

# JVP

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Program and Abstracts



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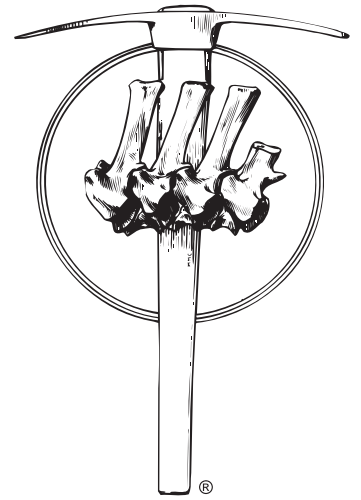
12 September 2007



## 67th Annual Meeting Society of Vertebrate Paleontology

The Jackson School of Geosciences  
University of Texas  
Austin, Texas USA  
October 17-20, 2007

Society of Vertebrate Paleontology  
ISSN 0272-4634



# Save the Date!

[www.vertpaleo.org](http://www.vertpaleo.org)



# Cleveland, Ohio



# SVP

## 68th Annual Meeting October 15–18, 2008

Renaissance Cleveland Hotel  
Cleveland, OH, USA

# JOURNAL OF VERTEBRATE PALEONTOLOGY

VOLUME 27, SUPPLEMENT TO NUMBER 3

September 2007

## ABSTRACTS OF PAPERS

### SIXTY-SEVENTH ANNUAL MEETING

SOCIETY OF VERTEBRATE PALEONTOLOGY

THE JACKSON SCHOOL OF GEOSCIENCES AT

THE UNIVERSITY OF TEXAS, AUSTIN

HILTON AUSTIN

AUSTIN, TEXAS

OCTOBER 17–20, 2007

#### HOST COMMITTEE

Christopher J. Bell, Chair; Timothy Rowe, Arthur Busbey, Brenda J. Chinnery-Allgeier, Eric Ekdale, Christian George, Chris Jass, Tom Lehman, Ernest Lundelius, Lyndon Murray, Martin Sander

#### EXECUTIVE COMMITTEE

Catherine Badgley, President; Blaire VanValkenburgh, Vice-President; Annalisa Berta, Past-President; Christopher A. Brochu, Secretary; Louis H. Taylor, Treasurer; P. David Polly, Member-at-Large; Jaelyn Eberle, Member-at-Large; Michael Gottfried, Member-at-Large

#### SYMPOSIUM CONVENORS

Jason Anderson, Thomas Eiting, Anthony Friscia, Anjali Goswami, Gregg Gunnell, H. Gregory McDonald, Andrew Milner, Eric Scott, Nancy Simmons

#### PROGRAM COMMITTEE

Jason Head, Chair; J. David Archibald, Jonathan Bloch, Gregory Buckley, Matthew Carrano, Kristi Curry Rogers, Ted Daeschler, Eric Dewar, David Froehlich, Michael Gottfried, F. Robin O'Keefe, Emily Rayfield, Rebecca Terry



# Welcome to Austin!

October 17–20, 2007

## To all of us attending the 67th meeting of SVP,

The Jackson School of Geosciences at the University of Texas has provided an unprecedented level of support for the annual meeting in the form of two substantial donations. One donation of \$15,000 provides student-member travel funds for travel to the Austin meeting. SVP members have matched this \$15,000 as a contribution to the student travel fund for travel to future meetings. A second donation greatly enlarges the base from which student-member travel funds will be drawn, thereby ensuring the availability of student travel awards well into the future. We heartily thank Dean Barron and the Austin Host Committee for this level of support. Their generosity and commitment set a new precedent for support of SVP.

Thank you,

Catherine Badgley  
President  
The Society of Vertebrate Paleontology



THE UNIVERSITY OF TEXAS AT AUSTIN  
**JACKSON**  
SCHOOL OF GEOSCIENCES

Austin is home to many famous museums and facilities that present numerous opportunities for engagement and entertainment beyond the confines of the meeting hotel! A few of the many attractions in and around the Austin area are highlighted below. For more information about Austin, visit <http://www.austin-texas.org/>. Enjoy your stay!

### Blanton Museum of Art

The newly-opened Blanton Museum of Art is the largest university art museum in the United States, with a spectacular building situated at the southern end of the central UT Campus. The museum sits at the NE corner of Congress Ave. and Martin Luther King Jr. Blvd., across the street from the Texas State History Museum. Paid parking is available at the Brazos Parking Garage on the UT campus or in the underground garage at the Texas State History Museum across the street. Visit the Web site at <http://blantonmuseum.org> for information on exhibits tours, and facilities. Phone 512-471-7324 for more information.

### Bob Bullock Texas State History Museum

The Bob Bullock Texas State History Museum opened in 2001 with three floors of exhibit space, an IMAX theatre, and a café with indoor and outdoor seating. The Museum is located at the SW corner of Congress Ave. and Martin Luther King Jr. Blvd. An underground garage is available for paid parking. Visit the Web site at [www.thestoryoftexas.com](http://www.thestoryoftexas.com) for information on exhibits, tours and facilities. Phone 512-936-8746 for more information.

### Dino Pit

The Dino Pit is an outdoor paleontology exhibit at the Austin Nature and Science Center in Zilker Park. It is a family-oriented site where visitors can conduct excavations in several sand-filled pits to discover casts of Texas fossil vertebrates. Each pit represents a different time and fauna (Permian terrestrial, Cretaceous marine, Cretaceous terrestrial, early Tertiary, and Late Pleistocene). It is located at 301 Nature Center Drive in Austin. Phone 512-327-8180 for more information.

