flapping ability.

Technical Session XVI (Saturday, November 8, 2014, 9:15 AM)

SYSTEMATIC POSITION OF THE CONTINENTAL LATE JURASSIC TELEOST *LUISIELLA FERUGLIOI* FROM PATAGONIA (ARGENTINA) AND THE OCCURRENCE OF A NEW GONDWANAN CLADE OF BASAL TELEOSTS

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Luisiella feruglioi is the main component of the Almada Fish Fauna of the continental Cañadon Calcareo Formation in Chubut, Argentina, representing one of the few Jurassic records of freshwater teleosts and the oldest known from South America to date. To evaluate its systematic position, a data matrix of 61 taxa (including 46 extinct and 15 living species) and 180 morphological characters from previous cladistic analyses as well as additional ones was built. After a thorough revision, most original characters were re-codified and special care was taken to avoid character definitions that imply the use of unspecified 'absence' states. Ingroup taxa included the Australian freshwater teleosts *Cavenderichthys talbragarensis* from the Upper Jurassic Talbragar Beds and *Leptolepis koonwarri* from the Lower Cretaceous Koonwarra Beds. Also, several taxa previously regarded as stem-group Teleostei and now considered as basal teleosts (e.g., *Siemensichthys*, *Eurycormus*) were included in the dataset. The parsimony analysis resulted in ten most parsimonious trees (MPTs) of 817 steps each, all of them supporting the monophyly of Teleostei sensu stricto. In all MPTs, *L. feruglioi* is recovered as a basal teleost immediately above the level of *Leptolepis coryphaenoides* and the sister taxon of *C. talbragarensis*, both taxa in turn forming a monophyletic group with *Leptolepis koonwarri*. The grouping of these three taxa represents a distinct Gondwanan clade of freshwater basal teleosts that evolved independently from marine basal teleosts of Europe and Chile. These results point to an earlier colonization of freshwater environments by teleost fishes than previously thought.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

VARIATION IN DENTAL MICROWEAR TEXTURES AS A PROXY FOR DIETARY BREADTH IN CERCOPITHECIDAE

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Dietary breadth, the number of different food categories eaten by a species, is one of the fundamental aspects of a species′ total dietary niche. Species that have narrow dietary niches are more likely than those with broad dietary niches to have small species ranges and to be less abundant. Thus, determining dietary breadth in fossil species is important for understanding their species distribution and evolutionary success. However, in taxa with generalized morphology and fairly generalized diets, such as the members of Primates, a method for approximating dietary breadth in fossil species is lacking. Here I present data to support the analysis of variation in dental microwear textures as a method to infer dietary breadth in the primate family Cercopithecidae.

I collected dental microwear scans from Phase II facets of first and second molars from 314 museum specimens of eight species of extant African monkeys (Cercopithecidae; n = 11 to 77) with differing dietary breadths. Dietary breadth was calculated based on average yearly frequency of foods consumed at study studies of wild populations. The overall variation in microwear variables in this sample was significantly

correlated with dietary breadth. In general, ANOVAs of single variables distinguished species with low dietary breadth from those with high dietary breadth, but species in the middle were undistinguished from either extreme. The variation in scale of maximum complexity was the single best predictor of dietary breadth, although the variation in complexity also differentiated species with narrow diets from those with broad diets. I discuss the feasibility of applying this method to fossil assemblages and the effect of seasonality on intraspecific microwear variation.

Technical Session IV (Wednesday, November 5, 2014, 4:00 PM)

COMPARATIVE FEEDING BIOMECHANICS OF *DIPROTODON OPTATUM* AND FUNCTIONAL INTERPRETATION OF THE EXTENSIVE ENDOCRANIAL SINUSES

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The extinct *Diprotodon optatum* was the largest marsupial, reaching over two tonnes. However, despite its large size, the cranium of *Diprotodon* is remarkably light and fragile, composed of bone and extensive endocranial sinuses. Cranial sinuses are air-filled cavities resulting from the resorption and deposition of bone through pneumatisation in response to biomechanical stress. The extraordinary preservation of the *Diprotodon* skulls found at Bacchus Marsh in southern Australia provide a unique opportunity to investigate hypotheses regarding the size, structure, and function of the atypically voluminous sinuses. A skull of *Diprotodon* was CT scanned and detailed 3D reconstructions of the cranium, mandible, and jaw adductor muscles were produced. Finite element analysis was used to identify areas of high and low stress, mechanical efficiency and bite performance in *Diprotodon*, four extant marsupials (*Vombatus ursinus*, *Phascolarctos cinereus*, *Macropus rufus*, and *Wallabia bicolor*), and two extant placentals (*Giraffa camelophardalis* and *Camelus dromedarius*) to test hypotheses on sinus function. In addition, manipulations to the geometry of the *Diprotodon* cranial model were performed to test changes in sinus structure and size (e.g. normal, 'filled' sinuses, sagittal crest models). Despite the apparent fragile nature of the cranium of *Diprotodon*, the model performed well and is relatively strong, indicated by low medial stress through the model. The mechanical efficiency of the skull was also relatively high, especially at the incisors when compared to the giraffe and camel. The large cranial sinuses do not seem to disadvantage *Diprotodon* in terms of performance, and may in fact help to dissipate stress over the cranium. However, sinuses are not the only factor allowing high performance because the wombat (*V. ursinus*), a species with relatively small sinuses, also performs very well. When examining the results from the manipulated models of *Diprotodon*, further evidence suggests that the 'normal' model is not disadvantaged by having large sinuses, and may help to move stress away from the face. The sinuses also allow the skull to be significantly lighter than if the frontal and parietal bones were not pneumatised. This study points to the significance of large sinuses in *Diprotodon*, and perhaps all marsupial megafauna, to reduce the weight of the skull while maintaining biomechanical performance.

Technical Session X (Friday, November 7, 2014, 11:15 AM)

PALEOECOLOGICAL AND CLIMATOLOGICAL RECONSTRUCTION USING CERTAIN TAXA RECOVERED FROM THE IRVINGTONIAN BIOTA AT EL GOLFO DE SANTA CLARA, NORTHWESTERN SONORA, MEXICO

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Extensive exposures of ancient Colorado River fluvio-deltaic deposits in northwestern Sonora, Mexico along the upper Gulf of California have yielded a diverse Irvingtonian paleobiota. Fossils have been found in badlands that developed in response to Late Pleistocene doming along the Cerro Prieto Fault.

Through joint efforts by the George C. Page Museum, Arizona Western College, the Center of Geociences of the National Autonomic University (Juriquilla, Mexico), and the Biosphere Reserve (San Luis del Rio Colorado, Mexico), about 20% of the region has been prospected and mapped.

To date, nearly 9000 mapped vertebrate fossil localities are documented and over 120 species have been identified. The paleobiota suggests the existence of four ecologic communities: freshwater aquatic, riparian galleria forest, shrub and brush woodland, and savannah-like grassland. A suite of specific species suggests that the Irvingtonian climate was quite different from the temperate desert that prevails in the area today.

The recovery of fan palm (*Washingtonia* sp.), giant tortoise (*Hesperotestudo* sp.), crocodile (*Crocodylus* sp.), boa constrictor (*Constrictor constrictor*), crested guan (*Penelope* sp.), flamingo (*Phoenicopterus* sp.), capybara (*Neochoerus* sp.), giant anteater (*Myrmecophaga tidactyla*), and prehensile-tailed porcupine (*Coendou* sp.) remains implies that the annual regional temperature supported tropical to subtropical climates, and that areas existed within the region where at least partial shade prevailed.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

PERIPTYCHIDAE; A PALEOCENE RADIATION OF UNGULATE-LIKE PLACENTAL MAMMALS

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The diversification of mammals at the beginning of the Cenozoic was one of the most important events in mammalian history and is a classic example of an evolutionary radiation. It has been difficult to address macroevolutionary questions among early placentals because their phylogenetic relationships remain poorly understood. A study of subgroups of “Condylarthra,” a wastebasket taxon of bizarre eutherian ‘ungulate-like’ mammals will help us understand this event. We present results of our examination of Periptychidae, a clade of ~45 species of “condylarths”, known solely from the Paleocene of North America and which exhibit specialized morphologies, diets, and were some of the first placentals to reach moderately large body sizes (~30 kg).

Periptychids were among the first placental mammals to appear after the Cretaceous–Paleogene (K–Pg) mass extinction and reached a maximum standing taxonomic diversity (~16 species) and body sizes of over 25 kg within 500 ka of the K–Pg boundary. Periptychids declined in taxonomic diversity through the Paleocene, becoming extinct ~2 Ma before the Paleocene–Eocene boundary. Phylogenetic analysis places Periptychidae as basal members of Euungulata within Laurasiatheria.

Two larger, more specialized members of Periptychidae are *Periptychus* and *Ectoconus*. *Periptychus* is known for its unusual dentition with swollen premolars and crenulated enamel, indicating an herbivorous/durophagus diet. The shift to an herbivorous diet and associated increase in body size apparently caused *Periptychus* and *Ectoconus* to evolve towards a graviportal mode of locomotion. This is reflected in the limb anatomy: long bones are robust with distal limb segments shortened relative to proximal segments; the astragalus is broad and flattened anteroposteriorly with a shallow trochlea and a short wide neck and head, which articulates with the navicular and cuboid (indicating an alternating tarsus); and the feet are broad with five spreading digits, with short, flattened unguals. Using a series of hind limb measurements for extant and extinct mammals, we conducted a principal component analysis to test where periptychids fall on the cursorial–graviportal spectrum of extant mammals. *Periptychus* plots in morphospace associated with incipient graviportality while *Ectoconus* plots in morphospace associated with true graviportality. Phylogenetic evidence suggests that these taxa evolved larger body sizes and locomotory habits independently from a smaller primitive ancestral state without first evolving cursioriality.

Technical Session XVII (Saturday, November 8, 2014, 2:30 PM)

CELLULOSE HERBIVORY OF BASAL SYNAPSIDA IS NOT LINKED TO ENDOTHERMY OR HIGH GROWTH RATES

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Herbivory first appeared independently in the fossil record during the late Carboniferous in the diadectids, captorhinids, bolosaurids, and more specifically, the pelycosaur-grade basal synapsids (Edaphosauridae and Caseidae). Fossil herbivores are easily distinguished by their specialized teeth and barrel-shaped trunks required to digest cellulose by symbiotic fermentation. One benefit of herbivory is that it allows animals to consume large amounts of food with minimal locomotion, thereby presenting a very effective and energy-efficient solution to daily physiological demands. Also, this permits larger body size because no energy is lost to trophic level effects.

It has been hypothesized that an elevated basal metabolic rate (BMR) together with an increase in body temperature in basal Synapsida would have furthered the evolution of herbivory and large body size because a high BMR would have allowed fast growth as well as improved fermentation efficiency. The evolution of BMR and thermoregulation is best understood through the study of bone microstructure, because bone histology, while not directly indicating metabolic rate, faithfully records growth rate, which in turn is closely tied to metabolic rate. We found that more derived synapsids such as the ophiacodontids and sphenacodontids had higher growth rates than the most basal amniotes. This is indicated by the histology of their long bones, showing woven bone matrix, large osteocyte lacunae, and high vascularity similar to that seen in therapsids.

Here, we reject the hypothesis that endothermy furthered the evolution of cellulose herbivory in pelycosaur-grade basal synapsids because histological analysis of the long bones of Edaphosauridae and Caseidae reveals mostly slow-growing lamellar or parallel-fibered bone. Vascularity is highly reduced or absent. This suggests that the pelycosaur-grade herbivores grew a magnitude slower than the contemporaneous carnivores, despite attaining considerably larger body size. This difference in growth rates between carnivores and herbivores calls into question the function of the iconic dorsal sail of edaphosaurids and sphenacodontids as a thermoregulatory organ.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A NEW PUTATIVE PLANKTON-FEEDING ODONTASPIDID SHARK CLADE BASED ON THE LATE CRETACEOUS FOSSIL RECORD OF RUSSIA AND THE UNITED STATES

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Eorhincodon casei from the lower Cenomanian of Belgorod Province in European Russia and *Megachasma comanchensis* from the mid-Cenomanian of Colorado in the United States are two Cretaceous nominal taxa initially described as possible planktivorous elasmobranchs. However, the type specimens of these two taxa were subsequently re-interpreted to represent taphonomically abraded teeth of an odontaspidid shark, *Johnlongia* (Lamniformes: 'Odontaspididae'). Here, we re-describe the holotype of *E. casei* and present multiple new specimens of the species from Saratov, Volgograd, and Penza provinces in European Russia as well as a new specimen of *M. comanchensis* from Texas, U.S.A. These new specimens, along with other previously described specimens, demonstrate that 1) the two nominal taxa represent valid species, 2) they merit placement in a new genus that belongs to the family Odontaspididae, and 3) the new genus is sister to *Johnlongia*. This taxonomic placement is significant because it serves as another example of a putative planktivorous clade derived from a piscivorous form with an implication that the likely planktivorous odontaspidid clade acquired a plankton-eating habit independent of the four known filter-feeding elasmobranch clades (Rhincodontidae, Megachasmidae, Cetorhinidae, and Mobulidae). It also indicates that planktivorous diet evolved at least three times independently in the order Lamniformes (i.e., Megachasmidae, Cetorhinidae, and Odontaspididae), and more significantly, the new fossil genus would represent the oldest known plankton-feeding elasmobranch in the fossil record. This study was funded in part by RFBR grant 14-05-00828 to E.P.

Technical Session XVII (Saturday, November 8, 2014, 2:00 PM)

FILLING OLSON'S GAP: A NEW PERMIAN TETRAPOD ASSEMBLAGE FROM THE MID-ZAMBEZI BASIN OF SOUTHERN ZAMBIA

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The tetrapod fossil record suggests that a major turnover took place between the Early and Middle Permian, with pelycosaur-dominated assemblages giving way to therapsid-dominated assemblages. The lack of appreciable overlap between these faunas has been termed Olson′s Gap and has been ascribed to a number of possible causes. A persistent problem with evaluating this evolutionary discontinuity is uneven geographic sampling: Early Permian tetrapods are known primarily from paleo-equatorial regions whereas Middle (and Late) Permian forms are generally known from high latitude areas, although some notable exceptions exist (e.g., the Moradi Formation of Niger). In addition, the critical Middle Permian interval is poorly represented in the fossil record, with most data historically coming from Russia or South Africa. Finding new Middle Permian tetrapod localities will be critical to addressing Olson′s Gap.

Here we report on a new collection of vertebrate fossils from the Mid-Zambezi Basin. Previously recorded tetrapods from the Zimbabwean portion of the basin include tapinocephalid and anteosaurid dinocephalians, but our recent collecting efforts in Zambia indicate that it preserves a much more diverse fauna. Two fossiliferous horizons have been discovered. The first is likely Middle Permian in age and correlative with either the *Eodicynodon* or *Tapinocephalus* assemblage zones of South Africa. Besides numerous tapinocephalid teeth, we recovered material pertaining to palaeoniscoids, temnospondyls, anteosaurids, burnetiids, dicynodonts, and gorgonopsids. An additional taxon diagnosed by a prominent boss along the ventral margin of the dentary and laterally compressed and serrated postcanine teeth could be a biarmosuchian, gorgonopsid, or therocephalian. Both the burnetiids and dicynodonts appear to represent new species. A second, presumably higher fossiliferous horizon was given cursory attention, but was found to contain the dicynodont *Endothiodon* and relatively small gorgonopsids. The second horizon probably correlates with either the *Tropidostoma* or *Cistecephalus* assemblage zones, but this tentative assignment will require additional sampling. Interestingly, the nodular preservation style present in the upper horizon resembles the upper portion of the Ruhuhu Formation, which also preserves *Endothiodon* and postdates the dinocephalian-bearing portion of the formation. This research supported by National Science Foundation EAR-1337569, EAR-1337291, and EAR-1336986.

Technical Session VI (Thursday, November 6, 2014, 9:45 AM)

EARLY EOCENE MICROSYOPINE MICROSYOPIDS (MAMMLIA, PRIMATES) FROM THE SOUTHERN BIGHORN BASIN, WYOMING: EVIDENCE FOR CLADOGENETIC SPECIATION AND EVOLUTIONARY RESPONSE TO CLIMATE CHANGE

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Microsyopidae are stem primates from the Late Paleocene-Middle Eocene of North America and the Late Paleocene of Europe. More than 1500 stratigraphically controlled dental and gnathic specimens of microsyopine microsyopids are known from the Willwood Formation (Wasatchian) of the Southern Bighorn Basin, allowing for unprecedented consideration of the systematics of the group and the extent to which evolutionary events are tied to climate change.

All material from the lowest 200 m (Wa0-Wa4) of the Willwood Formation pertains to *Arctodontomys wilsoni*. That species is replaced by the larger *Arctodontomys nuptus* near the top of a previously identified period of faunal turnover (Biohorizon A), associated with evidence of marked localized cooling. *Arctodontomys nuptus* persists as the only microsyopine in the record until 260 m, when *Microsyops angustidens* first occurs. The main feature that distinguishes *A. nuptus* and *M. angustidens* is the presence of a metaconid on p4 in the latter. In the 260-262 m interval there are a range of morphologies, including two specimens that demonstrate a small metaconid swelling, which can be interpreted as intermediates between the two species. After a 60+ m absence from the record, *A. nuptus* reoccurs above 322 m (Wa4). Thus, the transition at 260-262 m must have been a cladogenetic speciation event, with *M. angustidens* branching off from *A. nuptus*, but the latter species persisting.

With the exception of a few individuals of *A. nuptus*, all specimens from 264-359 m (Wa4) are referable to *M. angustidens*. At 360 m, the much smaller *Microsyops cardiorestes* first appears, alongside *M. angustidens*. This is near the base of a previously identified period of faunal turnover (Biohorizon B), associated with localized warming. *Microsyops cardiorestes* remains rare until 397 m, when it briefly becomes more common This increase in frequency is associated with a reduction in the average body mass of *M. angustidens*, which is replaced shortly thereafter by *Microsyops latidens*. This part of the section may be correlated with a global hyperthermal event (ETM2). The reduction in body mass in microsyopines with increased temperature parallels the dwarfing observed in many lineages in the earlier PETM hyperthermal.

In summary, the very densely sampled record of microsyopine microsyopids from the southern Bighorn Basin allows for fine-scaled documentation of transitions, some of which appear closely tied to environmental change. The dense sampling in this section also allows for a rare direct documentation of cladogenetic speciation.

Technical Session IX (Thursday, November 6, 2014, 2:30 PM)

REASSESSMENT OF *POLYGLYPHANODON* (SQUAMATA: BORIOTEIIOIDEA) AND THE EVOLUTION OF THE LOWER TEMPORAL BAR IN SQUAMATES

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Polyglyphanodon sternbergi from the Late Cretaceous of North America is amongst the most complete borioteiioid lizards known so far, and is commonly used for broad level squamate phylogenetic analyses as an exemplar of its clade. From the study of numerous articulated specimens of *P. sternbergi* in various museum collections, we find there are important discrepancies between the original description of its morphology, and what we have observed. We present here a re-diagnosis of the genus and type species, including: presence of paired frontals; anteriorly arched frontoparietal suture; presence of complete lower temporal bar formed by jugal (broken in the holotype and previously thought to be incomplete). Five specimens show no significant morphological differences compared to the holotype of *P. sternbergi*, but two others show differences in the extension of the jugal and the shape of the frontoparietal suture, indicating they possibly belong to a new species of *Polyglyphanodon*. It was determined that *P. sternbergi* lacks replacement teeth in the adults, the teeth were added posteriorly as in agamid lizards, and there was a change in diet over ontogeny. This pattern indicates that the anterior teeth should already be present in juvenile stages and are remarkably similar to the teeth in the holotypes of *Paraglyphanodon utahensis* and *Para. gazini*. No differences between the *Paraglyphanodon* species and *P. sternbergi* that are not related to ontogeny were found. Therefore, *Para. utahensis* and *Para. gazini* are proposed herein to be juveniles of *Polyglyphanodon* cf. *sternbergi*. Mesokinesis and metakinesis were absent in *P. sternbergi*. Also, increased contact between the quadrate and the squamosal indicates streptostyly was absent too (all features important to ensure precise interdigitation of the laterally expanded teeth). The lower temporal bar could, therefore, have helped to provide further stability during jaw opening and/or reduce stress in the temporal region. A complete lower temporal bar had been considered absent among all living and fossil squamates until it was recently described for the borioteiioid *Tianyusaurus*. Scorings for *P. sternbergi* in a data matrix with 363 characters/229 taxa were corrected, resulting in changes to 27% of its osteological character states. *P. sternbergi* was found to be in a different lineage in relation to *Tianyusaurus*, providing for the first time evidence that the lower temporal bar underwent independent (parallel) evolution among lizards (both within borioteiioids).

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed November 5 – 8, judging occurs Thursday, November 6)

CHARACTERIZATION OF FUNCTIONAL TRAITS IN THE CARNASSIALS OF THE WOLF (*CANIS LUPUS*) USING 3D SURFACE TEXTURE ANALYSIS

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3D surface texture analysis in carnivores illustrates the biomechanical constrains of the chewing process on the nano-scale and thus support our understanding of the general process of muscle tissue disintegration in the vertebrate oral system. During the mastication process, the diet of mammals leaves distinct patterns on the enamel surface of the teeth. In this study we compared two extant populations of the grey wolf (*Canis lupus*) from Alaska and Sweden with regard to their dietary behavior and tooth function using 3D surface texture analysis (ISO 21578). The populations are distinct in their natural diet and precise data on proportion of prey species available. Three facets of the upper first molar along the cusp and compression basins were investigated to test for functional traits of bone and cartilage crushing. Additionally, the antagonistic facets of the upper fourth premolar and the lower first molar were analyzed. The Swedish population feeds on a greater proportion of large ungulates, such as moose, than the population from Alaska. This is reflected in the surface 3D texture parameters, as 14 of 30 ISO 25178 parameters are highly indicative of the dietary behavior of the two populations. The facets on the lingual site of the compression basin of the upper first molars are characterized by lower skewness and lower peak density compared to the facets on the buccal site. Therefore facets on the buccal site are characterized as guidance facets, distinguished as attrition (tooth-tooth contact) dominated in their wear signature. The facets in the compression basin are more abrasion (tooth-bolus contact) dominated. Hence we conclude that shear-cutting is the main function of the upper fourth premolar and lower first molar. The corresponding facets are characterized by asymmetric surface textures, indicating that the upper molars have larger and deeper dales with few peaks. Facets of lower first molars are dominated by higher density of peaks indicating a higher surface roughness. This finding indicates that antagonistic facets may not be mixed when evaluating dental surface texture as a dietary proxy.

Technical Session VI (Thursday, November 6, 2014, 9:00 AM)

COUPLING ENVIRONMENTAL CHANGE AND ECOLOGICAL RESPONSE: THE MIOCENE OF THE MOJAVE DESERT, CALIFORNIA

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Changes in climate, vegetation, and landscape have influenced the diversity and ecology of mammals throughout the Cenozoic. Peak mammalian diversity in the tectonically active Basin and Range Province coincided with a regional pulse in extensional tectonics and a global warming interval, the Miocene Climatic Optimum, or MCO, from 17 to 14 Ma. The middle Miocene record from the Mojave Region is one of the most complete, continuous, and fossil-rich sections to span this interval of environmental and biotic change. We present findings from two regional formations, the

Crowder and Cajon Valley. We utilize these records to assess the history of mammal diversity and paleoecology at the basin scale within the Basin and Range Province. The Crowder and Cajon Valley formations represent basins that were separated by estimated tens of kilometers at the time of their deposition, but are now adjacent due to movement along the San Andreas Fault system. These formations are an archive of diversity for both small and large mammals with abundant rodent fossils. We analyzed fossil-bearing strata from the Crowder and Cajon Valley formations for carbon isotopic composition of preserved soil organic matter (SOM) and for phytolith composition. Within the Crowder Formation, phytoliths and SOM provide evidence for the earliest C_4 vegetation in the Mojave region at 16 Ma; phytoliths record a mixed forest and C_3-dominated grass ecosystem. Phytolith assemblages from the neighboring Cajon Valley Formation do not contain C_4 grass phytoliths, but indicate a predominantly forest ecosystem, with approximately 25% C_3 grass, while the SOM record indicates a wetter depositional environment than the Crowder. Our results suggest that early C_4 vegetation in the Mojave was sparse but stable (~4% over 2.3 Ma in the Crowder Formation) and spatially heterogeneous in extent, possibly restricted to drier basins. Shifts in the $\delta^{13}C$ composition of SOM represent variability in the aridity or sedimentary facies of these basins across the MCO. We have coupled the paleoecology of small-mammal assemblages to the changing environmental conditions by assessing body size and hypsodonty index of the most diverse and abundant small mammal taxa, Heteromyidae. Co-occurring species of heteromyid rodents show broad overlap in size and crown height relative to tooth size, suggesting greater similarity in dietary ecology at the community level than in modern communities dominated by heteromyids.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

EVOLUTIONARY, PHYLOGENETIC, AND FUNCTIONAL IMPLICATIONS OF MAMMOTH MOLAR MORPHOLOGY AS MEASURED BY COMPUTED TOMOGRAPHIC (CT) SCANS

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In the Late Pleistocene of North America, two species of *Mammuthus*, *M. columbi* and *M. primigenius*, prove difficult to differentiate between on the basis of their third molar (M3) morphology alone. This situation is due to the effects of dental wear; a newly-erupted, relatively unworn M3 exhibits drastically different characters than that tooth would retain after a lifetime of wear. On a highly-worn molar, the lophs that comprise the occlusal surface are more broadly spaced and the enamel that comprises the lophs thickens in comparison to these respective characters on an unworn molar. Since *Mammuthus* taxonomy depends on the lamellar frequency (no. of lophs/decimeter of occlusal surface) and enamel thickness of the third molar, given the effects of dental wear it becomes apparent that these quantities are variable throughout the tooth"s life. Therefore, how can we employ static taxonomic identifications that are based on dynamic attributes?

To help resolve the relationship between *M. columbi* and *M. primigenius*, we quantified the proportions of the characters that comprise the occlusal surface of *Mammuthus* third molars. Using Computed Tomographic (CT) scans, we digitized a sample of teeth from both species and created models of continual wear via the removal of slices from the occlusal surface to the base of the crown. At each time slice, the proportion of enamel/dentine/cementum making up the exposed surface of the tooth was calculated. We then examined the relationship between wear stage and dental character proportions to determine if there was a separation between the two populations of mammoth molars. Although this method was highly intensive and outside the realm of possibility for every mammoth tooth collected, it does serve as a standard that can be referenced by subsequent researchers to help resolve the identity of a species given solely a molar.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A CATARRHINE PRIMATE INFERENCE MODEL FOR HOMININ MORPHOLOGICAL EVOLUTION

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The reconstruction of hominin phylogenetic relationships and taxonomic identification is dependent upon a thorough understanding of the phylogenetic utility of craniodental characters. The development of an accurate inference model based on morphological variability and phylogenetic utility in extant primates is crucial to interpretations of the primate fossil record. Here, we describe the development of such a model in catarrhine primates. Three-dimensional craniomandibular data were digitized from 15 hominoid and 14 cercopithecoid taxa. Cranial modules were morphometrically delineated on the basis of three primary criteria suggested to influence phylogenetic utility: biomechanical strain, development, and anatomical complexity. The congruence of each cranial subset was statistically compared to a molecular consensus phylogeny.

In hominoids, the splanchnocranium, upper face, zygomatic, and zygotemporal regions reflected molecular distances most accurately, in contrast to previously proposed hypotheses regarding cranial module efficacy. In cercopithecoids, the basicranium, zygomatic, maxilla, temporal, and zygotemporal were the most reliable. Thus, only the developmental hypothesis was supported for this group. The cercopithecoids displayed dramatic sex differences in congruence of cranial regions, such that male morphology was more informative about phylogeny than was female morphology. No such differences were observed among hominoids. An allometric correction was applied to the cercopithecoid data by regressing the Procrustes variables over centroid size and taking the residuals. When the size-corrected data was compared to the molecular phylogeny, the number of congruent cranial subsets increased significantly.

The commonalities between the two samples included a consistently reliable zygomatic bone and zygotemporal region. However, in hominoids, the bones and regions of the face were generally the most congruent; whereas in cercopithecoids, the basicranium and temporal bone were typically most reliable, and both sex separation and allometric corrections had to be applied to obtain consistently reliable results. It is clear that the separate evolutionary histories and adaptive pressures experienced by these two groups resulted in differing patterns of phylogenetic utility. These differences in two closely related primate superfamilies highlight the importance of using taxonomically appropriate models for drawing inferences in the fossil record.

Research funded by the Leakey Foundation.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

BIOGEOGRAPHY AND MOLAR MORPHOLOGY OF PLEISTOCENE AFRICAN ELEPHANTS: NEW EVIDENCE FROM ELANDSFONTEIN, WESTERN CAPE PROVINCE, SOUTH AFRICA

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Loxodonta atlantica is the largest herbivore and only elephant from Elandsfontein (EFT), a middle Pleistocene fossil site in the Western Cape Province of South Africa. The two middle Pleistocene elephant genera of Africa, *Elephas* and *Loxodonta*, are traditionally thought to inhabit discrete regions. Molars from *Loxodonta atlantica* and *Elephas recki* exhibit strong similarities in morphology, raising the possibility that isolated molars may on occasion have been referred to a species based on geography rather than morphology. To provide insight into the evolution of African elephants, we use data from the literature and collect new data on the molar morphology of EFT elephants to address questions pertaining to: (1) the biogeography of *Elephas* and *Loxodonta* in the African fossil record; and (2) species assesment of elephants at EFT. Results show that the view of non-coexistence of *Elephas* and *Loxodonta* is overstated, as fossil remains of both genera can be found at the same localities in eastern Africa. Rare co-occurrences in the north and south, however, suggest habitat separation of the two genera in some regions of Africa. Furthermore, the relative proportion of one genus over the other has implications for interpreting the paleoenvironment of Pleistocene fossil sites. For example, the relative abundance of *Elephas* over *Loxodonta* is associated with a more open habitat, and the relative abundance of *Loxodonta* over *Elephas* is associated with a more closed habitat. Principal components analysis, the method of species assessment, of four molar measurements (height, width, enamel thickness, and average lamellar thickness) on *E. recki* (n=12) and *L. atlantica* (n=10) third molars resulted in two interpretable axes. The first axis (PCI) sorts specimens by species (*L. atlantica* is larger than *E. recki*), and the second (PCII) sorts *Loxodonta* by subspecies (the northern *L.a. atlantica* exhibits thicker enamel than the southern *L.a. zulu*). PCI illustrates that all EFT molars are more like *L. atlantica* than *E. recki*, corroborating previous species assessments. PCII shows that not all elephants at EFT are *L.a. zulu*, as previously documented, as a heretofore undescribed molar from EFT falls within the range of *L.a. atlantica* specimens. Thus, this new molar may be evidence of the first *L.a. atlantica* in southern Africa. Overall, this study shows the complexity of elephant biogeography in the Pleistocene of Africa, and contributes to the understanding of elephant evolution as a whole.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

THE COMPLETE SKELETON OF A PRIMITIVE MOSASAURIAN FROM THE TURONIAN OF NORTHEASTERN MEXICO

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The lizard clade Mosasauria underwent an adaptive radiation in the Late Cretaceous, producing predators of gargantuan proportions, and went extinct near the Cretaceous-Paleogene boundary. According to the traditional history of the clade, the long-necked dolichosaurs and primitive mosasauroids ('aigialosaurs') evolved in the Cenomanian of the Old World, and Mosasauridae diversified, increased in body size, and spread worldwide during the Turonian. Recent phylogenetic studies of Mosasauroidea have suggested that Mosasauridae (with its traditional content) is not monophyletic. Furthermore, limbs and girdles adapted for high-performance swimming and large body size may have arisen more than once. Finally, the phylogenetic position of Mosasauria within Squamata is in doubt.

A complete new skeleton from the lower Turonian of Vallecillo, Nuevo Leon, Mexico, sheds new light on these issues. The skeleton differs from the holotype of *Vallecillosaurus donrobertoi*, from the same locality, in minor, although telling, characters: extensive occurrence of caudal transverse processes, and different proportions of the hind limbs. The skull and axial skeleton are quite plesiomorphic. The skull is the best-preserved of any primitive mosasauroid; it shows plesiomorphies such as a premaxilla without ethmoidal foramina, a narrow frontal, and a long, delicate posteromedial process of the coronoid.

The new specimen significantly improves the understanding of early mosasauroid ecology and evolution. First, phylogenetic analysis of this specimen using carefully selected outgroups supports the monophyly of Dolichosauridae and Mosasauridae as historically construed. Second, the new specimen is recovered as the basal-most mosasauroid; it may be related to the specimens referred to *Conisaurus* from the Cenomanian of Texas, which would represent the earliest known expansion of the clade outside the Old World. Finally, it shows, like several mosasaurs, an anteriorly displaced tracheal bifurcation, possibly an adaptation for deeper diving.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

REGIONAL FAUNAL DYNAMICS IN RESPONSE TO CLIMATE CYCLING THROUGH PHYSIOGRAPHIC REGIONS

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Biozonation for late Quaternary mammals of North America is coarse when compared to fluctuating glacial/interglacial cycles. Lack of precise dating and a discontinuity between high resolution, isotopically driven climatic data and regional scale environmental response are partly to blame. However, extinction and origination are not the only ways mammalian fauna respond to climatic drivers. Ranges shifts, faunal associations disintegrate and reform, and species retract into and expand out of refugia. Such faunal dynamics are typically examined on a continental scale for cycles of immigration and/or emigration. However, linking mammal faunas to individual global climate cycles on a continental level creates a scaling issue where localized environment overplays and obscures global climate shifts. Using mammalian fauna from the Neotoma Database for the Quaternary, we investigated whether a regional zonation scheme is feasible in North America. It would require: (1) an objective criterion for defining regional boundaries that can be applied throughout the Quaternary; (2) demonstration that site occurrences are distributed uniformly enough between these regions to provide an adequate empirical base for documenting regional immigration and emigration events; and (3) demonstration that faunas are regionalized within these units. We investigated the usefulness of physiographic regions as a basis for defining regional faunal boundaries. Unlike species themselves, which move in response to glacial-interglacial boundaries, physiographic regions have remained fairly intact over the last part of the Quaternary, changing in degree but not in kind. Furthermore, physiographic properties such as elevation, topography, and bedrock exert a local influence on vegetation regardless of the climatic conditions and thus provide another sort of constancy. We quantified the distribution of Quaternary sites into nine time bins ranging from the recent to 380 ka. We found that the Colorado plateau, central lowland, and Ozark plateau retain a large proportion of localities relative to other provinces per unit area and per unit of time. The next phase of this work will be to determine whether the faunas in physiogeographic provinces record events that can define a regional biozonation scheme that builds on the existing regional rodent chronologies.

Symposium 1 (Wednesday, November 5, 2014, 12:00 PM)

PHYLOGENETICALLY INFORMED SKELETAL MORPHOMETRIC PREDICTORS OF BODY MASS IN THE DIVERSE 'WATERBIRD' CLADE (TETRAPODA, AVES)

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Body mass is a critical organismal variable that strongly correlates with many aspects of life history, ecology, functional morphology, and physiology. Generating robust regressions between skeletal measurements and body mass thus has wide-reaching implications for paleobiological inference. We assessed osteological correlates of body mass utilizing a dataset of the diverse 'waterbird' clade (e.g., penguins, loons, herons, pelicans) that spans a broad range of morphologies, ecologies, and body mass. The evolutionary history of body size in waterbirds is represented by a relatively rich fossil record, which includes ancient species that are morphologically similar to their modern relatives (e.g., *Limnofregata*), but also several giant forms (e.g., *Giganhinga*, *Icadyptes*). Our dataset included 42 species from 19 families of waterbirds. Measurements of nine skeletal traits (femur length, femur circumference, tibiotarsus length, tibiotarsus circumference, humerus length, humerus circumference, skull length, synsacrum length, and synsacrum width) were obtained from 191 specimens spanning the phylogenetic and morphological diversity of the group. Using species-averaged body masses drawn from the literature and three different waterbird phylogenies, regressions were performed using ordinary least squares (OLS), phylogenetic independent contrasts (PIC), and phylogenetic generalized least squares (PGLS). Robust correlations were recovered for each of the morphometric characters considered (R-squared values between 0.61-0.93), with tibiotarsus circumference displaying the strongest correlation with body mass and tibiotarsus length displaying the weakest. Akaike Information Criterion (AIC) values were utilized to infer the best-fit multiple regression models. Although phylogenetic topology and branch lengths have marked effects on specific regression equations, the strength of correlation, and rank-order performance of different skeletal predictors is not strongly influenced by phylogenetic uncertainty. These results indicate that accurate inference of body mass may be obtained from even fragmentary fossils with poor phylogenetic resolution, while at the same time, complete specimens of well-resolved taxa (e.g., *Limnofregata*) can be utilized to test more nuanced hypotheses of body mass evolution (e.g., interspecies/intraspecies variation in fossil taxa; rates of evolution through time, etc.).

Technical Session VIII (Thursday, November 6, 2014, 3:15 PM)

NEW SPECIMENS OF *INDOHYAENODON RAOI* FROM THE EARLY EOCENE OF VASTAN MINE, INDIA AND THEIR IMPLICATIONS FOR PHYLOGENY AND BIOGEOGRAPHY OF HYAENODONTID MAMMALS

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Among the rich early Eocene vertebrate assemblage from the Cambay Shale Formation of Vastan Lignite Mine in Gujarat, Western India there are amazingly no carnivoran mammals. The only carnivorous mammal discovered until now is the hyaenodontid *Indohyaenodon raoi*. New remains of this species are here described, including the first known rostrum, upper dentition, and postcrania, substantially expanding our knowledge of *Indohyaenodon* and providing insights into its functional morphology and phylogenetic relationships. Craniodental morphology suggests that *I. raoi* had a broad diet, including non-vertebrate material as well as flesh and bone of a diversity of prey species. Postcranial morphology is broadly similar to that of other early hyaenodontids and suggests a scansorial or arboreal locomotion. Tentatively referred radii would favor a somewhat more arboreal habitus. Dental morphology indicates that *I. raoi* is closely related to other South Asian hyaenodontids such as *Paratritemnodon indicus* from the middle Eocene Subathu Formation of northwest Sub-Himalaya (India) and *Kyawdawia lupina* from the middle Eocene Pondaung Formation of Central Myanmar. The three species share features including strong cingula, narrow premolars, and a reduced P4 protocone. Our phylogenetic analysis of the Hyaenodontidae corroborates this relationship, but indicates South Asian hyaenodontids as the stem of a group that includes most African hyaenodontids. This and other higher-level relationships within Hyaenodontidae are however weakly supported, and substantially different alternative hypotheses of relationships are not significantly less parsimonious, reflecting strong character conflict. Factors contributing to this conflict include the isolation of hyaenodontid faunas on different continents during much of the Eocene, canalization and simplification of carnivorous dentitions, and a lack of non-dental material for critical hyaenodontid groups. The new phylogeny is consistent with either an African or an Asian origin for the group.

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Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

CHONDRICHTHYAN DIVERSITY IN THE EARLY CARBONIFEROUS: NEW EVIDENCE FROM THE TOURNAISIAN OF NORTHERN GREAT BRITAIN

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The end-Devonian extinction event marked a profound change in the diversity of fishes. The dominant Devonian taxa, the acanthodians, placoderms and sarcopterygians, were suddenly and irrevocably replaced by minor components of the fauna, the actinopterygians and chondrichthyans. This replacement began in the Early Carboniferous but the evidence for it is poor. Few localities are known and fossils are rare. Until recently, the earliest Carboniferous chondrichthyans were known mainly from teeth collected from two localities in Russia and one in Canada. In the UK, the entire chondrichthyan fauna was represented by two teeth. During the past three years field work at two new sites in the Scottish Borders has uncovered an extraordinarily diverse fauna of Tournaisian chondrichthyans. Represented by well-preserved cladodont, xenacanth and bradyodont teeth, most of the taxa are new and undescribed. The bradyodont teeth have been found in large numbers and cover a broad size range, adding to growing evidence that a durophagous feeding habit was common during the recovery following the end-Devonian extinction. This contrasts with later Visean chondrichthyan faunas which are usually dominated by sharks with cladodont, petalodont and orodont-type teeth. In these later faunas bradyodonts are rare.

Symposium 2 (Thursday, November 6, 2014, 2:30 PM)

ENERGETICS INFERENCES OF NECK MUSCLE SIZE AND HEAD ACCELERATIONS OF LARGE THEROPOD DINOSAURS

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Computerized biomechanics methods, such as multibody dynamics and finite element analysis, enable sophisticated inference of possible functions in extinct animals. However, such methods can be fruitfully combined with first principles of mechanics and muscle function, from which R. McNeil Alexander derived the foundations of paleobiomechanics. For example, Alexander suggested that neck muscles of pachycephalosaurian dinosaurs might have absorbed energy of collisions. Using inverse dynamics, we can apply Alexander's insight with the ability of muscles to exert power per unit mass (watts/kg), to the question of how much muscle mass carnivorous dinosaurs would need to turn their heads in a given amount of time. This exercise addresses two interlinked inferences at once, within explicit quantitative ranges: the morphology and appearance of dinosaur necks, and their behavior when turning their heads. Rotational inertias of *Allosaurus* and *Tyrannosaurus* heads and necks were estimated with custom slicing methods and the program SolidEdge. Their rotational kinetic energies, at previously published accelerations in dorsiflexion and lateroflexion, were tracked in MSC Adams, and necessary musculoskeletal torques, angular work, and power calculated. The muscle masses necessary for these activities were used to guide reconstructions of the head dorsiflexor Musculus transversospinalis capitis, and lateroflexor M. longissimus capitis superficialis.