### Hartman Prehistoric Garden

The Hartman Prehistoric Garden is a 1.5-acre living exhibit in the Zilker Botanical Gardens featuring plants that represent major extant lineages of groups that were dominant in the late Mesozoic. The garden is nested within limestone cliffs, four ponds, and a large waterfall. A centerpiece of the garden is a fantastic bronze statue of an ornithomimid dinosaur crafted by the TMM exhibits designer John Maisano. The Garden is located at 2220 Barton Springs Road. For more information phone 512-477-8672, or visit [www.zilker garden.org/gardens/dino.html](http://www.zilker garden.org/gardens/dino.html).

### Texas Memorial Museum

The Texas Memorial Museum is the exhibit facility for the Texas Natural Science Center. It is located on the main University of Texas campus, at 2400 Trinity Street. A newly designed and completely renovated Paleontology Exhibit Hall highlights some of the Museum's finest fossil specimens, and is associated with a working paleontology laboratory and fossil discovery cabinets. For more information, phone 512-471-1604, or visit <http://www.utexas.edu/tmm/>.

### Lyndon Baines Johnson Library and Museum

The LBJ Presidential Library is administered by the National Archives and Records Administration. The Museum cultural and historical exhibits are open to the public, and admission is free. The facility is located on the University of Texas at Austin campus at 2313 Red River St. For more information, phone 512-721-0200.

### Lady Bird Johnson Wildflower Center

The Lady Bird Johnson Wildflower Center is dedicated to education and research about wildflowers and other native plants. In 2006 the facility became an Organized Research Unit of the University of Texas at Austin. Public gardens and viewing areas display native plants and flowers of the Texas hill country, and a series of walking trails allow public access to naturally-vegetated areas and research plots. The center is located in the hill country, at 4801 La Crosse Avenue, about a 20-minute drive southwest of the University of Texas campus. For more information call 512-232-0100 or visit <http://www.wildflower.org/>.

### Congress Avenue Bats

The Congress Avenue Bridge over Town Lake in downtown Austin is home to the largest urban bat colony in North America. Between March and November, an estimated 1.5 million Mexican free-tail bats reside under the bridge, and emerge at dusk to forage above the surrounding landscape. A visit to the bridge is an excellent opportunity to augment your experiences in the *Evolutionary History of Bats* Symposium at the meeting! For information, contact Bat Conservation International at 512-327-9721 or visit <http://www.austincityguide.com/content/congress-bridge-bats-austin.asp>.

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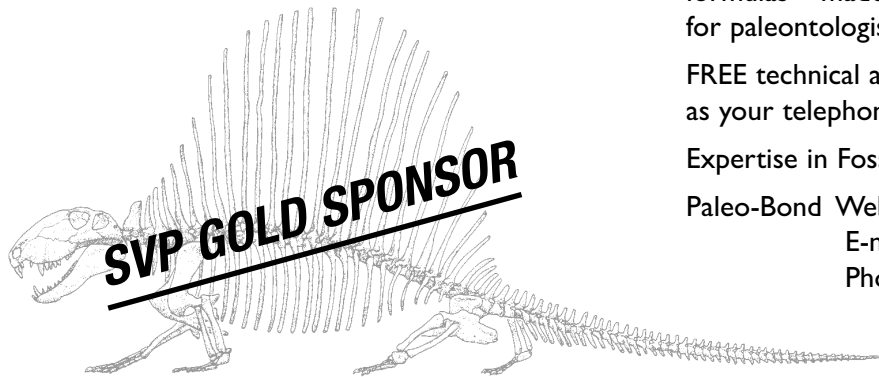
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## 2007 SVP Schedule of Events (subject to change)

All functions are located at the Hilton Austin unless otherwise noted

Event/Functions	Tuesday, October 16	Wednesday, October 17	Thursday, October 18	Friday, October 19	Saturday, October 20
Registration/ Membership Desk	4 pm - 7 pm Grand Ballroom Foyer	7 am - 5 pm Grand Ballroom Foyer	7 am - 5 pm Grand Ballroom Foyer	8 am - 5 pm Grand Ballroom Foyer	8 am - 5 pm Grand Ballroom Foyer
Plenary Session/Welcome		8 am - 8:15 am Grand Ballroom H			
Symposium		8:15 am - 12:30 pm Faunal Dynamics and Extinction in the Quaternary A Symposium Honoring Ernest L. Lundelius, Jr. Governor's Ballroom A	8 am - 12:15 pm Symposium: Fossils, Molecules and Morphology-Evolutionary History of Bats Governor's Ballroom A	8 am - 12:15 pm Symposium: The Dinosauridea - Focus on an Early Amphibian Radiation Governor's Ballroom A	8 am - 12:15 pm Symposium: Carnivora: Phylogeny, Form and Function Governor's Ballroom A
A.S. Romer Prize Presentations			8 am - 12:30 pm Grand Ballroom H		
Preparators' Session			8 am - 12:15 pm Governor's Ballroom B		
Technical Session		8:15 am - 12:30 pm Tech Session I Grand Ballroom H		8 am - 12:15 pm Technical Session IX Grand Ballroom H	8 am - 12:15 pm Technical Session XIV Grand Ballroom H
Technical Session		8:15 am - 12:30 pm Tech Session II Governor's Ballroom B		8 am - 12:15 pm Technical Session X Governor's Ballroom B	8 am - 12:15 pm Technical Session XV Governor's Ballroom B
Technical Session		1:30 pm - 4 pm Technical Session III Governor's Ballroom A	1:30 pm - 4 pm Technical Session VI Governor's Ballroom A	1:15 pm - 3:15 pm Technical Session XI Governor's Ballroom A	1:15 pm - 4 pm Technical Session XVI Governor's Ballroom A
Technical Session		1:30 pm - 4 pm Technical Session IV Grand Ballroom H	1:30 pm - 4 pm Technical Session VII Grand Ballroom H	1:15 pm - 4 pm Technical Session XII Grand Ballroom H	1:15 pm - 4 pm Technical Session XVII Grand Ballroom H
Technical Session		1:30 pm - 4 pm Technical Session V Governor's Ballroom B	1:30 pm - 4 pm Technical Session VIII Governor's Ballroom B	1:15 pm - 3:15 pm Technical Session XIII Governor's Ballroom B	1:15 pm - 4 pm Technical Session XVIII Governor's Ballroom B
Workshops/Educational Events/Workshops/ Educational Events		12:30 pm - 1:30 pm SVP Town Meeting on Evolution V Grand Ballroom H		Noon - 2 pm Communicating with the Media Meeting Room 406  Women in Paleontology Luncheon 12:15 - 1:15 pm Governor's Ballroom	8:30 am - 4 pm Teachers' Workshop Meeting Room 412