Results for necessary muscle mass give cross-sectional dimensions similar to those of previous reconstructions, but these were probably larger than necessary considering possible pennation and assistance from other muscles. *Allosaurus* and *Tyrannosaurus* needed respectively slender and bulky necks to attain the applied accelerations. Beyond this starting point, 'emaciated' and 'steroidal' assumptions of muscle size bracket ranges of inferred accelerations and feeding capability. This study affirms the interplay of assumptions in reconstructing the appearance and function of fossil animals, and the utility of back-to-basics, Alexander-inspired approaches to such inferences.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

MICRO-CT SCANNING PROVIDES SUFFICIENT RESOLUTION AS A NON-DESTRUCTIVE MEANS FOR STUDYING CHONDRICHTHYAN TOOTH HISTOLOGY

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Micro-computed tomography (micro-CT) scanning is cheaper and more accessible than synchrotron-CT and, unlike conventional electron microscopy, non-invasively provides information that can be used to construct a three-dimensional model of fossil tissues. We present the first 3D digital reconstruction of the dentine layers in a primitive xenacanthid chondrichthyan tooth, as well as the major canals in the tooth. Two teeth (one of the type series and a referred specimen) from a species of *Dicentrodus* from the Mississippian of Iowa, USA were scanned at the University of Calgary. We have

identified layered orthodentine and trabecular dentine layers and tissue that may be enameloid or durodentine in a member of the type series (hereafter, type).

The orthodentine in the cusps is mostly separated by the trabecular dentine in the base but continguous lingually, close to the coronal button. Trabecular dentine has obliterated most of the pulp cavity, constitutes the majority of the tooth base, and extends into the middle of the cusps. Its diameter narrows considerably a third of the way up the major cusp and, in the referred specimen, the minor cusp. Trabecular dentine in the minor cusp of the type terminates where the cusp is broken. Interestingly, the type appears to have been injured while the animal was still alive, as there is evidence of tissue remodeling.

A reticulating network of canals run from the nutrient foramina through the trabecular dentine layer, and sometimes into the orthodentine. The canals of the major cusp are connected to the large nutrient foramen ventral to the cusp, while the damaged minor cusp (in the type) lacks a direct connection. Few large canals run through the prominent anterior flange of the tooth base. *Dicentrodus* from Iowa has two tiny medial foramina between the cusps, on a thin ridge of trabecular dentine.

A phylogenetic analysis based on previous work demonstrates that *Dicentrodus* was a relatively primitive xenacanthid chondrichthyan. Digital study of chondrichthyan teeth may allow more phylogenetic characters to be identified and coded. The downside of micro-CT is that maximum resolution is greater than single-crystal size. In *Dicentrodus*, the limited resolution frequently blurred the line separating the orthodentine and the trabecular dentine. The segmentation of the type necessitated a prior hypothesis of tissue distribution. Thus, micro-CT may prove more valuable as an effective preliminary tool for studying teeth, followed by synchrotron or SEM study.

Technical Session VII (Thursday, November 6, 2014, 8:45 AM)

EVOLUTIONARY ORIGINS OF IMPEDANCE-MATCHING HEARING IN ARCHOSAURIA

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Impedance-matching hearing is considered an important refinement of the auditory system in the evolutionary history of tetrapods. It is a pressure-relief mechanism that reduces energy loss during sound transmission, protects against overstimulation and extends the hearing range to higher frequencies. Anatomically, it is characterized by the sub-division of the metotic foramen into a posterior vagus foramen and an anterior fenestra pseudorotunda, over which the secondary tympanic membrane is located. Impedance-matching hearing has evolved independently in several tetrapod groups including archosaurs, but although it has been suggested that it represents a homoplasy for birds and crocodiles, this hypothesis has never been tested.

We assembled an informal supertree to map 17 neuroanatomical characters for 110 archosaur taxa based to a large extent on personal investigations including use of micro-computed tomography. Optimizing the morphological traits on the phylogeny revealed that the fenestra pseudorotunda appeared six times independently in Archosauria, with seven reversals to the plesiomorphic state. While this character is anatomically and phylogenetically plastic in dinosaurs, it appeared only once in pseudosuchians. In addition, time-calibration of the phylogeny shows that most changes occur during the Early Cretaceous. When considering other neuroanatomical characters, many state changes are associated with the origin of many major groups of dinosaurs, but most of the changes occurred early in Crocodylomorpha, prior to the pterygo-quadrate abutting against the braincase wall, and in thalattosuchians. A tree-shape analysis revealed pseudosuchians had six shifts in diversification rates, while dinosaurs had eight. Saurischians account for the majority of these shifts, but while none of these was correlated with impedance-matching hearing, two-thirds of ornithischian shifts were. When other features are taken into account, the number of correspondences between characters and shifts increases significantly for dinosaurs, though for pseudosuchians the majority of the shifts are not correlated with changes in any of the characters surveyed. It is, therefore, possible to conclude that impedance-matching hearing is not homologous among archosaurs, and that it has played a role in the diversification of ornithischians. In addition, data confirm that selective forces acting primarily in the jaw musculature of pseudosuchians were a strong constraint in their braincase anatomy, that was broken by thalattosuchians.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

NEW DATA AND A REVIEW OF THE HYAENODONTANS FROM THE PALEOGENE OF AFRICA

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Hyaenodontida is a group of carnivorously adapted mammals, which was successful in the Paleogene of Africa. Contrary to Laurasian representatives, African hyaenodontidans had no ecological competitors until the late Oligocene.

On one hand, the late Eocene and early Oligocene hyaenodontidans have been known since the beginning of 20th century thanks to the discovery of fossils from the Fayum area (Egypt). On the other hand, the Paleocene-Middle Eocene history of these predators was clarified only recently thanks to fieldwork in Northern Africa (Algeria, Morocco, and Tunisia).

The recent discovery of the koholiine, *Lahimia*, in the Paleocene of Ouled Abdoun Basin (Morocco) allows the origin of the African hyaenodontidans to be traced as far back as the Selandian. A second Paleocene taxon is recorded in the Ouarzazate Basin (Morocco): *Tinerhodon* from the Thanetian. *Lahimia* and *Tinerhodon* interestingly display two distinct dental morphologies: *Tinerhodon* has very primitive dental features, while *Lahimia* is derived in the secant morphology of its molars and loss of P1. These differences can be explained by a presently unknown Paleocene radiation.

The recent discoveries of hyaenodontidans in the late early or early middle Eocene of Gour Lazib area (Algeria) and middle Eocene-early Oligocene of Dur At-Talah (Libya) show that three new families appeared in Africa, at least during the middle Eocene: Apterodontinae, Hyainailourinae, and Teratodontinae. The postcranial material of *Apterodon* shows that hyaenodontidans even occupied a semi-aquatic niche in Africa.

New fossils from Chambi, in Tunisia, show a common carnivorous fauna with the sites from Gour Lazib area. Interestingly, hyainailourines and teratodontines were also present in southern Africa (Sperrgebiet, Namibia; Lutetian); this is evidence that hyaenodontidans had a wide African distribution.

Hyaenodontidans show a global trend of body size increase during the Paleogene. However, the recent discovery of the small hyaenodontidan *Furodon* in the Gour Lazib area and Chambi shows that small hyaenodontidans co-existed with large ones.

Several hypotheses on hyaenodontidan origins in Africa were proposed. Some assume an endemic African origin, while others suppose several trans-Tethyan dispersals from Laurasia to Arabo-Africa. The best evidence is for the dispersal of endemic African hyainailourines and apterodontines in Europe around the Eocene-Oligocene boundary, participating in the renewal of the European carnivorous fauna at the 'Grande Coupure'

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

MULTIPLE ISSUES WHEN PREPARING AND PRESERVING LATE MIOCENE BEAKED WHALE (GRAM FM) FOR RESEARCH AND EXHIBITION: THE DIFFICULT TASK OF DOING AS LITTLE AS POSSIBLE

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A fossil whale discovered in the Gram Clay Pit in 1986 was the first fossil of a beaked whale (Ziphiidae) to be found in Denmark. Initial taphonomic processes resulted in a very disarticulated specimen with only the cranium and a few postcranial elements left. Compaction and movements within the sediment have led to severe fragmentation and shifting of especially cranium elements making it highly vulnerable to damage during excavation, preparation, and other handling. The specimen also had serious pyrite oxidation issues.

In combination, this made the fossil, particularly the cranium, unsuitable for exhibition and difficult to study. Because of this fragile, crumbling state, all treatment and handling degraded it slightly more. This was the motivation to "do as little as possible" by using the least invasive treatments possible.

From 1988-1994, the best preserved parts were prepared, treated for pyrite oxidation, and consolidated. In 2005, mandibles and 50 teeth were exhibited. Funds made it possible to start the preparation and conservation of the cranium itself. Subsequently, research on the whale specimen could begin.

Preparation was needed to ensure visibility, but also to remove degraded pyrite in the sediment. This was done carefully with solvents, brushes, and scalpel. Local cementation within the brain cavity was removed with a pneumatic chisel and scalpel. Usually carbonate concretions offers support, strength, and buffer capacity to the fossil, but in this case pyrite oxidation went on unnoticed in a thin layer of soft sediment between concretion and fossil, damaging the latter.

It proved difficult to make good, strong adhesions due to crumbling and worn down fracture surfaces. Occasionally epoxy putty was carefully and sparsely applied on a barrier between the fossil and putty of a reversible adhesive acrylate copolymer (Paraloid B-72).

Degradation products of pyrite oxidation were mechanically removed and the fossil was neutralized in ammonia vapour. Controlling the relative humidity, visual inspection, and pH spot tests above and below fossil surfaces are part of the careful monitoring to follow. Oxidized fossils waiting for treatment were stored in a dry and oxygen free microenvironment. Immersion in ethanolamine thioglycollate solution was a last resort to reduce pyrite oxidation.

Custom-made cradles are necessary to support the fossil in all situations. Every time a new cradle was made new damage was inflicted. Manufacturing re-usable cradles is problematic, especially for very fragile and complex shapes such as the cranium.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

NEW MATERIAL OF *SARCOSUCHUS HARTTI* (NEOSUCHIA: PHOLIDOSAURIDAE) FROM BAHIA, BRAZIL

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Sarcosuchus imperator is known from Cretaceous deposits of the Ténéré Desert and El Rhaz Formation that outcrop in Niger. In 1867, some teeth were found in the Lower Cretaceous Ilhas Formation at the Recôncavo Basin (Brazil, Bahia State) and were later referred to a new species, *Crocodylus hartti*. More material, including a lower jaw and some osteoderms, was attributed to this taxon and since they share similarities with the African specimens, the Brazilian species was reallocated to the genus *Sarcosuchus* with some authors regarding both as representing the same species. Among the features shared between those species are the spatulate shape of the anterior extremity of the mandible, the size variation pattern of the alveoli in the lower jaw, and a coarse ornamentation of the ventral surface of the dentary. Here we describe new material referable to *S. hartti* collected many decades ago from the Bahia State. The material consists of a right ramus of a mandibular symphysis (MN 7459-V) showing 14 alveoli and two isolated teeth (MN 7460-V and MN 7461-V). The characteristic ornamentation of the ventral surface is more tenuous than in *S. hartti*, with more sparse pits. A medial opening for the anterior process of the splenial (not preserved) is observed in dorsal view. Some alveoli are elliptical with the anterior margin displaced medially. There is a short inter-alveolar space with some laterally placed marks resulting from the occlusion of the maxillary teeth. There is a groove between the symphyseal suture and the medial alveolar margin starting next to the final portion of the anterior articulation for the splenial process. The teeth are short, robust and conical. The crown is slightly curved laterally and shows sharp anterior and posterior carinae, which are more prominent near the apex. The enamel is striated and presents some delicate wrinkles. The MN7459-V specimen presents some potential autapomorphies of *S. hartti*, such as the presence of elliptical alveoli in the dentary with the anterior margin dislocated medially, and a ventral groove between the mandibular symphysis and the medial alveolar margin situated at the final portion of the anterior splenial process. Therefore we conclude that *S. hartti* is a valid taxon.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

REVISION OF "PELYCOSAUR"-GRADE SYNAPSIDS AND PROBLEMS WITH THEIR PHYLOGENY

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Basal, "pelycosaur"-grade synapsids have been under cladistic investigation for a long time. Until a recent study revised long-established characters and bundled all well-known genera for the first time, these analyses had followed one single traditional line. Now, during a revision of basal Sphenacodontia, all previous character lists have been rephrased for an analysis resolving this particular stage of synapsid evolution. Primary data from newly documented specimens as well as so far unregarded taxa or new combinations are used to present an exhaustive search for sphenacodont interrelationships. Several characters lead to a more confusing picture than expected, as some genera show a remarkable spectrum of character combinations. Even removing little known taxa and gradual features, the trees differ much, depending on the list of chosen terminal taxa. In general, this is caused by the very similar morphology of the genera, varying in details that do not occur in straightforward patterns. Even Edaphosauridae did not come out as monophyletic at first because of the morphological similarities *Ianthasaurus* shares with some basal sphenacodonts. Basing on the assumption that the edaphosaur-type and the *Dimetrodon*-type elongated spines evolved singularly and irreversibly, these subgroups can be investigated separately. The following patterns recurred in different approaches. The very base is unresolved, such that neither varanopids nor caseasaurians are the basal-most synapsid members with certainty. Edaphosauridae are not necessarily the sister-group to all genera gathered as sphenacodonts so far. *Pantelosaurus* is rather high in the tree, close to Sphenacodontidae. *Tetraceratops* is not a therapsid, but a "haptodont"-grade genus. Less surprisingly, therapsids are not the sister taxon to classical sphenacodontids in all trees, suggesting a more basal origin within non-spenacodontid sphenacodonts.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

3-D SCANNING AND PRODUCTION OF ACCURATE FORM-FITTING SUPPORT CRADLES FOR FOSSILS USING CNC MILLING TECHNOLOGY (COMPUTERIZED NUMERICAL CONTROL TECHNIQUE): A PROJECT WITH THE GEISELTAL COLLECTION

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Supporting cradles are needed for long-term preservation and storage of fragile Cenozoic fossils, such as those housed at the Geiseltal collections. These cradles are traditionally produced by molding techniques, using materials such as plaster, epoxy resin, and silicone. These materials are relatively easily made by hand, but they degrade over time. Additionally, the fossils are affected both chemically and mechanically during the cradle's manufacture. Furthermore, it is not always possible to establish a perfectly fitting supporting structure. If the base does not fit exactly, the fragile fossils can become damaged during long-term storage.

Until recently, age-resistant materials such as polyethylene plates (e.g., Neopolen and Ethafoam) were rarely used to create support cradles because they are produced only by hand cutting the material to fit the object, which is very time-consuming.

The use of mobile 3D scanners offers the possibility to digitize detailed surface structures of fossils on all sides. From this scan, computer software can provide an accurate negative counterpart. CNC milling technology (Computerized Numerical Control Technique) is a form of 3D printing that can carve out detailed surfaces from age-resistant plastics such as Neopolen. This method can produce a support cradle to exactly fit a fossil of nearly any shape or size.

The procedure of scanning and printing cradles is non-invasive and non-destructive. This method is advantageous over traditional molding methods in that it does not require plaster, epoxy resin, or silicone, which can damage the fossil chemically and/or mechanically. This method has been successfully applied to the Geiseltal collection with large and fragile material including a synsacrum of the large flightless bird *Gastornis* and skulls of the large crocodile-relative *Asiatosuchus*. As costs of the methodology continue to reduce, it is our hope that it will be used as a standard for safe long-term storage of delicate fossil material.

Symposium 5 (Saturday, November 8, 2014, 2:30 PM)

TRACKING VARIATION IN SMALL MAMMAL FUNCTIONAL GROUP ABUNDANCE: IMPACTS OF QUATERNARY CLIMATE AND LAND USE ON THE COLORADO PLATEAU

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Analysis of community change in the fossil record is necessary for establishing baselines of biodiversity and 'normal' biotic fluctuation. Taxonomic turnover is a principal way in which communities respond to environmental change. However, metrics of community change that are ataxonomic, called ecometrics, are more broadly applicable when attempting to bridge long time and large spatial scales, where taxa are different but ecological players are comparable. Such ecometrics are also essential in forecasting how communities will respond to on-going global change, a key piece of information for biodiversity conservation. Metrics for spanning temporal and spatial scales allow us to use essential baseline information from the fossil record to inform understanding of rapid biotic change.

Using the Colorado Plateau as a case study, I examined changes in functional group diversity across the last 20,000 years. Functional groups, or guilds, are defined as suites of species that have the same general body size and diet; functional group diversity is the number of species in each category. Statistical differences between the last 400 years and previous time bins are driven only by the loss of native megaherbivores, but temporal resolution for older time periods is poor. Taking a closer look at the last thousand years, I analyzed changes in abundance, rather than diversity, of functional groups. I quantified regional abundance using nested subset patterns—nested metrics are typically used in a spatial framework, but can be translated to a temporal context. I also looked at changes in local abundance of functional groups over this time period, using data from a well-sampled region in southeastern Utah. In this area, abundances of some functional groups, like small herbivores, are essentially stable over the last ~1000 years while others have changed dramatically. For example, in the case of granivores, changes in functional group abundance mirror taxonomic changes: over the period, granivorous kangaroo rats (genus *Dipodomys*) decline continuously, in tandem with declines in abundance of the other 4 genera in the functional group. In contrast, herbivores between 0.5 and 1 kg increase in abundance, yet no new species are gained. Such changes in functional group abundance and diversity are used to interpret ecological processes taking place in both the fossil record and modern landscape.

Technical Session V (Wednesday, November 5, 2014, 3:15 PM)

GENOME SIZE AND OSTEOCYTE LACUNA SIZE IN RECENT AND FOSSIL SALAMANDERS

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Modern salamanders possess giant genomes compared to all other tetrapods and, directly correlated with this, by far the largest cells among tetrapods. While no entire genome of a salamander has been sequenced thus far, recent studies have shown that large introns and novel genes contribute to the enormous genome sizes. The extreme cell size impacts many aspects of salamander biology and has been suggested to be closely associated with the enormous plasticity in life history pathways and their high regenerative capacity that includes limbs, eyes, spinal cord and other complex tissues. In our study, we sectioned long bones ($n > 18$, mostly femora) of members of all modern salamander families with known genome sizes as well as long bones of members of several fossil amphibian lineages to investigate if: 1) the correlation between genome size and cell size that has been established based on leucocytes holds with respect to osteocyte size and; 2) investigate when within the long evolutionary history of the clade the large genome sizes evolved. For comparison, we sampled femora of a number of modern amniote and frog taxa with known genome sizes. Understanding the correlation between osteocyte lacuna size and genome size in modern taxa is vital for an investigation of genome sizes in fossil taxa. In order to minimize errors caused by variation in location and orientation of sections, we aimed to sample homologous elements in the same location and the same plane of sectioning. Our results show that genome size and osteocyte size are correlated in salamanders. Moreover, the large genomes of urodeles were already present in stem-group salamanders (Karauridae) and most likely evolved early in the evolutionary history of the salamander lineage, possibly as early as Paleozoic dissorophoid temnospondyls. This provides new insights into the deep time genomic evolution of urodeles and a novel dataset for understanding salamander origins and the evolution of central aspects of their biology, such as life history patterns, miniaturization, and developmental rates.

Symposium 5 (Saturday, November 8, 2014, 3:00 PM)

RED QUEEN AND COURT JESTER: BIOTIC AND ABIOTIC INTERACTIONS IN ECOLOGY AND EVOLUTION

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Geographic sorting of species by their ecometric traits occurs within a more general context of evolutionary ecological processes that operate at continental and local geographic scales and at ecological and paleontological time scales. Here I review the ecological dynamics of the Canadian lynx, *Lynx canadensis*, a top-level carnivore whose primary prey is the Snowshoe hare, *Lepus americanus*. This example shows how biotic and abiotic factors interact in the evolutionary process and in geographic differentiation. Lynx populations are affected both by density-dependent predator prey processes and density-independent climatic processes. Large-scale climatic processes lead to regional differences in snow conditions, which affect both the dynamics of lynx-hare population cycles and the dispersal behavior of the lynx. These processes have consequently led to subdivisions between eastern and western metapopulations of lynx across the Canadian continent, which in turn have led to evolutionary differentiation. The Eurasian lynx provides a useful point of comparison because this species has evolved in a different climatic context and has thus had a different evolutionary history. These examples demonstrate how abiotic and biotic forces are seen to affect evolution across time, and by so doing illuminate the roles of the Red Queen and the Court Jester hypotheses in macroevolution.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A NEW MEIOLANIID (TESTUDINATA: MEIOLANIIDAE) FROM THE MIDDLE EOCENE (SARMIENTO FORMATION) OF CENTRAL PATAGONIA (ARGENTINA): DIVERSITY, PHYLOGENY, AND PALEOBIOGEOGRAPHY OF HORNED TURTLES

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The objectives of the present work are: 1) to describe a new genus and species of a horned turtle and its geological setting; 2) to explore its phylogenetic relationships; 3) to analyze the diversity and evolution of the group in a paleobiogeographical frame; and 4) to compare the evolution of Meiolaniformes and other turtles with the well-recorded evolution of mammals in southern Gondwana. The specimens come from the lower Sarmiento Formation at Cerro Verde (Cañadon Hondo area). The level containing turtles and crocodyliforms is located at base of the section and is composed of laminated, fine tuffs interpreted as shallow ponds. It underlies another fossiliferous level composed of lenticular, massive sandstones bearing skeletal remains of mammals, referred by previous authors to the Casamayoran SALMA. Geometry and facies are interpreted a as fluvial depositional system. Cranial and postcranial remains of this new horned turtle have been

found and they represent the most complete meiolaniid known from South America. This new species differs from other meiolaniids in the peculiar thick half-moon shaped rim surrounding the cavum tympani, the presence of three cranial scutes K, an unenclosed canalis chorda tympani mandibularis, among other characters. The preliminary cladistic analysis, based on recent analysis of meiolaniforms, suggests this new species belongs to Meiolaniidae. However, due to the presence of few elements in common between this species and other meiolaniids, its phylogenetic position is not stable inside the clade. The paleobiogeographic analysis shows that meiolaniids would have originated in the area that is today represented by Antarctica, however there is no fossil record supporting this hypothesis. The comparison of the evolution of meiolaniforms with other amniotes suggests a common paleobiogeographical history of these clades in southern Gondwana. Furthermore, different proxies highlight that the paleobiogeographical history of meiolaniids is also controlled by the major climatic changes occurred during the Cenozoic caused mainly by the breakup of southern Gondwana.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

PALEOBIOLOGICAL PATTERNS IN THE LATE OLIGOCENE NSUNGWE FORMATION FAUNA, SOUTHWESTERN TANZANIA

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Field and laboratory studies of fossils from the western branch of the East African Rift System in southwestern Tanzania document a complex basin history with multiple Paleozoic–Cenozoic tectonic and depositional events. The Cenozoic depositional history of the Rukwa Rift, a key segment of the western Branch, is characterized by proximal alluvial fan systems that transitioned into a complex, volcanically-influenced landscape of fluvial, alluvial, and lacustrine depositional environments. Late Oligocene fossil-bearing facies of the Nsungwe Formation are dated at ~26–24 Ma via high-precision U-Pb and Ar/Ar geochronology of intercalated volcanic tuffs. Recent discoveries document the oldest African boid snake, the earliest evidence of venomous elapid snakes on the African continent, and the oldest colubroid-dominated snake fauna in Africa. A predominance of active foraging predator species dovetails well with sedimentology-based paleoenvironmental reconstructions of seasonal aridity in the region. The Nsungwe Formation fauna also contains the earliest evidence of the endemic African ranoid frog family Ptychadenidae in addition to a rare xenopodinomorph pipid frog. Localities in the late Oligocene Songwe Member of the Nsungwe Formation notably preserve a diverse mammalian fauna including rodents, macroscelideans, hyracoids, and anthracotheres. Significant primate discoveries include the first lorisiform from Africa south of the equator, the latest record of parapithecids, and the earliest evidence of the split between cercopithecoids and hominoids. Other vertebrate clades are preserved in the fauna, represented by articulated turtle and fish materials and avian cranial and postcranial elements, in addition to crocodylian and lepidosaurian remains. Nsungwe Formation discoveries offer a glimpse at the evolutionary history of late Oligocene terrestrial and freshwater habitats in eastern Africa, providing data on the complex tectono-sedimentary history of the Rukwa Rift Basin. Continued exploration offers a refined perspective on the Paleogene–Neogene transition on continental Africa, with expanded opportunities for recognizing trends in paleobiological diversity across habitat types and through time.

This research was supported by National Geographic Society (CRE), LSB Leakey Foundation, Ohio University African Studies Program, Ohio University Heritage College of Osteopathic Medicine, and the National Science Foundation (EAR 0617561; EAR 0933619; BCS 1127164; EAR 1349825).

Symposium 4 (Friday, November 7, 2014, 11:00 AM)

THE SALT OF LIFE: EURYHALINITY AND HALOTOLERANCE IN TEMNOSPONDYLS

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According to paleoenvironmental, paleogeographical, and/or morphological reconstructions, the first tetrapods were euryhaline: their Late Devonian bodyfossils are found mostly in margino-littoral paleoenvironments and they correspond to rather aquatic animals unable to sustain their own bodymass on land. This euryhalinity could be linked with their polydactyly because the same Hox genes A-D control the morphogenesis of the urogenital system (which regulates the inner salt concentrations) and of the autopodium. This euryhalynity explains the worldwide distribution of the tetrapods during the Late Devonian. It also fits with the earliest tetrapod trackways found in marine tidal sediments from the Middle Devonian of Poland.

Later, this plesiomorphic euryhalinity (re)appeared in many temnospondyl groups: the basal *Iberospondylus* from the Carboniferous of Spain is one of the first known euryhaline temnospondyl. This trait seems less common during the Permian, but it could be masked by the fact that most Permian temnospondyl localities are lacustrine. Temnospondyl euryhalinity is well visible after the Permian-Triassic extinction in various stereospondyl groups such as trematosaurians (e.g., *Aphaneramma* from the Triassic of Spitzberg), capitosaurians (e.g., *Edingerella* from the Triassic of Madagascar), and plagiosaurids (e.g., *Gerrothorax* from the Triassic of Germany).

How to explain this capacity to support various concentrations of salts in these amphibians? Living amphibians (i.e., lissamphibians) do not support very salty waters and do not seem appropriate for comparisons. Halotolerant and/or marine living amniotes such as sea turtles or seabirds may better help for actualistic reconstructions. Osmoregulatory organs such as kidneys, functional salt glands, or supraorbital glands are reviewed, and their hypothetic presence and role inferred in temnospondyls. The problem is that these labile organs do not leave compulsory traces on bones. Yet orbits, nostrils, and other cranial fenestrae, as well as endocranial and/or palatal bony processes, of peculiar shape and texture could accommodate such glands.

Technical Session III (Wednesday, November 5, 2014, 2:00 PM)

NEW ANATOMICAL DETAILS OF THE BASAL CERATOSAUR *LIMUSAURUS* AND IMPLICATIONS FOR THE JURASSIC RADIATION OF THEROPODA

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The basal ceratosaur *Limusaurus inextricabilis* from the Upper Jurassic (Oxfordian) Shishugou Formation of Xinjiang, China is notable for being the earliest edentulous theropod, the first ceratosaur known from Asia, and the only non-avian theropod known to display strong bilateral digital reduction. Here we present new details of its anatomy based on our study of 18 articulated or associated skeletons, including several young juveniles, and an analysis of its phylogenetic relationships.

Computed tomography (CT) reconstruction of a three-dimensionally preserved skull reveals an unusual pattern of quadrate pneumaticity and the structure of the palate. Pneumatic features of the posterior cervical and anterior dorsal vertebrae are present only in *Limusaurus* and other gracile ceratosaurs such as *Masiakasaurus* among non-avian theropods. Characteristic features of Abelisauroidea such as the relative development of prezygapophyseal-epipophyseal laminae in cervical vertebrae and double blood vessel traces in pedal unguals are individually, bilaterally, and serially variable in *Limusaurus*. This indicates that these features may be useful for diagnosing taxa as ceratosaurian, but have the potential to mislead taxonomic hypotheses for fragmentary taxa.

Morphologies from throughout the skeleton suggest that *Limusaurus* is a noasaurid ceratosaur, and a phylogenetic dataset built to test the relationships of basal Neotheropoda corroborates these observations through parsimony and Bayesian analyses. Optimization of manual characters suggests that the manual morphology of *Limusaurus* is unlikely to be representative of the averostran ancestor as previously hypothesized. However, we argue that the presence of bilateral digit reduction in *Limusaurus* and other ceratosaurs remains a key piece of evidence for understanding theropod digit homologies.

New anatomical insights from *Limusaurus* and other ceratosaurs we surveyed reveal that several Jurassic specimens from Laurasian landmasses previously referred to Coelophysoidea and Tetanurae can be identified as either stem averostrans or ceratosaurs. These discoveries reduce the typically long ghost-lineages recovered by other authors near the base of Averostra. Ceratosaur diversity known from northern landmasses now exceeds that from Gondwana during the Jurassic, though ceratosaurs achieve peak success in Gondwana during the Cretaceous. This research was supported by the National Geographic Society and NSF award numbers 1311000, EAR 0922187, and EAR 0310217.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

MORPHOLOGICAL DATA FOR *CRYPTAGAMA AURITA* YIELD NEW INSIGHTS INTO THE ENDEMIC AUSTRALIAN AGAMID LIZARD RADIATION

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The endemic Australian agamid lizard fauna represents a diverse and biogeographically interesting radiation that remains poorly understood. Phylogenetic analyses of both morphological and molecular data yield alternative hypotheses for relationships within the endemic radiation. Numerous fossil deposits across the continent contain fossilized remains of agamid lizards, but those materials remain unpublished and poorly studied. Adequate understanding of the fossil record and holistic perspectives on phylogenetic relationships within the group require detailed knowledge of skeletal morphology. Morphological data are deficient for the majority of Australian agamids and are completely absent for several taxa. One of those is the rare and enigmatic *Cryptagama aurita*. The species is known from only four specimens; a fifth individual recently was photographed, but not collected nor were tissue samples collected. There are no tissues available, and no skeletal preparations exist. We computed tomography (CT) scanned two specimens of *Cryptagama aurita*, including a relatively large individual, and an obviously juvenile specimen. *Cryptagama aurita* shares several features of the skull and mandible only with the bizarre thorny devil, *Moloch horridus*. Those characters include a lingual process of the coronoid bone that does not extend ventrally to the lower margin of the mandible, lack of caniniform teeth (also possibly absent in *Chelosania*), a reduced nasal that weakly meets the facial process of the maxilla, a weakly developed ventrolateral process of the basioccipital, and a flattened quadrate process of the pterygoid. Those features are not shared by any other endemic Australian agamids, are absent in the outgroups to that clade (e.g., *Physignathus*, *Agama*), and represent a derived condition within the Australian clade. These data provide the first hard evidence for a close relationship between *Cryptagama* and *Moloch*.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

CRACKING DINOSAUR ENDOTHERMY: PALEOPHYSIOLOGY UNSCRAMBLED

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The amniote eggshell functions as a respiratory structure adapted for the optimal transmission of respiratory gasses to and from the embryo according to its physiological requirements. Therefore amniotes with higher oxygen requirements, such as those that sustain higher metabolic rates, can be expected to have eggshells that can maintain a greater gas flux to and from the egg. Studies of extant amniotes have found that eggshells of reduced porosity impose a limit on the metabolic rate of the offspring. Here we show a highly significant relationship between metabolic rates and eggshell porosity in extant amniotes that predicts highly endothermic metabolic rates in dinosaurs. This study finds the eggshell porosity of extant endotherms to be significantly higher than that of extant ectotherms. Eggshell porosity values of dinosaurs are found to be significantly higher

than that of extant ectotherms, but not extant endotherms. Dinosaur eggshells are commonly preserved in the fossil record, and porosity may be readily identified and measured. This provides a simple tool to identify metabolic rates in extinct egg-laying tetrapods whose eggs possessed a mineralized shell.

Technical Session VII (Thursday, November 6, 2014, 8:30 AM)

EARLY ARCHOSAUROMORPH DISPARITY IS REPEATED BY DINOSAURS: CONVERGENCE OF PACHYCEPHALOSAURID CRANIAL MORPHOLOGY BY A NEW DOME-HEADED ARCHOSAURIFORM FROM THE UPPER TRIASSIC OF TEXAS

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Archosauromorph reptiles (i.e., crown archosaurs and their close relatives) possess disparate cranial morphologies and a diversity of body plans and sizes, which are unmatched by other contemporary vertebrates in the Mesozoic Era. Particularly in the Triassic, archosauromorph disparity was high and general body plans of some archosauromorphs (e.g., azendohsaurids, shuvosaurids, aetosaurs) were repeated later in the Mesozoic by other groups of archosaurs (e.g., early sauropodomorphs, ornithomimids, ankylosaurs). Here we present a case of convergence between a new early archosauriform from the early Late Triassic Otis Chalk vertebrate fossil assemblage of the Dockum Group of Texas and Cretaceous pachycephalosaurid dinosaurs. Like pachycephalosaurs, this Triassic specimen preserves a thickened and domed skull roof with obliterated cranial sutures, an expanded posterior margin of the skull (a synapomorphy of Marginocephalia), and large orbits. This new taxon possesses a large pineal foramen and an ossified orbital septum formed by the laterosphenoids. Computed tomographic data of this new taxon reveal large, laterally expanded olfactory bulbs and a complete, well-preserved left osseous labyrinth. The anterior semicircular canal has the largest diameter of the three canals, indicating increased sensitivity to changes in pitch. Though the facial region is incomplete, reconstruction of normal head posture from the orientation of the lateral semicircular canal with respect to the occipital condyle indicates the skull roof was held at a steep angle with the frontal region oriented almost entirely anteriorly and the parietal-squamosal region oriented in a nearly transverse plane. We included this specimen in a recent cladistic analysis of Archosauromorpha and found it as an early diverging archosauriform based on the presence of an antorbital fenestra and associated fossa in the lacrimal and an ossified laterosphenoid. The similarity between this new taxon and the cranial modifications of pachycephalosaurs over 100 million years later illustrates the early exploration of cranial morphospace in the Triassic. Distinctive cranial morphologies and modifications seen in Jurassic and Cretaceous dinosaurs are being found increasingly often in Triassic archosauromorphs. The acquisition of those cranial configurations implies that faunal and ecological shifts interpreted to occur among dinosaurs later in the Mesozoic possibly occurred much earlier, during the Triassic archosauromorph radiation.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A NEW STEREOSPONDYLOMORPHA TEMNOSPONDYL FROM THE MIDDLE/LATE PERMIAN OF SOUTH BRAZIL

STRAPASSON DE SOUZA, Adriana, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; LIMA PINHEIRO, Felipe L., Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; BENTO SOARES, Marina, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil

Temnospondyl amphibians have already been recorded in the fluvio-lacustrine deposits from the top of the Meso/Neopermian sequence from the Paraná Basin (Rio do Rasto Formation, South Brazil). This record includes *Australerpeton cosgriffi*, *Bageherpeton longignathus*, a short-snouted skull, a hemimandible, and a nearly complete skull not formally described. In this work a new temnospondyl is described. The material consists of disarticulated cranial and postcranial elements, preserved in association. The cranial elements include part of the orbital region of the skull roof, the basicranium, a number of endocranial elements, stapes, and a right hemimandible. The postcranial elements include vertebrae, ribs, pectoral girdle elements, a right femur, and a cluster of scales. This specimen is distinguished from all other temnospondyl taxa by the presence of the following combination of characters: epipterygoid robust with an elongated blade-like anterior process; broad sutural contact between parasphenoid and pterygoid; very elongated and deep muscular 'pockets' of parasphenoid, anterolaterally limited by very developed and sharp muscular crests that extend upward over the lateral side of the exoccipital condyles; small basioccipital ossification, visible only in occipital view, contributing to the exoccipital condyles; shagreen denticles on pterygoids and parasphenoid; and foramen for the internal carotid artery lying at the posterolateral corner of the parasphenoid, posterior to the pterygoid articulation. A phylogenetic analyses was performed using TNT v. 1.1 and based on a recently published dataset, resulting in 67 equally parsimonious trees of 633 steps (CI = 0.36, RI = 0.8). The phylogenetic analysis grouped the new material and *Australerpeton cosgriffi* in a monophyletic sister group inside Stereospondylomorpha. The study material displays a rhinesuchid pattern, which is similar to the South African rhinesuchids from the upper Permian Beaufort Group of the Karoo Basin, but differs from them by the presence of a robust and elongated epipterygoid with a blade-like anterior process in addition to elongated and deeper muscular pockets of parasphenoids, which allow the inclusion of this specimen into a new species. The new taxon will provide interesting data for biostratigraphic studies, which are already in progress. Funded by a student grant from Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES).

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

AN EMENDED DIAGNOSIS OF *MOSASAURUS HOFFMANNII* TO CLARIFY THE CONCEPT OF *MOSASAURUS*

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The first mosasaur fossils were discovered in the chalk quarries near Maastricht during the late 16th century. The second of these finds, referred to as "le grand animale fossile des carrières de Maastricht", received a great deal of contemporary attention, but the true affinities of the specimen remained unknown for many years. This confusion represented just the precursor to the taxonomic issues that have continued to plague the taxon. The binomial *Mosasaurus hoffmannii* was erected prior to the establishment of an internationally accepted code of nomenclature, spanning 21 years from description to erection of the specific epithet, with no description or diagnosis accompanying either the genus or the species name. While modern authors have diagnosed both the genus and the species, these diagnoses are incomplete and vague leading to *Mosasaurus* becoming a poorly defined waste basket taxon, with numerous weakly justified species assigned to it. We herein present the following much-needed emended diagnosis of *Mosasaurus hoffmannii* based on detailed study of the type specimen from the Museum National d"Histoire Naturelle in Paris MNHN AC9648: maxilla with little to no excavation for external naris; maxilla bearing 13 teeth; pterygoid tooth row straight, bearing 8 small, posteriorly curved, posteriorly carinate teeth; quadrate tall with short, curved suprastapedial process; infrastapedial process reduced; rim of tympanic ala grooved with distinct anterodorsal and anteroventral corners; dentary bearing 14 teeth; marginal dentition faceted and asymmetrically bicarinate; post-dentary unit height approximately half of length; femur greatly expanded medially and distally with long axes of articular surfaces perpendicular and internal trochanter robust and offset. Stabilization of the generic type around a robust diagnosis clarifies the concept of *Mosasaurus* by defining the species *hoffmannii*. Assessment of the morphology of existing species currently assigned to *Mosasaurus* results in the recognition of six diagnosable species.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed November 5 – 8, judging occurs Thursday, November 6)

EVOLUTIONARY BOTTLENECK OF MARINE REPTILES DURING THE TRIASSIC-JURASSIC TRANSITION

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Mesozoic marine ecosystems were inhabited by a disparate array of diapsid reptiles. The most diverse and varied group, Sauropterygia, spanned the entire Mesozoic and occupied a broad range of trophic niches throughout their evolutionary history. However, plesiosaurs were the only sauropterygians to transcend the Triassic-Jurassic transition, with other clades becoming extinct during the Late Triassic. Our aim was to test how this loss of phylogenetic diversity impacted patterns of morphological and potential ecological diversity in Sauropterygia, and assess if the group passed through an evolutionary 'bottleneck' at the Triassic-Jurassic boundary. We examine two elements of variation: cranial shape (morphology) and size. Geometric morphometrics and multivariate disparity analyses were implemented to calculate morphological variation. Our analyses reveal that Triassic sauropterygians (placodonts, nothosaurs and pachypleurosaurs) were significantly more morphologically disparate than Jurassic and Cretaceous plesiosaurs. At no point during the Jurassic or Cretaceous did sauropterygians achieve levels of morphological disparity equaling those in the Triassic. This provides robust support for the hypothesis that a loss of sauropterygian lineages during the Late Triassic reduced the clade's potential for generating morphological variation. In contrast, our analysis of size reveals that Jurassic and Cretaceous plesiosaurs explored a far greater range of cranial sizes, despite the disappearance of extremely small forms. This hints that Triassic sauropterygians and plesiosaurs explored variation differently, with Triassic lineages evolving disparate cranial shapes within a small size range, while plesiosaurs explored a great range of sizes but only limited shapes. Overall, our conclusions, in accordance with previous research on ichthyosaurs, suggest that the extinction of marine reptiles during the Late Triassic had profound effects on subsequent evolution, ecological diversity and ecosystem composition during the Jurassic and Cretaceous.