## 2007 SVP Schedule of Events (subject to change)

All functions are located at the Hilton Austin unless otherwise noted

Event/Functions	Tuesday, October 16	Wednesday, October 17	Thursday, October 18	Friday, October 19	Saturday, October 20
Poster Set-up		7:30 am - 9:30 am Poster I Set-up Grand Ballroom J/K	7:30 am - 9:30 am Poster II Set-up Grand Ballroom J/K	7:30 am - 9:30 am Poster III Set-up Grand Ballroom J/K	7:30 am - 9:30 am Poster IV Set-up Grand Ballroom J/K
Poster Viewing		9:30 am - 6 pm Poster I Viewing Grand Ballroom J/K	9:30 am - 6 pm Poster II Viewing Grand Ballroom J/K	9:30 am - 6 pm Poster III Viewing Grand Ballroom J/K	9:30 am - 6 pm Poster IV Viewing Grand Ballroom J/K
Poster Reception		4 pm - 6 pm Grand Ballroom J/K	4 pm - 6 pm Grand Ballroom J/K	4 pm - 6 pm Grand Ballroom J/K	4 pm - 6 pm Grand Ballroom J/K
Exhibit Viewing			9:30 am - 4 pm Grand Ballroom F/G	9:30 am - 4 pm Grand Ballroom F/G	9:30 am - 4 pm Grand Ballroom F/G
Annual Business Meeting/Open Executive Committee Meeting			5:30 pm - 7 pm Grand Ballroom H		12:15 pm - 1:15 pm Grand Ballroom H
Press Conference			4 pm - 5 pm Meeting Room 412		
Social Events		Welcome Reception 7 pm - 10 pm Buffalo Billiards	Student Roundtable Forum & Registration Exchange 8 pm - 10 pm Governor's Ballroom C	Auction/Reception 6:30 pm - 11 pm Governor's Ballroom	Awards Banquet 7 pm - 10 pm Governor's Ballroom  After Hours Party 10 pm - 2 am Governor's Ballroom Foyer
Beverage Service		7 am - 8 am Grand Ballroom Foyer	7 am - 8 am Grand Ballroom Foyer	7 am - 8 am Grand Ballroom Foyer	7 am - 8 am Grand Ballroom Foyer
Beverage Service		10 am - 10:15 am Grand Ballroom Foyer	10 am - 10:15 am Grand Ballroom Foyer	10 am - 10:15 am Grand Ballroom Foyer	10 am - 10:15 am Grand Ballroom Foyer
Speaker Ready Room	4 pm - 7 pm Meeting Room 404	7 am - 5 pm Meeting Room 404	7 am - 5 pm Meeting Room 404	7 am - 5 pm Meeting Room 404	7 am - 3 pm Meeting Room 404
Committee Mtg. Rooms		7 am - 7 pm Board Room 401	7 am - 7 pm Board Room 401	7 am - 7 pm Board Room 401	7 am - 7 pm Board Room 401
Committee Mtg. Rooms		7 am - 7 pm Meeting Room 406	7 am - 7 pm Meeting Room 402	7 am - 7 pm Meeting Room 406	
Committee Mtg. Rooms		7 am - 7 pm Meeting Room 412	7 am - 7 pm Meeting Room 412	7 am - 7 pm Meeting Room 412	

# Program at a Glance

TIME	Wed. 1	Wed. 2	Wed. 3	Thurs. 1	Thurs. 2	Thurs. 3	Fri. 1	Fri. 2	Fri. 3	Sat. 1	Sat. 2	Sat. 3
8:00 a.m.		Welcome	Dias da Silva	Dumont	Terry	Thompson	Carrol	Mateus	Kemp	Wolsan	Stocker	Luo
8:15 a.m.	McDonald	Maiolino	Harrison	Baker	Gates	Supplee	Witzman	Boyd	Kilbourne	Veron	Parker	Martin
8:30 a.m.	Ferrusquia-Villafranca	Rose		Teeling	Finarelli	Bover	Reisz	Richter	Williamson	Flynn	Kelner	Wilson
8:45 a.m.	Schultz	Koenigswald	Sidor	Eiting	Sipla	Davidson	Lillich	Schulp	Missiaen	Goswami	Langer	Giallombardo
9:00 a.m.	Sagebiel	Silcox	Ruta	Hand	Adam	Groenke	Millner	Butler	Wang	Holliday	Nesbitt	Weil
9:15 a.m.	Akersten	Beard	Sumida	Morgan	Jones	Cavigelli	Berman	Knoll	Bajpai	Benoit	Gignac	Case
9:30 a.m.	Burns	Kirk	Mueller	Gunnell	Boyer	Kaye	Maddin	Makovicky	Stucky	Friscia	Manning	Archibald
9:45 a.m.	Mead	Bloch	Tsuji	Van Den Bussche	Smith	Newman	Dlikes	Varricchio	Wood	Kawakami	Tsuhiji	Wood
10:00 a.m.	Schubert	Cuozzo	Tabor	COFFEE	COFFEE	COFFEE	COFFEE	COFFEE	COFFEE	COFFEE	COFFEE	COFFEE
10:15 a.m.	COFFEE	COFFEE	COFFEE	Sigé	Porro	Smith	Wernerberg	Weishampel	Croft	Werdeln	Shychoski	George
10:30 a.m.	Churcher	Flagle	Smith	Horacek	Bever	Shaw	Sanchez	Cuthbertson	Colbert	Wesley-Hunt	Smith	Beck
10:45 a.m.	Saunders	Grossman	Steyer	Hutcheon	Hinic-Frlög	Fox	Clack	Gangloff	Clyde	Yeakel	Brusatte	Rowe
11:00 a.m.	Springer	Folinsbee	Botha-Brink	Pedersen	Lee	Deck	Fröbisch	Evans	Walsh	Polly	Xu	Maga
11:15 a.m.	Harris	Gilbert	Huttenlocker	Czaplewski	Sansom	Stoehr	Bolt	Horner	Chew	Lewis	Balanoff	Roberts
11:30 a.m.	Semken	McBrearty	Fröbisch	Maitre	Samman	Brown	Sigurdson	Sullivan	Smith	Morlo	Turner	Weisbecker
11:45 a.m.	Bell	de Ruitter	Jasnoski	Habersetzer	Ksepka	Stevens	Anderson	Yates	Penkrot	Slater	Lamanna	Crompton
12:00 p.m.	Graham	Weston	Angielczyk	Simmons	Triche	Brown	Baez	Barrett	Secord	Wroe	Milner	Ruf
12:15 p.m.	Scott	Padian	Benton	LUNCH	Noto	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
12:30 p.m.	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
12:45 p.m.	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
1:00 p.m.	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
1:15 p.m.	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	Zack	Clementz	Li	Flynn	Wings	Zalmout
1:30 p.m.	Fox-Dobbs	Chapman	Evans	Foss	Chang	Hieronymus	Tsubamoto	Bibi	Hutson	Samuels	Curry Rogers	Beatty
1:45 p.m.	MacFadden	Miller	Sander	Holroyd	Goujet	Dufeau	Seymour	Biasatti	Maxwell	McGuire	Werning	Thewissen
2:00 p.m.	Fisher	Pobiner	Phillips	Brakora	Daeschler	Holliday	Tseng	DeSantis	Gishlick	MacPhee	Erickson	Bebej
2:15 p.m.	Rountrey	Irmis	O'Keefe	Sempregon	Tissandier	Owerkowicz	Wang	Strömberg	Rayfield	Winkler	Gatesy	Gingerich
2:30 p.m.	Gohman	Brady	Motani	Davis	Xu	Sadleir	Meachen-Samuels	Belmaker	Knight	Evans	Jackson	Uhen
2:45 p.m.	Dirks	Travouillon	Joyce	Macrini	Woodward	Drumheller	Wallace	Matson	Clarke	Green	Winkler	Pyenson
3:00 p.m.	Shockey	Hopkins	Folle	Clifford	Ostrowski	Stanton	Spaulding	Alroy	Stidham	Kalthoff	Sankey	Racicot
3:15 p.m.	Rincón	Daniel	Bhullar	Theodor	Ahlberg	Wheatley	Auction set up	Fahlke	Auction set up	Seiffert	Britt	Werth
3:30 p.m.	Tomiyia	Klug	Head	Hooker	Boisvert	Hastings	Auction set up	Fox	Auction set up	Barrow	Jinnah	Armfield
3:45 p.m.	Rivals	Pumell	Conrad	Mihlbachler	da Silva	Brochu	Auction set up	Koch	Auction set up	Sanders	Holtz	Churchill
4:00 p.m.												
4:15 p.m.												
4:30 p.m.												
4:45 p.m.												
5:00 p.m.												
5:15 p.m.												
5:30 p.m.												
5:45 p.m.												
6:00 p.m.												
Poster Session I												
Poster Session II												
Poster Session III												
Poster Session IV												