Technical Session X (Friday, November 7, 2014, 8:45 AM)

SHUITANGBA: A TERMINAL MIOCENE FOSSIL VERTEBRATE SITE IN YUNNAN, CHINA

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The lignite mines in the Zhaotong Basin of Yunnan have been known to be highly fossiliferous since the 1960s, but only a few cursory studies of the area and its fossils had been attempted. Of these, Shuitangba is the first to be systematically collected and studied. Magnetostratigraphic and biostratigraphic studies of the site place its age in the terminal Miocene, about 6 Ma, during the transition to cooler and drier conditions in Eurasia. The fauna is preserved in intercalated deposits of lignite and silty and peaty clays, and includes specimens of Mammalia (Primates, Insectivora, Carnivora, Rodentia, Lagomorpha, Perissodactyla, Artiodactyla, Proboscidea), Aves, Teleostei, Anura, Squamata, Testudines, and Crocodylia. The avifauna of Shuitangba is particularly striking as it is the most abundant component of the fauna and is dominated by a diversity of water birds. Noteworthy among Shuitangba mammals is a juvenile cranium of the hominoid *Lufengpithecus* and a mandible and postcrania of *Mesopithecus*, a colobine monkey. A complete cranium of an otter-like mustelid, *Siamogale*, and remains of diverse insectivoran and rodent species, including beavers, were also recovered.

Preliminary taphonomic analyses suggest that the large mammals at Shuitangba were buried relatively quickly after death and remained largely undisturbed until exposure. The fauna indicates a densely vegetated, moist-forest environment at the margin of standing water. Abundant remains of large tree trunks and branches, as well as seeds, provide further evidence of a heavily vegetated and well-watered habitat. Shuitangba mammals are mainly representatives of lineages with a wide distribution beyond Yunnan, although certain taxa appear to be endemic to southern China. Many of the late Miocene basins and mountain valleys in Yunnan were refugia, where lineages persisted that had gone extinct elsewhere. Shuitangba is suggested to reflect one such refugium and illustrates the regionally specific nature of environmental changes throughout the late Miocene within Yunnan. Research was funded in part by the National Science Foundation, Yunnan Natural Science Foundation, National Basic Research Program of China, Government of Zhaotong, and the National Natural Science Foundation of China.

Technical Session XVII (Saturday, November 8, 2014, 2:15 PM)

NEW DATA ON THE TRIASSIC-JURASSIC TETRAPOD ASSEMBLAGES IN THE FUNDY GROUP OF THE CANADIAN MARITIMES

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The Fundy Basin in Nova Scotia and New Brunswick is the largest of the exposed rift basins of the Newark Supergroup in eastern North America, which formed during continental rifting related to the breakup of Pangaea. Its up to 4,000 m thick fill of sedimentary and igneous rocks, known as the Fundy Group, can be divided into four tectonostratigraphic sequences (TS). The Permian-age Honeycomb Point Formation and possibly the Lepreau Formation in New Brunswick represent TS I. TS II includes the Wolfville Formation, which comprises the probably Middle Triassic “Economy Member” and the early Late Triassic (Carnian) “Evangeline Member.” Each of these members has yielded distinctive assemblages of continental tetrapods. The assemblage from the “Economy Member” comprises capitosauroid and trematosauroid temnospondyls and several reptiles including a tanystropheid. By contrast, the assemblage from the “Evangeline Member” only includes metoposaurid temnospondyls but numerous taxa of reptiles including procolophonid parareptiles, a rhynchosaur, a trilophosaur, and archosaurs. Archosaurian reptiles include aetosaurs, paracrocodylomorphs, and an ornithodiran. Contrary to published reports, there is no evidence for the presence of dinosaurs in the “Evangeline Member.” TS III comprises most of the Blomidon Formation and is Norian to Rhaetian in age. Strata of this sequence have yielded numerous tetrapod trackways but few skeletal remains. TS IV comformably overlies TS III and includes the late Rhaetian top of the Blomidon Formation, the late Rhaetian North Mountain Basalt, and the late Rhaetian to Hettangian (and possibly younger) McCoy Brook Formation. The latter overlies the North Mountain Basalt and has yielded a diverse assemblage of mostly small tetrapods. Recent work has correlated the Global Boundary Stratotype Section and Point (GSSP) for the base of the Jurassic Period above the North Mountain Basalt and close to the top of the lacustrine Scots Bay Member, with diverse faunal assemblages in both latest Rhaetian and earliest Hettangian strata. Thus, the strata of the Fundy Group preserve the only known stratigraphically tightly constrained record of biotic changes in continental ecosystems across the Triassic-Jurassic transition and are critically important to current debates concerning the tempo and mode of the end-Triassic extinction event.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A NEW TRIASSIC (LADINIAN) ASSOCIATION WITH A LARGE TEMNOSPONDYL, SAUROPTERYGIANS, A GIGANTIC PROLACERTIFORM, AND AN ARCHOSAURIFORM IN MIEDARY (SOUTHERN POLAND)

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A new Triassic vertebrate assemblage in Miedary, southern Poland was recently discovered. The sediments represent the lowermost Keuper (Miedary beds) of Middle Triassic (late Ladinian) age. Collected fossils comprises to an important component of the total vertebrate assemblage from the Triassic of Poland. The newly discovered material includes a large temnospondyl, sauropterygians, a gigantic prolacertiform, an archosauriform and a microfauna that includes numerous actinopterygian scales, skeletal elements and teeth. We collected the analyzed vertebrate fossils from three lithologically different types of deposits. The first assemblage occurs in yellowish dolomites, where poorly preserved invertebrate macrofossils (brachiopods, bivalves, gastropods) and microfossils (ostracods, foraminifera) were also found. It contains nothosaurid vertebrae and long bones, and numerous fish microremains. The second occurs in the grey-yellowish, sometimes greenish or reddish claystone and mudstone. We found isolated or partially articulated bones of temnospondyls, elongated vertebrae and long bones of prolacertiforms, and partially preserved long bones and teeth of archosauriforms from these deposits. We also found poorly preserved vertebrate coprolites and charophyte gyrogonites in the same clayish deposits. In sandstones we found intercalations of partially preserved and rich but highly disarticulated fish fossils (mainly scales) and poorly preserved plant remains. This new association from the marginal-marine strata shows some similarities to vertebrate assemblages known from the lower Keuper of Germany and also the Ladinian of southern Europe.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

MANUAL FLEXIBILITY AND GRASPING ABILITY IN THE BASAL TYRANNOSAUROID DINOSAUR *GUANLONG WUCAII*

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Suggestions that a high degree of manual grasping capability was widespread among non-avian theropod dinosaurs are common in the literature, but this possibility has been tested for relatively few taxa. We investigated the potential for one-handed grasping, a specific movement useful in predation and other activities, in the Late Jurassic basal tyrannosauroid *Guanlong wucaii*. We scanned the nearly intact left manus of the holotype of *G. wucaii* using a Konica Minolta Range7 laser scanner, imported surface models of the individual bones into the animation software package Autodesk Maya, and assembled them into an articulated hand. The range of flexion at each metatarso-phalangeal (MP) or interphalangeal (IP) joint was estimated by positioning the hand in Maya, using simultaneous physical manipulation of the fossil bones for guidance. There has been surprisingly little explicit discussion of criteria for determining limits on ranges of MP and IP joint motion in the dinosaur literature. We considered two thresholds as possible limits on flexion, the movement important in grasping: the point at which the palmar edges of the opposing articular surfaces were most closely aligned, and the point at which the two bones locked against one another. These thresholds respectively define hypothetical 'limited' and 'extreme' ranges of flexion. The geometry of the MP joint of digit III made the criterion for 'extreme' flexion hard to apply, and the 'limited' range of flexion at the joint was only 11°. For other joints the difference between the 'limited' and 'extreme' values ranged from 10°-34°, indicating that the range of flexion was difficult to constrain precisely.

Nevertheless, the results show that one-handed grasping ability in *Guanlong* was limited. Even assuming that 'extreme' flexion was possible, digit I could have participated in grasping only in that the ungual could be opposed to the metacarpus, probably at a considerable distance depending on the size of the keratin sheath. 'Extreme' flexion of digit II would have allowed the ungual to oppose the metacarpus or proximal phalanx, and the penultimate phalanx to oppose the metacarpus at a disadvantageous (diverging towards the wrist) angle. Only the slender digit III might have been able to bring the penultimate phalanx into opposition at an advantageous angle, depending on the range of flexion at the problematic MP joint. The hand of *Guanlong* may have been capable of raking and impaling prey with the unguals, but its capacity for seizing and manipulating small prey or other objects appears to have been minimal.

Technical Sesssion XII (Friday, November 7, 2014, 2:30 PM)

DIGITAL MODELING OF THE HIND LIMBS OF *EUDIBAMUS CURSORIS*: IMPLICATIONS FOR POSTURE AND LOCOMOTOR CAPABILITIES OF THE OLDEST KNOWN FACULTATIVE BIPED

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Eudibamus cursoris from the Early Permian Bromacker locality of central Germany is a small bolosaurid parareptile with hind limbs approximately equal to snout-vent length and twice the length of the forelimbs, suggesting it was the earliest known facultative biped, predating archosaurian bipeds by nearly 60 million years. The type specimen and a new specimen provide details of the ventral surface of the hind limb in *Eudibamus*. Both specimens were imaged with a Next Engine laser surface scanner and a complete right hind limb reconstruction was digitally modeled in Maya 3D computer animation software. The model was then inverted to generate a matching left hind limb. The presence of a well-developed dorsal rim of the acetabulum, manipulation of digital models in three-dimensional space, and comparison with similarly sized extant iguanid lizards capable of facultative bipedality suggest the femoro-acetabular joint in *Eudibamus* could accommodate positions ranging from a sprawling posture to approximately 20 degrees to horizontal. The relatively calm depositional environment of the Bromacker locality suggests that the hyperflexed position of the knee as preserved in both specimens could reflect a realistic end of the knee joint's range of potential excursion. If so, the knee joint would have been capable of greater than 135 degrees of motion. Notably, high knee angles (as much as 130 degrees) are characteristic of fast-running extant lizards that can achieve bipedality. The astragalus, calcaneus, and fourth distal tarsal have greater exposure on the ventral surface of the pes than the dorsal, and the centrale and fifth distal tarsal are visible only on the ventral surface of the pes. This results in a natural curvature of the pes that is constrained to a digitigrade posture with the distal phalanges approximately 35 degrees to the long axes of the tibia and fibula. Computer animated step cycles for walking and running gaits were generated using limb excursions conservatively less than the maximal estimated range of each joint. Inverse kinetics (placing the foot on the substrate and not allowing the skeletal elements contributing to any given joint to interpenetrate in three-dimensional space) suggest *Eudibamus* was capable of running in a manner similar to extant bipedal lizards such as *Dipsosaurus* or *Basiliscus*, but probably did not attain a strictly parasagittal limb position as in derived archosaurs.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

TARSAL BONE MORPHOLOGY OF CROCODILES REVEALS THE ANKLE JOINT MECHANISM

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Modern gharials and false gharials have a more aquatic life style and limited locomotive capability on land relative to other crocodiles. Nevertheless, their ankle range of motion (ROM) and ankle joint morphology are poorly understood. Here, we investigated the relationship between the ankle ROM and tarsal bone morphology.

Eight specimens of three crocodilian species (4 *Crocodylus porosus*, 3 *Gavial gangeticus*, 1 *Tomistoma schlegelii*) were analyzed using computed tomography (CT) scans with five positions from maximum dorsiflexion to plantar flexion. The average ROM between the tibia and first metatarsal of *C. porosus*, *T. schlegelii*, and *G. gangeticus* was 59.9-136.4°, 65.9-142.2°, and 79.2-122.7°, respectively. The average ROM between the tibia and fourth metatarsal was 52.7-147.6°, 71.8.7-154.7°, and 81.4-134.9°, respectively. All specimens showed that the ROM between the tibia and first

metatarsal was smaller than the ROM between the tibia and fourth metatarsal because the crocodilian foot was slightly everted in the position of maximum dorsiflexion and strongly inverted in maximum plantar flexion. *G. gangeticus* has the most diagnostic ankle joint morphology; the astragalus is in a more externally rotated position, the metatarsals are strongly inverted relative to the tibial axis, and the calcaneum is less ossified. *T. schlegelii* has an ankle morphology more similar to that of *C. porosus*, but the astragalus has a smaller articular facet for the first metatarsal than that of *C. porosus*.

The larger ROM between the tibia and fourth metatarsal is attributed to the observation that there are two joints between the tibia and the fourth metatarsal, i.e., the fibular-calcaneal joint and calcaneum-metatarsal joint. The ankles of *T. schlegelii* and *G. gangeticus* are less inverted at plantar flexion because their calcanei have smaller articular facets for the fourth metatarsal. In addition, dorsiflexion is limited in *G. gangeticus* due to the smaller first metatarsal articular facet of the astragalus. Thus *G. gangeticus* has an astragalus with a relatively large tibial facet. The steeply medially-directed tibial facet of the astragalus indicates that the foot of *G. gangeticus* is in an inverted position even in dorsiflexion. These osteological characters are found by investigation of ankle joint morphology and might be important keys to clarify the ankle movement of crurotarsan fossils.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

SLOW BURIAL IN A FAST WORLD: UNUSUALLY HIGH SKELETAL COMPLETENESS IN CHANNEL DEPOSITS

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When an articulated skeleton is discovered in a high-energy channel deposit, it may indicate that it was buried soon after death, before scavengers could dismember the carcass or other taphonomic processes could lead to disarticulation. Left unburied, fluvial currents could disperse any disarticulated skeletal elements. In the Winton Formation at Isisford in Queensland, Australia, however, articulated- and partially-articulated crocodyliform, osteichthyan, and non-avian dinosaur fossils have been found in what appear to be channel deposits—well-sorted, massive, fine- to medium-grained sandstones containing mud rip-up clasts and fragmentary wood. The partially-articulated skeletons have a high degree of completeness, with disarticulated skeletal elements remaining proximal to the skeleton. This suggests that the remains were scavenged or otherwise disturbed prior to burial, with no dispersal of isolated elements via high-energy currents. How could organic remains be buried in a channel environment without disarticulated elements becoming lost?

To address this question, taphonomic data (skeletal articulation, completeness, association, bone modification, and spatial data) have been collected from the Isisford specimens, along with results from actualistic decay experiments of modern crocodiles, osteichthyans, birds, and mammals (as analogues for non-avian dinosaurs) and small-scale sedimentological analyses. From this, a number of taphonomic scenarios have been hypothesized for the Isisford fossils, including: (1) carcasses washed onto point-bars prior to burial, with minimal influence of currents as decay progresses; (2) log-jams trapping and limiting skeletal dispersal; (3) obrution (catastrophic burial) some time after death; (4) soft tissue still present on disarticulated elements, attached to the carcass by dermis; and (5) rapid burial with post-burial bioturbation. The results of this analysis suggest that high-energy fluvial channels do not preclude the preservation of complete but partially articulated skeletons. Only by examining taphonomy and sedimentology in concert can the idiosyncrasies of fluvial channel preservation be constrained and refined.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

AMPHIBIANS AND SQUAMATE REPTILES FROM THE LATE MIOCENE MORSKAYA 2 FAUNA (RUSSIA)

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The Morskaya 2 locality (Azov Sea Region, Russia; middle Turolian, MN 13) provides a unique and one of the most abundant late Miocene vertebrate faunas of European Russia. The vertebrate assemblage includes fishes, amphibian, reptiles, birds, and mammals that up to now have been described only partly. The material of amphibians and squamate reptiles from Morskaya 2 is relatively poor and includes about 60 bones, mostly represented by fragmentary snake vertebrae. Nevertheless, this material allows us to newly recognize the following taxa: *Bufo* sensu stricto (Bufonidae), *Pelophylax* sp. (Ranidae), *Pseudopus pannonicus* (Anguidae), *Lacerta* sp. (Lacertidae), cf. *Eryx* (Boidae), *Natrix* sp., and a small-size colubrine (Colubridae). The *Bufo* from Morskaya 2 is similar to *Bufo bufo*, but differs in larger size, more elongated vertebrae, shape and proportions of scapula, radioulna and ischium, and wider pars descendens ilii. *Bufo* from Morskaya 2 may represent a new species which is ancestral to the *Bufo bufo* species group. The anguine lizard is assigned to *Pseudopus pannonicus* based on its large size similar to that of recent *P. apodus*. cf. *Eryx* is the first record of an erycine snake in the Miocene of Russia. *Natrix* sp. is most similar to *Natrix rudabanyaensis* from the Miocene of Hungary and Romania, but is too fragmentary for a detailed identification. The new data provide a clear snapshot of a still nearly unknown late Miocene herpetofauna of Russia. The paleoecological implication of this assemblage are unclear.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

A RE-EVALUATION OF *MICROHYRAX LAVOCATI*: IMPLICATIONS FOR THE EARLY RADIATION OF THE ORDER HYRACOIDEA (MAMMALIA, AFROTHERIA)

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Among the rare early Paleogene sites from the Afro-Arabian continent, those from the Gour Lazib area in Algeria yielded the earliest diverse hyracoid assemblage, dated from the late Ypresian or basal Lutetian. *Microhyrax lavovati* is the smallest species of this hyracoid assemblage. Up to now, only a few specimens of *Microhyrax* have been described, among them the holotype (a lower jaw with p3–m3), a possible upper M3, and a maxillary fragment with M1-3. Current phylogenetic reconstructions suggest that *Microhyrax* is one of the earliest offshoots of the hyracoid order. Recent paleontological fieldwork in the Gour Lazib area at Chambi in Tunisia, has led to the recovery of numerous new specimens of *Microhyrax* allowing a reassessment of this critical basal hyracoid. The new material includes isolated deciduous and permanent teeth, fragmentary dentaries, maxillaries, isolated petrosals, as well as two partial skulls. These specimens properly document, for the first time, the upper dentition of *Microhyrax*. Actually, the maxillary and upper molar currently attributed to *Microhyrax* belongs to *Helioseus*, another hyracoid of the Gour Lazib fauna. These new data are essential because they reveal that, in all recent cladistic analyses, discussing the relationships of stem hyracoids and afrotherians as a whole, *Microhyrax* is wrongly coded as a chimera. New data reveal that *Microhyrax* is very peculiar in combining: a long astragalar neck; anterior orbit border above P4–M1; deep antorbital groove; procaviid-like petrosal; slender mandible with a variable occurrence of a coronoid canal; no evidence for an internal mandibular fenestra; long and slightly molarized lower premolars with individualized metaconid and simple talonid; P3–4 without mesostyle or hypocone, but having a large parastyle and a distinct postprotocrista bearing a central crista; simple upper molars with tiny mesostyle and parastyle, poorly W-shaped ectoloph without lingual spurs, and a protocone lacking a postprotocrista. Some specimens also indicate possible sexual dimorphism in body size and jaw depth. This mosaic morphology of *Microhyrax* challenges our view of the early history of hyracoids and could support a surprisingly high position of this genus in the phylogenetic tree of hyracoids.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

CROCODYLOMORPHA FROM THE UPPER CRETACEOUS TAMAGAWA FORMATION OF THE KUJI GROUP, IWATE PREFECTURE, NORTHEASTERN JAPAN

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The Upper Cretaceous Kuji Group of Iwate Prefecture in northeastern Japan comprises, from bottom to top, the Tamagawa Formation, Kunitan Formation, and Sawayama Formation, respectively. The upper part of the Tamagawa Formation yields diverse terrestrial vertebrates such as turtles, crocodiles, and dinosaurs. Through several intensive excavations between 2012 and April 2014, nearly 600 vertebrate specimens have been collected from the two main localities of the Tamagawa Formation, the quarry of Kuji Amber Museum (KAM) and the left bank of Osawada River (OSD). Among these materials, 74 specimens belong to the Crocodylomorpha, including a frontal bone, isolated teeth, vertebra, rib bones, limb bones, and osteoderms.

Amphicoelous vertebral centra and the typical overlapping margin of the osteoderms suggest that the Kuji materials most likely belong to a more basal grade (e.g., *Shamosuchus* from Mongolia) of Cretaceous crocodylomorphs than the eusuchian clade. The teeth discovered from the two main localities are particularly robust, with a subconical shape and circular or elliptical bases, features commonly seen in extant crocodilians, such as *Alligator sinensis* and *Osteolaemus tetraspis*. These teeth suggest that they may have fed on rigid prey such as crustaceans, gastropods and turtles as in the modern forms.

Technical Session III (Wednesday, November 5, 2014, 3:45 PM)

NEST TYPE AND INCUBATION BEHAVIOR IN OVIRAPTOROSAURS IN RELATION TO BODY SIZE

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In the past 20 years, the abundance of well-preserved specimens of oviraptorosaur eggs and nests has shed light on their nest types and incubation behaviors. Although large oviraptorosaur species have yet to be found associated with their nests, prior discoveries of smaller species (Oviraptoridae) of adults in brood-like positions atop egg clutches suggest that these dinosaurs sat on their nests during incubation. This is in contrast to the results of water vapor conductance studies of oviraptorosaur eggs, which have suggested that incubation occurred in covered nests, like extant crocodilians or megapodes, rather than in open nests with a brooding adult as in most birds. Here we reexamine oviraptorosaur eggs in order to resolve this discrepancy in their nest types and associated incubation behaviors and to determine how these features are affected by changes in body size. Eggshell porosity, shell strength, and clutch morphology were examined for eggs and nests of small (*Elongatoolithus* and *Macroolithus*; egg mass 200-840 g) and large forms (*Macroelongatoolithus*; egg mass 2960-6590 g) recovered primarily from Cretaceous deposits of Jiangxi and Henan provinces in China. Adult body mass for these egg sizes was estimated using clutch volume (clutch size × egg volume) and shows a range of 60 to 4000 kg. Estimations of the eggshell porosity from all egg sizes were consistent with the eggs of birds that brood in open nests. This contrasts with the results of prior water vapor conductance studies, which have suggested incubation in covered nests. Examination of clutch morphology revealed that all oviraptorosaur clutches are laid in a circular fashion with the long axis of the eggs arranged radially relative to the center of the nest. There is a positive allometric change in clutch morphology in that small eggs (*Elongatoolithus* and *Macroolithus*) are packed with a small central open space, whereas large eggs (*Macroelongatoolithus*) are arranged in a large ring with a large central space. Estimations of egg strength from shell thickness indicated that unlike smaller eggs, the shell of large eggs (*Macroelongatoolithus*) may not have been strong enough to directly withstand the adult body mass. These results indicate that oviraptorosaurs incubated their eggs in open nests regardless of adult size, and that small oviraptorosaurs could have sat

atop packed eggs, whereas large species may have distributed most of their weight across the large central opening while on the nest.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

PHYLOGENETIC POSITION OF A NEW HESPERORNITHIFORM FROM THE UPPER CRETACEOUS OF HOKKAIDO, JAPAN

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The only record of a hesperornithiform (MCM.A.773) from Japan, which includes four cervical and two thoracic vertebrae, distal ends of left and right femora, and a middle shaft of a right fibula, is known from the Upper Cretaceous Kashima Formation (Coniacian to Santonian) of the Yezo Group, Hokkaido Prefecture. This specimen clearly belongs to Hesperornithiformes because the femur has laterally expanded fibular condyle, but its phylogenetic status remains unresolved. In this study, we performed a phylogenetic analysis utilizing 250 characters and 64 taxa including seven genera of hesperornithiforms and two unnamed hesperornithiforms from Hokkaido (MCM.A.773) and Manitoba, Canada (V-2487) with an outgroup (Dromaeosauridae). It recovers 18 MPTs, and the strict consensus tree clarified the relationships within Hesperornithiformes except for a polytomy consisting of *Hesperornis*, V-2487, and *Asiahesperornis*.

The clade Hesperornithiformes is supported by six synapomorphies of the cervical vertebrae and hind limbs, including a laterally expanded fibular condyle of the femur. The monophyletic clade of *Enaliornis* and *Pasquiaornis* shows a sister-group relationship to the clade consisting of the remaining hesperornithiforms, where the Hokkaido hesperornithiform is the most basal taxon. Hesperornithidae includes *Parahesperornis*, V-2487, *Hesperornis* and *Asiahesperornis* with seven synapomorphies of the hind limbs. Two of the synapomorphies for the family are associated with the function of digit IV: transversely extended metatarsal trochlea IV and remarkably enlarged medial trochlea and distal extension of reduced lateral trochlea on the distal articular surface of the digit IV phalanges. It is suggested that the latter character may be related to a specialization for twisting digit IV and a change from webbed to lobed feet by previous studies; therefore, a specialization in the movement of digit IV plays an important role for derived hesperornithiforms, Hesperornithidae.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

VIRTUAL BRAIN ENDOCAST RECONSTRUCTION OF A PLIOCENE DOLPHIN FROM NORTHERN ITALY (MAMMALIA, CETACEA, ODONTOCETI)

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A partial skeleton of a Pliocene dolphin was found near Castell'Arquato, northern Italy, which includes the skull, cervical and thoracic vertebrae, and ribs. The ear bones are still covered by the matrix. The dentary is closely associated with the skull. The preservation of the specimen is exquisite. The skull was submitted to a CT scan-based investigation directed at the reconstruction of a virtual brain endocast. The CT scan revealed that the internal part of the skull is mostly well-preserved, but it shows fractures in the basioccipital-basisphenoid and alisphenoid series, affecting the accuracy of the ventral side of the brain endocast. As far as the brain is concerned, the virtual reconstruction revealed that the right hemisphere is significantly smaller than the left hemisphere. Apart from that, the pattern of brain vasculature and surface morphology were reconstructed and compared with the corresponding portions of living odontocetes. As brain characters are not usually included in phylogenetic datasets of cetaceans, we hope that the reconstruction of the brain endocast of this specimen will add significant additional information for a more inclusive (in morphological terms) phylogenetic analyses of whales and dolphins.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

ISOTOPE ECOLOGY OF A NEW MAMMALIAN FAUNA FROM THE LATE MIDDLE MIOCENE OF TROPICAL SOUTH AMERICA (PERUVIAN AMAZONIA)

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The Miocene is an epoch where important biological and tectonic events occur in South America and when defining features of modern tropical rainforests seem to have appeared in the now Amazonian region. However, vertebrate fossils from this epoch are scarce, especially within the intertropical area, which is believed to have hosted major events in the evolutionary history of many clades of plants and animals. The mammals from the Fitzcarrald local fauna, a new fossil assemblage from the late middle Miocene of western Amazonia in Peru, are here presented as well as isotopic data to examine resource partitioning among major clades and canopy structure in proto-Amazonia.

The mammal fauna from Fitzcarrald consists of at least 18 genera, including sloths, glyptodontids, astrapotheres, toxodonts, litopterns, rodents, odontocetes, and one marsupial. At the generic level, the Fitzcarrald local fauna possesses the highest similarity with the late middle Miocene La Venta fauna in Colombia (Simpson index ~69%). Interestingly, this faunal similarity is much higher with younger but low latitude Acre in Brazil (~40%) than with coeval but mid-latitude Quebrada Honda in Bolivia (~16%). These results further confirms the previously observed pattern of climatic/geographic provincialism between northern and southern South America starting from early midde Miocene times.

Isotopic analyses were performed on enamel of astrapotheres and toxodonts, and outer dentine of fossil sloths (mylodontids and megalonychids). Rare Earth Elemental analyses, used as a proxy to calculate relative diagenesis of xenarthran outer dentine normalized to bone, indicate that the original biological signal of fossil sloths was preserved. Results of $\delta^{13}C$ show significant different values ($p < 0.05$) that indicate resource partitioning among both ungulates, and between the two fossil sloth clades. Average isotopic data indicate a somewhat open canopy forest ($\delta^{13}C$ ~-12‰) with values 1) equivalent to those found in the middle Miocene of Panama, the early Eocene Big Horn Basin in Wyoming, or modern open canopies of eastern China; but 2) about 5‰ more positive than those in modern Amazonia.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

EVOLUTIONARY RELATIONSHIPS OF ATOPOSAURID CROCODYLOMORPHS, AND EVIDENCE FOR ALLOPATRIC SPECIATION DRIVING THEIR HIGH DIVERSITY IN THE LATE JURASSIC OF WESTERN EUROPE

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Atoposaurid crocodylomorphs represent an important faunal component of Late Jurassic to Early Cretaceous Laurasian semi-aquatic to terrestrial ecosystems. Despite being consistently recovered at the base of Neosuchia, the major crocodylomorph lineage leading to extant crocodilians, their species-level taxonomy and inter-relationships remain poorly understood. We present a systematic taxonomic review of the group, noting numerous anatomical differences between specimens from geographically discrete localities in the Late Jurassic of western Europe. In particular, we recognise a new species of *Alligatorellus* from Germany, previously referred to the contemporaneous French taxon *Alligatorellus beaumonti*, and synonymise the sympatric *Alligatorium paintenense* with *Alligatorium franconicum*. A comprehensive species-level phylogenetic analysis of unambiguous atoposaurids (15 OTUs and 450 characters) recovers a clade comprising *Alligatorellus, Alligatorium, Atoposaurus*, and *Montsecosuchus*. *Theriosuchus* is shown to represent a monophyletic, diverse, and long-lived genus that forms the sister taxon to this clade of atoposaurids. The poorly known *Theriosuchus grandinaris*, from the Early Cretaceous of Thailand, is excluded from this grouping and is instead positioned at the base of Atoposauridae, although this likely reflects its incomplete nature. Incorporation of putative atoposaurids, such as *Karatausuchus* from the Late Jurassic of Kazakhstan, will be crucial in clarifying these relationships. Our revision of atoposaurids leads us to recognise the existence of three sympatric genera in the Late Jurassic of western Europe, with a distinct species of *Alligatorellus*, *Alligatorium*, and *Atoposaurus* present in both French and German basins. This high diversity of closely related species might have been caused by allopatric speciation, driven by fluctuating highstand sea-levels during an interval when western Europe formed an island archipelago system. It is possible that the small body size of atoposaurids resulted from island dwarfing during this interval, but testing of this idea will have to await the discovery of more basal forms from non-island settings.

Technical Session VIII (Thursday, November 6, 2014, 1:45 PM)

USING THE EXTENDED PRICE EQUATION TO QUANTIFY SPECIES SELECTION IN LATEST PALEOCENE AND EARLIEST EOCENE MAMMALS

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Species selection—covariation of species' traits with their net diversification rates—is an important potential driver of macroevolutionary trends. Most previous tests for species selection rely on indirect evidence for its presence or absence, and have not directly quantified its strength relative to other macroevolutionary forces such as anagenic change. We used an extension of the Price equation to isolate and quantify the macroevolutionary drivers of body size change in mammalian communities from the latest Paleocene and earliest Eocene of the Bighorn and Clarks Fork Basins of Wyoming. Dwarfing of mammalian taxa across the Paleocene–Eocene Thermal Maximum has been suggested to reflect species selection, but alternative explanations have been proposed. The exceptional temporal control of the fossil record from these sites allows ancestor–descendant relationships to be reconstructed. We used the Price equation to take advantage of this phylogenetic information to partition macroevolutionary change in mean mammalian body size into three terms attributable to distinct, directional macroevolutionary forces: species selection operating on the resident mammals, anagenic change within resident mammalian lineages, and change introduced by migrants into the area. The substantial decrease in mean mammalian body size in the Bighorn and Clark Fork Basins across the PETM is attributable to non-random immigration of small species (the single most important contributor) and to anagenic evolution towards smaller body sizes, with these two factors being partially cancelled out by species selection favoring larger-bodied species. The smaller changes in mean mammalian body size observed across other time periods primarily reflect species selection, with anagenic change and immigration either adding or subtracting modest amounts to the effect of species selection. An interesting direction for future work would be to use the Price equation to partition species selection from selection operating within and among populations within species.

Technical Session X (Friday, November 7, 2014, 8:30 AM)

PHYLOGENY OF THE LIVING AND FOSSIL LIPOTYPHLA (MAMMALIA) AND THE EVOLUTION OF TALPID FOSSORIALITY

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The order Lipotyphla has historically been a wastebasket taxon for various living and extinct insectivoran-grade placental mammals. Uncertainty over its constituent extant

families, a shortage of hard tissue synapomorphies, and a "primitive", generalised body plan have all contributed to the taxon′s status as a poorly defined repository for various mammalian fossils. In the last twenty years, molecular systematic analyses have stabilized the extant members of the order, now known to include hedgehogs (Erinaceidae), moles (Talpidae), shrews (Soricidae), and *Solenodon*; however, the relationships between and within these families remain poorly understood while the fossil record is difficult to integrate. We present a new combined analysis phylogeny of extant and extinct Lipotyphla. The dataset samples 78 taxa (29 extinct) predominantly at the generic level. It is based on 270 morphological characters, and over 25,000 bases of DNA from both nuclear and mitochondrial loci known for living taxa. We find support for an erinaceid-soricid clade, to the exclusion of Talpidae, with *Solenodon* the sister group to all other extant Lipotyphla. Bayesian analysis suggests a close relationship between *Solenodon* and both the extinct Apternodontidae and *Centetodon*.

Here, we use this phylogeny to study the evolution of fossoriality in Talpidae. Although best known as subterranean (fossorial) animals, a number of talpids exhibit semiaquatic adaptations or possess a more generalised, semi-fossorial body plan. There are two distinct clades that exhibit extreme fossoriality, along with gross similarity in their forelimb anatomy: the Eurasian Talpini and predominantly American Scalopini. However, their relatedness is uncertain. Our data suggests a rapid radiation of the major talpid tribes, preventing a definitive resolution of intertribal relationships. However, the incorporation of fossil data, especially new micro-CT data of four exceptionally preserved talpid fossils (*Mygalea jaegeri*, *Geotrypus montisasini, G. antiquus*, and *Proscapanus sansaniensis*), has helped to identify early members of the extant tribes. The placement of such character-rich fossils helps to determine the states of fossoriality-linked characters at the root of these tribes. These fossils help to provide evidence for independent specialisation into extreme fossoriality in the Talpini and Scalopini from a semi-fossorial ancestor, greatly improving the explanatory power of our combined analysis phylogeny.

Technical Session VI (Thursday, November 6, 2014, 8:30 AM)

EVOLUTION OF MAXIMUM BODY SIZE IN NORTH AMERICAN LAGOMORPHS

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Lagomorphs (rabbits, hares, and pikas) today represent a successful group of herbivores as judged by their near-global distribution and high local abundance in many regions. Curiously, this mammalian order exhibits rather limited morphological variation, which is particularly striking when compared to the disparate forms attained by its sister clade, Rodentia. Because body size evolution is potentially a key catalyst for additional morphological, ecological, and taxic diversification, we investigate here the reason for the relatively narrow range of lagomorph body mass ($10^1 \approx 10^3$ g) in continental settings throughout their history. In view of multiple examples of gigantism in insular lagomorphs and the foraging theory for mammalian herbivores, we hypothesized that the evolutionary increase in the maximum body size of lagomorphs was suppressed by the widespread presence of small ungulates during much of the Cenozoic. We first collected dental measurements and associated individual weight data for 29 extant lagomorph species and derived allometric equations for body mass estimation using the generalized least-squares regression to take into account phylogenetic covariance and intraspecific variation in body size. We then estimated body masses of 70 North American fossil species known from the last 30 million years and compared the trajectory of their maximum body mass over this time to that of the minimum body mass of ungulates. The result shows: (1) an initial period of overlapping lagomorph and ungulate size ranges in the late Oligocene; and (2) a prolonged period of non-overlapping body size ranges between the two groups over the course of Miocene to Pliocene, with the maximum lagomorph body mass gradually increasing (by three folds) in parallel with the minimum ungulate body mass. Regression analysis using a first-order autoregressive model supported strong correlation ($R^2 = 0.992$, $p < 0.0001$) between the maximum lagomorph size and the minimum ungulate size during much of the Neogene. These findings cannot be readily explained by temporal variation in fossil recovery potential, changes in taxonomic diversity, global climatic trends, or macroevolutionary diffusion. Instead, the overall pattern is more consistent with a scenario in which the establishment of extensive grasslands in North America restructured competitive interactions among small terrestrial herbivores, thereafter constraining the body size evolution of lagomorphs through the process of niche partitioning.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

WEAR AND MICROWEAR PATTERNS IN ISOLATED THEROPOD TEETH FROM THE UPPER CRETACEOUS OF THE SOUTHERN PYRENEES, SPAIN

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The study of wear and microwear patterns in teeth has become an important tool for paleontologists by providing indirect evidence of diets and chewing mechanisms, independent of tooth morphologies. With these studies, it is possible to determine changes in diets of fossil species before there are evolutionary changes in the tooth morphologies. These results can be applied to problematic fossil taxa with unusual teeth that cannot be compared directly with better known species. In spite of the potential for determining diets of components of paleoecosystems, studies of this type are rare and are dominated by studies on herbivorous animals. In this study, a preliminary analysis of the wear and microwear features of theropod dinosaur teeth from five sites from Upper Cretaceous strata of the South-Pyrenees Basin (Spain) was performed. Four theropod groups (indeterminate coelurosaurs, dromaeosaurids, cf. *Richardoestesia*, and an indeterminate large theropod) were examined to infer the relationship between diets and tooth damage, including wear facets and microwear scratches. The most important characteristics to observe in wear facets are their morphologies, orientations and positions. In microwear scratches it is necessary to observe their dimensions, orientations, and associations. These characteristics can be compared with patterns known for living carnivorous animals to interpret dental wear in theropods.

The teeth studied do not show strong indications of wear. Wear facets affect primary to the tips of large and small teeth, so size does not seem to have been a factor related to dental wear. Microwear is represented by scratches and pits. Pits, formed when hard particles impact enamel, are uncommon in the sample. Two families of scratches have been identified. One family is parallel to the anterior or posterior edges of the teeth and denticles, and the second one is oblique. These two kinds of scratches are present in all of the studied theropod teeth, indicating that there was probably a common feeding model for all of these taxa. It is suggested that these dinosaurs probably selectively removed flesh from bone, and avoided any contact with the bones of their prey. This was probably only possible if they were eating prey that was either considerably larger than themselves, or that they were eating prey that was generally small enough to be swallowed whole.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

FOSSIL COLLECTION PRACTICES AND THEIR EFFECT ON MUSEUM COLLECTIONS COMPOSITION AND PALEOBIODIVERSITY ESTIMATES: EXAMPLES FROM THE MIDDLE EOCENE OF NORTH AMERICA

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Numerous studies have utilized collections-based data to evaluate potential mammalian paleoecological trends, and they typically focus on evaluating some aspect of diversity, whether taxonomic or ecological. This type of approach relies on raw counts of specimens and taxa, data that are generally taken from the scientific literature. Recent studies have demonstrated that museum collections data should be incorporated into diversity studies whenever possible because the sole use of literature-derived data produces an additional taphonomic filter. Yet, the effects that field collection practices have on the diversity of museum collections and the paleoecological studies executed using these collections are poorly understood.

We selected nine middle Eocene mammalian assemblages of Uintan and Duchesnean North American Land Mammal Age (NALMA) to examine the effect of fossil collecting practices on overall diversity. Over 27,000 individual cases were evaluated for both taxonomic and body mass diversity, representing 14 orders, 123 genera, and over 130 species of mammals. These data were compared among the nine assemblages, and then combined into two larger groups for the purpose of comparing the older to the more recent collections that were made using different fossil collection techniques, including wet-sieving of bulk matrix samples. Rodents, insectivorans, and primates exhibit more than twice the generic diversity in collections made during the last 30 years than collections made prior. Also, the taxonomic diversity of the Duchesne River Formation assemblage (Utah) was doubled due to recent wet-sieving efforts. Additionally, the new collections contain as many as two to over 100 times more specimens for some taxa, particularly for the following groups: rodents (13,850 specimens), primates (1,411), perissodactyls (532), insectivorans (6,655), and artiodactyls (2,084). Furthermore, there is a greater diversity of body mass sizes in the newer collections, with 31% of genera classified as weighing < 500 grams, and some genera with species spanning more than one body mass class (e.g., *Protoreodon*). These data demonstrate that wet-sieving greatly increases the number of small-bodied taxa available for study, and it is therefore essential that fossil collecting practices be routinely evaluated as an aspect of taphonomic investigations because of their significant effect on paleoecological interpretations.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

BONE HISTOLOGY OF AN IMMATURE *TYRANNOSAURUS REX* WITH COMMENTS ON UNUSUAL ENDOSTEAL BONE TISSUE

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Histological sampling of a small *Tyrannosaurus rex* (BMRP 2006.4.4) reveals a thin layer of structurally distinct bone lining the mid-diaphyseal medullary cavity of the partial tibia. This bone tissue is highly vascularized, separated from the cortex by the endosteal laminar bone (ELB), and has greater porosity than either cortical bone (CB) or endosteal laminar bone. Such morphology suggests this tissue is avian medullary bone (MB), which is found in medullary cavities of long bones and skulls of reproductively mature extant avians prior to and during egg shelling. Minimum lines of arrested growth (LAG) count from the tibia places BMRP 2006.4.4 at 10 years of age and the lack of an external fundamental system (EFS), coupled with the fibrolamellar cortical bone structure and wide LAG spacing, suggests the individual was still actively growing at the time of death. Previous histological sampling of the fibula from BMRP 2006.4.4 returned a slightly higher minimum age (13). If the distinct endosteal tissue is MB, this would necessitate reproductive maturity in *Tyrannosaurus rex* prior to 13 years of age. The fibrous, well-vascularized outgrowth in question is lined by lamellar tissue, and such an additional ELB layer associated with MB is previously figured in specimens of non-avian dinosaurs *Allosaurus* and *Tenontosaurus*. However, to our knowledge, no extant avian MB exhibits a lamellar border separating it from the medullary cavity, and other reports speculate the endosteal tissues present in the *Allosaurus* and *Tenontosaurus* specimens are instead the result of pathology. The constrained location (i.e., the fibula of BMRP 2006.4.4 did not contain vascularized tissue deep to an ELB) and unusual structure (i.e., the additional endosteal laminar layer) suggest that the 'medullary bone' found in the tibia of BMRP 2006.4.4 is instead pathological, perhaps the result of viral avian osteopetrosis, for which the microstructural features are consistent. Therefore, detailed analysis of this unusual tissue within the tibia of a juvenile *Tyrannosaurus rex* specimen urges caution when diagnosing avian medullary bone from pathologic bone in non-avian dinosaurs.