## WEDNESDAY MORNING, OCTOBER 17, 2007

### SYMPOSIUM: FAUNAL DYNAMICS AND EXTINCTION IN THE QUATERNARY: A SYMPOSIUM HONORING ERNEST L. LUNDELIUS, JR.

GOVERNOR'S BALLROOM SALON A

**MODERATORS: ERIC SCOTT AND H. GREGORY MCDONALD**

- 8:15 McDonald, H., Bryson, R. CLIMATIC PARAMETERS AND THE PALEOECOLOGY OF PLEISTOCENE MAMMALS: THE USE OF THE MACROPHYSICAL CLIMATE MODEL
- 8:30 Ferrusquia-Villafranca, I., Arroyo-Cabrales, J., Martinez Hernandez, E. and Gama-Castro, J. PLEISTOCENE MAMMALS OF MEXICO: A CRITICAL REVIEW OF REGIONAL CHRONOFAUNAS, BIOGEOGRAPHIC PROVINCIALITY AND CLIMATE CHANGE RESPONSE
- 8:45 Schultz, G. PLEISTOCENE (IRVINGTONIAN, CUDAHYAN) VERTEBRATES FROM THE TEXAS PANHANDLE AND THEIR GEOGRAPHIC AND PALEOECOLOGIC SIGNIFICANCE
- 9:00 Sagebiel, J. THE LATE PLEISTOCENE VERTEBRATE FAUNA FROM ZESCH CAVE, MASON COUNTY, TEXAS
- 9:15 Akersten, W., Yensen, E. and Mead, J. THE JAGUAR CAVE ENTRANCE FAUNA: ~ 40,000 BP HIGH ALTITUDE MICROVERTEBRATES NEAR THE CONTINENTAL DIVIDE IN EASTERN IDAHO
- 9:30 Burns, J. MAMMALIAN FAUNAL DYNAMICS IN LATE PLEISTOCENE ALBERTA, CANADA: "I KNOW THEY CAME THIS WAY, WHICH WAY DID THEY GO?"
- 9:45 Mead, J., White, R., Hollenshead, M., Baez, A. and Carpenter, M. LATE PLEISTOCENE *CYNOMYS* (RODENTIA, SCIURIDAE, PRAIRIE DOG) FROM NORTHWESTERN SONORA, MEXICO
- 10:00 Schubert, B. AN UPDATE ON THE PALEOBIOLOGY OF GIANT SHORT-FACED BEARS, *ARCTODUS SIMUS*
- 10:15 BREAK
- 10:30 Churcher, C. THE CAPE ZEBRA (*EQUUS CAPENSIS*) IN THE LATE PLEISTOCENE AND HOLOCENE OF AFRICA, AND THE NATURALLY RESTRICTED DISTRIBUTION OF EQUIDS IN AFRICA
- 10:45 Saunders, J., Campbell, G., McCullum, J. and Treworgy, J. "A NEW LAND OF THE EYE": PARADIGMS AND PROBOSCIDEANS IN THE SOUTHERN GREAT LAKES REGION, USA
- 11:00 Springer, K., Scott, E., Sagebiel, J. and Murray, L. THE DIAMOND VALLEY LAKE LOCAL FAUNA: LATE PLEISTOCENE VERTEBRATES FROM INLAND SOUTHERN CALIFORNIA
- 11:15 Harris, J. and Ward, J. LATE PLEISTOCENE ENVIRONMENT AT RANCHO LA BREA
- 11:30 Semken, H. and Graham, R. AMS 14C ANALYSIS OF LATE PLEISTOCENE NON-ANALOG (DISHARMONIOUS) FAUNAL COMPONENTS FROM CAVE DEPOSITS IN SOUTHEASTERN NORTH AMERICA
- 11:45 Bell, C. APOMORPHIES, PRECONCEPTIONS, THE PULL OF THE RECENT, AND CIRCULARITY: A CRITICAL LOOK AT NORTH AMERICAN QUATERNARY VERTEBRATE FAUNAL DYNAMICS
- 12:00 Graham, R. THE ROLE OF NON-ANALOG BIOTAS IN THE TERMINAL PLEISTOCENE EXTINCTION
- 12:15 Scott, E. EXTINCTIONS, SCENARIOS, AND ASSUMPTIONS: CHANGES IN LATEST PLEISTOCENE LARGE HERBIVORE ABUNDANCE AND DISTRIBUTION IN WESTERN NORTH AMERICA

### TECHNICAL SESSION I

AUSTIN GRAND BALLROOM SALON H

**MODERATORS: WIGHART VON KOENIGSWALD AND KAILA FOLINSBEE**

- 8:00 WELCOME AND INTRODUCTORY STATEMENTS
- 8:15 Maiolino, S. and Boyer, D. EVIDENCE FROM CLAW MORPHOLOGY FOR A DIVERSITY OF POSITIONAL BEHAVIORS IN PLESIADAPID "PLESIADAPIFORMS"
- 8:30 Rose, K., Rana, R., Singh, L., Sahni, A. and Smith, T. EARLY EOCENE PRIMATES FROM PENINSULAR INDIA
- 8:45 Koenigswald, W., Ruf, I. and Gingerich, P. WELL PRESERVED SKULL OF A EUROPEAN APATEMYID (MAMMALIA) FROM THE PHOSPHORITES DU QUERCY
- 9:00 Silcox, M., Bloch, J., Boyer, D. and Houde, P. CRANIAL ANATOMY OF *LABIDOLEMUR KAYI* AND THE RELATIONSHIPS OF THE APATEMYIDAE
- 9:15 Beard, K.C. THE OLDEST NORTH AMERICAN EUPRIMATES (OMOMYIDAE: *TEILHARDINA* SP. NOV.) AND MAMMALIAN BIOGEOGRAPHY NEAR THE PALEOCENE-EOCENE BOUNDARY

- 9:30 Kirk, E. and Williams, B. NEW SPECIMENS OF *MYTONIUS* (PRIMATES, OMOMYOIDEA) FROM THE DEVIL'S GRAVEYARD FORMATION, TEXAS
- 9:45 Bloch, J. and Boyer, D. THE OLDEST NORTH AMERICAN RODENT SKELETON: EVALUATION OF THE COMPETITION HYPOTHESIS IN PALEOCENE PRIMATE EVOLUTION
- 10:00 Cuozzo, F. and Sauter, M. PATTERNS OF DENTAL PATHOLOGY IN SYMPATRIC LIVING LEMURS (*LEMUR CATTALIA* AND *PROPLITHECUS VERREAUXI*) INDICATE EVOLUTIONARY DISEQUILIBRIUM IN MADAGASCAR
- 10:15 BREAK
- 10:30 Fleagle, J., Gilbert, C. and Baden, A. COMPARING PRIMATE CRANIA : THE VALUE OF FOSSILS
- 10:45 Grossman, A. and Semprebon, G. LOW MAGNIFICATION DENTAL MICROWEAR OF EARLY AND MIDDLE MIOCENE CATARRHINES FROM AFRICA: IMPLICATIONS FOR DIETARY DIVERSITY
- 11:00 Folinsbee, K. HISTORICAL BIOGEOGRAPHY OF PAPIONIN MONKEYS AND CORRELATED PATTERNS IN PLIO-PLEISTOCENE VERTEBRATES
- 11:15 Gilbert, C. A NEW GENUS OF PAPIONIN MONKEY FROM THE PLIO-PLEISTOCENE OF SOUTH AFRICA AND THE BIOGEOGRAPHY OF THE *CERCOCEBUS/MANDRILLUS* CLADE.
- 11:30 McBrearty, S. FIRST FOSSIL CHIMPANZEE
- 11:45 de Ruiter, D. ANIMAL PALEOCOMMUNITY VARIABILITY AND HABITAT SPECIFICITY OF *AUSTRALOPITHECUS ROBUSTUS* IN SOUTH AFRICA
- 12:00 Weston, E. and Lister, A. BRAIN SIZE AND INSULAR DWARFISM: A CASE STUDY OF THE EXTINCT DWARF HIPPOPOTAMUSES FROM MADAGASCAR
- 12:15 Padian, K. HOW VERTEBRATE PALEONTOLOGISTS CAN CHANGE THE PUBLIC UNDERSTANDING OF EVOLUTION