Technical Session XIII (Friday, November 7, 2014, 2:30 PM)

THE DIVERSITY OF COPULATORY STRUCTURES AND REPRODUCTIVE STRATEGIES IN STEM GNATHOSTOMES

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Placoderms (stem gnathostomes) preserve the earliest evidence of vertebrate reproductive structures in the fossil record. Newly discovered pelvic and reproductive structures in antiarchs (sister-group of all other gnathosotmes), ptyctodonts and arthrodires (more crownward members of the stem ganthostomes) challenge established ideas on the origin of the pelvic girdle and reproductive complexity, in particular the position of the pelvic fin and the relationship of the male clasper to the pelvic girdle. Absence of articular surfaces between the clasper and girdle in the Arthrodira, along with evidence from the Ptyctodontida, indicate these are separate structures along the body, with claspers representing a third set of paired appendages serially homologous to pectoral and pelvic fins; the zone of fin competence was thus more extensive when these appendages first evolved. The discovery that placoderm claspers were not part of the pelvic skeleton led to a re-examination of the antiarchs, a group that, with the exception of the yunnanolepids, have lost the pelvic girdle and fins; absence of these had previously suggested that antiarch reproductive biology was indeterminable. We describe new antiarch dermal copulatory structures, including retractable claspers closely associated with trunk armor plates, again independent of the pelvic skeleton. Thus claspers in placoderms and sharks develop in different ways; in sharks, claspers develop from the pelvic fin while the claspers in placoderms develop separately, in the expanded zone of fin competence.

Further information on early gnathostome reproductive processes is preserved with additional embryos recovered from ptyctodonts and arthrodires, including that multiple embryos were the norm, but also for the first time, embryos of differing sizes, and that marked sexual dimorphism occurred at the embryonic stage (e.g., male claspers preserved in some embryos). By comparison with other gnathostomes, these observations suggest more complex reproductive strategies in placoderms than previously appreciated. Thus sexual dimorphism, copulatory reproduction, internal fertilization and large offspring with substantial maternal investment originated at the base of the gnathostome radiation, providing the first evidence of K-selected reproductive strategies within the vertebrates. Funding: Australian Research Council.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

NEW DATA FROM THE LOWER CRETACEOUS THEROPOD TRACKWAYS IN MUENCHEHAGEN (LOWER SAXONY, GERMANY)

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Berriasian sandstones from the Bueckeberg Formation in Lower Saxony, northern Germany have produced dinosaur tracks for more than two centuries. Muenchehagen, about 50 km west of Hannover, is one of the key localities, yielding the only Lower Cretaceous sauropod tracks found in Germany, as well as abundant ornithopod and theropod trackways. While the geological profile in the active Wesling Quarry adjacent to the Dinosaurier-Park Muenchehagen is just 5.62 m in thickness, it contains at least six track-bearing strata. Most tracks are reasonably well preserved in fine-grained quartz sandstones (thickness: 0.1-1 m), but one horizon (Lower Level, lithological unit [LU] 7) yields excellently preserved trackways in a silty mudstone layer, probably representing the background sedimentation. Within the last ten years, at least eight trackways of theropod dinosaurs with a total of >100 footprints have been found, documented and (as far as possible) excavated in Muenchehagen. In most cases, footprints as well as their natural casts can be excavated. The theropod trackways suggests two size-classes. The abundant smaller size-class is typically around 30 cm in footprint length; with associated pace lengths often >100 cm which indicate fast moving animals. The larger size-class is represented by only one trackway with 40 consecutive tracks; footprint length is >35 cm and mean pace length 114 cm. Another area in the Upper Level (LU 16) shows theropod and a few ornithopod tracks going in four different directions, forming the only trampled area in Muenchehagen. Changes in substrate composition have caused variations in footprint outline and especially the preserved claw impressions. The consistent documentation of all finds with digital photography allows the photogrammetric creation of 3D models of the trackways which currently serve as an objective dataset for our research regarding speed reconstructions and ichnotaxonomy. At least two theropod ichnotaxa are already known from the Bueckeberg Formation: the large *Bueckeburgichnus* and the medium sized *Megalosauripus*. The latter is a common ichnotaxon, e.g., also found in the contemporaneous Huerteles Formation in Spain; and many tracks in Muenchehagen can be assigned to that ichnotaxon. Some tracks also have similarities with the two large ichnotaxa *Irenesauripus* and *Eubrontes* as well as the smaller ichnotaxon *Anchisauripus*.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed November 5 – 8, judging occurs Thursday, November 6)

MORE THAN ONE WAY TO BE A GIANT: CONVERGENCE AND DISPARITY IN SAURISCHIAN DINOSAUR HIP JOINTS DURING BODY SIZE EVOLUTION

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Reconstructing joint anatomy and function is critical to understanding posture, locomotor behavior, ecology, and evolution of extinct vertebrates. Saurischian dinosaurs evolved a wide diversity of hip joint morphology and locomotor postures, as well as seven orders of magnitude in body size. The very largest saurischians possess incongruent hip joints in which the subchondral surfaces differ in shape and size, suggesting that large volumes of soft tissues mediate hip articulation during locomotion. This study tested the relationships among hip joint dimensions, morphological characters, body mass, and locomotor postures of sauropodomorph and theropod dinosaurs. Femora and pelves of 84 taxa were digitized using 3D imaging techniques. Discrete and continuous characters were analyzed using phylogenetically corrected correlation to reveal trends in body size evolution. Unlike smaller, basal dinosaurs, giant theropods and sauropods convergently evolved highly incongruent bony hip joints by reducing supraacetabular ossifications and medially deflecting the proximal femur, such that only the femoral head region inserted within the acetabulum. In sauropod femora, the head and antitrochanter possess irregularly-rugose subchondral surfaces for thick hyaline cartilage whereas the neck has a transversely-striated surface for thin fibrocartilage. In contrast, osteological correlates suggest theropods covered their femoral head and neck with thinner hyaline cartilage whereas the antitrochanter was instead covered in fibrocartilage. These findings indicate that the femoral articular cartilages of giant sauropods were built to sustain heavy compressive loads whereas those of giant theropods experienced compression and shear forces. Additionally, sauropods used thick hyaline cartilage for maintaining joint congruence, whereas theropods relied primarily on acetabular soft tissues such ligaments and cartilages rather than femoral articular cartilages. These data indicate that saurischian hips underwent divergent transformations in soft tissue morphology reflective of body size, locomotor posture, and joint loading.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

A SPECIMEN-LEVEL CLADISTIC ANALYSIS OF *CAMARASAURUS* (DINOSAURIA, SAUROPODA) AND A REVISION OF CAMARASAURID TAXONOMY

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Camarasaurus is considered one of the best known sauropod dinosaurs from the Upper Jurassic Morrison Formation of the USA. Numerous finds are referred to four widely accepted species: *C. supremus* (type species), *C. grandis*, *C. lentus*, and *C. lewisi*. The osteology of the genus is considered completely known, but this knowledge is mostly based on specimens referred to *Camarasaurus* without using phylogenetic methods. The state of the holotypic material is often deemed unfavorable for phylogenetic methods. Type specimens were found mingled with other specimens (AMNH 5760 with 5761; YPM 1901 with 1902 and 1905), and two species are based on juvenile material (*C. grandis*, *C. lentus*). Phylogenetic studies thus generally include *Camarasaurus* as genus. As such, intrageneric variation is excluded a priori, and the possibility that some specimens used for scoring might be erroneously referred to the genus is ignored.

In order to assess the species taxonomy of *Camarasaurus*, a specimen-level cladistic analysis was performed with all holotype specimens formerly proposed to belong to *Camarasaurus*, and the most complete referred skeletons. The ingroup counts more than 20 specimens, all but one (GMNH-PV 101) scored based on personal observations. Outgroup taxa cover early eusauropods, Diplodocoidea and titanosauriforms.

The final cladogram shows the classical type specimens of *Camarasaurus* as sister-clade to a group with the *Cathetosaurus* type specimen, and the specimens GMNH-PV 101 and SMA 0002. In order to assess taxonomic issues, two earlier proposed numerical approaches were tested: apomorphy counts between sister-clades (proposed in diplodocids), and character dissimilarity (proposed in plesiosaurs). Additionally, homoplastic rates for the diverging characters were incorporated in the apomorphy counts, in order to include a value for taxonomic significance of the trait in question. These methods support the validity of the three historic *Camarasaurus* species (*C. supremus*, *C. grandis*, *C. lentus*), and corroborate proposals for the re-establishment of *Cathetosaurus* as distinct genus. The revised character scoring for genera and species refines their diagnoses, and will help to resolve the phylogenetic position of unstable taxa like *Europasaurus*, *Jobaria*, or *Haplocanthosaurus*.

Technical Session X (Friday, November 7, 2014, 10:45 AM)

NEW APPROACHES TO CHARACTERIZING FEEDING SPECIALIZATION AND RECONSTRUCTING ITS EVOLUTIONARY PATHWAYS BASED ON COMPARATIVE BIOMECHANICS OF LIVING AND FOSSIL CARNIVOROUS MAMMALS

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The ability to capture and process prey is critical to the survival of predatory species, and therefore is thought to represent a main locus of selection in their craniodental evolution. A complex link between the morphology of the masticatory apparatus and its mechanical properties and performance is demonstrated in a wide range of living vertebrates, but the generality of such form-function relationships is still unclear and poorly explored. Here we introduce an integrated approach to studying form, function and the links in their evolution using comparative biomechanics. We describe craniodental form using 3-D geometric morphometric analyses and reconstruct craniodental function using 3-D finite element analysis within a phylogenetic context. A preliminary dataset of seven extant and fossil carnivorous mammal species is used in this pilot study. Our findings indicate that despite strong phylogenetic signal in both craniodental form and function, a link between extant dietary groups and cranial mechanical properties can nevertheless be established after accommodating phylogenetically conservative similarity due to common ancestry. Such a link is then applied to interpreting diet in two extinct species. In addition, analyses of reconstructed ancestral cranium models at internal nodes of the phylogeny of Carnivoramorpha indicate a decoupling of the mechanical properties that characterize inferred evolutionary pathways at internal nodes versus known dietary groupings of terminal taxa. Taken together, the results derived from these new analyses provide a refined basis for

reconstructing extinct predator dietary capability based on a morpho-functional linkage model that ties morphology directly to predicted dietary groups through functional simulations of the overall craniodental form.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

RICH ARTIODACTYL ASSEMBLAGE FROM THE MIDDLE EOCENE PONDAUNG FORMATION, MYANMAR

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The middle Eocene Pondaung Formation of Myanmar, which is currently dated as ca. 38–40 Ma, yields many land vertebrate fossils. Its mammalian fauna has often been used as a standard in comparisons with other more fragmentary Eocene mammalian faunas in southern China and Southeast Asia. Recent progress of the excavations and descriptive work on the mammalian fossils from the formation have indicated that m more artiodactyl taxa existed in the Pondaung fauna than previously thought. However, the updated Pondaung artiodactyls have not been systematically analyzed as an assemblage (or a fauna).

Here, the artiodactyls of the Pondaung Formation were reviewed to understand their updated diversification and phyletic and paleobiogeographic features. In the Pondaung mammal fauna (including about 40 genera), around 11 genera and 17 species of artiodactyls have been recognized, although their generic and specific taxonomy has been complicated. The Pondaung artiodactyls include several major artiodactyl groups such as primitive bunodont anthracotheriids, primitive ruminants, paraphyletic dichobunoids, and a possible raoellid. Among these artiodactyl genera, more than half (8 genera) are endemic to the Pondaung fauna. The Pondaung anthracotheriids, ruminants, and some dichobunoids likely have closer phyletic relationships with those from the middle/late Eocene of central and southern China than with those from the middle/late Eocene of northern China and Mongolia. The possible raoellid *Myanmarius* may have a phyletic relationship with the raoellids from the early/middle Eocene from Indo-Pakistan and central China. These features of the Pondaung artiodactyls imply that the artiodactyl assemblages of the northern part of eastern Eurasia were paleobiogeographically separated from those of the central and southern parts of eastern Eurasia during the middle Eocene, and that the Pondaung artiodactyl assemblages were also semi-separated within the central and southern parts of eastern Eurasia at that time.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A BASAL PAREIASAUROMORPH PARAREPTILE FROM THE PERMIAN CHICKASHA FORMATION OF OKLAHOMA AND ITS PALEOBIOGEOGRAPHIC SIGNIFICANCE

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The 'nycteroleters' are a group of small to medium sized parareptiles primarily restricted to the Middle and Late Permian of Russia. Only two of these are known from outside of Russia; an unnamed partial skeleton from the *Tapinocephalus* Assemblage Zone of South Africa, and a preliminary study identified another skeleton (UCMP 143277) from the Chickasha Formation of Oklahoma. This Oklahoman nycteroleter was identified from remains that were formerly considered to be seymouriamorph, and was named *Macroleter agilis*. The presence of *Macroleter* in North America makes this taxon the only direct link between the Middle Pemian faunas of the Russian platform and the Early Permian of North America. This study undertakes a detailed description of the remains and the first phylogenetic analysis of parareptiles including this important taxon.

UCMP 143227 shows a number of features that identify it as a pareiasauromorph, including the morphology of the cranial sculpture, the swollen neural arches, and the presence of three sacral ribs. In the intervening years since its original description, all other nycteroleters (7 species in 5 genera) have been re-examined and each has been included in an extensive analysis of parareptilian relationships. This recent information, in addition to the restudy of the type and only specimen of '*M.*' *agilis* allows us to include this taxon in a phylogenetic analysis for the first time. In a large matrix comprised of 166 characters and 37 taxa, UCMP 143227 falls within the clade containing pareiasaurs and the nycteroleters, but is a member of a polytomy at the base of this clade. There is no direct support that '*M.* ' *agilis* is the sister taxon of *Macroleter poezicus*, the latter being the type species of the genus. This suggests that UCMP 143227 should be assigned to a new genus. Despite the current lack of resolution, '*M.* ' *agilis* remains the only North American, and oldest member of Pareiasauromorpha, a clade that dispersed globally by the Late Permian. The presence of this basal pareiasauromorph in Oklahoma, and the presence of other, more basal parareptiles in this region, supports the Laurasian origin of this clade.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

INSIGHTS ON ARCHOSAURIAN GROWTH: A CASE STUDY OF AN ASSEMBLAGE OF *REVUELTOSAURUS CALLENDERI* FROM PETRIFIED FOREST NATIONAL PARK, ARIZONA

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In 2005, the first partial skeleton of *Revueltosaurus callenderi* was found at the Revueltosaurus Quarry (RQ; minimum of 209 Ma), in the Chinle Formation of Petrified Forest National Park (PEFO). Since that initial discovery, a total of 11 individuals of *R. callenderi* have been discovered from the RQ and three from the Giving Site, a stratigraphically adjacent quarry, as part of a continuing paleontological inventory at PEFO. Because the RQ encompasses a relatively complete assemblage of individuals, it provides an opportunity to understand growth variation in a single, presumably penecontemporaneous population of *R. callenderi*. I analyzed nine individuals, eight from the Revueltosaurus Quarry and one for comparison from the Giving Site, and created cross-sectional petrographic slides of nine femora and two paramedian osteoderms. After the slides were imaged, growth and body size curves were created from eight specimens by measuring zone width, zone area, mid-diaphysieal circumference, and the major and minor axes of the femoral cross-section. Age estimates and curves for both osteoderms and femora were fitted to models using a mixed-effects regression. *Revueltosaurus* first experienced a period of slow growth with many LAG packets, low osteocyte density, parallel fibered bone, and very little cortical bone in each zone. This slow growth was followed by a period of active, rapid growth with extensive vascularization and thick sequences of cortical bone laid down between LAGs. This interval was followed by a slowing of growth; however none of my specimens have the external fundamental system, so it cannot be presumed that they were skeletally mature. Based on the growth curves as well as the femoral microstructure, *Revueltosaurus* exhibited sigmoid growth. The histological description of this Late Triassic pseudosuchian provides insight into early growth dynamics in the broader context of Archosauria.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A LARGE-BODIED CROCODYLIFORM FROM THE UPPER CRETACEOUS BAHARIYA FORMATION, BAHARIYA OASIS, WESTERN DESERT OF EGYPT

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The caudal portion of a lower jaw (Carnegie Museum 83044) was recovered in 2000 from the Upper Cretaceous (Cenomanian) Bahariya Formation of the Bahariya Oasis, Western Desert of Egypt. The specimen measures 240 mm in preserved length, and includes portions of the left articular, angular, and surangular from a large-bodied crocodyliform. Several features differentiate this specimen from named crocodyliform taxa from the Bahariya Formation. These include: (1) transversely-oriented glenoid (angled rostromedial to caudolateral in *Stomatosuchus*); (2) glenoid divided into separate lateral and medial facets (undivided in *Aegyptosuchus*); (3) glenoid with well-defined and discontinuous or sinuous caudal boundary (low, continuous transverse ridge in *Libycosuchus*, *Aegyptosuchus*, and *Stomatosuchus*); (4) base of retroarticular process restricted to medial portion of articular (originates from entire width in *Libycosuchus*, *Aegyptosuchus*, and *Stomatosuchus*).

Although Carnegie Museum 83044 is roughly 3.5 times larger, it exhibits similarities with fragmentary remains previously described from the Bahariya Formation as 'Crocodilian G'. These include the divided articular surface, the well-defined caudal margin of the glenoid, and the medial position of the retroarticular process. The new specimen differs from 'Crocodilian G' in the discontinuous or sinuous nature of the caudal ridge bounding the glenoid. Although the central portion of this ridge is broken, its preserved lateral and medial edges are angled such that it would not have extended in a linear fashion caudal to the glenoid as in the other Bahariya taxa. The specimen also appears distinct from the large North African pholidosaurids *Elosuchus* and *Sarcosuchus*, but similar to the mahajangasuchids *Kaprosuchus* and *Mahajangasuchus*, in the medial position of the retroarticular process.

The Bahariya Formation fauna is notably rich in large archosaurian predators, as represented by crocodyliforms (*Stomatosuchus*, *Aegyptosuchus*) and non-avian theropods (e.g., *Spinosaurus*, *Carcharodontosaurus*). Carnegie Museum 83044 documents the presence of a third large-bodied crocodyliform taxon in the assemblage, and further suggests an unusual trophic structure for the Bahariya paleoecosystem. Comparisons with penecontemporaneous crocodyliform faunas from elsewhere on the African continent suggest similarly high diversity but the dominance of distinct clades and ecomorphotypes (e.g., small-bodied notosuchians in mid-Cretaceous deposits of Tanzania and Malawi).

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

BASAL DIVERGENCE IN ANGUIMORPHA ILLUMINATED BY A CRETACEOUS GASTRIC PELLET

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In recent years, combined evidence analyses of morphological and molecular data have rapidly gained popularity in systematics. However, due to large amounts of missing data, the inclusion of fossil taxa can lead to poorly resolved strict consensus trees. In this work, we used molecular data from 46 loci and morphological characters from 67 fossil and 30 extant taxa to examine the basal relationships in Anguimorpha. Analysis of this combined evidence data matrix leads to a well-resolved phylogenetic hypothesis. The strict consensus tree is congruent with the estimated ages of the fossil taxa, the oldest taxa taking the most basal positions. Furthermore, a new taxon from Early Cretaceous of Mongolia is recovered as the basalmost monstersaur. This taxon was found in what is suspected to be a fossilized gastric pellet. If the new taxon is excluded from the data matrix, parsimony analysis is unable to recover an informative strict consensus tree. Thus the new taxon fills a morphological gap with its unique mixture of characters between basal anguimorphs and other monstersaurids. This study illustrates how combining extensive morphological and molecular data sets can help resolve phylogenetic relationships, even with groups that contain fossil taxa with large amounts of missing information.

Symposium 3 (Friday, November 7, 2014, 11:00 AM)

'TIP-DATING' WHEN ALL YOU HAVE ARE FOSSILS: COMPARING TRADITIONAL AND BAYESIAN APPROACHES TO FOSSIL DIVERGENCE TIMES

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Divergence timing is critical in paleontological and neontological studies. Chronostratigraphically constrained fossils are the only direct evidence of absolute timing

of species divergence. Strict temporal calibration of fossil-only phylogenies provides minimum divergence estimates, with various methods proposed to estimate divergences beyond these minimum values. We explore the utility of simultaneous estimation of tree topology and divergence times using BEAST tip-dating on datasets consisting only of fossils, a technique that has become available by combining relaxed morphological clocks and birth-death tree priors that include serial sampling (BDSS) at a constant rate through time. We compare BEAST results to those from the traditional maximum parsimony (MP) and undated Bayesian inference (BI) methods. Three overlapping datasets were used that span 250 million years of archosauromorph evolution leading to crocodylians. The first dataset focuses on early Sauria (~40 taxa, 240 characters), the second on early Archosauria (~75 taxa, 400 characters) and the third on Crocodyliformes (~100 taxa, 340 characters). For each dataset, three time-calibrated trees (timetrees) were calculated: a 'null' timetree with node ages based on earliest occurrences fossil record; a 'smoothed' timetree using a range of time added to the root that is then averaged over zero-length internodes; and a BEAST timetree. As expected, both the smoothed timetrees and the BEAST timetrees provide node-age estimates older than the minimum ages of the null timetrees. Comparisons within datasets show that the smoothed and BEAST timetrees provide remarkably similar estimates. Only near the root node do BEAST estimates fall outside the smoothed timetree range. The BEAST model is not able to overcome limited sampling to correctly estimate divergences considerably older than sampled fossil occurrence dates. Conversely, the smoothed timetrees consistently provide node-ages far older than the strict dates or BEAST estimates for morphologically conservative sister-taxa when they sit on long ghost lineages. In this latter case, the Bayesian model appears to be correctly moderating the node-age estimate based on the limited morphological divergence. Topologies are generally similar across analyses, but BEAST trees for crocodyliforms differ when clades are deeply nested but contain very old taxa. It appears that the constant-rate sampling assumption of the BDSS tree prior influences topology inference by disfavoring long, unsampled branches.

Technical Sesssion XII (Friday, November 7, 2014, 1:45 PM)

THE APPENDICULAR SKELETON OF *BUNOSTEGOS AKOKANENSIS* (PARAREPTILIA: PAREIASAURIA): EVIDENCE FOR THE EARLIEST EVOLUTION OF A FULLY PARASAGITTAL QUADRUPED

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Pareiasaurs were a group of broadly distributed terrestrial herbivorous reptiles that lived during the Middle to Late Permian (~265-252 Ma). Field work in the Moradi Formation of northern Niger has produced many postcranial elements - the scapulocoracoid, humerus, radius, ulna, pelvis, and femur - of *Bunostegos akokanensis*, along with previously described cranial material. In contrast to most other pareiasaur-bearing strata, the Moradi Formation was deposited in an arid climate with shallow groundwater tables forming an isolated 'wet desert' environment. Other taxa discovered in the Moradi Formation include the captorhinid *Moradisaurus grandis*, the temnospondyls *Nigerpeton ricqlesi* and *Saharastega moradiensis*, and an indeterminate rubidgine gorgonopsid.

Here we present evidence for the earliest evolution of parasagittal (i.e., non-sprawling) posture of both forelimb and hind limb in *Bunostegos*. The forelimb is restricted to an upright posture by virtue of a ventrally-oriented glenoid fossa, in-line proximal and distal humeral articulation surfaces, a restrictive distal humeral joint with a continuous radial-ulnar condyle between two distally projecting epicondyles, a deep and narrow ulnar fossa, and pronation of the radius. Other autapomorphies of *Bunostegos* are likely related to locomotion and include the lateral origin of a thick and extended acromion process, the presence of coracoid rim buttresses along the margin of the coracoid plate, and a large and robust olecranon process with proximal folding crests forming a deep trough. The adducted stance of the hind limb is characterized by a large supraacetabular buttress forming a dorsal roof to a deep and round, laterally oriented acetabulum, a dorsoventrally thick and robustly wide pelvic symphysis extending the full length of the puboischiatic plate, a medially directed femoral head, and femoral condyles that are near equal in distal extent, with a dorsally elaborated lateral condyle that wraps up and over the medial condyle. The addition of postcranial data to a revised phylogeny of parareptiles failed to move *Bunostegos* from a relatively basal position within Pareiasauria. The postcranial skeleton of *Bunostegos* is dominated by joint morphologies indicative of a parasagittal posture, which is unique among Permian tetrapods and predates the appearance of non-sprawling posture in Late Triassic archosaurs, Late Jurassic multituberculates, and Early Cretaceous therians. Supported by NSF EAR-0617718.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

ISOTOPE COMPOSITIONS (C, O, SR) OF VERTEBRATE FOSSILS FROM THE MIDDLE EOCENE OIL SHALE OF MESSEL, GERMANY: IMPLICATIONS FOR THEIR TAPHONOMY AND PALAEOENVIRONMENT

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The middle Eocene oil shale deposits of Messel are famous for their exceptionally well-preserved, articulated 47 Ma vertebrate fossils that often still display soft tissue preservation. The isotopic compositions of oxygen, carbon, and strontium were analysed from skeletal remains of Messel's terrestrial and aquatic vertebrates to determine the condition of geochemical preservation. Authigenic phosphate minerals and siderite were also analysed to characterise the isotope compositions of diagenetic phases. The distinct isotopic compositions of diagenetic and in vivo endmembers in the special taphonomic and geologic setting of the meromictic Messel maar lake enable us to clearly detect the alteration of bioapatite, at least for terrestrial vertebrates.

The enamel of the hippomorph perissodactyl *Propalaeotherium* has preserved low $\delta^{13}C$ values of –8.8 ± 0.7‰, typical for C_3 plant-feeders. This is in accordance with its leaf-dominated diet in q C_3 plant ecosystem. Dentine of the same teeth has 15 to 17‰ higher $\delta^{13}C$ values, indicating diagenetic exchange with the strongly ^{13}C-enriched dissolved inorganic carbon of the anoxic lake bottom water. Bones and scales of aquatic vertebrates have similarly high $\delta^{13}C$ values (3.6 to 10‰). Enamel $\delta^{18}O_{PO4}$ values ~18 ± 0.6‰ of *Propalaeotherium* still record its drinking water composition and are ≥ 2‰ lower than those of bones and scales of aquatic vertebrates that lived in the ^{18}O-enriched lake water. Enamel $^{87}Sr/^{86}Sr$ ~0.711 still reflect the feeding habits of *Propalaeotherium* on Palaeozoic bedrocks surrounding the Messel maar. Dentine of the same teeth has much lower $^{87}Sr/^{86}Sr$ ~0.706 due to diagenetic Sr uptake from the volcanically influenced lake water.

Enamel of Messel fossils is geochemically exceptionally well-preserved and still contains near-in vivo C, O, Sr, and possibly even Nd isotope compositions while bone and dentine are clearly altered during diagenesis. Isotope analysis of enamel from Messel vertebrates can thus be used to reconstruct their diet, drinking water, habitat use and ambient temperatures. Preliminary data for *Propalaeotherium* will be discussed. Furthermore, lake water and air temperatures for Messel will be inferred from vertebrate bioapatite $d^{18}O$ values.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A NEW SPECIMEN OF *AGOROPHIUS PYGMAEUS* (CETACEA, ODONTOCETI, AGOROPHIIDAE) FROM THE EARLY OLIGOCENE ASHLEY FORMATION OF SOUTH CAROLINA, U.S.A.

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The whereabouts of the single partial skull holotype of *Agorophius pygmaeus* (the monotypic form for both the genus *Agorophius* and the Family Agorophiidae) has not been known for approximately 140 years. Since the discovery of *Agorophius pygmaeus*, many additional taxa and specimens have been placed in the Family Agorophiidae, only to be reclassified and removed later. This has created confusion as to what is and what is not an agorophiid and a lack of clarity as to what characteristics delimit the Agorophiidae. A newly discovered skull of an agorophiid recently collected from the bed of the Ashley River, South Carolina, U.S.A., is assigned to this species. It derives from the base of the upper Ashley Formation (Rupelian, early Oligocene). The new specimen consists of most of the skull and periotics, which are well preserved and described for the first time in an agorophiid. The new specimen provides an opportunity to diagnose the Agorophiidae and place the genus and species within the phylogenetic context of the early odontocete radiation in the Oligocene, along with other taxa such as the Patriocetidae, Simocetidae, Waipatiidae, and Xenorophidae. Based on this new understanding, Agorophiidae are known with certainty only from the early Oligocene of South Carolina, with other, as yet undescribed specimens from the Oligocene of the North Pacific (Japan, Mexico, and Washington state).

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

TAPHONOMY OF THE STANDING ROCK *EDMONTOSAURUS* BONEBED, CORSON COUNTY, SOUTH DAKOTA: IMPLICATIONS FOR BIOMOLECULAR PRESERVATION

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Recent reports in molecular paleontology present clear evidence of biomolecules preserved in geologically ancient fossils. Yet, little is known as to how this remarkable preservation is possible. The first step in advancing this knowledge is to identify, in fine detail, geologic, environmental, geochemical, and taphonomic circumstances that correlate to soft tissue retention. With this goal, we performed a detailed taphonomic examination of a case study site yielding bones preserving soft tissue remains, the Standing Rock Hadrosaur Site, in Corson County, South Dakota. Over 4700 bones of the hadrosaurid dinosaur *Edmontosaurus* have been collected from this bonebed in the Cretaceous Hell Creek Formation. Demineralization of cortex samples from multiple bones have yielded pliable soft tissue structures consistent in morphology with osteocytes, blood vessels, and fibrous bone matrix. That every skeletal element can be accounted for suggests the assemblage is autochthonous and argues against depositional sorting biases. Rarity of bone weathering and abrasion support this inference of brief exposure and transport prior to burial. However, all bones are found disarticulated in a slightly normally-graded distribution in a sandy mudstone, indicating moderate postmortem decay and disruption of carcasses. A slight bidirectional pattern of bone orientations and infrequent preburial breakage, primarily of cranial elements and vertebral processes, provide supporting evidence for moderate flow energy during bonebed deposition. Yet, fluid flow was low in energy as most bones lie nearly horizontal. Additional faunal components, though rare, are indicative of a fluvial-coastal setting. Cumulatively, these findings support the conclusion that a herd of primarily subadult and adult *Edmontosaurus* died in an ephemeral fluvial channel side-marsh setting in a geologically quick event and, following brief decay and scavenging by theropods, their bones were mixed into a single deposit by a flooding event. Abundant goethite concretions in the bonebed horizon agree with this interpretation by diagnosing the original setting as wet and dysaerobic. Oxygenated flood waters and/or groundwater oxidized initially sideritic concretions to goethite, facilitating rapid local cementation of portions of the sediment that may have aided stabilization of soft tissues by shielding them from prolonged exposure to pore fluids. Our results corroborate previous propositions that iron rich environments and rapid burial can permit soft tissue preservation.

Technical Session XVI (Saturday, November 8, 2014, 9:00 AM)

TEETH INSIDE AND OUTSIDE THE MOUTH: A MICRO-CT ANALYSIS OF TOPOGRAPHIC RELATIONSHIPS IN SAWFISH AND SAWSHARK DENTITIONS (ELASMOBRANCHII; CHONDRICHTHYES)

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Sharks and rays have been studied extensively to address the origin and evolution of teeth in jawed vertebrates. They possess a micromeric dermal skeleton in which odontodes form as separate placoid scales (denticles) in a pattern distinct from teeth on the jaws. On the rostrum of sawfish (Pristidae), sawsharks (Pristiophoridae) and the fossil Sclerorhynchoidea, rostral teeth differ from oral teeth and placoid scales, presenting a challenge in understanding the morphogenesis of this rostral pattern, and if it is related to that of the dentition.

Sawshark, sclerorhynchid, and sawfish rostra are convergently evolved feeding and/or sensory structures; sawsharks belong to the Elasmobranchii (modern sharks), sawfish and sclerorhynchids to the Batoidea (rays and skates). Sawfish retain their rostral teeth through life, with dentine being deposited at their base to maintain relative tooth size during ontogeny and through wear. Sawfish rostral teeth are of similar size and spacing on the edges of the rostrum and located in deep sockets in living taxa or shallow pits in the Paleogene *Propristis*. In contrast, sawsharks and sclerorhynchids add new rostral teeth through life. Sawsharks and sclerorhynchids possess lateral rostral teeth and smaller teeth on the ventral surface of the rostrum. Lateral teeth are arranged in irregular sets of small, medium and large sizes, each of comparable morphology and located in shallow pits.

Micro-CT (computed tomography) was used to study sites of new rostral tooth addition, development, replacement and patterning on sawshark, sawfish and sclerorhynchid rostra, for comparison with scale and dentition patterns. In sawsharks, for example, the apparent regular spacing of the lateral rostral teeth is a result of rostrum growth, while replacement occurs irregularly, after tooth loss. Nevertheless, retained depressions in the prismatic cartilage reciprocates the morphology of the tooth base and replacement occurs in a size-specific manner, at specific locations on the rostrum.

We suggest that rostral teeth represent neomorphic structures, patterned independently of oral teeth. A robust rostrum, with lateral (and ventral) dermal structures occurs only in chondrichthyans, but appears to have evolved independently on at least three separate occasions within the group, including twice within the batoids. In the batoids, the sclerorhynchid rostrum and rostral teeth converges strongly on that in the sawsharks. Funding source: Natural Environmental Research Council.

Technical Session XI (Friday, November 7, 2014, 2:45 PM)

COMPARABILITY OF DENTAL MICROWEAR TEXTURE DATA BETWEEN STUDIES.

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Dental microwear, microscopic use-wear on teeth and tooth-like structures, has been studied for a broad variety of fossil taxa from conodonts to hominins. Distinctive patterns have been associated with diet, environment, food acquisition and processing, social grooming, and other activities. And we can use this as a tool to infer aspects of the lives of past vertebrates, given a reliable method for describing and comparing microwear surface patterning. New approaches to quantifying microwear patterns using 3D point clouds and automated surface texture analysis have emerged over the past decade. These are touted to provide measures free from 'noise' introduced by observer measurement error. But this does not necessarily mean data are comparable between studies, because different instruments have different optical and light properties, different resolutions, and different work envelopes. Here we report results of a study comparing microwear texture data collected using two different white-light confocal profilers, a Sensofar Plμ standard and a Plμ NEOX, with a decade of technological advances in both hardware and software separating them.

Our initial analyses evinced marked differences between the instruments (e.g., fractal complexity values for the Tasmanian devil, *Sarcophilus harrisii*, were up to an order of magnitude greater using the Plμ NEOX than the Plμ standard). Differences were attributed to varying instrument resolution, lateral point spacing, work envelope, source light type, surface stitching procedure, and data processing algorithm. We were, however, able to achieve comparable results using a protocol that matches attributes between the instruments. This was confirmed by comparison of data obtained using the Plμ standard (previously published data for the early hominins *Australopithecus africanus, Paranthropus robustus*, n = 19) with those from the Plμ NEOX. Fractal complexity and surface anisotropy values were compared using Spearman's correlation tests and a ranked data MANOVA, with sample (taxon) and instrument as the factors. Results indicate significant correlations between data collected for specimens using the two different instruments. Further, differences between the taxa identified with the Plμ standard were also evident using the Plμ NEOX. This gives us confidence that microwear texture data generated using different instruments can be compared, but only if software and hardware differences are identified and taken into account.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

DESCRIPTION OF THE MIDDLE EAR CAVITY OF *DESMOSTYLUS* (MAMMALIA, AFROTHERIA) USING HIGH-RESOLUTION X-RAY MICRO CT SCAN

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Desmostylians are known from the Oligocene to Miocene shallow marine strata around the North Pacific. Their paleoecological restoration such as preferences of diet and habitat still remains controversial because they have peculiar features that are rarely found in general mammals.

Anatomical structures of the hearing apparatus are expected to have a deep relationship with the extent of ecological adaptation in a variety of animals. The auditory region of desmostylians, however, has hardly attracted attention hitherto. There were only a few descriptions regarding an external acoustic meatus and foramina of the temporal fossa which communicate to the epitympanic sinus. We reconstructed the inner structure of the auditory region of a well-preserved skull of *Desmostylus hesperus* collected from the middle Miocene Tachikaraushinai Formation at Esashi City, Hokkaido, Japan by high-resolution micro CT scan and 3D computing method.

Reconstructed CT images showed a well-developed large cavity spreading out across the large part of the squamosal and mastoid without including a clear septum and cancellous bone. It might comprise the middle ear cavity and epitympanic and hypotympanic sinuses. The large middle ear cavity of some terrestrial taxa (e.g., notoungulata, demoptera, and proboscidea) was supposed to provide low-frequency sensitivity for adapting to terrestrial open environments. However, the presence of enlarged middle ear cavity in desmostylians may have a different auditory function from that of other terrestrial mammals because desmostylians are considered to be aquatic or semiaquatic.

Technical Session VII (Thursday, November 6, 2014, 11:45 AM)

PTEROSAUR TAILS TELL TALES OF MODULARITY AND HETEROCHRONY IN THE EVOLUTION OF THE PTERODACTYLOID BAUPLAN

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The evolution of pterodactyloids from basal pterosaurs in the Early-Middle Jurassic involved a complex series of anatomical transformations that affected the entire skeleton. Until recently, almost nothing was known of this major evolutionary transition that culminated in the Pterodactyloidea, a morphologically diverse and ecologically important clade that dominated the aerial environment throughout the mid-late Mesozoic. The discovery of *Darwinopterus*, a transitional form from the early Late Jurassic of China, provided the first insights into the sequence of events that gave rise to the pterodactyloid bauplan and hinted at an important role for modularity, but was largely silent regarding the anatomical transformations themselves, or the evolutionary mechanism(s) that underlay them. A series of recent finds allowed us to construct a complete postnatal growth sequence for *Darwinopterus*. By comparing this sequence with those for *Rhamphorhynchus* and *Pterodactylus*, pterosaurs that phylogenetically bracket *Darwinopterus*, it is possible to map key anatomical transformations such as the evolution of the elongate, complex tail of basal pterosaurs into the short, simple tail of pterodactyloids. In *Darwinopterus* hatchlings the tail is shorter than the dorsal-sacral series (DSV) and consists of around 18 simple vertebral ossifications. The tail is longer (1-2 x DSV) in juveniles and has a normal complement of about 30 caudals, but only reaches its full length (2-3 x DSV) and complexity in adults. Basal pterosaurs largely conform to this pattern, although some species, including *Rhamphorhynchus*, have longer tails with up to 40 caudals. Generally, the tail of adult pterodactyloids, including *Pterodactylus*, resembles that of *Darwinopterus* hatchlings (≤18 ossified vertebrae; tail ≤0.7 x DSV; vertebrae simple, blocky), but occasionally develops a little further (e.g. in *Pterodaustro*) corresponding to the condition seen in early juveniles of *Darwinopterus* and paralleling the developmental pattern observed in long-tailed pterosaurs. The short tail of adult pterodactyloids, and anurognathids, basal pterosaurs that also have relatively short tails, appears to be neotenic, resulting from a sharp decrease in growth rate compared to the rest of the skeleton. This mechanism, heterochrony acting upon a distinct anatomical module to effect a large-scale morphological transformation, can be applied to other modules to generate the derived features (e.g. elongate neck and metacarpus, reduced fifth toe) that typify the pterodactyloid bauplan.

Technical Session XIV (Saturday, November 8, 2014, 11:00 AM)

A NEW CHARACTER SET FOR THE ANALYSIS OF SAUROPOD PHYLOGENY, AND ITS IMPLICATIONS FOR THE EVOLUTIONARY HISTORY OF EUSAUROPODA

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Despite considerable progress over the past 20 years, many aspects of sauropod phylogeny remain unresolved or controversial. Problems stem from ambiguous character definitions as well as high levels of homoplasy and missing data. Moreover, recent analyses have relied heavily on data sets that were generated 10-15 years ago: these require substantial revision and augmentation in the light of recent discoveries. As a first step towards the production of a thoroughly revised character set, we have created a data set of 700 characters for 53 eusauropod taxa. This emphasizes Diplodocoidea (29 taxa) but has representatives of Macronaria and non-neosauropods. Approximately 10% of these characters are new, and many others have been heavily revised and rescored based on first-hand examination of specimens.

Analysis of this data set in TNT, with *Shunosaurus* as the outgroup, produced 102 most parsimonious trees of length 2173 steps. The relationships of Flagellicaudata and Titanosauriformes are fully resolved but resolution is lower among non-neosauropods and rebbachisaurids. Application of reduced consensus clarifies the positions of most taxa via a posteriori removal of highly incomplete forms such as *Histriasaurus*. The results support many widely accepted aspects of eusauropod phylogeny, including the monophyly of Neosauropoda, Diplodocoidea, Flagellicaudata, Macronaria, Titanosauriformes and Titanosauria. However, the positions of some taxa or clades differ from those proposed by most recent analyses. For example, *Haplocanthosaurus* is placed as a non-neosauropod, rather than as the most basal diplodocoid. The monophyly of Turiasauria is partially supported, with *Losillasaurus*, *Turiasaurus* and *Zby* forming a

clade which has an unstable position near to the base of Neosauropoda; but the basal macronarian *Galveosaurus* does not cluster with other turiasaurs. *Rapetosaurus* is more closely related to saltasaurids than to *Malawisaurus*, contradicting the largest previous analysis of titanosaur relationships.

Reconstruction of ghost ranges and biogeographic analysis provide insights into eusauropod evolutionary history. For example, *Bellusaurus* is found to be the most basal macronarian, indicating that neosauropods were present in East Asia during the Jurassic, contrary to the hypothesis that members of this clade did not invade this area until the Cretaceous. The position of *Bellusaurus* also suggests that Macronaria and Diplodocoidea diverged in, or before, the early Middle Jurassic prior to the break-up of Pangaea.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

TYRANNOSAURUS MIGHT RUN FASTER THAN HUMAN: A DETAILED STUDY BASED ON AVAILABLE KNOWLEDGE OF EXPERIMENTAL BIOLOGY AND COMPUTER SIMULATION

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A theory of static calculation was previously presented, stating that *Tyrannosaurus* was not a fast runner. The work postulated a certain mid-stance posture, and obtained the result that *Tyrannosaurus* muscle is insufficient to support it. The work and subsequent studies brought insight on the prediction of running ability of *Tyrannosaurus*. However, parameters involved in the evaluation have not been fully analyzed. Moreover, the evaluation methodology is a static one, hence speed estimation is quite limited. We calculated whole running motion of *Tyrannosaurus* based on time-dependent biomechanical calculations with the use of the evolutionary computation method. As a result, we obtained the possible locomotion pattern of *Tyrannosaurus*, and found a possibility that the mid-stance posture is more upright than reported in previous works. This result gives smaller estimation of muscle mass needed to support the posture, and shows that *Tyrannosaurus* could run at a speed of 14 m/s.

Detailed discussion of involved parameters is also presented. Among them the most important parameters is maximum muscle stress, which is the one at which the muscle exerts force best. We have examined 110 references on this issue. As a result, we have found that previous works misunderstood the parameter as isometric tetanic tension. The correct parameter has been stated as specific tension in experimental biology, and the parameter range spans widely as ~11-220 N/cm^2. The previous works assumed this parameter as 30 N/cm^2. Therefore the muscle can generate larger force than previously assumed, which makes *Tyrannosaurus* possibly capable of fast running. The mechanical power of muscle during running is also calculated in our dynamical simulation. This is the first study in this research area. The value of mechanical power also allows for fast running in *Tyrannosaurus*.

We have completed work discussing known biomechanical parameters based on 150 references of experimental biology, and then applied this to the discussion of running ability of large bipedal theropod, *Tyrannosaurus*. The result shows a possibility that *Tyrannosaurus* might run faster than a human. At the presentation, we show all of the data that support the above statements.

Preparators' Symposium (Saturday, November 8, 2014, 3:00 PM)

TRANSFER PREP OF AN EOCENE BIRD FROM THE GREEN RIVER FORMATION, WY.

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The Green River Formation of the Eocene Epoch is famous for its vast array of beautifully preserved taxa. The fine-grained limestone can record the finest details for posterity, including ephemeral specimens of plants, insects, even feathers. While not common, bird fossils have been discovered in the limestone and can range from a single feather to a fully articulated specimen. Usually, bird fossils are found as a single specimen on one slab. When an exquisitely preserved complete 52 million year old bird with feathers was discovered in the 'split-fish layer' from southwestern Wyoming as a slab and counterpart, it presented a challenging opportunity to attempt 'transfer prep' of the specimen's bones onto one slab.

Bird fossils are notoriously delicate. Their bones are small, thin and hollow; and feathers are essentially a carbon stain showing what type of feather it used to be. Regarding this specimen, all features were present: skull, entire skeleton, feathers. The most important feature (the skull) was on the left slab, as well as its feet and claws. Some of the limb bones and half of the furcula were also on the left slab. The feathers and a greater percentage of the bones were better preserved and more intact on the right slab.

After initial dissent on my part, and persistent insistence on the curator's part, it was finally decided that as much bone material as possible on the left slab was to be removed and transferred to the right slab. The goal was to make one complete bird fossil, containing as much original material as possible. If a bone could be removed from the left slab, it would be carefully dissected off and then transferred into place in its negative impression on the right slab. The bone, now glued into place, could then have the excess matrix removed, and it would join the rest of the skeleton and feathers on the right slab. As much of the left slab as possible was to be left intact for 'destructive sampling'.

While a daunting project, the bird's bones proved robust enough to manipulate after careful consolidation of all bones (left and right). Great care was taken to consolidate only bone material. After using extremely fine tools and precise application of glue and consolidants, most of the skeleton was eventually assembled on to the right slab, with minimal destruction to the left side.

This project begged some difficult questions, including ethical ones. "Is this really necessary?" "What is the purpose of this?" At what point does a preparator say, "No!", to drastic alteration of an important specimen? What is the argument for/against a project of this nature?

Technical Session XV (Saturday, November 8, 2014, 9:00 AM)

BODY SIZE EVOLUTION ON PALAEO-ISLANDS: ANTIQUITY OF THE ISLAND RULE AND TEMPORAL FLUCTUATIONS

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We assessed the generality of the island rule in a database comprising 63 species of fossil mammals from islands world-wide, ranging from the late Miocene to the early Holocene, and tested whether observed patterns differed among taxonomical and functional groups. Body mass of each pair (insular mammal and its ancestral taxon) was estimated using the same method. We found that across 7 orders of fossil mammals (Proboscidea, Cetartiodactyla, Rodentia, Lagomorpha, Soricomorpha, Erinaceamorpha, Carnivora), body size evolution exhibited the predicted graded trend from gigantism in small mammals to dwarfism in large mammals. Body size decrease was most dramatic in Elephantidae and Hippopotamidae, notably *Palaeoloxodon falconeri* and *Hippopotamus minor*. Body size increase was most dramatic in species that utilized aquatic prey (*Megalenhydris*, *Nesiotites*). The island rule appears to be a pervasive pattern, exhibited by mammals from a broad range of orders, functional groups, and time periods. Our findings confirm the hypothesis that ecological release in species-poor biotas may result in the convergence of insular mammals on the size of intermediate but absent species. The more pronounced gigantism and dwarfism of palaeo-insular mammals relative to what is found in extant mammals is consistent with a hypothesis that emphasizes the importance of ecological interactions that play out over time: the time in isolation from mammalian predators and competitors was 0.1 to > 1.0 Ma for palaeo-insular mammals, but < 0.01 Ma for most extant populations of insular mammals.

We also assembled data on temporal variation in body size and associated variation in ecological characteristics (colonization or extirpation of mammalian competitors and predators) for 19 species of fossil, non-volant small mammals across 4 large (> 3640 km^2) palaeo-islands ranging between the late Miocene and early Holocene. We found that following first appearance in the insular fossil record, small mammals tended to increase in body size, in accordance to the predictions of the island rule hypothesis. These trends, however, ceased or were reversed following colonization of the focal islands by mammalian predators or competitors. Temporal trends as observed in palaeo-insular mammals indicate that the observed trends for any particular species, island and climatic regime may be strongly influenced by interactions among species.

This research was co-financed by the European Union and Greek national funds (Research Funding Program THALIS-UOA MIS375910, KA:70/3/11669).

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

AN INVESTIGATION OF SEXUAL DIMORPHISM AND POPULATION STRUCTURE OF THE DODO (*RAPHUS CUCULLATUS*) BASED ON THE MARE AUX SONGES FOSSIL REMAINS

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The dodo (*Raphus cucullatus*), a large flightless pigeon once endemic to the island of Mauritius, is an icon of human-induced extinction. Unfortunately, very few fragmentary remains exist from specimens collected before the bird's extinction in the 17th century, and many aspects of dodo anatomy and biology remain poorly known. A large part of our knowledge of the dodo derives from bones collected from the Mare aux Songes (MAS), a mid-Holocene fossil concentration Lagerstätte first discovered in 1865 but considered lost midway through the 20th century. The 2005 rediscovery of the MAS has enabled us to address longstanding questions regarding the remains collected at the locality and to examine sexual dimorphism and population structure.

To this purpose, we performed a biometric study using 10 different linear dimensions on the largest sample of dodo skeletal remains ever analyzed, consisting of more than 750 bones selected for their completeness. We analyzed tarsometatarsi, tibiotarsi and femora from the recent Dodo Research Project (DRP) excavations as well as historically collected materials from multiple museum collections. Kolmogorov-Smirnov Z-tests and Wald-Wolfowitz runs tests were used to examine potential differences between historically collected remains and bones collected by the DRP. Bones from the recent DRP excavations were statistically indistinguishable from the historically collected bones, enabling us to combine these data in further analyses. We performed two-step cluster analyses to search for naturally occurring size fractions in the data, using a log-likelihood distance measure and Schwarz's Bayesian information criterion. Mann-Whitney-Wilcoxon tests were performed to determine the significance of the obtained fractions.

Our results identify two significantly different size classes, with the bones of one morph 5% larger on average, which we interpret as evidence for sexual dimorphism in the dodo. Both size classes contain approximately equal numbers of bones. We interpret the larger bones as being from males and the smaller from females, since males are generally larger in extant columbids. The observed sexual dimorphism is significantly less pronounced than previously hypothesized or observed in the closely related extinct flightless Rodrigues Solitaire, but similar to the degree of skeletal dimorphism observed in closely related living columbids. The skeletal metrics of the MAS dodos provide a new intriguing window on the population structure and dynamics of this iconic and enigmatic extinct bird.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

A NEW RECORD OF A PALEOGENE CETACEAN (BASILOSAURIDAE, AFF. *BASILOTRITUS*) FROM THE ST. PIETERSBERG, MAASTRICHT, SOUTHEAST NETHERLANDS

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The European fossil record of cetaceans is especially limited for the Eocene and early Oligocene. Only a few isolated bones or at best partial skeletons are known from Austria, England, Germany, Russia and the Ukraine.This is why the systematics, phylogenetic relationships, and paleobiogeography of European basilosaurids are still poorly understood.

Here we report on about 40 bones, including five fragmentary vertebral centra and rib fragments, collected in April 1979 in a section exposed at the ENCI quarry, St. Pietersberg, Maastricht (southeast Netherlands).

The fragments originate from the Klimmen Member, a shallow-marine unit dated as latest Priabonian (latest Eocene) to early Rupelian (early Oligocene). Because the uppermost sediments of the unit are lacustrine to continental, we consider the finds to belong to the lower, maybe Priabonian, marine strata.

Although the fragmentary preservation precludes a more specific attribution, one pachyostotic vertebra bears a close resemblance to vertebrae of the basilosaurid *Basilotritus*, previously recorded from the Bartonian or Priabonian of the Ukraine, the Bartonian or Priabonian of Germany, and the Bartonian of Virginia, USA. Sharing a roughly similar size, this vertebra displays in section also the typical multi-layered, dense cortical bone observed in *Basilotritus*, differing from the condition in known neocetes. Pachyostosis has been noted in ribs and/or vertebrae of basilosaurid taxa, possibly helpful in controlling buoyancy. Other diagnostic features of *Basilotritus*, for example the vertebral transverse processes, could unfortunately not be assessed ; better preserved specimens are needed to confirm this preliminary attribution. This find corroborates previous records of basilosaurids in the shallow-marine Paleogene regions of Europe.

Technical Session V (Wednesday, November 5, 2014, 2:00 PM)

THE EFFECTS OF SAMPLING AND RESEARCH EFFORT BIAS ON THE 'POOR' LISSAMPHIBIAN FOSSIL RECORD OF THE LAST 80 MILLION YEARS

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Understanding the dynamics of past biodiversity fluctuations and their causes is one of the main goals of modern paleontology due to the utility of this information when modeling future trajectories of modern biodiversity dynamics as a result of climate change. While the dynamics of more captivating groups, such as dinosaurs and mammals, are beginning to be unraveled, the environmentally sensitive lissamphibians have received little attention, despite being the most endangered living vertebrate group. We examine biodiversity patterns through the last ~80 million years of the lissamphibian fossil record in an attempt to understand the factors that shaped their evolutionary history and are likely to affect their future biodiversity and distribution.

Examination of our dataset of 1030 occurrences, representing 280 species, shows a gradual increase in species richness leading up to the present day, with a possible peak interrupted by an early Miocene extinction (18 Ma). However, this diversity trend is strongly correlated with sampling. We removed the effects of sampling from the data using a model-based approach. The model-detrended curve shows that most of the trends are explainable as a consequence of sampling. Exceptions to this result are lower-than-expected diversity after the Cretaceous-Paleogene mass extinction event, and higher-than-expected diversity during the early Oligocene (Rupelian) cooling event and towards the recent, although the magnitude of these changes is restricted to <30 species.

Although many observed changes in lissamphibian paleobiodiversity can be explained by biases in their record rather than biological causes, a plot of descriptions-through-time shows a positive slope, suggesting that our knowledge of fossil lissamphibian species is steadily growing, without signs of plateauing. Our poor understanding of patterns in lissamphibian paleodiversity might therefore be better attributed to a lack of research effort, rather than what is often considered a sparse fossil record. Future research documenting new fossil lissamphibians will greatly improve our understanding of how these highly sensitive species have resisted extinction over their evolutionary history.

Technical Session III (Wednesday, November 5, 2014, 4:00 PM)

LAY-BROOD-REPEAT: NESTING SITE FIDELITY IN ECOLOGIC TIME FOR TWO CRETACEOUS TROODONTID DINOSAURS

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Whereas 'biological site fidelity' refers to regular re-use of a favored locale (e.g., a breeding ground or nest) by an individual animal, 'paleontological site fidelity' typically refers to repeated use of a nesting locality by a herd or species over geological time scales. Two new Cretaceous specimens, Museum of the Rockies 676, from the Campanian Two Medicine Formation of Montana, USA, and Zhejiang Museum of Natural History M8711, from the Albian Liantoutang Formation of Zhejiang, China, each preserve two closely superimposed clutches of the egg form *Prismatoolithus*. These eggs belong to the Troodontidae, small theropod dinosaurs sharing a close ancestry with birds. *Prismatoolithus* clutches consist of 10-24 closely spaced, elongate eggs arranged with their long axis vertical to subvertical within the substrate and leaning towards the clutch center. This 'planted' arrangement likely required adults to physically work the sediment prior to oviposition. In both specimens, eggs of a lower clutch are truncated at a level below what would normally preserve in an undisturbed hatched clutch. The disturbance occurs in association with eggshell debris and in the Zhejiang specimen conforms to the concave-down base of the overlying clutch. Truncation likely resulted from sediment preparation by the adult and subsequent oviposition. These traces differ from past examples of dinosaur site fidelity in: 1) the close or cross-cutting relationship of the clutches, 2) the precise overlay of clutch atop clutch, and 3), given the compact arrangement of troodontid clutches within a nest structure, the implication of nest reuse. In contrast to the stacked egg horizons of previous paleontological examples, these specimens approximate site fidelity on an ecological rather than geological scale and at the individual rather than species level. Given the likely extended occupation of troodontid nesting sites by attending adults, factors such as nesting success, territoriality, and favorable substrates may have influenced the behaviors recorded by these specimens. Occurrence of site fidelity in two troodontids widely separated geographically and temporally emphasizes the influential role of oviparity, its spatial restrictions, and parental care in the ecology of dinosaurs like *Troodon*. The arrangements of eggs as clutches within the geologic record represent trace fossils. Thus, they record past in situ behavior, providing important insight into dinosaur nesting. National Science Foundation grants EAR # 847777 and IRES # 0854412 supported this research.

Technical Session V (Wednesday, November 5, 2014, 2:45 PM)

RECENT AND FOSSIL EURASIAN CENOZOIC GIANT SALAMANDERS (PANCRYPTOBRANCHA, LISSAMPHIBIA): SYSTEMATICS, PHYLOGENY, BIOLOGY AND PALEOCLIMATIC SIGNIFICANCE

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Giant salamanders, Cryptobranchidae, represent a clade of large, tailed amphibians reaching about 2 m in total length. They are strictly aquatic and today confined to clear, well-oxygenated, cold mountain streams and rivers. Four (or five) species ranging throughout the Tertiary of Eurasia (*Zaissanurus beliajevae*, Kazakhstan; *Ukrainurus hypsognathus*, Ukraine; *Andrias scheuchzeri*, Central and Eastern Europe), as well as three recent species (*Andrias davidianus*, China; *Andrias japonicus*, Japan; *Cryptobanchus alleganiensis*, Northern America) are currently referred to this group.

We provided detailed osteological and anatomical studies on cranial and postcranial skeletal elements of all fossil and recent species. Morphological and osteological characters were used to clarify systematics within the group. A phylogenetic analysis of all Tertiary and recent giant salamanders recovers a monophyletic group of Asian and North American cryptobranchids, but places *U. hypsognathus* outside crown group Cryptobranchidae. *U. hypsognathus* and Cryptobranchidae are included into the total clade Pancryptobranchidae. Our result suggests that Cryptobranchidae originated in Asia and dispersed to North America.

The study on recent and fossil giant salamander species provided extended information on their life style and life history strategy. We show that *Av. exsecratus* is the first lissamphibian showing a peramorphic life history and semiterrestrial life style. Recent (*Andrias*, *Cryptobranchus*) and fossil (*Zaissanurus*, *Ukrainurus*, *Andrias*) giant salamander genera are otherwise characterized by a paedomorphic life history and fully aquatic life style.

We analyze fossil distribution of the group in the Cenozoic of Eurasia and show that morphological stasis is also maintained by stable environments, making giant salamanders an ideal proxy-group for environmental and paleoclimatic studies. The climate space of recent and fossil cryptobranchids is best characterized by high humidity with mean annual precipitation values over 900 mm. This project was supported by the Deutsche Forschungsgemeinschaft (DFG), grant BO 1550/14 (to M.B.).

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

A UNIQUE OCCURRENCE OF A PSAMMOSTEID HETEROSTRACAN IN THE LOWER-MIDDLE DEVONIAN (EMSIAN-EIFELIAN) BOUNDARY BEDS OF THE PRAGUE BASIN

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Agnathan remains are very rare in the Silurian and Devonian sediments of the Prague Basin (central Bohemia). Only two separate head carapace plates of psammosteid heterostracans are deposited in the National Museum in Prague. Both originate from a single locality - the former so called Prastav Quarry near the village Holyne south west of Prague. No other vertebrate remains are known from this locality.

The larger of the plates was described as *Schizosteus perneri*. It is a well preserved left branchial plate exposed partly from the dorsal side and partly with the inner surface of the ventral side. It is some 17 cm long, slightly convex in shape, with the anterior end incomplete and two transverse fractures. The ornament on the dorsal side is composed of well bordered round or rhombic tubercles with stellate ridges. The tubercles are large at the lateral margin and getting smaller towards the posterior end of the plate. The tubercles tend to be arranged in lines on most of the plate surface.

These agnathan remains are embedded in a greenish grey compact limestone. The Prastav Quarry sequence comprises the upper part of the Trebotov Limestone of Emsian age and the basal part of the Chotec Limestone of the Eifelian. The exact layers which yielded the specimens are unknown. As there are no detectable index fossils in the matrix surrounding the fossil and the basal Chotec Limestone is lithologically very similar to the uppermost part of the Trebotov Limestone, it can be determined only that the fossils originate from the Emsian-Eifelian boundary interval.

Psammosteid heterostracans are known mainly from the Northern hemisphere or more precisely the Euramerican paleoprovince (Old Red Sandstone, Baltica) in the Lower and Middle Devonian. Therefore, the occurrence of this heterostracan on the southern hemisphere in strata older than the Givetian is very rare.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A PARTIAL BIRD WITH PRESERVED FEATHERS FROM THE PALEOCENE OF THE CENTRAL YUKON TERRITORY, CANADA

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Bird fossils are virtually unknown from the Cenozoic of Canada, despite an extensive record of other vertebrates from this time. In 1983, a partial fossil bird with several preserved feathers was found along Fifteenmile Creek, north of Dawson City in the Yukon Territory. The geology of this region is highly complex due to the multiple accreted terranes that compose the bedrock of the area, but this fossil has been dated as Paleocene based on associated plant leaves found on the same block. Leaves of several taxa, including *Metasequoia* cf. *occidentalis*, *Cercidiphyllum*-like, and *Carpinus*-like foliage are visible on one face of the block containing the fossil. The preserved feathers are all flight feathers, and the fine-scale preservation of the feathers allows for visualization of the individual barbules. These barbules are clearly differentiated into distinctive proximal and distal forms, and interlock to produce vaned (pennaceous) feathers. In terms of overall shape, the feathers appear to be asymmetrical and lack plumulaceous basal barbules, displaying all of the characteristics of modern flight feathers. Several of the feathers show variation in colouration that may be indicative of original colour patterning, although further work using mass spectrometry is needed to fully assess their preservation. Regardless, the geographic and temporal placement of this fossil is an important datapoint to our understanding of bird evolution during this period.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

PHYLOGENETIC AND LIFE HISTORY IMPLICATIONS OF TOOTH ERUPTION PATTERNS IN ARTIODACTYLA AND CARNIVORA

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The morphology and amount of teeth in mammalian dentitions hold essential information about phylogeny and diet. Evolutionary lineages show specific patterns of tooth replacement, which is hypothesized to be linked with life history traits. For example, the shifting of the time of replacement tooth eruption in primates has been suggested as indicative of life span and speed of growth. The tendency to replace teeth early in species with fast growth and long life span is called 'Schultz's'rule'. In order to test the validity of this pattern in different clades, new data on the tooth eruption patterns of two ecologically distinct mammalian groups were studied based on examination of more than 500 specimens representing 52 species. In Artiodactyla the first molar is usually the first permanent tooth to erupt, whereas in Carnivora the sequence starts with the replacement of the first incisor. Among cervids, the small-sized *Capreolus capreolus* starts replacing the deciduous dentition after the second molar has emerged, whereas larger-sized species such as *Dama dama* usually replace the first deciduous tooth before this event. On the other hand, in viverrids the replacement pattern between the two small sized species *Genetta genetta* and *Paradoxurus hermaphroditus* exhibit differences. The eruption of the second molar is delayed in the second species and even postdates the final positioning of the permanent canine. These and other examples illustrate major common patterns. The examination of dental eruption patterns while controlling for phylogenetic effects, together with other markers of growth and palaeohistology, can provide insights into life history evolution in extinct and extant mammals.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

CRANIAL MORPHOLOGY AND ONTOGENY OF *VARANUS BENGALENSIS* (SQUAMATA; VARANIDAE)

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Extant members of *Varanus* display a great range of body sizes relative to other lizard genera. The family Varanidae consists of only two extant genera, *Varanus* and *Lanthonatus*, but contains fossil representatives dating back to the Late Cretaceous; early members already exhibited substantial size variation. The oldest record of *Varanus* dates back to at least the early Miocene. Extant varanids live in the Old World, ranging from Africa, east through southern Asia, and south into Australia. Formerly known as *Varanus monitor*, *Varanus bengalensis* has one of the most expansive distributions within the genus, found from eastern Iran to the Indonesian Islands.

Due to the extensive size disparity within the genus, questions of dwarfism, gigantism, and stage of ontogentic development present intriguing taxonomic issues when working with the fossil record. It is apparent from the literature that some of the taxonomic problems reflect the near lack of descriptive morphology and its variation within an ontogenetic series in extant members of *Varanus*. We attempt to close this gap. Consequently, we provide the descriptive cranial morphology of an ontogenetic series of 43 skulls of *V. bengalensis*. Specimens used in this study are curated at the Florida Museum of Natural History and the Laboratory of Vertebrate Paleontology at East Tennessee State University collections. Specimens range in age from hatchlings up to 10+ years of age. Skeletal elements selected for detailed analysis include: parietal, pterygoid, frontals, premaxilla, maxilla, quadrate, and dentary. Linear measurements, landmarks, and thin-plate splines were used to demonstrate the ontogenetic change among the specimens.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A NEW SPECIES OF THE ARMIGATOIDEI (CLUPEOMORPHA) WITH IMPLICATIONS FOR THE PHYLOGENETIC RELATIONSHIPS WITHIN ELLIMMICHTHYIFORMES

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The Ellimmichthyiformes are a diverse group of fishes of extinct clupeomorphs. Members of this order had a wide geographic distribution and a great range of ecological adaptations with a fossil record known from freshwater, marine, and estuarine sediments in Europe, North and South America, Asia, and Africa. In spite of the long history of taxonomic studies on the Clupeomorpha including ellimmichthyiforms, phylogenetic relationships within the group remain unresolved. Description of a new taxon here provides a better insight into the evolutionary history of the Ellimmichthyiformes.

A new species of a small ellimmichthyiform is described from the Cenomanian-Turonian (Upper Cretaceous) Akrabou Formation, Morocco. Based on the morphological examination of eight specimens, the new species can be tentatively placed in the genus *Armigatus* that was previously known from Late Cretaceous localities in Lebanon. Similar to the previously described species of *Armigatus*, the new taxon shows some characteristics of the basal ellimmichthyiforms, including unfused neural spines on the proximal vertebrae, a gap between the dorsal series of scutes and the back of the skull, as well as some general body proportions. The new species is distinguished from all known members of *Armigatus* by having a shorter anal and dorsal fin and lacking teeth on the parasphenoid and ectopterygoid bones. The latter characteristic, along with the small size of the new species, suggest a feeding behavior different from that of *A. brevissimus* and *A. alticorpus,* with the members of the new species most likely being filter feeders. When included in a phylogeny of the Ellimmichthyiformes, the new species helps to resolve interralationships of the basal members of the order within the family Armigatidae, and indicates the order of acquisition of key characters. The new taxon also provides valuable new information about the biogeography and paleoecology of the ellimmichthyiforms as a whole, and more specifically the Armigatidae, a family found in both fresh and marine waters from the Cretaceous through Eocene.

Technical Sesssion XII (Friday, November 7, 2014, 2:45 PM)

ASSESSING THE COMPLETENESS OF THE FOSSIL RECORD: COMPARISON OF DIFFERENT METHODS APPLIED TO THE PARAREPTILES

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Any paleontological study, being based on the imperfect fossil record, will be distorted by its gaps and biases. To avoid these issues, various means of estimating completeness have been proposed, but historically, many of these methods were prone to subjectivity, used in isolation, or focused only on taxic diversity questions. To best understand the information carried by the fossil record, it is important to apply multiple methods to assess completeness, as different measures respond to different factors. Here we address the fossil record of Parareptilia, a major Permo-Triassic amniote clade, applying two recently proposed measures of specimen completeness: the skeletal completeness metric (SCM) and the character completeness metric (CCM). SCM quantifies how complete the known skeletal material is for a taxon, whereas CCM measures the amount of phylogenetic information available for a taxon. Two methods of implementing the CCM are used: one based on the ratio between the number of codable characters for a given taxon and the overall number of characters in one or multiple phylogenetic datasets; the other assigns a percentage of the global phylogenetic information to each bone of the skeleton, the sum giving the total completeness. In this study we compare the three completeness results using correlation tests. The two CCM methods show a strong correlation with each other, implying that the measured signal is the same for both. However, only the second implementation of the CCM correlates significantly with the SCM. We suggest that this is due to character selection in phylogenetic datasets. For example the majority of parareptile datasets focus on cranial characters even though the skull represents only a small portion of the skeleton. There is no correlation between taxic diversity of parareptiles and their completeness, implying that the observed fluctuations in parareptile diversity are not driven by variations in completeness of the fossils. The mean completeness of parareptiles through time is consistently high (34-62%) compared to previously studied tetrapod clades, suggesting that most parareptile taxa are based on reasonably complete specimens. Clade-specific differences reveal no link between body size and completeness, with large-bodied, heavy pareiasaurs being virtually as complete (28-57%) as small, lizard-like procolophonoids (38-60%). However, they confirm the impact of ecology on the completeness of the fossil record: for example, aquatic mesosaurs are better preserved (CCM and SCM >80%) than terrestrial taxa.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

ARMORING THE TITANS: STUDYING THE VARIABILITY ON THE MORPHOLOGY OF LAURASIAN TITANOSAUR OSTEODERMS.

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Titanosaurs were the only sauropods known to bear a dermal armor, with two different types of ossifications: small, irregular dermal ossicles and larger osteoderms, with up to three recognized morphotypes. Although the findings have increased in the last decades, many questions remain open about their intra-individual, intra-specific and phylogenetic distribution.

The titanosaur osteoderms found in the Northern Hemisphere are usually associated with basal lithostrotians, and represent variations of the bulb and root morphotype: amygdaloid outline, one or more internal keels, convex external surface with two regions in external and lateral views, a round end that might be concave, flat, or convex with a regular, radial ornamentation pattern (the bulb) and the more elongated and irregularly ornamented end (the root).

There is no direct information on the arrangement of the dermal armors consisting of bulb and root osteoderms, but the information provided by the collection from the 'Lo Hueco' site (Upper Cretaceous, Cuenca, Spain) allows us to better understand their variability. Most of the sauropod osteoderms known from Laurasia have an asymmetric plan, with a straight and a curved side, suggesting that each had a specular counterpart, that is, at least a right and a left osteoderm per transverse row. We interpret the bulb as

posterior, the straightest side as medial and the curved as lateral, according to i) the bulb orientation towards the curved side and 'outwards' and ii) animals that bear spikes tend, with few exceptions (i.e. *Edmontonia*), to project them posterolaterally. A few osteoderms are, however, almost symmetric.

An elliptic Fourier analysis performed on the outline of these osteoderms, in visceral view, shows that their morphological variability is a cline. That cline ranges from osteoderms with flat bulbs that can be rounded or slightly elongated, elongated osteoderms with convex bulbs whose convexity decreases as they become more elongated and very elongated osteoderms with concave bulbs. The finding of a partially articulated titanosaur specimen with two osteoderms associated, one rounded and one elongated, implies that the morphological cline of bulb and root osteoderms might correspond to intra-individual variability.

We propose a conjectural distribution of the bulb and root osteoderms that constitute the described morphological cline to build the dermal armor of the European Upper Cretaceous titanosaurs, arranged in parasagittal series, as in the archosaurian primitive condition.

Romer Prize Session (Thursday, November 6, 2014, 8:15 AM)

INSIGHTS INTO THE MICROBIOME ASSOCIATED WITH BONE DECAY DURING EARLY DIAGENESIS FROM RRNA GENE SEQUENCING OF BIOFILMS FROM ACTUALISTIC EXPERIMENTS

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Despite considerable evidence for microbial activity during early diagenesis of fossilized bone, little is known about the microbial consortia (microbiome) associated with bone decay. A better understanding of the microbiome may reveal new insights into the identities, function, and microbe-bone interactions of microbial communities with bone during early fossilization. To better understand the bone decay microbiome, I simulated aspects of natural bone decay in marine, lacustrine, and terrestrial environments by adding defleshed bones to mesocosms containing natural sediment and water. I sequenced part of the 16S rRNA bacterial taxonomic identifier gene of the biofilms growing on and within the bone at two month intervals over one year to study the microbiome and identify the composition, diversity, and function of bacterial communities growing on decaying bone.

Sequencing results indicate that the bacterial communities on bone surfaces differ among the experimental treatments, although the dominant bacterial group in most experiments was the phylum Proteobacteria (Alphaproteobacteria, Deltaproteobacteria, Gammaproteobacteria, and Epsilonproteobacteria). Bacterial communities within the decaying bones differ from bone surface communities, and are primarily composed of organisms that carry out fermentation. Dominant bacterial groups were found to change throughout the experiment and this successional trend generally reflects a turnover of more abundant sulfide-oxidizing bacteria earlier in the experiment to predominantly sulfate-reducing bacteria later in the experiment.

Sulfide minerals were observed on all experimental bones (except the controls) in the form of framboids on bone surfaces and putative nanocrystallites lining bone trabeculae. Bioerosion textures were predominantly observed on treatments exposed to light, suggesting phototrophic bacteria as causal agents of some fossilized bioerosion features. Fungi or eukaryotes, which were not identified in the experiment, are more likely responsible for bioerosion textures in fossils deposited in aphotic environments.

My results provide a new glimpse into signatures of microbial activity in fossil bone, and provide a starting point for using evidence of microbial processes in more detailed taphonomic and environmental analyses.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

PALEOENVIRONMENTAL DISTRIBUTION OF THE LATEST CRETACEOUS DINOSAURS IN SOUTHWESTERN EUROPE

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Paleoenvironmental preferences for Cretaceous dinosaurs at a regional scale have been mainly assessed in the North American region. In southwestern Europe, the dinosaur-bearing formations ranging the late Campanian to the latest Maastrichtian encompass coastal, transitional and continental environments that produced hundreds of fossil localities with evidence of titanosaurid sauropods, nodosaurid ankylosaurs, dromaeosaurid and abelisaurid theropods, and rhabdodontid and hadrosaurid ornithopods. In order to study environmental associations of dinosaur taxa we have constructed a database with 660 occurrences distributed in 485 fossil localities with information on the stratigraphic age, the type of evidence (skeletal, eggs, tracks), the taxonomy, and the paleoenvironment, among others. The depositional environments that yielded dinosaur fossils have been allocated to one of two broad categories (coastal and inland) that were subsequently divided in various sub-environments (coastal, paralic and continental). We performed multiple chi-squared analyses with counts of the number of localities where a given taxon or type of evidence occur in each environment type. As a whole, the most abundant dinosaur type-remains are eggs and eggshells (50% of occurrences), followed by skeletal remains (43%) and tracks (7%). Sauropods are the taxonomic group more frequently represented in the region (57%), followed by hadrosauroids (19%), theropods (13%), rhabdodontids (6%), and ankylosaurs (5%). The fossil richness (occurrences/site ratio) is nearly constant through the coastal and inland environments. All chi-squared analyses considering taxonomic occurrence denote a positive and statistically significant association ($p<0.05$) between all the dinosaur taxa and inland (continental) environments. Similarly, the analyses considering the type of evidence also yield the same result, although sauropod tracks are notably found in paralic sub-environments. Our results concur with recent works indicating that titanosaur sauropods and hadrosaurs preferred inland environments but clearly disagree with others suggesting that the latter as well as nodosaurid ankylosaurs were positively associated with marine or coastal settings. The preference for inland environments in all of the herbivorous dinosaurs of southwestern Europe points to probable niche partitioning that would imply resource partitioning, as suggested for herbivores in other dinosaur-bearing formations.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

MARINE FOSSILIFEROUS STRATA FROM BEAUJOLAIS (FRANCE) POINT TO AN EXTENSIVE TOARCIAN (LOWER JURASSIC) KONSERVAT-LAGERSTÄTTE

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Konservat-Lagerstätten, strata preserving exceptionally preserved fossils, are useful for paleontologists as they provide rare snapshots of the diversity and biology of extinct organisms. However, most of the Konservat-Lagerstätten are restricted to peculiar settings with favorable depositional conditions for soft tissue preservation and are thus generally localized to the regional scale. One of the most famous of these sites is the Lower Jurassic Lagerstätte of the Holzmaden area, SW Germany, which has yielded several marine vertebrate specimens preserving skin impressions and stomach contents. The geographical extent of the fossiliferous strata of these sites are thought to be limited by the size of the restricted basin in which they were deposited, thus limiting their relevance for reconstructing marine vertebrate biology and diversity at a large paleogeographic scale. In this study we report on recent excavations by our team in Lower Toarcian strata located in the Beaujolais region, SE France. The site has not only yielded an abundant record of marine invertebrates (mostly ammonites and belemnites) but also a vertebrate fauna comprising ichthyosaurs, plesiosaurs, marine crocodilians, fishes (Chondrichthyes, Actinopterygii), and, most significantly, an ichthyosaur specimen preserving probable soft tissues and stomach contents. Combined with previous European records, such as the fossils of Strawberry Bank, Somerset, UK, these findings indicate that the studied strata from Beaujolais represent the southern limb of an extensive Konservat-Lagerstätte of early Toarcian age, which likely covers much of Western Europe and possibly extends well beyond. Geochemical and sedimentological data show that the formation of this Lagerstätte was intimately linked to the dramatic environmental perturbations of the Toarcian Oceanic Anoxic Event, which led to the widespread development of anoxic to euxinic conditions that favored exceptional fossil preservation.

Technical Session VII (Thursday, November 6, 2014, 11:15 AM)

PALEO-COLOR: TOWARDS A COMPLEMENTARY TOOL KIT

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Since the discovery of melanosomes in fossil feathers in 2008, several studies have investigated the taphonomy of soft tissues in vertebrates which can largely be ascribed to melanin residues in integuments and certain organs, such as the liver and the eye retina. Its preservation allow for reconstructing aspects of original melanin-based coloration, which is of great macroevolutionary significance. The most extensive studies have utilised the identification of melanosomes under scanning electron microscopes (SEM) and presented quantitative and statistical means to confidently assess colours, such as black, brown, grey, and even iridescence.

From more direct approaches, such as mass spectrometry, it is now clear that molecularly intact melanin survives in fossils dating back to the Jurassic, but more often it is a diagenetic product that makes up the 3D melanosomes observed. In the process of alteration, the melanosomes shrink, which has raised some concern about the use of melanosome morphologies for reconstructing ancient colour patterns in birds and non-avian dinosaurs.

In this talk, I will review the different approaches for characterizing melanin in fossil vertebrates in order to present a robust and critical set of methods for color reconstruction. Currently, the two strongest and complementary methods are the identification of melanosomes by morphology under the SEM, which allow for confident assessment of broad categories of melanin-based colour as well as iridescence irrespective of diagenetic alterations. The other method is the minimally destructive time-of-flight secondary ion mass spectrometry producing spectra that allow for easy and fast characterization of the diagenetic alteration of the melanin.

The use of metal mapping such as copper and zinc is not particularly helpful, as it is not specific to melanin or any other particular organic substance and is sensitive to diagenetic and meteoric alterations as well as the thickness of the material exposed, which has yielded wildly speculative reconstructions as of lately. Other aspects that need consideration, are the contribution of other pigments and photonic nano structures that produce color. In these melanin sometime serves as an underlying basal absorptive layer, but does not contribute directly to the observed colours, but in other cases completely masks them and then can be largely ignored.The emerging field of paleo-color is contributing a palette for reconstructing ancient animals and allow for characterising important aspects of macro-evolutionary patterns.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

EVOLUTION OF SMALL MAMMALS DURING THE PALEOCENE–EOCENE THERMAL MAXIMUM: A CASE STUDY USING AUTOMATED GEOMETRIC MORPHOMETRIC METHODS TO QUANTIFY TOOTH SHAPE AND SIZE

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The Paleocene–Eocene Thermal Maximum (PETM) is marked by a rapid negative carbon isotope excursion with an associated shift towards warmer global temperatures by ~5–10 °C. At least 40% of the measured mammalian genera in the Bighorn Basin (BHB) are smaller in size during the PETM compared to adjacent, cooler intervals, suggesting a relationship between climate change and body size. Specimens of over 77 mammalian species in the high-resolution Cabin Fork BHB PETM section provide an opportunity to test whether taxa exhibit 'individualistic' or 'coordinated' responses to major climate perturbations. However, size changes correlated with climate proxies have been documented in only one lineage (*Sifrhippus*) in that section. Changes in shape were not addressed.

Here, we establish methods for quantifying both shape and size change at high stratigraphic and morphologic resolution using molar teeth of two small bodied (~24 g) taxa with problematically similar molar morphology to explore method performance. We sampled first and second lower molars of *Macrocranion junnei* and cf. *Colpocherus* sp. from two levels representing the lower (Castle Gardens: CG) and the upper (Middle Ridge: MR) intervals of the PETM.

Teeth with complete occlusal surfaces were digitized using a µCT scanner (CG, n = 45; MR, n = 14). We used the R package auto3dgm to automatically generate 128 evenly spaced 3D correspondence points per tooth. Principal components analysis (PCA) and pairwise comparisons of PC eigenvalues indicate a single statistically significant eigenvalue (PC 1). Shape variation along PC 1 corresponds to previously published differences between *M. junnei* and cf. *Colpocherus* sp. Specimens corresponding to each taxon occupy non-overlapping, significantly different morphospace. We post hoc re-identified each specimen as either *M. junnei* or cf. *Colpocherus* sp. based on cluster identity and analyzed each taxon separately (cf. *Colpocherus* sp.: CG = 18, MR = 6; *M. junnei*: CG = 27, MR = 8). Welch's t-tests for differences in centroid size results in no significant difference between sites. The two localities completely overlap in morphospace for each taxon and are not distinct from each other.

Our methods successfully differentiate problematic taxa, and have the potential to quantify changes that would be otherwise difficult to evaluate. Patterns of body size for both taxa are not coordinated with those previously documented. Our methods can be applied to a range of elements, stratigraphic levels, and taxa to more fully document morphological patterns through the PETM.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

FEATURES OF FORELIMB MYOLOGY MAY PROVIDE MORPHOLOGICAL SUPPORT FOR AFROTHERIA.