## TECHNICAL SESSION II

GOVERNOR'S BALLROOM SALON B

**MODERATORS: MICHAEL BENTON AND JOHANNES MUELLER**

- 8:15 Dias da Silva, S. and C. Marsicano. THE PHYLOGENETIC POSITION OF *SANGAIA LAVINAI* AND STATUS OF THE RHYTIDOSTEIDAE (STEREOSPONDYLI: TREMATOSAURIA)
- 8:30 Harrison, L. and Larsson, H. MOLECULAR EVOLUTION AND CORRELATION OF *HOXA-11* AND *HOXA-13* GENES TO SKELETAL EVOLUTION AND GENE EXPRESSION CHANGES ACROSS THE FIN TO LIMB TRANSITION
- 8:45 Sidor, C., Damiani, R., Hammer, W. and Steyer, J.S. NEW TEMNOSPONDYLS FROM THE TRIASSIC OF ANTARCTICA
- 9:00 Ruta, M. and Benton, M. CALIBRATED DIVERSITY, TREE TOPOLOGY AND THE MOTHER OF MASS EXTINCTIONS: THE LESSON OF TEMNOSPONDYLS
- 9:15 Sumida, S. and Dodick, J. A NEW GENUS AND SPECIES OF CAPTORHINID REPTILE FROM THE LOWER PERMIAN OF NORTH-CENTRAL TEXAS ILLUSTRATING THE COMPLEXITY OF SIZE AND CRANIODENTAL EVOLUTION IN THE CAPTORHINIDAE
- 9:30 Mueller, J., Reisz, R., Chatterjee, S. and Kutty, T. S. A PASSAGE TO INDIA: A SMALL CAPTORHINID FROM THE UPPER PERMIAN KUNDARAM FORMATION AND THE POSTGLACIAL DISPERSAL OF EARLY REPTILES.
- 9:45 **Tsuji, L. and Mueller, J.** MIDDLE EAR EVOLUTION AND IMPEDANCE-MATCHING HEARING IN PARAREPTILIA
- 10:00 Tabor, N., Thomas, S., Sidor, C., Looy, C. and Steyer, J.S. PALEOCLIMATIC INDICATORS FROM THE MORADI FORMATION OF NIGER INDICATE PROGRESSIVE ARIDIFICATION OF CENTRAL PANGAEA DURING THE PERMIAN
- 10:15 BREAK
- 10:30 Smith, R., Sidor, C., Tabor, N., Steyer, J.S. and Chaney D. VERTEBRATE TAPHONOMY OF A PERMIAN "WET DESERT" IN CENTRAL PANGAEA
- 10:45 Steyer, J.S., Gand, G., Smith, R., Sidor, C. and Tabor, N. THE FIRST TETRAPOD TRACKWAYS FROM THE PALEOZOIC OF WEST AFRICA: ONE STEP TOWARDS RECONSTRUCTING THE LANDSCAPE OF CENTRAL PANGAEA

- 11:00 Botha-Brink, J. and Modesto, S. EVIDENCE OF SOCIAL AGGREGATION IN A PALEOZOIC BASAL SYNAPSID ('PELYCOSAUR') FROM SOUTH AFRICA
- 11:15 Huttenlocker, A., Rega, E. and Sumida, S. NEW HISTOLOGICAL INVESTIGATIONS OF HYPERELONGATE NEURAL SPINES IN EUPELYCOSAURS (AMNIOTA: SYNAPSIDA) AND THE AFFINITIES OF *LUPEOSAURUS KAYI*
- 11:30 Fröbisch, J. and Reisz, R. GLOBAL TAXONOMIC DIVERSITY OF ANOMODONTS (THERAPSIDA) ACROSS THE PERMIAN-TRIASSIC BOUNDARY
- 11:45 Jasinowski, S., Rayfield, E. and Chinsamy, A. ELUCIDATION OF DICYNODONT CRANIAL FUNCTION USING FINITE ELEMENT ANALYSIS
- 12:00 Angielczyk, K., Roopnarine, P. and Wang, S. DOES EXTINCTION RESISTANCE EXPLAIN CHANGES IN TROPHIC NETWORK STRUCTURES IN TERRESTRIAL VERTEBRATE COMMUNITIES?
- 12:15 Benton, M., Ruta, M., Twitchett, R., Valentin, T. and Surkov, M. MASS EXTINCTION OF TETRAPODS AT THE PERMO-TRIASSIC BOUNDARY IN RUSSIA