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Molecular support for Afrotheria is strong, but morphological support for the clade has been lacking. New dissections of afrotheres and reanalysis of previously published myological descriptions for other mammals indicates that features of the musculature may be useful additions to morphological datasets. The dissected mammals were the afrotheres *Orycteropus afer, Potamogale velox, Microgale dobsoni, Calcochloris leucorhinus, Rhynchocyon cirnei, Elephantulus brachyrhynchus, Petrodromus tetradactylus, Procavia capensis, Heterohyrax brucei,* and artiodactyls *Pecari tajacu,* and *Tragulus napu* for comparison.

A total of 60 characters were identified and scored for 46 orders or families of mammals, and the program Mesquite 2.75 used for a parsimony analysis. The 50% majority rules consensus tree of 178 trees indicates that forelimb myology places *Orycteropus* as basal within eutherian mammals along with Tenrecidae and Macroscelididae rather than with the paenungulates and ungulates. The forelimb myology characters, particularly features of the flexor muscles of the forearm and the muscles of the manus, indicate that *Orycteropus* is most closely related to Chrysochloridae and Tenrecidae (Afrosoricida) with Macroscelididae as the sister group to this clade, together comprising Afroinsectiphilia. The forelimb myology of the ungulates is quite derived in comparison with *Orycteropus*; Paenungulata do share many similarities with the ungulates, however, but still retain some primitive features in common with *Orycteropus*.

In addition to myological features linking *Orycteropus* with the Afrosoricida, some possible myological synapomorphies for Afrotheria are identified, notably an unusual muscle identified here as m. cubitalis. This indicates there may be morphological support for Afrotheria in the myology.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

USING MSC ADAMS TO DETERMINE THE EFFECTS OF ARTICULAR CARTILAGE CAP SHAPE AND THICKNESS ON THE DYNAMICS OF THE ELBOW JOINT OF A TITANOSAURIAN SAUROPOD

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Soft tissues rarely preserve in the fossil record, leaving many questions unanswered about the biology and anatomy of ancient organisms. For example, how thick was dinosaur articular cartilage and what are the biological and biomechanical implications of its thickness? Debate ensues whether dinosaur cartilage was thin as in large extant mammals or thick, affecting estimates of range of motion and locomotor habits. As a case study, we are modeling the dynamics of the elbow of MPM-PV-1156, a very large titanosaurian sauropod specimen (under study) from the Campanian-Maastrichtian of Argentina. We used a dynamic simulation program, MSC Adams, in an iterative process to add complexity, each time making our elbow model more realistic. Soft tissue reconstructions were based on extant phylogenetically bracketing taxa and fossil data. Modeling dynamics in ADAMS is beneficial because joint motion does not have to be restricted by joint type. Instead, the shape of the contact surfaces, i.e. the articular cartilage, and the direction of forces applied determine the motion of the joint. This allows the shape and thickness of articular cartilage caps to be altered and the resulting effects on the dynamics to be resolved. By not limiting motion based on joint type (e.g., simple hinge joint), constraining forces from ligaments are required to hold the joint together. Both modeling methods are simplifications and require assumptions, especially when modeling extinct organisms. Our method uses assumptions refined from previous attempts to model dinosaur biomechanics by other researchers. This has allowed us to gain insights into joint mechanics since this method does not rely on oversimplified assumptions on joint constraints. For instance, in our model the forces of ligaments, whose attachment sites are based on extant crocodilians, pull the radius medially in relation to the humerus. This supports previous hypotheses suggesting a more anteromedial position for the radius and that the medial distal condyle of the humerus should articulate with both the radius and ulna. This project is ongoing and will help resolve the relationship between the morphology of articular cartilage caps and joint dynamics.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

ENDOCRANIAL ASPECTS OF *NOTHOSAURUS MARCHICUS* (DIAPSIDA, SAUROPTERYGIA) FROM THE LOWER MUSCHELKALK OF WINTERSWIJK (THE NETHERLANDS) REVEALED THROUGH PROPAGATION PHASE CONTRAST X-RAY SYNCHROTRON MICROTOMOGRAPHY

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Sauropterygian skeletal elements from the Lower Muschelkalk outcrops at the Winterswijkse Steengroeve, a quarry complex in the east of the Netherlands, have generally retained their original, three-dimensional morphology. Among these Anisian sauropterygian remains are several well-preserved skulls that allow for a study of the relatively undistorted endocranial morphology. Conventional, absorption-based computed microtomography (µCT) was found to leave important endocranial features unresolved due to the low contrast between the fossil bone and the micritic limestone matrix. A selected *Nothosaurus marchicus* skull from the Winterswijk locality was therefore subjected to Propagation Phase Contrast X-ray synchrotron microtomography (PPC-SR µCT) on the ID19 beamline of the ESRF (Grenoble, France). The use of 13 meters of propagation at high energy revealed the endocranial vault and additional endocranial cavities that accommodated important elements of the neurosensory and circulatory systems, which cannot be otherwise visualized. A virtual cranial endocast was constructed and subsequently described and compared with cranial endocasts of taxonomically and ecologically related taxa to aid the interpretation of specific morphological features and to identify similarities and differences in endocranial morphology. In the significantly dorsoventrally flattened *Nothosaurus marchicus* skull, the endocranial vault is a straight cavity that does not exhibit the sigmoidality typically observed in other taxa. The otic capsule is marked by a pronounced constriction posterior to the cerebral domain that is accentuated by the architecture of cranial elements supporting the massive jaw musculature. The portion of the endocranium that accommodated the olfactory tract takes the shape of an elongated, anteriorly trending process that terminates in a relatively restricted olfactory bulge, suggesting limited in vivo olfactory performance. As such, the endocranium of *Nothosaurus marchicus* provides information on its sensory dependence and will add to the knowledge on morphological features described from traditional morphological studies.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

ON A POTENTIAL FOSSIL HOTSPOT FOR PENNSYLVANIAN–PERMIAN NON-AQUATIC VERTEBRATES IN EUROPE

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The Saar-Nahe Basin of southwest Germany is one of the largest basinal structures of the European Variscides. Its up to 6,500 m thick succession of volcano-sedimentary rocks has long been known for abundant and diverse continental biota of Pennsylvanian–Permian age. A significant lack of knowledge, however, concerns body fossil remains of semi-terrestrial to terrestrial vertebrates. Some progress in bridging the gap was recently made by the description of terrestrially adapted lepospondyls, as well as two isolated mandibles of an eryopoid temnospondyl and a sphenacodontid synapsid (*Cryptovenator hirschbergeri*), respectively. Both of the latter two specimens come from fluvio-lacustrine deposits of the Gzhelian-Asselian Remigiusberg Formation at the base of the local Rotliegend. The discovery site is an active hard rock quarry (Remigiusberg quarry) near the small town of Kusel in the central part of the Saar-Nahe Basin. In autumn 2013, two more fossil tetrapod specimens were discovered in correlative strata of the same locality. In contrast to the aforementioned jaw fragments, the new specimens are partially articulated skeletons. A ≥ 10 cm wide skull with remains of the anterior postcranium is currently in preparation. The second specimen points (before final recovery and lab preparation work) to an edaphosaurid preserving at least significant parts of the back sail. Edaphosaurids are only known from three other specimens from the European part of Pangea—isolated dorsal vertebrae from two localities in the Czech Republic and a fragmentary, postcranial skeleton from the Doehlen Basin of southeast Germany. Due to the excellent outcrop conditions and the relative abundance of non-aquatic vertebrates, the Remigiusberg Formation at the Remigiusberg quarry near Kusel offers the potential to become another important locality for late Paleozoic terrestrial tetrapods in Europe.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

FIRST APPROACH TO A RECONSTRUCTION OF THE ADDUCTOR CHAMBER OF *RIOJASUCHUS TENUISCEPS* (ARCHOSAURIA: PSEUDOSUCHIA) FROM THE LOS COLORADOS FORMATION, LATE TRIASSIC OF ARGENTINA

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Riojasuchus tenuisceps is a terrestrial quadrupedal ornithosuchid archosaur from the Late Triassic of Argentina. A muscular reconstruction of the adductor chamber of *Riojasuchus* was made based on the information known for other extant species of reptiles: *Caiman latirostris*, *Alligator mississippiensis*, *Iguana iguana*, and *Sphenodon punctatus*. The M. adductor mandibulae externus (MAME) originates in the supratemporal fenestra attaching to the postorbital, squamosal, and parietal, and inserts on the dorsal surface of the surangular. Unlike *Caiman* and *Alligator,* the quadrate of *Riojasuchus* seems to be excluded from the MAME attachment area because of its anterodorsal orientation and the squamosal and quadratojugal overlapping its anterior surface. The M. adductor mandibulae posterior (MAMP) is dorsoventrally oriented, originating on the ventral region of the quadrate and inserting on the dorsal area of the angular and articular, filling the posterior half of the internal mandibular fenestra as in recent crocodiles. The M. pseudotemporalis (MPst) attaches to the laterosphenoid, but in *Riojasuchus*, as well as in *Sphenodon* and *Iguana*, the laterosphenoid has no bridge as that recognized on crocodiles. The MPst of *Riojasuchus* is dorsoventrally oriented unlike that of *Caiman*, *Alligator*, and *Iguana* which is posterodorsally oriented. The MPst would insert on the cartilago transiliens, connecting with the M. intramandibularis (MI) that inserts in the dorsal surface of the angular and medial surface of the dentary and splenial. The M. depresor mandibulae (MDM) is more dorsally oriented in *Riojasuchus* (65°) than in *Caiman* (45°), with an insertion on the squamosal more alike to that of theropod dinosaurs (*Tyrannosaurus*, *Allosaurus*). This is because of posteroventrally oriented process of the squamosal which takes MDM the attachment area backwards and closer to the articular. The M. pterygoideus dorsalis (MPtd) covers the dorsal region of the palate but the attachement area is not clearly defined in *Riojasuchus*; it inserts on the medial region of the angular and articular. Conversely, the M. pterygoideus ventralis (MPtv) attaches on the posterodorsal region of the pterygoid and inserts on the posterolateral side of the angular and articular covering the posterior region of the mandible as seen in recent reptiles. This reconstruction of the adductor chamber of *Riojasuchus* is the first step that will allow us in a near future to make biomechanical analysis on the skull of this reptile.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

DIFFERENT PATTERNS OF MASTICATION (POM) IN NEOGENE PROBOSCIDEANS

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Neogene proboscideans from Eurasia and the Americas represent four different patterns of mastication. Jaw movement and function can be reconstructed from wear facets of the complex molar morphology and by occluding virtual models with the 'occlusal fingerprint analyser' (OFA). The movement is not only controlled by muscle activity but by the morphology of the antagonistic teeth as well. Jaw movement is symbolized by the mastication compass, differentiating direction and inclination during each phase of the power stroke.

The deinotherian pattern of mastication (POM) (e.g., in *Prodeinotherium, Deinotherium*) is characterized by two functions during phase I of the power stroke. The shear-cutting at the crest of the facet on the trailing side of the lophs is followed by compressing between the lophs. No facets indicate a phase II. The lophodont teeth in the mammutian POM (e.g., in *Mammut*, *Zygolophodon*) show mainly an orthal compressing, with a slight lateral movement in phase II. In the gomphotherian POM (e.g., in *Gomphotherium angustidens*), the bolus is compressed orthally controlled by the antagonist tooth during phase I. In phase II, first lower molars move in mesio-lateral direction grinding across the pretrite side. In the elephantian POM (e.g., in *Stegodon, Elphas, Mammuthus*, *Loxodonta*), jaw movement is in a mesial direction without inclination and the only function is grinding.

During ontogeny, wear modifies the function of the first three patterns of mastication intensively. With a lower profile the teeth change to grinding. Only hypsodont molars in the elephantian POM start and continue with grinding.

From the African Paleogene probocideans, the genera *Phosphatherium, Daouitherium, Barytherium*, and *Numidotherium* are very close to the deinotherian POM, whereas *Phiomia* and *Palaeomastsodon* and especially *Moeritherium* are distinctly different in the function of their molars.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

MULTIPLE ANOMALIES OF VERTEBRAE IN FOSSIL SEA COWS (MAMMALIA, SIRENIA): CHARACTERISTICS AND POTENTIAL CAUSES

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One of the main skeletal characteristics of sea cows, or sirenians, is pachyosteosclerosis. The vertebral arches and the spinous and transverse processes of the vertebrae, especially, show a thickened and dense bone histology. These vertebral processes serve as attachment areas for ligaments and muscles of the back and contribute to static and dynamic stability during the extension and flexion of the vertebral column when they are normally developed. On the contrary, deviations from normal vertebral formation, or anomalies, have potential clinical relevance.

In this study, a number of fossil sirenian vertebrae from the early Oligocene of Central Europe are shown to be affected by a combination of different anomalies. For the identification of these and to distinguish such from potential diseases, morphological data were employed that were, amongst others, received from X-ray computed tomography (CT) and neutron tomography (NT).

All vertebrae considered here belong to the caudal column. Besides left-right asymmetries of the centrum, a number of caudals additionally show underdeveloped transverse processes on one side of the centrum. This growth retardation likewise causes a left-right asymmetry that is interpreted here as hypoplasia. Three vertebrae are exceptional in being characterised by the simultaneous presence of three different kinds of anomalies: left-right asymmetric centra, hypoplastic transverse processes to both sides of the centra, and aplasia that is characterised by the lack of the neural arches. Therefore, the vertebrae reflect a hexagonal outline with rounded edges that indicate the position of the lost or underdeveloped elements. These vertebrae provide the hitherto oldest known record of anomalies and a combination of these in any sirenian.

Hypoplasia, the underdevelopment of an organ or parts of it, and aplasia, the total absence of an organ, are classified as congenital defects or malformations that lead to direct effects and are caused by either a genetic defect or ontogenetic alteration. Vertebral malformations have environmental as well as genetic components to their origin. As environmental influences are more probably expected to induce single or localized axial defects as are hypoplasia and aplasia, the scenario of toxin-producing harmful red tide blooms is hypothetically discussed as a potential cause because these algal blooms naturally occur in the sirenian habitat. Potential consequences as to a functional deficiency of the vertebral column in the animal's lifetime is also a consideration.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

AZHDARCHIDS FROM THE TRANSYLVANIAN BASIN (SEBES FORMATION, ROMANIA): IMPLICATIONS FOR THE PALEOBIOLOGY OF EUROPEAN LATE CRETACEOUS PTEROSAURS

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Well-preserved pterosaur remains are rare in the European Late Cretaceous but recent and ongoing discoveries in the Sebes Formation of the Transylvanian Basin are helping to change this picture. Over the last years, we have collected fossils that document the presence of at least four distinct size-classes of azhdarchid pterosaurs (ranging from ca. 1 to >10 m in presumed wingspan) from a series of localities in the Sebes Formation, around the town of Sebes in western Romania.

Augmenting anatomical and phylogenetic information provided by the ca. 3 m wingspan *Eurazhdarcho*, we report a new semi-articulated partial skeleton of ca. 5 m wingspan short-necked azhdarchid from the Glod-D site at Sebes, the most complete Maastrichtian pterosaur yet collected from the European Late Cretaceous. Preserved, phylogenetically informative elements of this new specimen include a mandibular symphysis, the atlas-axis complex, three mid-posterior cervicals, a near complete humerus and wing phalanges. The partial skeleton also preserves some as yet unidentified skeletal elements. Comparative analysis of overlapping elements indicates that this Glod-D azhdarchid is distinct morphologically from the giant >10 m wingspan *Hatzegopteryx* (mandibular symphyses; cervical vertebrae; humeri) and the similarly-sized *Eurazhdarcho* (cervical vertebrae, wing phalanges) although it was collected in close proximity to identifiable remains of both contemporary taxa. The cause of death is unknown, but the pterosaur carcasses/body parts were washed into shallow crevasse splays, sometimes scavenged and buried in a short time. This new Glod-D specimen thus lends further support to the hypothesis that azhdarchids in the Transylvanian Late Cretaceous occupied non-overlapping ecological niches. The peculiar taphonomic context, and the fact that well-preserved autochthonous pterosaur remains are recorded in several layers, suggests that the Sebes-Glod site area was constantly inhabited by diverse non-competitive azhdarchid taxa.

To date, we have collected more than 50 identifiable azhdarchid pterosaur fossils from spatially restricted outcrops of the Sebes Formation (exposed over 130 km^2 and ca. 450 m in thickness). This has allowed us to create a singular dataset of Maastrichtian azhdarchid diversity in this undersampled region of Europe, a fluviatile series of paleo-island settings, and test hypotheses of pterosaur paleobiology, size-class distribution and survivorship up to the end-Cretaceous mass extinction.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A CASE OF PARALLELISM BETWEEN A MID-CRETACEOUS LAMNIFORM AND MODERN CARCHARHINIFORM SHARKS

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The Cretaceous marine fauna is characterized by a great diversity of lamniform sharks, but most of them were described only on the basis of isolated tooth material. Among them, '*Carcharias*' *amonensis* is a geographically widespread, relatively small-sized shark reported from the Cenomanian of North America, Europe, Africa, Middle East and East Asia. This common species was originally referred to the genus *Odontaspis* then, more recently, tentatively assigned to the genus *Carcharias*. At higher taxonomic levels, '*C.* ' *amonensis* has regularly been assigned to the Odontaspididae owing to its dental features, while its ascription to the Lamniformes is supported by its osteodont tooth histology (as opposed to the carcharhiniform orthodont teeth).

Here we report an incomplete articulated skeleton from the Moroccan fish-bearing Agoult locality that provides new insights into the systematic affinities of '*C.* ' *amonensis*. This specimen is exposed in dorsoventral view and consists of the head, the branchial region and one pectoral fin. The complete tooth set is preserved and shows a gradient monognathic heterodonty. One of the most striking features is the shape of the head, broader than long and sub-trapezoidal. The maximum width of the head is reached at the level of the orbital region. The postorbital process is laterally expanded and shows a relatively anterior position. No supraorbital crest is developed between the preorbital and postorbital processes. These cranial anatomical features are unknown among fossil and modern representatives of the Odontaspididae, and to a greater extent, among Lamniformes. This suggests that this species should be assigned to a new genus belonging to its own family.

Several morphological similarities (e.g., size, dentition, head shape) can be noted between '*C.* ' *amonensis* and the extant carcharhinid *Triaenodon obesus*. By the lateral expansion of the postorbital processes and nasal capsules, '*C.* ' *amonensis* is also reminiscent of the extant sphyrnid *Sphyrna tiburo*, in which a reduced but true cephalofoil is nevertheless developed. Like these modern carcharhiniform sharks, '*C.* ' *amonensis* was a medium-sized (~ 1 m long) predator that lived in shallow warm waters. The abundance of '*C.* ' *amonensis* teeth in some Cenomanian localities suggests that this shark might have had gregarious habits, as in the whitetip reef shark *T. obesus*. This represents a good example of morphological (and probably ecological/behavioral) parallelism between two distantly related shark groups separated from each other by nearly 100 million years.

Symposium 3 (Friday, November 7, 2014, 8:30 AM)

MACROEVOLUTIONARY MODELS AND TIP-DATING: TURNING PUTATIVE ASSUMPTIONS INTO TESTABLE HYPOTHESES

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Tip-dating affects macroevolutionary issues as broad as possible morphological and phylogenetic 'explosions' down to those as fine as which speciation models predominate within a clade by affecting how much time we allot evolutionary change. Consider three basic 'speciation' models that paleontologists might encounter: (1) continuous morphological change (i.e., 'Darwinian' speciation) with continuous cladogenesis; (2) pulsed morphological change in which rates of change are elevated during events paleontologists recognize as speciation (e.g., punctuated equilibrium and related models), but where speciation events are continuous through time; and (3) pulsed turnovers, in which morphological change is pulsed and these pulses are concentrated in particular intervals of time. Model 1 is the simplest (one distribution of morphological rates and one distribution of cladogenetic rates) and it typically will imply the deepest divergence times given for any dataset. Model 2 adds complexity (separate pulse and background rates of change instead of a shared rate for pulses and background time as in Model 1) and increases the probability of change over short intervals of time. Model 3 is the most complex (pulsed vs. background rates for both character change and speciation) and can predict considerable morphological change over short intervals of time even with uniform per-speciation rates of change. Thus, a key issue when contrasting these models is: given apparent frequencies of change within lineages and hypothesized changes between lineages, can we allot as much time as Model 1 requires for divergences?

Tip-dating procedures usually assume Model 1, but it is easy to modify the underlying Mk methods to allow for Models 2 and 3. These can be combined with divergence-time likelihoods given stratigraphic data, using occurrence data to estimate distributions of preservation rates; the divergence-time likelihoods now give us not simply likely divergence times, but the relative likelihoods of the basic speciation models. Case studies with two groups of Ordovician gastropods show that tip-dating with pulsed change (Model 2) yields vastly better likelihood than does continuous morphological change (Model 1). In one of the two gastropod cases, pulsed speciation (Model 3) hypothesis model likelihoods still more. Thus, evolutionary models that might seem to invalidate tip-dating procedures actually are testable hypotheses given a tip-dating framework.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

RECENT FINDS FROM THE LATEST MIOCENE/EARLY PLIOCENE GRAY FOSSIL SITE LAGERSTÄTTEN OF EASTERN TENNESSEE, SOUTHERN APPALACHIANS, USA

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Though discovered over 10 years ago (May 2000), the late Hemphillian (latest Miocene/early Pliocene) Gray Fossil Site (GFS) of eastern Tennessee continues to produce extraordinary new discoveries. In addition to excavation, intensive screening and picking over the last 5 years has increased the taxonomic list to roughly 60 vertebrate taxa, many of which are new forms. *Tapirus polkensis* is the most abundant mammalian taxon (MNI > 100), with an unprecedented sample including many articulated skeletons representing all stages on ontogeny, as well as many 3D skulls and jaws. Though known for the tapirs, the GFS contains an abundance of turtles, particularly semi-aquatic taxa; several of which represent new species. Highlights of the new vertebrate taxa still being described include: $\geq$ 3 soricids (among $\geq$10 taxa total), *Teleoceras* sp. nov., *Plionarctos* sp. nov., and *Alligator* sp. nov. *Teleoceras* sp. nov. is represented by two nearly complete male skeletons and remains from at least three other individuals. *Plionarctos* sp. nov. is represented by more material than any other fossil site containing the genus, including the first ever recovered cranial material. *Alligator* sp. nov. is represented by many individuals including juveniles and adults. Other recent additions to the biota include: ostracodes, gastropods, bivalves, $\geq$ 12 insects (including 5 beetle families), lizards (including *Heloderma* sp.), snakes, lagomorphs, rodents, $\geq$ 4 talpids, > 3 tayassuids, and > 14 birds. Some previously described taxa now include additional specimens. *Pristinailurus bristoli* is now represented by 2 nearly complete skeletons that exhibit extreme sexual dimorphism. The large morph is nearly 3 times the size of the extant red panda, *Ailurus fulgens*. In addition to the beaver *Dipoides* sp., *Castor* sp. has now been recovered from the site. Clearly these two taxa were exhibiting niche partitioning to co-exist, implying that the former was likely acting very different than extant beavers. With the exquisite preservation of plants (> 30 genera), insects, other invertebrates and vertebrates, the Gray Fossil Site not only acted as a unique forest refugium during a time of spreading grasslands, but should also be considered a true lagerstätten.

Technical Session XVII (Saturday, November 8, 2014, 3:45 PM)

NON-MAMMALIAN CYNODONT (SYNAPSIDA, THERAPSIDA) DIVERSITY PATTERNS AND THE QUALITY OF THEIR FOSSIL RECORD

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Cynodontia is a major clade of therapsids that includes both mammals and a diverse array of Permian and Mesozoic non-mammalian species. Here we present a global analysis of non-mammalian cynodont diversity and fossil record quality, comparable to those recently published for anomodonts and other Permo–Triassic vertebrates. Using a database of global cynodont records and a supertree of eight recently published phylogenies, we calculated taxic (TDE) and phylogenetic (PDE) diversity estimates for cynodonts. TDE and PDE indicate that cynodont diversity slowly increased from their origination in the early late Permian, had a minor drop at the Permian–Triassic Boundary, and rapidly increased to an overall peak in the early Triassic, which was followed by a high diversity plateau during most of the Triassic. At the end of the Triassic, cynodont diversity collapsed severely and remained low during the Jurassic and Cretaceous. The major differences between the TDE and PDE are in the Rhaetian (high TDE; low PDE) and Hettangian (high PDE; low TDE). The difference in the Rhaetian is most certainly due to the large number of extremely fragmentary taxa that were never included in a phylogeny. To test whether the difference in the Hettangian is due to polytomies in the consensus supertree, we calculated a mean PDE out of 72 most parsimonious trees as well as a PDE from the tree with the highest stratigraphic consistency, as measured by the Gap Excess Ratio. However, the pattern remained the same, confirming the overall high diversity of cynodonts in the earliest Jurassic. In addition, the eight recent phylogenetic datasets were used to calculate the character completeness metric (CCM2) for each taxon and consecutive time intervals. A total of 261 characters were subdivided into four anatomical categories (skull, axial skeleton, girdles, limbs), with the majority of published characters (88%) referring to the skull. The mean completeness of cynodonts calculated over the entire time interval is 52.83%, with scores ranging from 45.08% to 62.45%. Our analysis suggests that TDE, PDE and CCM2 are independent of one another, as they generally lack significant correlation. Consistently high completeness scores and the lack of correlation with biodiversity patterns indicate the high quality of the Permo–Triassic cynodont record, comparable to that of anomodont therapsids.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

A GEOMETRIC MORPHOMETRIC INVESTIGATION OF WING SHAPE ACROSS AVES REVEALS STRONG PHYLOGENETIC SIGNAL AND A PREVIOUSLY UNRECOGNIZED IMPORTANCE FOR COVERT FEATHERS

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Avian wing shape is known to be related to flight performance, migration, foraging behavior and display. Historically, two approaches have generally been taken to quantifying wing shape: one utilized linear measurements of the feathered airfoil to assess the relationship between wing span, wing length, aspect ratio and flight style or flight behavior. The second has investigated how skeletal measures relate to wing shape, motivated by an interest in inference of flight style in extinct taxa. These traditional morphometric approaches focus on estimating the wing outline but reveal little information about the spatial distribution of wing shape changes. The covert feathers, layered over the anterior wing, also contribute to airfoil shape (especially camber). However, no previous assessments of avian variation in wing shape have taken variation in these feathers into consideration.

Here, we utilize geometric morphometrics to assess broad patterns in avian wing shape variation by using landmarks to define the wing outline and the distribution of both dorsal and ventral greater covert feathers for 105 avian species. Principal component analysis of 90 variables reveals that the first two PCs explained 77.49% of wing shape variation. Greater primary covert length and secondary feather length are most heavily weighted on PC1 which explained most of the variance. PC2 explained much less of the variance and mainly reflected wing tip shape. Results show that the distribution of taxa in phylomorphospace along the PC1 axis is strongly correlated with phylogeny and ecology. Permutation tests, as well as evaluation of Pagel"s lambda and Blomberg"s K reveal significant phylogenetic signal in the dataset. Phylogenetic ANOVA and regression analyses indicate that the observed variation is only very weakly correlated with flight style and an investigated set of aerodynamic parameters. A more robust relationship between wing shape and flight performance may emerge, but only after avian flight styles and fundamental descriptors of flight behaviors are more precisely and quantitatively assessed. So far such data is lacking for many avian species. Covert length is found to vary markedly across avian taxa, and shifts in covert feathering track phylogeny and ecology indicating that covert feather length may be important to consider in the inference of the flight behaviors of extinct taxa.

Technical Session X (Friday, November 7, 2014, 11:30 AM)

THE PLIOCENE TIBETAN PLATEAU AS A TRAINING GROUND FOR COLD ENVIRONMENT ADAPTATION AND ORIGIN OF HOLARCTIC MEGAFAUNA

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The 'Third Pole' of the world is a fitting metaphor for the Tibetan Plateau, in allusion to its vast frozen terrain, rivaling the Arctic and Antarctic, at high altitude but low latitude. Modern Tibetan mammals are represented by species adapted to cold climate (hypothermia), low oxygen (hypoxia), high UV radiation, and in some cases low precipitation. Iconic mammals such as the Tibetan yak (*Bos grunniens*) and the Tibetan

antelope (or chiru, *Pantholops hodgsonii*) have acquired adaptations for hypothermia (long and thick hair and a reduced number of sweat glands) and hypoxia (small size of red blood cells and genes associated with energy metabolism and oxygen transmission). Knowledge about how Tibetan faunas have evolved is still poorly understood but patterns are emerging from field explorations in several basins in the Tibetan Plateau during the past 15 years. Few lineages are entirely confined to the plateau, with the exception of *Pantholops* and *Pseudois* (bharal or blue sheep), two endemic genera in Tibet whose beginning can be traced to the late Miocene or Pliocene of the Qaidam and Zanda basins. Many Tibetan lineages, however, show close relationships to those in northern Eurasia and North America, including extinct megafaunal elements such as *Coelodonta* (woolly rhino), *Panthera* (snow leopard relative), *Chasmaporthetes* (running hyena), and *Sinicuon* (hunting dog). These are consistent with our "out of Tibet" hypothesis previously based on the woolly rhino only. More recently, we discovered an extinct fox from the Pliocene Zanda and Kunlun Pass basins that is closely related to the extant arctic fox (*Vulpes lagopus*), linking the "Third Pole" to arctic faunas. With the exception of the *Pantholops* lineage going back to the late Miocene, most other native Tibetan lineages appeared in the Pliocene, at a time when the arctic climate was up to 8°C warmer than present. The Pliocene Tibetan Plateau has thus served as a major training ground for cold adaptations. As the subsequent Ice Age became prevalent, some of the Tibetan mammals left their center of origin and gave rise to members of the Pleistocene megafauna.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

THE FIRST HOLOMORPHIC FOSSIL CHIMAEROID FISH (CHONDRICHTHYES, HOLOCEPHALI) FROM AFRICA

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Articulated specimens of chimaeroids are extremely rare in rocks of Cretaceous age, being known from a handful of partial skeletons from the British and Lebanese chalk. A near complete and articulated specimen of *Elasmodectes willetii* from Morocco represents the best preserved chimaeroid skeleton from the Cretaceous and the first holomorphic specimen from the Mesozoic of Gondwana. *Elasmodectes willetii* was previously only known from the Cenomanian grey chalk of southern England, thus this record represents an appreciable extension of its range.

The specimen, NHM UK P.73270, was purchased by the Natural History Museum, London (NHM UK) from a Moroccan dealer at the Arizona Mineral and Fossil Show at Tucson, USA. It comprises a slab of heavily fractured grey mudstone, mounted on an epoxy base and covered with a thick layer of transparent consolidant. The provenance was uncertain, but a consensus was that the specimen was from one of the old Jebel Tselfat localities, most likely Aïn el Kerma, to the west of Fez, Morocco. The fish fauna from this region was monographed sixty years ago by Camille Arambourg but the precise locations of the excavations were not published The localities are small hillside outcrops of black Cretaceous shale which have been tentatively dated as being latest Cenomanian in age, corresponding with the Cenomanian-Turonian extinction event, Oceanic Anoxic Event 2 (OAE2).

We visited Jebel Tselfat and located the Ain el Kerma excavation in the side of a badland erosion gulley. The site was overgrown, having been last exposed fifteen years ago. Nevertheless, the sediment, a weathered and shattered black organic-rich shale, closely matched the specimen and incidentally yielded a couple of impressions of bony fish skulls. Samples were taken for sedimentology and micropaleontology which closely matched the specimen. The surface coating of consolidant was removed by the NHM Conservation Centre and the specimen photographed in visible and UV light and computed tomography (CT) scanned. It preserves details of the whole dentition, circumchordal rings, the dorsal fin and finspine and some muscular soft tissue preservation.

This exercise demonstrates the importance of commercial collecting, without which this unique specimen would not exist. This also shows the importance of investigative fieldwork in order to establish a robust provenance, without which the specimen would be virtually worthless.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

IDENTIFICATION TO THE INDIVIDUAL LEVEL OF STELLER'S SEA COW (*HYDRODAMALIS GIGAS*) BONE THROUGH THE USE OF MICROSATELLITES

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Six microsatellite loci were isolated from Steller's sea cow (*Hydrodamalis gigas*) using published primers for manatee and dugong microsatellites. It was found that the primers DduC05, Tmakb60, TmaSC5, and TmaE11 all successfully amplified microsatellites from *H. gigas*. The primers DduB02 and TmaE1 did not show clear amplification, which may have been due to an incorrect melting temperature. Research is still in progress to optimize polymerase chain reaction for better amplification. The DNA samples that were used were from bone found on Bering Island and St. Lawrence Island. We intend to use these primers on several other samples of *H. gigas* to further test microsatellite amplification. DNA will be sequenced using primers with a fluorescent label. Sequenced alleles can then be sized and scored to indicate a difference in the number of repeats and thus a difference in individuals. This is the first time that *H. gigas* microsatellite loci have been isolated and once completed this project should allow for identification of bones to the individual level. Furthermore, this research potentially allows for an estimate of population size for a newly discovered St. Lawrence Island sea cow population.

Symposium 3 (Friday, November 7, 2014, 9:45 AM)

TESTING THE MOLECULAR CLOCK USING SIMULATED TREES, FOSSILS, AND SEQUENCES

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The molecular clock provides the most powerful means of establishing an evolutionary timescale. Approaches to calibrating the molecular substitution rate vary in their assumptions and complexity, differ in their use of geological evidence, and invariably yield different divergence estimates. Surprisingly, competing approaches to calibration have never been tested because, in reality, the true evolutionary timescale is never known. Consequently, it has not been possible to assess the accuracy and precision with which divergence times can ever be known. The solution is to use simulated data, where the relationship between times of divergence, molecular rate variation, and fossil evidence is known. In this study, we develop simulations that combine realistic models of speciation, molecular evolution, and fossil preservation. We use a non-random stratigraphic model of preservation, based on the well-defined depositional cycles that have been documented for the past 250 Ma. We first test the accuracy and precision of four quantitative and probabilistic methods of deriving temporal constraints from the fossil record. We implement these as bespoke calibration priors in Bayesian molecular clock analyses and assess the accuracy and precision of posterior divergence estimates—these are compared to the use of arbitrary priors. Finally, we present a case study using primates. The results demonstrate that paleontological constraints can be accurate but will typically be imprecise. Accurate molecular divergence estimates require both accurate and precise fossil-based constraints. However, the accuracy of posterior estimates is not determined by the accuracy of the specified fossil-based calibrations. Instead, the accuracy is determined by the way in which the calibrations are effectively implemented by contemporary Bayesian models of divergence time estimation. The analysis of the primate fossil and molecular data illustrates that this has material consequences for understanding the evolution of this group—reliable hypothesis testing surrounding the K–Pg boundary requires a higher degree of precision than is obtainable from current knowledge of the primate fossil record.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed November 5 – 8, judging occurs Thursday, November 6)

RECONSTRUCTING JUVENILE MORPHOLOGY: A NON DESTRUCTIVE METHOD TO DETECT HISTOLOGICAL STRUCTURES IN COMPUTED TOMOGRAPHY (CT) AND ITS POTENTIAL FOR FUTURE RESEARCH, USING THE EXAMPLE OF SAUROPOD RIBS

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Knowledge about ontogenetic changes during the growth of an individual is indispensable for understanding the life of extinct animals with no recent equivalent. However, in most cases, only little is known about the ontogenetic changes in morphology from a juvenile to an adult, especially when there are no juveniles preserved or it is unclear whether or not the individuals in question belong to the same species. For sauropods, the largest terrestrial animals ever, hatchlings and young juvenile fossils are extremely rare. Historically, their bones were studied with the destructive method of histology to find out more about their life history, growth, reproduction and skeletal maturity. Due to remodeling, there is no growth record preserved in sauropod long bones. Hence, earlier studies used ribs for skeletochronology, even though the morphometric change during ontogeny has precluded the calculation of a single rib-based growth curve for an individual to date. This study presents a new method using computed tomography (CT) that avoids unnecessary damage to the bone and additionally has the potential to reconstruct the bone morphology at different ontogenetic stages of the individual. By scanning a complete sauropod rib, Lines of Arrested Growth (LAGs) become visible. These structures are one of the most important elements of traditional bone histology. Being visibly detectable in the CT, the necessity of histological sectioning could be avoided or the best area to sample could be detected before cutting the bone. Furthermore, this method could be used to reconstruct the real bone surface of the individual in different ontogenetic stages by following a single LAG through the bone. For sauropod research, this opens new possibilities to calculate a correction formula for the morphometric changes during ontogeny, which can be used for a growth curve using only one dorsal rib. This method may not only be useful for future studies concerning the life history of sauropods, but also for the understanding of the ontogenetic history of all kinds of vertebrates that show LAGs in some of their skeletal elements. In some cases it may even have the potential to combine two taxa formerly thought to be different species by ascertaining the change in bone morphology from juvenile to adult forms.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

HIPPARIONINE HORSES (MAMMALIA, PERISSODACTYLA, EQUIDAE) FROM MARAGHEH, NORTHWEST IRAN REVISITED

WATABE, Mahito, Osaka City University, Sumiyoshi-Ku, Osaka, Japan; ATAABADI, Majid Mirzaie, University of Zanjan, Zanjan, Iran

Maragheh in northwestern Iran is one of the most important late Miocene mammalian fossil localities with rich fossil occurrences and its preservation quality, in which many cranial, dental, and postcranial bones of hipparionine horses have been found. The cranial specimens can be classified by their snout proportions, facial morphology including shape and location of the preorbital fossa, and their size, and the postcranials by their size and especially proportions. The facial morphology provides five groups: *Hipparion urmiense*, *H. gettyi*, *H. prostylum* (*H. schlosseri*), *H. moldavicum*, and *H. matthewi*. The postcranial bones especially the third metapodial, astragalus, and calcaneus are sorted out by proportions (former two elements) and size (latter two). Two proportions of the third metapodials are recognized: robust and slender. The slender form is further divided into two sub-groups: large and small. The small form is *H. matthewi*. The slender postcranial bones correspond to the skull of *H. matthewi,* and the large form to *H. moldavicum*. The robust postcranials are attributed to *H. prostylum* with larger skull and dental size than *H. moldavicum*. *Hipparion urmiense* (=*H. campbelli*), which has a very narrow upper snout and reduced preporbital fossa, bears the slender third metapodial. *Hipparion hippidiodus*

from the upper Miocene in the western part of Northern China also belongs to this group. The taxa *H. moldavicum*, *H. prostylum*, *H. matthewi*, and *H. urmiense* are widely distributed in other upper Miocene (Turolian in western, and Baodean in eastern Eurasia). *H. moldavicum* and its taxonomic relatives are distributed in the localities of the northern shore of the Black Sea, Greco-Iranian, and Northern China provinces. *H. prostylum* is of South France and Greco-Iranian form. *H. matthewi* is endemic to the Greco-Iranian province. *H. urmiense* is also widely found from the late Miocene to early Pliocene strata in Northern China, central Asia, and Maragheh. The distribution patterns of these taxa are supported by occurrence of the groups of postcranial elements varied in size and proportions. The locality with multiple occurrences of hipparionine taxa such as Maragheh is particularly important for understanding of the ecology and environments of the Pikermian faunal localities, and biostratigraphic correlation of them, considered from the view points of comprehensive analysis on cranial and postcranial parts.

Technical Session XV (Saturday, November 8, 2014, 9:45 AM)

R2D3 AND C3PO: A COMPANION TOOL FOR TESTING THE FIDELITY OF TWO-DIMENSIONAL GEOMETRIC MORPHOMETRIC DATA IN A THREE-DIMENSIONAL WORLD OF VERTEBRATE CRANIA.

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Geometric morphometrics is a powerful method for characterizing and analyzing the morphology of extant and extinct organisms. Typically, specimens are digitized using two- or three-dimensional (2- or 3-D) landmark points. Although the use of 2-D landmarks may be sensible for characterizing the shape of flat specimens and structures (e.g., the bodies of fishes), they are also commonly used for highly 3-D objects such as the vertebrate skull. Yet, whether 2-D landmarks effectively capture the shape of such systems remains untested. This issue is critical because if 2-D data fail to reflect 3-D shape differences, they could generate spurious results. If shown to be accurate proxies for 3-D shape, however, 2-D data could obviate the additional time and expenses associated with 3-D data collection and analysis. Here I investigate the case in crocodylian crania using two new analytical tools I developed for evaluating the overall fit between 2-D and 3-D geometric morphometric data. The R script Run 2-D or 3? (R2D3) compares 2-D and 3-D landmark data from the same specimens to quantitatively test whether the two data sets are significantly congruent in their underlying patterns of shape variation. Beyond comparisons to 3-D data, 2-D shape data may contain different signals based on which anatomical view was used for placing landmark points. To determine which anatomical plane captures the 3-D shape of specimens most effectively, the script Compare 3 Perspectives to Original (C3PO) takes a 3-D data set and projects the coordinate points onto three orthogonal anatomical planes (i.e., frontal, sagittal, transverse). Similar to R2D3, it tests for congruence between the original 3-D shape data and each of the three projected 2-D data sets. Results from performing these analyses on 204 cranial specimens of crocodylians indicate that 2-D landmark points digitized from the frontal plane (i.e., in dorsal view) characterize the overall 3-D shape of the cranium with significant degree of fidelity. In contrast, 2-D data collected from the sagittal and transverse planes (i.e., in lateral and anterior views) fail to adequately capture 3-D shape. Together, R2D3 and C3PO provide a new and quantitative means for verifying the use of 2-D landmarks on 3-D specimens.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

TESTING INTER- AND INTRASPECIFIC VARIATION IN THE JUGAL OF HADROSAURID DINOSAURS

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Hadrosaurid dinosaurs are notably recognized by amazing variation in cranial morphology, including highly diagnostic ornamentation. Accordingly, phylogenetic systematics in this group has stressed the importance of cranial variation for species recognition and phylogeny, with only a relative few interpreting the nature of variation given the fact that hadrosaurid skull shape can change drastically throughout its growth. In the skull, the jugal bone has been instrumental in defining hadrosaurid systematics, representing as many as 10% of facial characters. Given its putative phylogenetic importance and large sample sizes, the hadrosaurid jugal offers a model system in which to investigate intra- vs. interspecific variation in non-avian dinosaurs and test the underlying phylogenetic assumption that inter- rather than intraspecific variability represents the main source of variation in this group.

Here we quantify variation in a sample of 151 hadrosauroid jugals (51 species), including various growth stages. Shape was analyzed using geometric morphometrics of two landmark-based datasets: 1) homologous landmarks, and 2) sliding semilandmarks (outlines). Principal component analyses of both datasets reveal similar overall distribution of specimens. When only adults are analyzed, results support the diagnostic potential of the jugal at higher taxonomic levels. Non-hadrosaurid hadrosauroids and hadrosaurids occur on opposite sides of PC1 and lambeosaurines and saurolophines plot separately along PC2, with some overlap. Genera overlap extensively; especially lambeosaurines, which share the same morphospace. Saurolophinae exhibits greater variation than Lambeosaurinae, and some genera show distinct variants. Distinction between taxonomic groups, including at the familial level, diminishes significantly once juvenile specimens are included.

Phylogenetic analyses based on morphology operate on the assumption that variation defined by a character is taxonomic. Our results support the taxonomic utility of the jugal (in particular at high taxonomic scales), with the caveat that ontogenetically equivalent, and mature, stages are being compared. Despite its potential utility, this study recovered substantial intraspecific (or intrageneric) variation in the hadrosauroid jugal and stresses the importance of understanding the nature of variation when building phylogenetic characters. Failure to do so may lead to either topological errors or undesirable noise (i.e., extensive polytomies) in resultant analyses.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

HISTOLOGY OF PACHYCEPHALOSAURID CRANIA REVEALS EVIDENCE OF MULTIPLE TISSUE TYPES AND VARIABLE ORIGIN OF APICAL PATHOLOGIES

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Recent interpretations of cranial 'lesions' on the apex of pachycephalosaurid domes as evidence of head-butting trauma were evaluated by histological examination. Three pachycephalosaurid frontoparietal domes with apex 'lesions' were sectioned in coronal and sagittal planes to determine if the tissues beneath and adjacent to the 'lesions' were likely pathologic in origin. Pachycephalosaurid domes are highly complex, mineralized organs that were clearly not formed by ordinary intramembranous ossification. Pachycephalosaurid domes possess a wide variety of osseous tissues found adjacent to one another. These tissues are characterized as being: (1) vascular or avascular; (2) cellular or acellular; (3) densely fibrous or non-fibrous; and (4) woven or hypermineralized regions. Lines formed of alternating tissue types, rows of osteocyte-like structures, dense fibers, or resorption surfaces can also be present.

A large *Pachycephalosaurus* fronto-parietal dome (BMRP2001.4.5) with shallow, smoothly rounded apical surface depressions, previously interpreted as head-butting 'lesions', reveals a highly angular resorption surface at depth. Subsequent growth from the resorption surface by a variety of osseous tissues, including woven bone, has altered the original angular surface morphology, smoothing the boundaries of the surface lesions. An unidentified pachycephalosaurid skull (MOR 2915), possessing a cluster of apical pits, also reveals evidence of an angular resorption surface at depth that was subsequently overlain exclusively by radially oriented woven bone. A fronto-parietal dome (MOR 2555) with abundant pitting and an uneven apical surface shows evidence of surface resorption but lacks evidence of a deeper irregular surface as observed in BMRP2001.4.5 and MOR 2915. The deep resorptive unconformities in the two skulls are possibly pathologic in origin, but the angularity of these resorption surfaces suggest causes that would have been much more traumatic than head-butting. The pitting and uneven surface of MOR 2555 could be a result of a variety of causes, including disease or senescence. Until our understanding of the ontogenetic histology of these highly complex dome tissues improves, all interpretations remain highly speculative, particularly those that claim 'lesions' are caused by head-butting behavior.

Technical Session IV (Wednesday, November 5, 2014, 2:30 PM)

MAMMALIAN MIDDLE EAR EVO-DEVO: HOW MUCH DOES ONTOGENY RECAPITULATE ONTOGENY?

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The homologies between the amniote lower jaw and the mammalian middle ear (MME) represent one of the oldest successes of relating developmental patterns to deep-time evolutionary processes. However, the striking parallels between MME development and evolution remain rarely quantified. In this study, we ask to what degree MME development and evolution correspond with view to: (1) the allometry of the middle ear; and (2) the timing of ossicle detachment from the lower jaw. By investigating µ-CT scanned developmental series of 5 species of Australian marsupials, we show that previous suggestions that developmental negative allometry mirrors evolutionary negative allometry as a driver of MME detachment cannot be substantiated. The notion of negative developmental allometry may have arisen through the use of the functionally highly constrained diameter of the tympanic ring as an indicator of middle ear growth. However, Meckel′s groove in the dentary - which houses Meckel′s cartilage, the scaffold and predecessor of tympanic ring, hammer, and anvil - exists across developmental stages. As in fossils, this trait is a useful indicator of the developmental timing of ME detachment because Meckel′s cartilage is the last point of contact between the lower jaw and the ME. The developmental disappearance of Meckel′s groove coincides with tooth eruption, with groove closure normally occurring around the time the first molars erupt. This might suggest a biomechanical cause of the developmental and perhaps also evolutionary detachment of the middle ear, lending support to an older set of hypotheses that biomechanical changes related to mastication may have caused the final detachment of the middle ear bones from the lower jaw. Intriguingly, groove closure occurs much faster in small species, which may have implications for the understanding of MME evolution during the miniaturization of the mammalian ancestors.

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Symposium 5 (Saturday, November 8, 2014, 3:15 PM)

TOWARDS AN ECOMETRIC ANALYSIS OF CARNIVORES

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The use of animal traits to reconstruct past environmental parameters originated with and has continued to be used for herbivorous mammals—mainly medium- to large-sized ungulates. Environmental reconstructions have proven spectacularly successful for a restricted set of parameters, notably precipitation. However, a mammalian community is composed of more than herbivores and in order to study community dynamics more broadly other trophic levels must be considered. The presence or absence of carnivores is known to have a significant impact on community structure and diversity, but an ecometric analysis of carnivores is not straightforward because they are a trophic step removed from the climate-plant dynamics that are key to herbivore ecometrics.

What little work has been done has followed two paths. Past work shows that the carnivore locomotor apparatus is sensitive to substrate and therefore, studies of the locomotor apparatus have used a trait-based approach to tracking environments. Analyses of the feeding apparatus, on the other hand, have studied the interaction between

carnivore guild structure and environment. A fundamental problem with carnivore ecometrics in a paleontological context is that, while different plant matter has fundamentally different properties, leading to a strong correlation between diet and dental traits, "meat is meat" regardless of its source, so that more subtle analyses are required to isolate ecometric signals from carnivore data. A particularly confounding problem is that both craniodental and postcranial elements in carnivores carry a very strong phylogenetic signal.

In this presentation I propose a research agenda to extend the usefulness of carnivores as ecometric markers complementing herbivores. Development and use of more precise measures of ecometric disparity is high on such an agenda. Because of the clear size demarcation at ca. 21-22 kg, research into ecometric differences between large and small carnivores is likely to be fruitful, because the two groups experience at least partially different selective regimes and may have different trait-environment relationships. A "carnivory index" analogous to the ungulate "hypsodonty index" is less likely to be useful because there exists no theory to explain differences in average "carnivory" between local communities. Such theoretical developments in carnivore guild dynamics are essential to furthering the field of ecometrics.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

FOSSIL TURTLE EGGS FROM THE UPPER CRETACEOUS (CAMPANIAN) MORONDAVA BASIN, MADAGASCAR

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Malagasy fossil eggs are previously known from Cenozoic deposits, with perhaps the most famous specimens being those of the extinct Elephant bird (*Aepyornis*); however, no Mesozoic specimens have been previously described. Three spherical eggs were discovered in Upper Cretaceous marine rocks of the Morondava basin in the Belo Region of western Madagascar. Two of the eggs lack eggshell and their morphology results from infilling by sediment prior to surface erosion. The third egg measures approximately 33.5 mm in diameter and preserves eggshell on half of the specimen. Eggshell thickness averages 0.44 mm and shell units are tightly interlocking, with a height to width ratio of 2:1. The lower two-thirds of the eggshell exhibits tight, interlocking acicular crystalline structures that radiate from a nucleation site, allowing definitive assignment to Testudines. Additionally, these characters demonstrate that the eggs are from a taxon that produced rigid rather than pliable-shelled eggs. The eggshell microstructure differs from all previously described turtle oospecies; however the specimens are referred to *Testudoolithus* oosp. rather than assigned to a new oospecies because of diagenetic alteration. Taxonomic identification of the eggs is difficult to determine because they are not associated with embryonic remains or within a gravid female. Although these specimens occurred in marine rocks, they should not be interpreted as sea turtle eggs (Chelonioidea) because the poorly mineralized eggshell of sea turtles consists of loosely organized shell units that differ significantly from the rigid eggshell of the Malagasy eggs. This also suggests that the eggs were transported from the paleo-nesting environment during their taphonomic history. These specimens are important because they are the first fossil eggs from the Mesozoic of Madagascar and illustrate the importance of the Morondava basin to the paleontological history of Madagascar.

Technical Session IX (Thursday, November 6, 2014, 3:30 PM)

BONE HISTOLOGY AND GROWTH IN THE LARGEST KNOWN SNAKE, *TITANOBOA CERREJONENSIS*

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Terrestrial vertebrates reach exceptionally large body sizes compared to close relatives by increasing growth rate or growth duration, or a combination of both. The ~13 m long Paleocene boid *Titanoboa cerrejonensis* is the largest known snake, but its growth strategy and longevity are unknown. To address this, we histologically sampled vertebrae (centra + serial sections of the prezygapophyses and zygosphenes) and ribs from 5 individuals of *Titanoboa*, including two juveniles. We assessed ontogenetic changes in histology and relative growth rate (inferred from the number and spacing of lines of arrested growth, or LAGs), and compared rib histology to that of *Python reticulatus*, the longest extant snake.

Juveniles and adults are histologically similar. Their centra are typical of squamates in having a periosteal band of avascular, parallel-fibered/lamellar compact bone with LAGs. Unlike most squamates, the centrum, prezygapophyses, and zygosphenes contain large amounts of trabecular bone. The trabeculae obscure nearly the entire record of growth in the prezygapophyses and anterior 2/3 of the zygosphenes, which have been used successfully in previous skeletochronological studies of limbless taxa. The extensive trabeculae may reflect the aquatic ecology of this taxon.

Like most squamates, *Titanoboa* ribs have a thick compacta of parallel-fibered/lamellar bone and a small, open medullary cavity. They are mostly avascular, but large secondary osteons occur endosteally. The ribs of the adults show dozens of dark lines, potentially suggesting growth lasting 60 years or longer. However, in polarized light, most do not correspond with birefringence patterns, and at high magnification, relatively few show breaks in tissue deposition indicative of true LAGs. True LAGs are nearly always double or triple LAGs, and the zones between them contain large numbers of Sharpey's fibers. The number and spacing of these compared to *Python* suggest that *Titanoboa* achieved large size by increasing growth rate in addition to duration. This contrasts the growth strategy of other giant Cenozoic reptiles such as crocodylians, who achieved enormous size by increasing growth duration alone.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

NEW HIGH-PRECISION $^{40}AR/^{39}AR$ GEOCHRONOLOGY OF FOSSIL-BEARING STRATA OF THE CACHAPOAL VALLEY, ANDEAN MAIN RANGE, CHILE

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The Abanico Formation yields fossil mammals at several localities in the Las Leñas and Cachapoal river drainages, central Chile. Colhuehuapian-aged fossils from the Las Leñas Valley, $^{40}Ar/^{39}Ar$ dated at 20.09 Ma, underlie strata dated at 16.1 Ma. In the Cachapoal Valley to the NW, steeply-dipping beds have yielded fossils of likely Tinguiririan age, notably a polydolopine marsupial and an interatheriid notoungulate. The fossils at Cachapoal are expected to be 31–32 Ma, based on previous argon dates for the Tinguiririan SALMA at Termas del Flaco in the Tinguiririca Valley to the south, which range from 31.3–31.65 Ma in direct association with fossils. Our $^{40}Ar/^{39}Ar$ results in this talk are the first radioisotopic dates of strata in the Cachapoal Valley. These results are significant in constraining the age of fossils recovered there, as well as reconstructing regional tectonics and temporal relationships between the Abanico Formation (Fm) and the overlying Farellones Fm. The mammal fossil-bearing Abanico Fm in the Cachapoal and Las Leñas valleys is strongly folded, likely most recently by a tectonic episode post-dating 16.1 Ma, based on the youngest dates known from the tightly folded strata in the Las Leñas Valley.

The early–mid Cenozoic distal volcaniclastic lithologies preserving most of the mammal fossils in the Andean Main Range have been difficult to date with argon geochronology due to extensive tectonism and alteration, with the exception of strata in the Tinguiririca, Las Leñas, and Laguna del Laja areas. Our initial results from Cachapoal show that the area holds promise for reliable argon dating; future work will target samples directly associated with fossils. Samples from three igneous units were analyzed by $^{40}Ar/^{39}Ar$ incremental step-heating with a CO^2 laser in the AGES lab at Lamont-Doherty Earth Observatory, with Fish Canyon sanidine (28.201 Ma) as monitor standard. Aliquots were first run with steps of 1, 4, and 8 Watts laser power. The three-step runs all gave integrated age uncertainties less than 4%. A second groundmass aliquot of the sample with the oldest apparent age was run with 1, 2, 3, 6, and 8 Watt steps. The isochron from all eight steps gave a mid–late Miocene age, consistent with the youngest date previously reported from the Las Leñas Valley, and with strata above Tinguiririan-aged fossil beds at Termas del Flaco. Details of these and other results from the Cachapoal Valley will be presented, emphasizing the refinements they provide to the ages of fossils, strata, and tectonic events in this part of the central Chilean Andes.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

USING GAMMA-RAY SPECTROMETRY TO NON-DESTRUCTIVELY DETERMINE THE AGE OF RADIOACTIVE VERTEBRATE REMAINS

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The enrichment of uranium in fossils is well documented, but most techniques used to determine absolute ages require partial destruction of specimens. By applying a new method of gamma-ray spectrometry to radioactive vertebrate samples, we may determine the absolute age of fossils ranging from 13 000 Ka-54 Ma. Uranium ions commonly substitute for calcium ions in the bioapatite crystal lattice of teeth and bones. Reliable bioapatite geochemical substitutions are dependent on the assumption that uranium was introduced rapidly post-mortem, enrichment occurred early in diagenesis, and bones and teeth remained closed with respect to uranium during geologic time. The isotopes ^{235}U and ^{238}U and various daughters including ^{224}Ra, ^{226}Ra, and ^{214}Pb, are the focus for pulse height analysis of the gamma-ray spectrum produced by each specimen. Analysis using peak height ratios indicate that when the areas of peaks corresponding to daughter isotopes are added together, compared to the areas under peaks corresponding to parent isotopes, and plotted against logarithmic values of age, a nearly linear graph is produced. The consistent manner in which the peaks change from 13 000 Ka to 54 Ma shows phenomenologically that the different spectra serve as an indicator of time, and thus can yield reliable age dates.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

PHYLOGENETIC CHARACTERS IN THE AXIAL SKELETON: A COMPARISON OF METHODS FOR CODING SERIAL VARIATION

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Axial skeleton characters typically make up a disproportionately small fraction of phylogenetic matrices, and this omission of phylogenetic information from the axial skeleton is likely to negatively impact the accuracy and resolution of analyses. One obstacle to including more axial skeleton characters is the difficulty of making accurate homology statements between serially repeating structures, (such as ribs and vertebrae) if the number of these structures varies between taxa. Several different approaches are available to address these ambiguous homology problems, such as assigning a character state to be the average value of the whole series, or a polymorphic state that encompasses the range of character values observed in the series (i.e., the average neural spine length versus the range of neural spine lengths).

Simulated phylogenies and datasets (20–50 taxa and 20–200 characters) were used to compare these different methods of coding serial variation. Taking the average character state of the axial series resulted in more accurate phylogenies than using the entire range of values as a character. This result was independent of the number of taxa and characters. Both methods were consistently more accurate than picking a character state randomly from the range of observed values in a taxon. To mimic palaeontological datasets, where most taxa do not preserve complete axial skeletons, the analyses were

rerun with varying amounts of missing data. As the amount of missing data increased, the accuracy of the averaging method decreased, and at high proportions of missing data it was less accurate than the range method. This tipping point occurs when approximately 50% of data is missing. These results suggest axial characters have significant potential to enhance the accuracy of morphological phylogenies, but that the range of serial variation present in the axial skeleton should be considered when designing and coding axial skeleton characters.

Education and Outreach Poster Session (Poster displayed November 5 – 8)

UNDERSTANDING GLOBAL CHANGE: A NEW UNIVERSITY OF CALIFORNIA MUSEUM OF PALEONTOLOGY WEB RESOURCE

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For more than 125 years, fossil vertebrates, invertebrates, microfossils, and plants from more than 10,000 localities worldwide have been housed at the University of California Museum of Paleontology (UCMP). In addition to these extensive fossil holdings, significant online resources are linked to UCMP educational websites supporting the needs of both the research and teaching communities. As an early proponent of the web as a tool to create online exhibits highlighting important events in the fossil record, the UCMP has delivered paleontological information online for more than 20 years. These efforts have produced two award winning UCMP websites, *Understanding Evolution* (www.understandingevolution.org) and *Understanding Science (*www.understandingscience.org*)* which, together, receive 20 million page views annually. The success of these websites confirms that teachers value a 'one-stop shop' for rigorously vetted educational resources on evolution and the nature and process of science.

A new UCMP web resource, *Understanding Global Change*, will launch in early 2015 providing content, teaching resources, and strategies for K–16 educators to effectively incorporate global change science into their existing curricula. Topics will include the science behind global change, the multiple interactions and feedbacks between the climate systems, and the biotic impacts of past and current global change. Users can explore changes in climate, biogeography, biodiversity, ocean composition, and sea level, while drawing relevance to societal impacts and how human activities have become a "force of nature.' The site builds on direct feedback from educators, aligns with disciplinary core ideas and cross-cutting concepts from the Next Generation Science Standards, and provides new avenues and opportunities for public engagement on the complex topic of global change.

Technical Session VII (Thursday, November 6, 2014, 10:30 AM)

PATTERNS OF CROCODYLIFORM CRANIAL DISPARITY THROUGH THE MESOZOIC AND CENOZOIC USING A NOVEL METHOD OF PHYLOGENETIC CORRECTION FOR DISPARITY ANALYSIS OF CONTINUOUS DATA

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Crocodyliforms are traditionally considered a morphologically conservative group, retaining a similar body plan and small range of cranial morphologies throughout their evolutionary history. This qualitative assessment ignores many extinct highly divergent groups, particularly Mesozoic forms. Here I employ two-dimensional geometric morphometrics including landmarks and sliding semilandmarks to characterize the skull shape of 131 extant and extinct crocodyliforms from the Early Jurassic through the recent. These data were subjected to a principal component analysis (PCA). From the PCA results I calculated several metrics of disparity across 32 time bins spanning the entire stratigraphic range of the group. The data were phylogenetically corrected using a novel method based on squared change parsimony. Sensitivity analysis shows the method to be robust with respect to the length of time bins and sampling position within time bins. Range-based disparity metrics are significantly correlated with diversity (though this is not detrimental if differences in sample size reflect true changes in diversity), while variance-based metrics showed no significant correlation. Crocodyliform skull shapes are not evenly distributed through time. Modern crocodylian cranial disparity is low relative to Cretaceous levels, but is similar to Jurassic levels. Cranial disparity peaked in the Late Cretaceous followed by a dramatic decline in the Maastrichtian, even though diversity remained high into the Paleocene. The decline in disparity was driven by the evacuation of the region of morphospace exemplified by taxa possessing a short and narrow snout (e.g., *Protosuchus*). This portion of morphospace was never explored by crown-group crocodylians. The work presented here demonstrates the importance of phylogenetic corrections in disparity analyses, particularly when studying clades with unsampled gaps in their fossil records.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed November 5 – 8, judging occurs Thursday, November 6)

QUANTITATIVE INVESTIGATION OF THE STERNAL MORPHOLOGY OF STATIC AND DYNAMIC SOARING BIRDS

WILLIAMS, Megan, University of Cambridge, Cambridge, United Kingdom; MCNAMARA, Ken, University of Cambridge, Cambridge, United Kingdom

The sternum is the origin of major flight muscles in birds, both of the down stroke (M. pectoralis pars thoracicus) and upstroke (M. supracoracoideus). Morphological aspects, such as a reduced carina, have been associated with flight loss. This study investigates the association of sternal morphology with soaring flight.

Birds display a range of flight styles, using wings in different ways to achieve lift. In soaring flight, energy is extracted from the atmosphere and converted to potential or kinetic energy, in contrast to other flight styles where energy is gained from flapping. We focused on dynamic (energy from wind shear) and static (energy from thermals) soaring as these make little use of flapping flight.

Sterna were sampled from adult specimens (static soaring: n=26, dynamic soaring: n=27, non-passerine flapping/flap-gliding species: n=25). Material was sourced from the Natural History Museum London, University Museum of Zoology Cambridge, Oxford University Natural History Museum and Colchester Natural History Museum. Morphometric analyses were performed on photographs of the sterna in ventral, rostral and lateral views. Linear measurements of the sternum were made and standardized for body size using a geometric mean of synsacral length and femur average midshaft diameter. Samples of 25 specimens per flight group were subjected to ANOVA and canonical variate analysis (CVA).

ANOVA showed significant differences in sternal morphology between flight styles, with a deeper sternum/carina relative to its length in soarers compared with non-soarers. In static soarers this is due to a shorter sternum, whereas in dynamic soarers it was due to increased dorsal-ventral depth of the carina. Relative to body size, static soarers have a smaller lateral carina area than non-soarers, which in turn have a smaller area than dynamic soarers. In addition, dynamic soaring birds have a broader sternal body. CVA of sternal measures produced a 76% rate of correct group assignment, indicating the sternum is a strong predictor of flight style.

Geometric morphometric analysis of the sternum in lateral view using landmarks and semilandmarks was performed on the full data set. Principal components analysis showed the flight styles occupied distinct regions of morphospace, with static and dynamic soarers clearly separated. A jackknifing procedure performed on a CVA of the first 5 principal components gave a correct group assignment rate of 84.62%, corroborating results of traditional morphometric analysis in associating sternal morphology with flight style.

Education and Outreach Poster Session (Poster displayed November 5 – 8)

PALEOFEST: 15 YEARS OF SCIENCE EDUCATION SUCCESS

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PaleoFest is an educational program that celebrates the science of paleontology. Started in 1999 by Burpee Museum of Natural History and typically held on the second weekend in March, PaleoFest is a program that utilizes three main components: paleo-themed stations throughout the museum for young children (ages 3–6); more intensive hands-on paleontology workshops for older children (ages 6–10); and college-level lectures given by noted paleontologists for college students and interested public alike. Although there are numerous scientific symposia that focus on aspects of geology and paleontology, and educational programs that introduce children to paleontology through family friendly workshops and activities, PaleoFest is the first program to successfully merge these concepts, allowing for a 'science meets the street' weekend event. In its 15 years, PaleoFest has grown in attendance and scope. The event now averages approximately 3000–3500 people served for a weekend for a typical PaleoFest.

During this event, the general public is encouraged to interact with the visiting paleontologists, and also with preparators in the fossil lab. This allows them the opportunity to see a variety of work done in paleontology, and allows for a less imposing environment than larger, more formal events. Over PaleoFest's 15 years, more than 12,000 children have participated in workshops and related events. Additionally, PaleoFest can be expanded into a full symposium, as it was in 2013, when Burpee teamed with the Cleveland Museum of Natural History for 'The End of the Dinosaurs: Changes in the Late Cretaceous Biosphere.' Thirty two presentations were given in two days, with an average attendance for each talk of 200 people-,placing the cumulative lecture attendance alone over 6000 people served. Symposia on the scale of PaleoFest provide an opportunity for high school and college students to become immersed in professional content and allow for easy discussion with professionals; including potential advisors. For those hobbyists in the crowd, PaleoFest increases science literacy and access to the newest information. PaleoFest is a unique, exciting, educational program that is engaging for all levels of interest in science and paleontology. In a time when science education scores in the United States continue to fall behind other countries, PaleoFest is a program that stands as an exemplar for science education, using paleontology as the primer.

Technical Session II (Wednesday, November 5, 2014, 11:30 AM)

CHRONOSTRATIGRAPHY OF THE CRETACEOUS-PALEOGENE TRANSITION IN THE SAN JUAN BASIN, NORTHWESTERN NEW MEXICO

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The San Juan Basin of New Mexico (USA) contains one of the few records of superposed Late Cretaceous and early Paleocene terrestrial faunas and floras. However, the ages and durations of the Upper Cretaceous Naashoibito Member (Mbr) of the Kirtland Formation (Fm) and the lower Paleocene Ojo Alamo Sandston (Ss) and Nacimiento Fm are poorly constrained. This limits the ability to correlate these fossil records to the global time scale and hinders efforts to examine such factors as diversity and survivorship of plants and animals across the K-Pg boundary. The ages of the Naashoibito Mbr and the Ojo Alamo Ss are especially contentious and age interpretations range from Campanian to early Paleocene.

Here we present new geochronologic results that combine magnetostratigraphy and $^{40}Ar/^{39}Ar$ dating of detrital sanidine from sedimentary units and sanidine phenocrysts from a volcanic ash to constrain the ages of the Naashoibito Mbr, the Ojo Alamo Ss, and the lower Nacimiento Fm. Coupled detrital sanidine dates, magnetostratigraphy, and mammal biochronology indicate that the Naashoibito Mbr correlates to chrons C30n-C29r, suggesting a relatively short depositional history. These results indicate that the youngest Cretaceous sedimentary rocks in the San Juan Basin were likely deposited within the last ~400 ka of the Cretaceous and that there is a significant unconformity in the Kirtland Fm between the Naashoibito Mbr and the underlying De-Na-Zin Mbr. Further, it suggests that the Naashoibito Mbr is correlative in age to much of the Hell Creek Fm in the Northern Great Plains. Magnetostratigraphy of the Ojo Alamo Ss and the

Nacimiento Fm at both De-na-zin Wash and near Mesa de Cuba indicate that there is no evidence for significant diachroneity at the base of the Nacimiento Fm across the basin. The Ojo Alamo Ss was deposited in chron C29r and the lower Nacimiento Fm in chrons C29r-C28r. Deposition of basal Paleocene strata in the basin began <300 ka after the K-Pg boundary. Magnetostratigraphy and an $^{40}Ar/^{39}Ar$ sanidine date from an ash within the Nacimiento Fm demonstrate that the middle Puercan Land Mammal Age (Pu2) interval zone began within ~350 ka of the K-Pg boundary. An $^{40}Ar/^{39}Ar$ date from a probable volcanic ash coincident with the first occurrence of Pu3 mammals suggests that only ~150 ka separated the type Pu2 and Pu3 faunas. This new chronostratigraphic framework indicates that diverse, ecologically complex mammal faunas were present locally within no more than a few hundred thousand years after the extinction of non-avian dinosaurs.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

EXCEPTIONALLY WELL-PRESERVED MAMMAL FOSSILS FROM THE UPPER CRETACEOUS (CAMPANIAN) EGG MOUNTAIN LOCALITY (TWO MEDICINE FORMATION)

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The Late Cretaceous represents a critical but poorly understood period in the evolution of mammals. Spectacular but rare specimens and dental analyses suggest ecological diversification among non-therian mammals, and molecular clock studies assert that many modern lineages originated during this time. However, analyses of fossil data do not support this claim for crown therians, and stem therians, although taxonomically diverse, appear to remain morphologically and ecologically uniform. A largely untested assumption is that these Mesozoic mammals were constrained to be generalized, small-bodied, nocturnal insectivores because of selective pressures (predation, competition) imposed by dinosaurs at this time. The Cretaceous record of mammals consists predominantly of isolated elements (e.g., jaws and teeth), occurring within allochthonous and time-averaged microsite assemblages. These records permit gross analysis of diversity and disparity through time, but they are inadequate to fully address the ecological factors potentially underlying these large-scale patterns.

Recent field work at the Egg Mountain locality, a dinosaur-nesting site in the Upper Cretaceous Two Medicine Formation of Montana, has yielded exceptionally well-preserved and largely autochthonous mammalian fossils. Here, we describe three new specimen blocks. One contains semi-articulated dental, cranial, and postcranial (distal humerus, radius, ulna, femur, tibia, fibula) remains, likely of a single individual of the multituberculate *Cimexomys judithae*. The second contains associated, disarticulated dental, cranial, and postcranial (ulna, hand) remains of at least three individuals of the marsupialiform *Alphadon halleyi*. And the third contains portions of at least four fragmentary skulls of *A. halleyi* and that of a small lizard with only a few postcranial elements. Within the context of the site, these two *Alphadon* concentrations defy a hydraulic origin and suggest concentration by biotic factors. Study of these specimens has just begun, but they hold potential to improve our assessment of the ecologies of these taxa, clarify our understanding of their phylogenetic relationships, and establish associations among their dental, cranial, and postcranial elements. Moreover, because Egg Mountain is situated in the Western Interior of North America among several intensely studied, often well-dated Late Cretaceous localities with large fossil sample sizes of isolated remains, these specimens will inform studies of these other sites.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

ONTOGENETIC BIOMECHANICS AND TRAIT INTERACTIONS IN THE RODENT CRANIUM

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Developmental insights into morphospace structuring have recently enabled an appreciation of the factors that influence the evolution of development on a macroevolutionary scale, providing a promising avenue to address fundamental issues such as why development has evolved along a specific route, and how that may be generalized to explain observed morphological diversity. Rodents are unparalleled among mammals in terms of taxonomic success, and exhibit phenomenal levels of morphological diversity as well as a rich fossil record. These features provide a wealth of opportunities to explore phylogenetic, ecologic, or functional hypotheses relating to developmental morphospace occupation. In this study we investigate the importance of ecology in shaping trait interactions over the course of ontogeny by constructing 3D biomechanical models to detail how stress and strain magnitude and distribution changes during cranial growth in rodents, and combining these insights with ontogenetic 3D geometric morphometric data. We applied Finite Element Analysis (FEA) to ontogenetic series for 3 species (12 Finite Element models) to investigate whether patterns of stress and strain vary over the course of ontogeny in the rodent cranium, and whether those patterns align with trait covariances and differ by dietary habit. Results of modularity analyses on ontogenetic trait data indicate that covariance patterns change over the course of ontogeny, indicating ontogenetic repatterning of covariance structure is common. Our ontogenetic FEA models that detail stress and strain patterns in the cranium provide novel, quantitative data on so far unstudied trait correlations induced by the interrelationship between muscle and bone during growth. Uniting these two quantitative approaches yields important information for advancing the understanding of morphological trait variation, which is typically studied only at the adult stage, and supports the adaptive role of diet as a basis for ontogenetic evolution in rodents.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

THE DIGITAL *ARCHAEOPTERYX* - A HIGH-RESOLUTION PHOTOGRAMMETRIC 3D MODEL BENEFITING FUTURE RESEARCH

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Due to its exceptionally beautiful preservation, the Berlin specimen of the basal avialan *Archaeopteryx* is one of the most iconic fossils worldwide and often regarded as a symbol for evolution. *Archaeopteryx* is not only significant due to its transitional phylogenetic position between non-avian dinosaurs and Aves, it is also important for studies regarding the origin of flight, biomechanics (e.g., ranges of motion or body mass), morphometric studies, or soft tissue reconstructions. However, the permanent display of the original fossil in the exhibitions of the Museum für Naturkunde Berlin restricts research access to the specimen. Digital three-dimensional (3D) modeling offers an alternative way to access this exquisite specimen, allowing archiving, analyzing, and visualizing the fossil without potential damage to the original or the need to withdraw it from public display.

Photogrammetry is the method of choice for surface-only 3D digitizing because it is a relatively easy, cheap and fast technique. Hence, two photography sessions, two years apart, of the Berlin specimen of *Archaeopteryx* were carried out and the photographs were subsequently processed in the photogrammetric software Agisoft Photoscan Pro. Results illustrate the immense progress in technology and software performance in photogrammetry within the last years. The newest resulting 3D model is based on approximately 125 high resolution (20 megapixel) photos taken with a DSLR Canon EOS 70D and a 60 mm macro lens on a tripod. Complications during photo shooting included suboptimal light conditions in the display area, shiny bone surfaces due to lacquer coatings, the relatively large minimum distance of the camera as well as limited camera angles caused by the permanent installment of the specimen in a secured metal frame. Nevertheless, the final model has a sub-mm resolution and surface textures with genuine colors. It is now available for further research and exhibition purposes. If possible (copyright issues), the aim is to document all other *Archaeopteryx* specimens via photogrammetry and to make the resulting 3D models available to all interested researchers. Technical advice on equipment and camera settings (e.g., use of suitable scale, lens, tripod, even lighting conditions, low ISO, small aperture) for researchers working on the original specimens can facilitate the process of correct photographic documentation of the other specimens.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

***AFRICANOMYS* (RODENTIA: CTENODACTYLINAE) AND A NEW SPECIES OF HIPPOSIDERIDAE (CHIROPTERA) FROM THE MIOCENE KHASM EL-RAQABA LOCALITY, EASTERN DESERT, EGYPT.**

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Prospecting at Khasm el-Raqaba in the Eastern Desert of Egypt has yielded jaws, isolated teeth, and postcrania of ctenodactyline rodents (gundis) and hipposiderid bats, as well as two isolated small snake vertebrae. These specimens came from a single fissure-fill developed in the Gebel Hof Formation, a middle Eocene limestone unit. Rodent remains are fragmentary and include a maxilla, four mandibles, and two isolated teeth. On M1-M3, the endoloph is relatively lingual in position and the flexids lack cement. The posterior lobe of M3 is reduced. These characters support assignment to *Africanomys*; similar size of M1 and M2 and overall tooth size suggests assignment to *A. minor*. Specific identification of the lower jaws is less clear, but presence of a strong masseteric crest, limited development of a posterolophid on p4, overall morphology including a weak postero-labial ledge on m1, and overall size are within the range of variation observed in *A. minor* from Pataniak 6, Jebel Irhoud, Morocco. *Africanomys* cf. *A. minor* is also reported from Sheikh Abdallah, Egypt, which is considered to be slightly younger than Pataniak 6. The fossil bat specimens can be assigned to *Hipposideros* (subgenus *Pseudorhinolophus*) based on the presence of a relatively less reduced P2, a high mandibular coronoid process, a reduced m3, and a weak secondary cusp on upper canines. They are morphologically similar to *H. (P.) bouziguensis* from the middle Miocene of France but differ from that taxon in being smaller in all tooth dimensions. They are also similar to *Asellia vetus* from Beni Mellal, Morocco, but differ in retaining P2 and in being larger in all tooth dimensions. Based on comparisons with extant and extinct hipposiderids, the specimens from Khasm el-Raqaba can be assigned to a new species of *Hipposideros (Pseudorhinolophus)*. An age of middle to early late Miocene for the fossils from Khasm el-Raqaba is supported based on faunal correlation using the rodents. The fossil bats do not contradict this age determination, being similar to *H. (P.) bouziguensis* from the middle Miocene of France.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed November 5 – 8, judging occurs Thursday, November 6)

CAN TOOTH POSITION-SPECIFIC ENAMEL CONTENT PREDICT JAW BIOMECHANICS IN UNGULATES?

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The distribution of dental tissues in mammalian herbivores can be very different between taxa and dietary regimes. While grazers have more elaborate and complexly folded enamel ridges, browsers have less complex enamel ridges which can even be so far reduced that they do not functionally contribute. This distribution in occlusal enamel proportion has so far not been addressed for single tooth positions in hypsodont species. However, several studies have noted differential wear rates between tooth positions in small mammals (rabbits, guinea pigs). This phenomenon may be related to differences in tooth morphology, leading us to question if gradients in enamel proportion are also found along the tooth row in large herbivores. We apply CT-scanning and quantify volumes of dental tissues in molar teeth of 20 extant perissodactyls and artiodactyls to test the following hypotheses:

1. Gradients in enamel proportion along the tooth crown increase early in tooth wear in hypsodont dentitions.

2. Enamel proportion is specific to tooth position and relates to biomechanical constraints like local bite force.

In *Equus quagga*, we find an apical-basal gradient of decreasing enamel proportion in all cheek teeth. The apex morphology with less enamel and hence more soft dental tissues

is functionally interpreted to ensure fast exposition of enamel ridges which can then act as shear-cutting blades to process the food. This will reduce time between eruption and full functionality.

Independent of phylogenetic affiliation, we find three different patterns of crown enamel proportions between molars M1, M2, and M3: 1) almost no difference; 2) higher enamel proportion in M2 than in M1 and no obvious difference between M2 and M3; and 3) higher enamel proportion in M3 than in M2, while M1 equals or has less enamel then M2. We understand this pattern to relate to species specific traits in jaw biomechanics—short lever systems and long tooth rows result in highest bite force at the molar teeth. If the distal tooth positions converge lingually, M3 takes the highest bite force, a condition displayed by those species we find to have highest enamel proportions in M3. We thus conclude that the enamel proportion is positively correlated to bite forces. This is regarded as a constraint resulting in adaptive response that levels wear rates and increases functional integrity of the tooth row. Due to the general mechanism underlying this phenomenon, we anticipate enamel proportions to support reconstruction of jaw biomechanics and adaptive traits also based on isolated teeth of extinct mammals.