### WEDNESDAY AFTERNOON, OCTOBER 17, 2007

#### TECHNICAL SESSION III

GOVERNOR'S BALLROOM SALON A

**MODERATORS: BRUCE MACFADDEN AND FLORENT RIVALS**

- 1:30 Fox-Dobbs, K. and Koch, P. MEGAFAUNAL CARNIVORE SPECIES INTERACTIONS AND DIETS IN LATE PLEISTOCENE ALASKA
- 1:45 MacFadden, B. and Hulbert, R. REASSESSMENT OF A LATE PLIOCENE (LATE BLANCAN) AGE FOR MAMMOTH FROM FLORIDA: EVIDENCE FROM REE DIAGENESIS
- 2:00 Fisher, D. and Fox, D. LIFE HISTORY AND UNILATERAL LOSS OF MOLAR FUNCTION IN THE COHOES MASTODON: A CASE STUDY IN NUTRITIONAL STRESS?
- 2:15 Rountrey, A., Fisher, D., Mol, D., Lazarev, P., and Boeskorov, G. PRENATAL TO EARLY JUVENILE WOOLLY MAMMOTH LIFE HISTORY AS REVEALED BY STRUCTURAL AND COMPOSITIONAL ANALYSES
- 2:30 Gohman, S., Fox, D., Fisher, D., Vartanyan, S. and Tikhonov, A. PALEODIETARY AND ENVIRONMENTAL IMPLICATIONS OF CARBON AND NITROGEN ISOTOPIC VARIATION IN LATE PLEISTOCENE AND HOLOCENE TUSKS OF *MAMMUTHUS PRIMIGENIUS* FROM NORTHERN EURASIA
- 2:45 Dirks, W. and Bromage, T. ENAMEL MICROSTRUCTURE AND THE TIMING OF PLATE FORMATION IN *ELAPHAS (PALAEOLOXODON) CYPRIOTES*
- 3:00 Shockey, B., Salas, R., Pujos, F., Guyot, J.-L. and Baby, P., PLEISTOCENE CAVE FAUNAS FROM THE ANDES OF CENTRAL PERU: A GLIMPS OF ANDEAN LIFE OF THE GREAT AMERICAN BIOTIC INTERCHANGE
- 3:15 Rincón, A., Parra, G., Prevosti, F., Steadman, D. and Alberdi, M. A NEW PLEISTOCENE VERTEBRATE ASSEMBLAGE IN A TAR PIT FROM EL BREAL DE OROCUAL, NORTHEASTERN VENEZUELA.
- 3:30 Tomiyia, S. PALEOECOLOGY OF LATE PLEISTOCENE MAMMALS FROM PACHECO, CALIFORNIA, AND IMPLICATIONS FOR THE STABILITY OF SMALL MAMMAL COMMUNITIES
- 3:45 Rivals, F., Schulz, R. and Kaiser, T. CLIMATE RELATED NICHE SEGREGATION AND RESOURCE PARTITIONING OF THE UNGULATE FAUNAS FROM THE MIDDLE PLEISTOCENE SUCCESSION (OIS 14-12) AT THE CAUNE DE L'ARAGO CAVE (FRANCE)

#### TECHNICAL SESSION IV

AUSTIN GRAND BALLROOM SALON H

**MODERATORS: MAK PURNELL AND RALPH CHAPMAN**

- 1:30 Chapman, R. and Sadleir, R. THE PERILS OF PINOCCHIO: ROBUSTNESS AND METHOD SELECTION IN GEOMETRIC MORPHOMETRICS
- 1:45 Miller, J. HABITAT DIFFERENTIATION BASED ON TAXON-FREE ANALYSIS OF SKELETAL REPRESENTATION IN YELLOWSTONE NATIONAL PARK, WY

- 2:00 Pobiner, B. TAXON SPECIFICITY IN BONE DAMAGE LEVEL AND TOOTH MARK FREQUENCY INFLICTED BY EXTANT AFRICAN CARNIVORES
- 2:15 Irmis, R., Pyenson, N. and Lipps, J. FORMATION OF MARINE BONEBEDS: INSIGHTS FROM THE MIDDLE MIOCENE SHARKTOOTH HILL BONEBED OF CALIFORNIA
- 2:30 Brady, M. and Rogers, R. EXPLORING THE ORIGINS OF MICROFOSSIL BONEBEDS
- 2:45 Travouillon, K., Legendre, S., Archer, M. and Hand, S. EXPLAINING THE GAPS IN BODY MASS DISTRIBUTIONS (CENOGRAMS): STATISTICAL VISUALIZATION OF THE ECOLOGICAL IMPACT OF INTRODUCED SPECIES
- 3:00 Hopkins, S. EVOLUTION OF BURROWING IN SMALL MAMMALS AND THE IMPORTANCE OF FOSSIL DATA IN CHARACTER RECONSTRUCTION
- 3:15 Daniel, J. and Witmer, L. THE ROLE OF SOFT TISSUES IN SEDIMENT INFILLING AND PATTERNING: AN ACTUALISTIC STUDY WITH OSTRICH HEADS
- 3:30 Klug, S., Kriwet, J. and Witzmann, F. DIRECT EVIDENCE OF PREDATOR-PREY-RESOURCE INTERACTIONS IN A PERMIAN AQUATIC ECOSYSTEM
- 3:45 Purnell, M. TESTING FUNCTIONAL HYPOTHESES - TOOTH MICROWEAR AS A PROXY FOR DIRECT OBSERVATION OF FEEDING IN LIVING AND FOSSIL NON-MAMMALIAN VERTEBRATES

### TECHNICAL SESSION V

GOVERNOR'S BALLROOM SALON B

**MODERATORS: RYOSUKE MOTANI AND ROBIN O'KEEFE**

- 1:30 Evans, S., Jones, M. and Krause, D. A GIANT HYPEROSSIFIED FROG WITH SOUTH AMERICAN AFFINITIES IN THE LATE CRETACEOUS OF MADAGASCAR
- 1:45 Sander, P. and Chen, X. A NEW SHASTASAURID ICHTHYOSAUR FROM THE UPPER TRIASSIC OF GUIZHOU, CHINA, AND IMPLICATIONS FOR ICHTHYOSAUR ECOLOGICAL DIVERSITY
- 2:00 Phillips, A., Cumbaa, S. and Schroder-Adams, C. A CENOMANIAN MARINE BONEBED FROM THE NORTHEASTERN MARGIN OF THE WESTERN INTERIOR SEAWAY, CANADA: DEPOSITIONAL ENVIRONMENT, TAPHONOMY & FAUNAL COMPOSITION
- 2:15 O'Keefe, F.R. JURASSIC INFANTICIDE? FIRST EVIDENCE OF PLESIOSAUR PREDATION ON NEONATAL ICHTHYOSAURS
- 2:30 Motani, R., Hirayama, R., Sato, T., Konishi, T. and Montanez, I. GENERIC DIVERSITY OF MARINE REPTILES THROUGH THE MESOZOIC AND SEA LEVEL CHANGES
- 2:45 Joyce, W., Lucas, S., Scheyer, T., Hunt, A. and Heckert, A. A PRIMITIVE TURTLE FROM THE LATE TRIASSIC OF NEW MEXICO AND THE GRADUAL ORIGIN OF THE TURTLE SHELL
- 3:00 Folie, A. EVOLUTION OF THE AMPHIBIANS AND SQUAMATES OF THE CONTINENTAL CRETACEOUS-PALEOGENE TRANSITION IN EUROPE
- 3:15 Bhullar, B.-A. THE ENIGMATIC FOSSILS *EXOSTINUS* AND *RESTES*: RESOLVING THE STEM AND THE CROWN OF *XENOSAURUS*, THE KNOB-SCALED LIZARDS
- 3:30 Head, J. MORPHOLOGY, MOLECULES AND TIME: EFFECTS OF COMPETING PHYLOGENETIC HYPOTHESES ON ECOMORPHOLOGICAL HISTORIES IN SNAKES
- 3:45 Conrad, J. and Norell, M. SCINCID (SQUAMATA) PHYLOGENY AND SNAKE ORIGINS: LIFESTYLE NEED NOT EQUAL HOMOPLASY