Symposium 4 (Friday, November 7, 2014, 11:15 AM)

EVOLUTION OF BODY SIZE IN PALEOZOIC TEMNOSPONDYLS: A TEST FOR COPE'S RULE

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Cope's Rule states that evolutionary lineages tend to increase in mean body size through geological time, possibly because a larger body size provides numerous selective advantages. The mechanisms leading to phyletic size increase are still poorly understood, and although Cope's Rule has been demonstrated in several lineages of vertebrates and invertebrates, it has been shown to be absent in others. In this study, we tested if Cope's Rule operated in Paleozoic temnospondyls, using 130 taxa ranging from the Mississippian to the latest Permian-earliest Triassic. Our analyses are based on a new time-calibrated tree of Paleozoic temnospondyls and investigate models of skull size evolution in the group, with skull length measured along the midline of the dorsal skull projection (from the tip of the premaxillae to the end of the postparietals) as a proxy for size. The pairwise average squared Euclidean distance among all pairs of taxa is used to plot skull size disparity through time and to compare it with 1000 simulated disparity plots under Brownian motion. The observed disparity shows an overall decrease through time, appears consistently lower than the mean simulated disparity (except in the latest Permian), and is significantly lower than expected during the middle one-third of the group's history. Overall, skull size evolves in accordance with a Brownian model (trait variance increasing proportionally to amount of shared ancestry, i.e. no trends towards increasing or decreasing character values), but this is only slightly better than a random walk model towards an optimum (Ornstein-Uhlenbeck, i.e. selection for a given phenotype), and both are significantly better than other models. Major shifts in the rate of skull size diversification affect the early radiation of dvinosaurs and two branches from among branchiosaurid dissorophoids: one branch leading to the *Melanerpeton* complex and one branch subtending apical members of the *Apateon* clade. In conclusion, our analyses indicate that Cope's Rule did not operate in most Paleozoic temnospondyls. The only remarkable size increase occurred in edopoids and archegosaurids, whereas there was a miniaturization trend in amphibamids and branchiosaurids.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

WHAT JUVENILE HIPPARIONINE SKULLS REVEAL ABOUT TAXONOMY AND PHYLOGENETIC RELATIONSHIPS: AN EXAMPLE FROM OLDUVAI, TANZANIA

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Traditionally, the morphological characteristics of juvenile hipparionine skulls and dentitions have largely been ignored when assessing the taxonomy and phylogenetic relationships within and between the various Old World hipparionine lineages. However, recent studies have suggested the presence of valuable systematic information in such juvenile material. We measured and described a juvenile hipparionine skull from Olduvai Gorge site BKII, Tanzania (ca. 1.2 Ma), and compared the results with juvenile hipparionine material from a range of other Old World and New World localities. Facial morphology, including a long preorbital bar and a preorbital fossa that is reduced in size, as well as skull and dental dimensions indicate that this Olduvai specimen belonged to the late African species *Eurygnathohippus cornelianus*. Morphology and dental metrical data such as occlusal length versus width, and protocone length versus width of the Olduvai dP2, dP3, and dP4 support the conclusion that *Eurygnathohippus cornelianus* is a member of the "*Sivalhippus*" complex, which includes the following superspecific taxa: *Sivalhippus, Eurygnathohippus, Plesiohipparion* and *Proboscidipparion*. There are considerable differences between the "*Sivalhippus"* complex and other lineages, but the Central European *Hippotherium* clade in particular, especially in dP2 size and protocone morphology: dP2s are large and elongate in taxa belonging to the "*Sivalhippus"* complex (including the Olduvai specimen), and protocones of all studied positions are consistently larger and more elongate in those taxa than seen in the *Hippotherium* lineage. These results, which were obtained independent from but are consistent with findings using adult specimens, underline the potential of and need for a more thorough study of juvenile hipparionine material in the future.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

PALEOBIOGEOGRAPHY OF NON-EQUID PERISSODACTYLS FROM THE EARLY MIOCENE OF PANAMA

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The early Miocene in North America is marked by many first appearances of allochthonous mammals with Eurasian origins, correlated with Oligocene–Miocene glacioeustatic lowstands and opening of Bering dispersal routes. New chalicotheriid and rhinocerotid fossils from the Panama Canal Basin have implications for the timing of these trans-continental dispersals and associated role of the New World Tropics. A lower molar of a schizotheriine chalicothere from the Las Cascadas fossil assemblage, late Arikarrean North American Land Mammal Age (NALMA), represents the first occurrence of Chalicotheriidae in Central America. The molar is similar in size to the smallest chalicotheres from the Oligocene–earliest Miocene, including *Schizotherium* (Eurasia) and *Moropus* cf. *oregonensis* (Gulf Coast, USA). Paired cuspids posterior to the metaconid and slightly curved lophids distinguish it from the known genera of North American schizotheriines: *Moropus* and *Tylocephalonyx*. An associated upper dentition and isolated teeth of a rhinocerotid from the Cucaracha Formation, early Hemingfordian NALMA (He1), represents a third genus of rhinoceros in the Centenario Fauna. Tooth size, M1-2 proportions, and the following features distinguish the specimens from previously described *Floridaceras* and *Menoceras* in the Centenario Fauna: moderate crochets/antecrochets on the M1-2, weak to no crochets/antecrochets on the P3-4 and M3, and cristae on P4-M1. We tentatively identify the new rhinocerotid fossils as *Aphelops* cf. *megalodus*. The primitive morphology of the chalicotheriid and the fact that it post-dates the first arrival of North American chalicotheriids during the Oligocene isotopic event 2 (Oi2) suggest chalicotheriids emigrated from Eurasia multiple times. Co-occurrence of *Floridaceras* and *Aphelops* in the Centenario Fauna indicates both genera immigrated to North America at the start of the He1 biochron instead of in separate events. These new occurrences suggest a pattern of early Miocene mammalian dispersal characterized by high-latitude corridors, integration within tropical faunas, and lack of mid-latitude records. A dispersal mechanism involving glacioeustastic lowstands and tropical-adapted taxa crossing a Bering land bridge poses a paleobiogeographic paradox, which may be ameliorated by evidence of temperate biomes in the Arctic at this time. Additionally, paleoenvironments of the tectonically-developing Central America may have provided more niche space for immigrant taxa than higher latitudes during the early Miocene.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

JUVENILE DIPLODOCID SAUROPODS FROM THE LATE JURASSIC MORRISON FORMATION OF MONTANA

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Much of what we know about the Morrison Formation and its dinosaurs is derived from localities within the Colorado Plateau. The few sauropod bones so far described from the Morrison Formation of Montana provide unique insights into the skeletal anatomy, phylogeny, and paleobiology of Late Jurassic sauropod dinosaurs. Here we describe several immature sauropod skeletons that are derived from three distinctive horizons in a single locality in southwestern Montana. These specimens are particularly significant because they: (1) record new occurrences of sauropod taxa that are in line with southern Morrison Formation faunas; (2) include articulated and associated postcranial and cranial material; and (3) document well-preserved individuals that highlight ontogenetic trends, particularly in cranial and vertebral anatomy.

Museum of the Rockies (MOR) locality # M-048 records multiple depositional events in an anastomosed fluvial system. Specimen MOR 592 is represented by a partial braincase and dentary, a partial vertebral series, pelvic elements, femur, ribs, and chevrons. MOR 7029 is represented by a complete skull a partial cervical series. Both specimens share a suite of diplodocid cranial synapomorphies, including a paroccipital process with a rounded, pendant distal end. They differ from *Apatosaurus* and *Suuwaasea* in the presence of anteroposteriorly compressed, pendant basioccipital processes. The presence of a fossa surrounding the preantorbital fenestra and anteroposteriorly compressed basal tubera indicate that MOR 592 and 7029 are most closely affiliated with *Diplodocus*. These specimens present cranial morphologies which have been hypothesized to indicate sub-adult status, such as anterior portions of the skull that are rounded with a more extensive tooth row and the presence of a postparietal foramen. Immature postcranial character states, including weakly expressed neural spine bifurcation, are present in the vertebral series. Femoral proportions and bone histologic analysis of MOR 592 correspond to Histologic Ontogenetic Stages 8–9 (out of a total 13). The association of well-preserved cranial and postcranial material is generally rare for sauropods, particularly for representatives of early ontogeny. The new specimens allow us to test ontogenetic hypotheses such as niche partitioning in juvenile and adult diplodocids in greater detail.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

SIZE-FREQUENCY DISTRIBUTIONS OF TWO HADROSAURID DINOSAUR ASSEMBLAGES: IMPLICATIONS FOR AGING AND GROWTH RATES

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Size-frequency distributions of long bones, in which multiple peaks are presumed to reflect cohorts, can be used to assess age and population structure in fossil assemblages. Applying this approach to a small sample of hadrosaurid (Dinosauria: Ornithischia) long bones (n=58) from the Dinosaur Park Formation (DPF), Alberta, it has been suggested that DPF hadrosaurids attained adult body size within three years of age. This

interpretation conflicts with skeletochronological estimates of 6-10 years for the penecontemporaneous hadrosaurids *Maiasaura* and *Hypacrosaurus* from Montana. To assess the validity of the previously reported DPF hadrosaurid size-frequency distribution and the potential utility of size-frequency distributions to estimate age, we expanded the DPF data set and compared it to the presumed catastrophic mass death assemblage of *Edmontosaurus annectens* found at the Mason Dinosaur Quarry (MDQ) in the Hell Creek Formation of South Dakota. Size-frequency distributions were generated for long bones (e.g., humeri, femora, tibiae) using total bone length, and qualitatively compared across elements.

The DPF and MDQ samples each consisted of over 400 long bones with individual elements (e.g., femora, tibiae) typically represented in excess of 80 specimens. The size-frequency distribution of the DPF sample reveals a minimum of four relatively distinct peaks along a positive parabolic distribution consistent with a long-term, time-averaged origin. The smallest peak occurs at a size consistent with the first year of life, while the first peak of small bones suggests high juvenile mortality due to its high frequency. The peak composed of the largest individuals is the most variable and may include overlapping age classes. The size-frequency distribution of the MDQ sample reveals a minimum of four peaks, with femora and tibiae showing five distinct peaks. The MDQ frequency peaks were generally level across the size range, as expected in a catastrophic death assemblage. The expanded DPF data set fails to reject the idea that the DPF hadrosaurids approached adult body size within three years, and the MDQ data suggests that the larger *E. annectens* approached adult size in a minimum of five years. The presence and consistency of multiple size-frequency peaks in both datasets suggests their potential as a general age indicator and is consistent with proposed high growth rates in hadrosaurids, but future research integrating histological data is needed to further test these hypotheses.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

A LOWER CRETACEOUS HIGH-LATITUDE MARINE TELEOST LAGERSTÄTTE FROM AUSTRALIA

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Lower Cretaceous (Albian) deposits of the Toolebuc Formation and Allaru Mudstone represent a conformable sequence of carbonaceous shallow marine shale that crops out over vast areas of central and northeastern Australia. These units are best known for exceptionally preserved marine amniote remains; however, they have also yielded a diverse assemblage of teleosts that incorporate early representatives of cosmopolitan groups. Significantly, the paleolatitudinal placement of northeastern Australia was at around 60°S during the late Early Cretaceous. This, coupled with the frequent recovery of outstanding three-dimensional articulated skeletons, highlights the Australian sequences as a globally important lagerstätte for exploring the radiation history of basal teleost clades. As currently understood, the Toolebuc/Allaru teleost fauna comprises a number of large-bodied forms that have not yet been contextually examined in terms of their biostratigraphical and paleobiogeographical relationships. The taxa described to date include the filter-feeding aspidorhynchiform *Richmondichthys sweeti*, mid-level trophic predators such as the albuliforms *Marathonichthys coyleorum*, *Stewartichthys leichhardti*, *Euroka dunravenensis*, and elopiforms *Flindersichthys denmaedi, Pachyrhizodus marathonensis*, *Pachyrhizodus grawii*, as well as pelagic macrophagous pursuit hunters like the ichthyodectiform *Cooyoo australis* (up to three meters long) and hyper-specialized ″swordfish-like″ pachycormiform *Australopachycormus hurleyi*. Some smaller species such as the neoteleost *Dugaldia emmelta* and a new enchodontid have also been identified but many more await formal documentation. The chronostratigraphical distribution of these fossils is restricted to the middle-upper Albian, but is probably affected by limited sampling and a widespread marine regression that took place during the Cenomanian. Irrespectively, a marked pattern of basinal endemism is evident at genus and species level. Similar compositional signatures have been reported for coeval marine amniotes, chondrichthyans, and macroinvertebrates, and most likely reflect cladogenesis of Tethyan immigrants within a restricted epeiric seaway. Also curious is the occurrence of nascent members of Late Cretaceous global lineages (e.g., enchodontids), which could implicate the austral Gondwanan region as a major center of Mesozoic teleost evolution.

Symposium 3 (Friday, November 7, 2014, 11:15 AM)

FOSSILSÂ--ONLY TIP-DATING OF DEINONYCHOSAURIAN THEROPODS: A COMPARISON OF METHODS AND MODELS

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Fossil calibrations are commonly used to attach dates to occurrences on molecular phylogenetic trees. In recent years, Bayesian methods have emerged for treating the fossils as terminal branches in divergence dating analyses, allowing researchers to use likelihood-based methods to co-estimate the phylogenetic tree and divergence dates from combined molecular and morphological data. Because Bayesian methods have carried the assumption of a molecular clock, traditionally molecular data have been included in any studies, even those with abundant fossil data. Likelihood models for estimating phylogenetic trees from fossil data are also compatible with divergence dating analyses and, in this study, we explore the efficacy of these methods in all-fossil analyses.

Here, we perform a novel analysis of divergence dates in the deinonychosaurian theropod dinosaurs and avian birds, including *Archaeopteryx*. In this analysis, we re-examined a published data set of 89 taxa and 374 morphological characters. Using relaxed-clock models implemented in BEAST and Mr. Bayes, we co-estimated phylogenetic trees and divergence dates from this dataset. In both cases, *Archaeopteryx* is supported as a basal bird. BEAST returns a far more well-resolved topology. However, Mr. Bayes returns a tree that aligns better with suggested dates from the fossil record, placing the *Archaeopteryx* divergence from the rest of the avian taxa at about 167.5 Ma [152-183 Ma 95% Highest Posterior Density interval]. Divergences obtained in this analysis are largely younger than dates suggested in recent analyses of molecular data on the origin of the Aves clade.

Technical Session VI (Thursday, November 6, 2014, 12:00 PM)

MICRO-BIOMECHANICS OF THE KEBARA 2 HYOID AND ITS IMPLICATIONS FOR SPEECH IN NEANDERTHALS

WROE, Stephen, University of New England, Armidale, Australia; D'ANASTASIO, Ruggero, University Museum – State University G. d'Annunzio, Trieste, Italy; TUNIZ, Claudio, The "Abdus Salam" International Centre for Theoretical Physics, Trieste, Italy; MANCINI, Lucia, University Museum – State University "G. d'Annunzio", Trieste, Italy; CESANA, Deneb, University Museum – State University "G. d'Annunzio", Trieste, Italy; DREOSSI, Diego, Elettra-Sincrotrone Trieste S.C.p.A., S.S. 14 – km 163.5 in Area Science Park, Trieste, Italy; RAVICHANDIRAN, Mayo, University of Toronto, Toronto, ON, Canada; ATTARD, Marie, University of New England, Armidale, Australia; PARR, William, University of New South Wales, Sydney, Australia; AGUR, Anne, University of Toronto, Toronto, ON, Canada

The description of a Neanderthal hyoid from Kebara Cave (Israel) in 1989 fueled considerable scientific debate on the evolution of speech and complex language. Gross anatomy of the Kebara 2 hyoid differs little from that of modern humans. However, whether *Homo neanderthalensis* could use speech or complex language has remained controversial. Similarity in overall shape does not necessarily demonstrate that the Kebara 2 hyoid was used in the same way as that of modern *Homo sapiens*. The mechanical performance of whole bones is partly controlled by internal trabecular geometries, largely regulated by bone-remodeling in response to the forces applied. Here we show that both the Neanderthal and modern human hyoids also present very similar internal architectures and micro-biomechanical behaviours. Our study incorporates detailed analysis of histology, meticulous reconstruction of musculature, and computational biomechanical analysis with models incorporating internal micro-geometry. Because internal architecture reflects the loadings to which a bone is routinely subjected in life, our findings are consistent with a capacity for speech in the Neanderthals.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

NEW MATERIAL OF *SAURICHTHYS* FROM MIDDLE TRIASSIC CHINA SHEDS NEW LIGHT ON INTERPRETING THE PHYLOGENETIC CHANGES OF SAURICHTHYIFORM HAEMAL ELEMENTS

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The axial skeleton of the saurichthyiform fishes is unique among all known vertebrates in the duplication of the neural arch per somite underlying their elongate body plan. This is a consistent pattern conserved over a long evolutionary span of the group. However, in contrast to the stable neural patterning, the evolutionary changes of the haemal elements are much more complex. Based on a recently published saurichthyiform phylogenetic analysis, it was noted that there was a distinct morphological shift in the haemal skeleton, leading to the phylogenetic change of the haemal/neural arch ratio from 1:2 to 2:2, and the emergence and doubling of the haemal spines. These switches were attributed to the existence and expansion of the ventral intercalaries. But it is still an open question as to how the secondary intercalaries emerged. And these changes of the haemal arches appeared to be very abrupt without any intermediate stages.

A new taxon of *Saurichthys* from Middle Triassic of southwestern China has an axial skeleton with a two patterns of haemal elements seen in both primitive and derived saurichthyiform members. Based on its position in a new phylogenetic tree of the saurichthyiform intrarelationships, it is clear that the new taxon represents the intergrade stage of the shift from the plesiomorphic 1:2 to the more derived 2:2 for the neural/haemal ratio, and it also signifies the first emergence of the haemal spines in saurichthyiform phylogeny. On the other hand, the current material displays some ontogenetic stages that may recapitulate the evolutionary changes of the haemal elements, thereby providing an alternative model for the haemal transformation within this group. We note that during the development there might be a subdivision of the large haemal element that resulted in the doubling of the haemal arches and spines per segment. Interestingly, this ontogenetic subdivision pattern appears to parallel the phylogenetic changes of the haemal element within the saurichthyiform fishes. Therefore, we propose here a hypothesis that the double haemal arches and spines in derived saurichthyiform fishes may result from the subdivision of the plesiomophic large and spine-free haemal elements, rather than the secondary introduction and expansion of the ventral intercalaries. If it is the case, this is also an example echoing Haeckel" s biologenetic law 'Ontogeny is the short and rapid recapitulation of phylogeny'.

Poster Session III (Friday, November 7, 2014, 4:15 - 6:15 PM)

***ATOPODENTATUS UNICUS* IS A SAUROPTERYGIAN, WITH A HIGHLY SPECIALIZED FEEDING ADAPTATION**

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The Luoping fauna (Anisian, Middle Triassic) in southwestern China has become famous in recent years. The reptilian assemblage of the fauna is mainly comprised of ichthyosaurs, a number of sauropterygians (pachypleurosaur-like forms and nothosaurs), saurosphargids, and archosauriforms. *Atopodentatus unicus* is the most recently reported reptile in the Luoping Fauna. It has a total length of close to three meters but its head is proportionally small, approximately 12 cm long. The dentition of *A. unicus* is fence or comb-like and bears more than 175 pleurodont teeth in each ramus of the upper and lower jaws, tooth crowns are needle-like distally and blade-shaped proximally; its rostrum strongly bends downward and the anterior end of its mandible expands both

dorsally and ventrally to form a shovel-headed structure, and its ungual phalanges are hoof-shaped. The specializations of the jaws and dentition indicate that the reptile may have been adapted to a way of bottom-filter feeding in water. It is obvious that such delicate teeth are not strong enough to catch prey, but were probably used as a barrier to filter microorganisms or benthic invertebrates such as sea worms. These were collected by the specialized jaws, which may have functioned as a shovel or pushdozer (the mandible) and a grasper or scratcher (the rostrum). A detailed phylogenetic analysis suggest that *A. unicus* is a sauropterygian, most probably related to the Placodontia.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

TYPE OF MESOWEAR UTILITY BY EXTANT RUMINANTS WITH WELL-DOCUMENTED ECOLOGICAL FEATURES

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Dietary composition of herbivores is closely related to the vegetational condition they live in. Therefore, dietary reconstruction of fossil ungulates provides important paleoecological information. Fossil teeth, especially, have been thought of as a main source of paleodietary reconstruction because it is most likely to be preserved. Mesowear analysis, a method used to reconstruct diets based on facet development on the occlusal surface of cheek teeth, has been mainly applied to reconstruct the paleodiet of extinct species. However, detailed information of food habits and habitat environment is normally limited for skeletal specimens of extant ruminants used in mesowear analysis.

In order to test the validity of mesowear analysis, mesowear variables were examined in two extant ruminants, sika deer (*Cervus nippon*) and Japanese serow (*Capricornis crispus*). The deer are relatively opportunistic feeder but the serow are selective. The deer show browsing diet in an evergreen broad-leaved forest whereas the deer in a deciduous broad-leaved forest mainly rely on graminoids that dominate forest floor. On the other hands, the serow populations show typical browsing diets in forest habitats. Their contrastive feeding ecology is expected to be expressed in tooth wear. Fortunately, previous ecological studies well documented quantitative dietary compositions of each population by stomach content or fecal analysis. We scored 621 specimens from 15 populations of the deer and two of the serow populations.

Hierarchical cluster analysis using mesowear variables placed the deer and serow separately within a dietary continuum of extant ruminants. The deer in south and west Japan were classified into browsers, and the deer in north and east Japan were into mixed feeders. The serow were classified as browsers though the deer from the same habitat as mixed feeders. These results were concordant with the quantitative dietary analyses. Regression analysis using mesowear score, diets, and annual precipitation in habitat of 15 populations of the deer also indicated that the graminoid proportion in their diets is the most important factor determining mesowear. Furthermore, other extant ungulate datasets calculated from previous studies indicated that species with greater dietary variation showed higher standard deviation of mesowear score. These results suggested that mesowear is under strong influence of dietary variation, providing further confidence for mesowear analysis as a paleodiet reconstruction method.

Romer Prize Session (Thursday, November 6, 2014, 8:00 AM)

RESOLVING THE LOCOMOTORY ECOLOGY OF THE ANCESTRAL SNAKE: LISTENING TO WHAT THE EAR TELLS US

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Major evolutionary transitions often involve dramatic locomotor specializations, as seen in the origin of tetrapods, whales, and birds. The debate over the origin of another such group, the snakes, has long centered on whether they first evolved a limbless condition in a terrestrial fossorial or an aquatic habitat. For the few stem snakes that are known, empirical data needed to reconstruct their locomotory ecology have remained elusive, largely reflecting the incompletely preserved nature of the postcrania. This study develops locomotion indicators in the vestibular portion of the snake inner ear, an endocranial balance apparatus present in all vertebrates and preserved in several fossil snakes. To test the hypothesis that shape of the inner ear indicates locomotion in snakes, I reconstructed virtual models of the bony labyrinth (ossified inner ear) from computed tomography (CT) scans of 44 extant species including 35 snakes and nine lizards and amphisbaenians. The majority of families of extant snakes were sampled, and three locomotor groups were represented: terrestrial fossorial, terrestrial generalist, and aquatic. Based on 28 three-dimensional and 17 two-dimensional shape variables, geometric morphometric properties of the bony labyrinths were analyzed using Principal Component Analyses (PCA) and MANOVA statistics, to test shape separations among locomotor groups. Results show that fossorial species demonstrate expansion in the horizontal plane of the vestibule, whereas aquatic species demonstrate reduction in the vestibule. In PCA analyses of three-dimensional and two-dimensional morphometric data, separation is distinct between typical terrestrial burrowers and marine agile swimmers on the first principal component, despite overlap of the generalist group with some locomotor specialists in the morphospaces. MANOVA test using Procrustes scores found significant ($p < 0.05$) difference in the shape of the vestibule among the three locomotor groups, whereas phylogenetic signal is insignificant ($p = 0.063$) among all samples. Using published CT images, a stem snake *Dinilysia patagonica* was included in the two-dimensional geometric morphometric analysis, and was estimated as an active burrower due to its extremely large vestibule resembling modern burrowers, especially the sunbeam snake (*Xenopeltis unicolor*). *Dinilysia patagonica* is found from the Late Cretaceous of South America; its fossorial habit provides new evidence of adaptations to subterranean environments in the early evolutionary history of snakes.

Poster Session I (Wednesday, November 5, 2014, 4:15 - 6:15 PM)

A NEW MARINE VERTEBRATE OUTCROP FROM THE LATE CRETACEOUS (CAMPANIAN) OF SOUTHEASTERN ANATOLIA, TURKEY

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The Cretaceous succession in southeastern (SE) Anatolia (Turkey) consists of thirty formations included in four stratigraphical Groups, characterized by carbonate, partly clastic and evaporitic facies. These deposits are of particular economical importance as they host some main/major hydrocarbon reservoirs in SE Turkey. In the Mardin-Mazidag region located in the SE of Anatolia, just near the Syrian border, several stratigraphical units of the Cretaceous sequence rest unconformably above Paleozoic rocks, among which the Karabogaz Formation (early-middle Campanian). This formation, overlain unconformably by the Germav Formation (Late Campanian-Maastrichtian), is characterized by an alternance of calcareous and marly levels with cherts and includes important phosphate deposits that had been mined in this region for many years. It is the equivalent of the phosphatic Soukhne Group of Syria, which has yielded many marine vertebrate remains. The Karabogaz Formation contains marine fossil remains such as planktonic foraminifera, fish teeth and scales, as well as marine reptile teeth and indeterminate bone fragments. The marine reptile teeth can confidently be identified as belonging to the Mosasauridae, a successful squamate group with a global distribution during the Late Cretaceous. The remains indicate that at least two different mosasaurid clades are represented. This is the first time that marine vertebrate remains are found and identified in this area of Turkey. They add to our knowledge of the Arabian Platform Late Cretaceous marine vertebrate faunas.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

CENOZOIC MARINE BIRD COMMUNITIES IN THE SOUTHEAST PACIFIC OCEAN: NEW LOCALITIES AND FOSSILS ADDRESS WHETHER THE HISTORY OF MARINE CURRENTS IS THE ONLY EXPLANATION OF RECENT AVIAN DIVERSITY

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Neogene marine vertebrate localities are abundant along the western margin of South America. Recent fieldwork has recovered several new fossil birds from different localities in the Atacama Desert, Northern Chile. These fossils raise questions about the differences between fossil bird communities and extant diversity. The fossil record shows that several bird species are found at Miocene localities in southern Peru (Pisco Formation) and northen Chile (Bahía Inglesa Formation). Fossil penguins of the extant genus *Spheniscus*, such as *S. muizoni*, *S. megaramphus*, and *S. urbinai* are reported from both units. Sulid species are also shared between both geological units, including the recently recognized *Sula sulita*. Especially interesting is *Spheniscus urbinai,* which is the best-represented penguin species in the Bahía Inglesa Formation. This species was recovered from localities ranging from 14°S (Pisco Formation, southern Peru where the holotype was recovered) to 31°S (Coquimbo Formation, north-central Chile), an almost 2000 kilometer range. Juvenile penguin fossils of uncertain taxonomical affinities are reported from the Pliocene locality 'Los Negros' of the Bahía Inglesa Formation; these are most likely referable to the extinct species *Pygoscelis grandis*. All families of birds studied from the Bahía Inglesa Formation show higher generic and specific diversity than extant communities. The study of a new unit late Pleistocene in age, that overlies the Bahía Inglesa Formation, shows that over the Plio-Pleistocene boundary, a reduction in bird diversity took place. Penguins were strongly affected; from the four species reported in the Bahía Inglesa Formation, only one penguin referred to the extant species *Spheniscus humboldti* is reported in the late Pleistocene. The first record of Laridae and the diving petrel *Pelecanoides* are also reported from this locality, indicating a faunal turnover at the end of the Neogene. The fossil record of birds indicates that during the Neogene, no major differences exist over the latitudinal range studied. During the Pliocene, the influence of a cold current is hypothesized, but changes in sea level over the Plio-Pleistocene boundary should also be considered responsible for the reduction in diversity. For example, the loss of breeding areas for certain species could explain local extinction, and together with the emergence of the Humboldt current system, could explain the differences between present and past avian diversity.

Poster Session II (Thursday, November 6, 2014, 4:15 - 6:15 PM)

SABER-TOOTH ORIGINS: A NEW SKELETAL ASSOCIATION AND THE AFFINITIES OF MACHAEROIDINAE (MAMMALIA, CREODONTA)

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Machaeroidinae is a clade of highly derived, saber-toothed hypercarnivorous eutherian mammals known from the late early to middle Eocene of North America. The group is notable for representing the first appearance of a saber-tooth morphology among carnivorous mammals. Because of their highly derived craniodental morphology, machaeroidine affinities have long been unclear. Consensus has focused on two Paleogene carnivorous groups, oxyaenids and limnocyonine hyaenodontids, but it has not been possible to securely establish a relationship to one or the other group. Because material has been very limited, postcranial morphology has not been considered in studies of machaeroidine affinities.

A newly recognized skeletal association from the Uinta Formation of Utah significantly improves knowledge of the machaeroidine postcranium and provides new evidence for the affinities of the group. Collected early in the twentieth century, the specimen of interest lacks meaningful dental material, obscuring its affinities. Fortunately, even though preserved maxillary fragments are edentulous, their alveolar pattern is unique to Machaeroidinae among Uintan carnivorous mammals, an identification supported by the morphology of other cranial fragments that match Bridgerian *Machaeroides eothen*. The new specimen preserves portions of both girdles, all long bones, and elements of the pes, including the first known machaeroidine tarsals.

The skeleton shows numerous indicators of mobility at major joints, suggesting adaptation to irregular substrates and is consistent with machaeroidines being scansorial or arboreal.

Several postcranial features, particularly in the tarsus, provide clear evidence for oxyaenid affinities. These include a prominent posterior projection on the distal tibia, a broad, flat astragalar tibial facet with minimal posterior extension, strongly curved ectal facets on both proximal tarsals, absence of a calcaneal fibular facet, and very deep ungual fissures. In addition, the skeleton of *M. eothen* has a strong, elevated deltopectoral crest, another feature typical of oxyaenids. Taken together, postcranial morphology strongly favors oxyaenid affinities.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

SECOND THERIZINOSAURIAN MASS DEATH LOCALITY IN THE LOWER CRETACEOUS CEDAR MOUNTAIN FORMATION YIELDS A NEW TAXON

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The Crystal Geyser Quarry (CGQ), a rare mass death site in the Lower Cretaceous Yellow Cat Member of the Cedar Mountain Formation, east central Utah, is notable for representing one of the largest site-specific assemblages of a maniraptoran dinosaur worldwide, and entombs the copious, disarticulated remains of the primitive therizinosaurian *Falcarius utahensis*. Here we report a second paucispecific therizinosaurian bone bed in the Yellow Cat known as the Suarez Site, discovered approximately 800 m to the northwest of the CGQ. Suarez Site excavations have resulted in the collection of hundreds of elements of a therizinosaurian, representing a minimum number of 25 individuals. The bulk of these materials were tentatively assigned to *F. utahensis* pending study; however, an isolated partial maxilla described in 2010 as *Geminiraptor suarezarum* was referred to Troodontidae.

Comparison between *F. utahensis* and the Suarez therizinosaurian is complicated by the extensive amount of material being prepared from both localities, together with the disarticulated nature of the remains, preservation of ontogenetic sequences at both sites, and expected individual variation. Nonetheless, several attributes of the Suarez therizinosaurian indicate that it represents a more derived morphotype distinct from the variation observed in *F. utahensis*. In particular the more prominent development of the altiliac condition of the ilium, large distal boot of the pubis measuring more than half the pubic length, relatively straight and acuminate symphyseal aspect of the dentary, reduced recurvature of the dentary teeth, and marked ventral displacement of the mandibular condyle of the quadrate appear distinct.

Initially, variability in these features was attributed to ontogenetic sampling. However, the maximum femur length (FL) (400 mm) and general FL distribution are near equivalent, falling within the range of 250-400 mm in both samples. Moreover, ordinary least-squares regressions of length against transverse width of the proximal and distal femur indicate gross femoral proportions from the Suarez Site overlap the near full range of variation observed in *F. utahensis*. Finally, paleohistological data from both samples indicates comparable growth stages are represented, supporting the taxonomic as opposed to ontogenetic distinction of the Suarez materials. Several cranial elements have been recovered from the Suarez Site including a postorbital, frontal, quadrate, lacrimal, jugal, and dentary, yielding new information of phylogenetic interest.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

PRELIMINARY REPORT ON A NEW MIDDLE PLEISTOCENE (> 700 KA) HORSE (*EQUUS* SP.) SPECIMEN FROM YUKON, CANADA.

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Horse (*Equus* sp.) fossils are common from the Pleistocene faunas of Eastern Beringia, the unglaciated regions of Alaska (USA) and Yukon, Northwest Canada. At least four types of fossil horses can be identified in in Yukon: (1) *E. lambei* (most common; smallest body size); (2) *E.* cf. *scotti* (medium size); (3) *E.* cf. *verae* (large Sussemoid from Old Crow Basin); and (4) North American stilt-legged. Most of these identifications are based on isolated specimens with little stratigraphic or chronological data. Ancient genetic analysis has questioned many of the described fossil *Equus* species, suggesting that all late Pleistocene horses belong to a single Holarctic species, except for the endemic North American stilt-legged horses.

In 2011, new *Equus* sp. material was recovered from a placer gold mining locality on Paradise Hill in the Klondike region of west-central Yukon. A partial cranium, complete mandible, and several post-cranial elements were recovered in situ within frozen gravel stratigraphically below loess sediments that, based on tephras, place the horse within the Middle Pleistocene (>700 ka). Preliminary measurements on the 3rd metatarsal, and overall cranial dimensions suggests the Paradise Hill specimen is larger than the common Late Pleistocene *E. lambei* from the region and closer in size to *E. scotti*. For the upper cheek teeth, the protocone on the P2 is short and rounded; on the P3 and M1, short and triangular; and on the P4, M2—M3 are long, shallow and wrinkled. A single well-developed mandibular canine is present, indicating the fossils are from a male, and tooth wear suggests it was an adult (~6–8 years in age). The left 3rd mandibular incisor has a closed, rounded infundibula. The lower cheek teeth all exhibit relatively broad, flattened, and angular shaped lingualflexids (though more 'U' shaped than 'V' shaped). The ectoflexids on the upper molars are deep and enter into the isthmus (with slight penetration on the M2 and M3), while the position of the ectoflexid on the P3 and P4 relative to the pre-and postflexid are intermediate. Several of these characters are consistent with those of caballine horses, though the lingualflexids on the Paradise Hill *Equus* specimen are less distinctly 'U' shaped and the molar ectoflexid are deeper than those of the common Late Pleistocene caballine *E. lambei* from Yukon. Further work, including morphometrics, detailed dental descriptions and ancient DNA are in progress to further refine the species determination of the Middle Pleistocene Paradise Hill *Equus* fossils.

Technical Session II (Wednesday, November 5, 2014, 10:30 AM)

PHYLOGENETIC ANALYSIS OF NEOPLAGIAULACIDAE (MAMMALIA, MULTITUBERCULATA) AND ITS IMPLICATIONS

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Neoplagiaulacidae was the taxonomically richest family of multituberculates, with a time span from Aquilan (middle Late Cretaceous) to Chadronian (latest Eocene). All members had a single pair of blade-like ultimate premolars (p4 and P4). However, the morphology of p4 and P4 were quite diversified within the family. This project presents the first well-resolved phylogeny of neoplagiaulacids, revealing the interrelationships among the major genera within the family (i.e. *Mesodma*, *Ectypodus*, *Parectypodus*, *Neoplagiaulax*, *Mimetodon*, *Xyronomys*, etc.) and evolutionary trends in the bladed premolars.

The phylogenetic analyses of neoplagiaulacids were conducted using parsimony. In the analyses, thirty-five relatively well-studied species of neoplagiaulacids were included. Taxa that have been previously classified as neoplagiaulacids but that lack reliable synapmorphies of neoplagiaucids (e.g. *Xanclomys*) were excluded. *Dakotamys malcolmi*, *Cimexomys gratus*, and *Cimexomys judithae* were included as outgroups. Four selected ptilodontids were included to assess the affinity of ptilodontids. Only dental characters were included because for the majority of species non-dental or postcranial characters were not available. More than one-third of the dental characters used were ratios of metric data. Those characters were coded either as ordered multi-state characters or "as such", and analyses were conducted in both ways.

The resulting most parsimonious trees using the different coding schemes generally agreed with each other on most of the clades and other major fundings. There was a morphological and taxonomic radiation of neoplagiaulacids across the K/Pg boundary. Dominant trends in the bladed premolars after the K/Pg boundary in different lineages included elongation relative to the molars (e.g., *Neoplagiaulax*) and parallel increases in crown height (e.g., *Ectypodus* and *Parectypodus*). *Parectypodus* and *Ectypodus* were found to not be monophyletic, and these taxa await taxonomic revision. Ptilodontids may have evolved from *Parectypodus*, notably by further enlargement of the blades. *Mesodmops dawsonae*, the only included non-North-American neoplagiaulacid, previously thought to be close to *Mesodma* and *Mimetodon* because of its low p4, forms part of a clade together with other Eocene taxa.

Technical Session V (Wednesday, November 5, 2014, 3:00 PM)

LIFE HISTORY DYNAMICS OF THE TIGER SALAMANDER, *AMBYSTOMA TIGRINUM*, IN RESPONSE TO LATE PLEISTOCENE CLIMATE

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The Ziegler Reservoir fossil site in Snowmass Village, CO presents a continuous late Pleistocene fossil record spanning 130-45 Ka between the Bull Lake and Pinedale Glaciations, and consists of fine-grained lake and marsh sediments interbedded with debris flows. Tiger salamanders, *Ambystoma tigrinum,* the most widely distributed salamanders in North America, are present throughout the record. In this study, we apply an understanding of extant tiger salamander populations to the most prolific *Ambystoma* fossil record from North America in order to reconstruct paleoenvironmental conditions at high elevation across a global climate transition. Sampled data represents ~80% of the total collected salamander elements. More than 25 000 elements (Number of Identified Specimens [NISP]) have been identified, including more than 5700 non-atlas vertebrae, and over 400 atlases (MNI). Vertebral morphology is used as proxy for developmental stage, and centrum dimensions are used as proxies for body size. We find no correlation between the energy of the depositional environment (as a function of lithology), and 1) average body size, 2) morphological abundance, and 3) preservation quality (as the ratio of trunk vertebrae: atlas). Percent abundance of aquatic and terrestrial morphs fluctuate around an optimum of 50:50 (± 20) across the entire record, suggesting external controls that regulate population composition via shifts in life history strategy. Neotenic morphs increased in abundance throughout the Sangamon interglacial, coupled with a decrease in the smallest and an increase in the largest neotenic size. Maturation of young larvae into aquatic adults at an early age suggests overcrowding in a highly stable and resource-rich aquatic habitat. In contrast, the abundance of very large neotenes suggests that cannibalism developed as an alternate life history in overcrowded ponds. We find an increasing abundance of large cannibalistic morphs across the glacial-Sangamon interglacial transition. Metamorphosed morphs were on average larger than neotenic morphs throughout the interglacial, suggesting optimal conditions on land that were conducive to post-metamorphic growth. The absence of complete neoteny in the population over ~85 Ka despite optimal aquatic conditions can be attributed to environmental stressors and overpopulation. Changes in *Ambystoma* life history suggests competitive adaptation amongst individuals in a permanent, yet spatially-limited lake surrounded by a warm terrestrial environment during the interglacial period.

Technical Session XIV (Saturday, November 8, 2014, 10:30 AM)

A NEW BASAL NEOCERATOPSIAN (ORNITHISCHIA, CERATOPSIA) FROM THE LATE CRETACEOUS OF CENTRAL CHINA

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Neoceratopsians are a group of derived ceratopsian dinosaurs exclusively known from the Cretaceous of North America, Europe, and Asia. Although the basal members of the Neoceratopsia are similar to more basal ceratopsians in being small in size and having premaxillary teeth, they possess many derived features absent in more basal ceratopsians. Here we report a new basal neoceratopsian based on a specimen recovered from the Upper Cretaceous Xiaguan Formation of Neixiang County, Henan Province, China, which has produced abundant dinosaur egg fossils but few skeletal fossils. The specimen

preserves a partial semi-articulated skeleton including a partial skull. The preserved elements include cervical, dorsal and caudal vertebrae, right humerus, both ilia, ischium, both femora, left tibia, left fibula, left astragalus, left calcaneum, several metatarsals, and pedal phalanges. The new specimen is clearly referable to the Ceratopsia based on the presence of a rostral bone, the narial fossa separated by a flat margin from the ventral margin of the premaxilla, the laterally projected and crested jugal, and the predentary with a wide ventral process. Furthermore, it is inferred to be a neoceratopsian based on the presence of several derived features known only in neoceratopsians such as the rostral with a well-developed lateral process, the antorbital fossa oval in shape, the predentary relatively long and keeled and with beveled dorsal margin, and the postdentary mandibular elements shortened. Several plesiomorphic features suggest that the new neoceratopsian is probably a basal member of the group. For example, the rostral appears unkeeled anteriorly as in basal ceratopsians such as *Chaoyangsaurus*, *Psittacosaurus* and *Liaoceratops*; the nasal horn and the epijugal are absent as in basal ceratopsians; the jugal crest is low and ridge-like unlike the prominent one in more derived neoceratopsians; the femoral fourth trochanter is pendent as in *Psittacosaurus* and other basal neoceratopsians. The most salient feature of this new basal neoceratopsian is the edentulous premaxilla, which is not known in other basal neoceratopsians. This new specimen adds to our knowledge of neoceratopsian diversity, and it suggests the character evolution in neoceratopsians is more complex than previously thought.

Poster Session IV (Saturday, November 8, 2014, 4:15 - 6:15 PM)

NEW CETACEAN AND SIRENIAN FAUNAS AND SEA LEVEL CHANGE IN THE SAMLAT FORMATION, UPPER EOCENE, NEAR AD-DAKHLA IN SOUTHWESTERN MOROCCO

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The Eocene Guerran Member of the Samlat Formation is primarily marine siliceous chalk, becoming more clastic farther onshore. In the vicinity of Ad-Dakhla in southwestern Morocco, the Eocene part of the Samlat Formation is exposed in cliffs along the Atlantic coast from south of El Argoub village to the military position commonly named “Garitas”. This sequence of strata was divided it into three units. The lower unit (Unit 1) includes some 22 m of rhythmically-bedded, chert-rich marine siltstones and marls. These are overlain by 1–1.5 m of vertebrate-bearing conglomeratic sandstone, another 4–8 m of rhythmically-bedded siltstone and marl, and a second 3–6 m unit of vertebrate-bearing muddy sandstone (Unit 2). Bonebeds B1 and B2 are both located in Unit 2. The highest unit (Unit 3) is a 2–3 m interval of sandy to bioclastic limestone of Neogene age.

Cetacean skeletons are rare but cetacean vertebrae are common in the lower sandstone (bed B1), where many show the effects of reworking. The cetaceans in bed B1represent a minimum of five species, from smallest to largest: cf. *Saghacetus* sp., cf. *Stromerius* sp., *Dorudon atrox*, cf. *Dorudon* sp., and *Basilosaurus isis*. Bed B1 yields rib fragments that may represent sirenians, but sirenians, if present, are rare. The only identifiable cetacean found in the upper sandstone (bed B2) is *Basilosaurus* sp. Dugongid sirenians identified as cf. *Eosiren* sp. are the most common mammal in bed B2. We interpret co-occurrence of the typically early Priabonian species *Dorudon atrox* and *Basilosaurus isis* with smaller species more like middle Priabonian genera *Saghacetus osiris* and *Stromerius nidensis* to indicate that bed B1 was deposited during low sea stand Pr-2 between the early and middle Priabonian (between the early and middle late Eocene). Bed B2 is separated from B1 by an interval of deeper water sediment accumulation. Bed B2 could represent a later phase of Pr-2 or a subsequent Priabonian low sea stand (possibly Pr-3).

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SVP 75th Annual Meeting

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