### POSTER SESSION I

Authors must be present from 4:00–6:00 p.m.

Posters must be removed by 6:15 p.m.

1. Chavez, A. A PRELIMINARY REPORT ON THE LATE QUATERNARY VERTEBRATE FAUNA FROM SIERRA DIABLO CAVE, HUDSPETH COUNTY, TEXAS
2. Galbreath, G. A THEORY OF LATER HOLOCENE MEGAFUNAL EXTINCTION
3. Carranza-Casteñeda, Ó. THE EARLY BLANCAN - IRVINGTONIAN GLIPTODONTS FROM CENTRAL MEXICO
4. Nye, A., Schubert, B. and Wallace, S. PLEISTOCENE PECCARIES FROM GUY WILSON CAVE, SULLIVAN COUNTY, TENNESSEE

5. Jimenez-Hidalgo, E., Guerrero-Arenas, R., Santiago-Romero, H. and Ceballos-Gutierrez, L. A PRELIMINARY REPORT ON A NEW PLEISTOCENE FAUNAL SITE FROM NORTHEASTERN OAXACA, SOUTHERN MEXICO
6. Lindsey, E. and Barnosky, A. THE DEVELOPMENT OF A DATABASE COMPRISING THE LATE-QUATERNARY MAMMALIAN PALEONTOLOGICAL RECORD FOR SOUTHERN SOUTH AMERICA
7. Bravo-Cuevas, V. and Priego-Vargas, J. PRELIMINARY INVESTIGATION ON THE ANCIENT DIETARY REGIME OF PLEISTOCENE HORSES FROM THE STATE OF HIDALGO, CENTRAL MEXICO
8. Telegina, S., Gorelik, V., Narochnyi, V., Glazunova, V.A. and Rezvyi, A. THE LATE PLEISTOCENE LOCALITY LUGOVSKOE (WESTERN SIBERIA, RUSSIA)
9. Orchard, D. and Rincón, A. DEVELOPMENTS IN THE PALEONTOLOGY OF QUATERNARY TAR SEEPS (MENES) IN VENEZUELA
10. Lewis, P., Stidham, T. and Kennedy, A. A PLEISTOCENE FAUNA FROM THE KOANAKA HILLS, BOTSWANA: IMPLICATIONS FOR REGIONAL PALEOENVIRONMENT
11. Gust, S. AGE STRUCTURE OF THE DIRE WOLF AT RANCHO LA BREA
12. Johnson, E., Arroyo-Cabrera, J., Whynott, A. and Moretti, J. ROLAND SPRINGS RANCH LOCALITY 1 — A PLEISTOCENE LOCALITY ON THE SOUTHERN PLAINS OF TEXAS
13. Blois, J. and Hadly, E. MAMMALIAN RESPONSE TO QUATERNARY CLIMATE CHANGE IN NORTHERN CALIFORNIA
14. Horgen, S., Brenzel, D. and Semken, H. THE TARKIO VALLEY GROUND SLOTH EXCAVATIONS: AN ADULT JEFFERSON'S GIANT GROUND SLOTH (*MEGALONYX JEFFERSONII*) IN ASSOCIATION WITH TWO JUVENILES FROM THE LATE PLEISTOCENE OF SOUTHWESTERN IOWA
15. Smith, K. and Fisher, D. SEXUAL DIMORPHISM IN TUSKS OF GREAT LAKES-REGION AMERICAN MASTODONS (*MAMMUT AMERICANUM*)
16. Kappelman, J., Ruez, D., de Vos, J., Huffman, F. and Zeim, Y. FOSSIL VERTEBRATES FROM THE RELOCATED 1936 MOJOKERTO HOMININ SITE, EAST JAVA
17. Huffman, F., Buffler, R., Kappelman, J., Ruez, D. and Zeim, Y. SEDIMENTOLOGICAL AND PALEOGEOGRAPHICAL CONTEXT OF THE MOJOKERTO HOMININ SITE, EAST JAVA
18. Shabel, A. BIOGEOCHEMICAL INDICATORS OF ECOLOGY AMONG AFRICAN CARNIVORANS: A TEST OF THE DUROPHAGE HYPOTHESIS OF THE ROBUST AUSTRALOPITHECINES (*PARANTHROPUS*)
19. Patel, B., Rossie, J., Biechele, M., and Hill, A. FUNCTIONAL MORPHOLOGY OF THE *EQUATORIUS AFRICANUS* HAND
20. Zylstra, M., Begun, D. and Ketcham, R. THE STRUCTURE OF TRABECULAR BONE IN SELECTED HAND ELEMENTS IN A LATE MIOCENE HOMINOID, *DRYOPITHECUS BRANCOI*
21. Domingo, L., López-Martínez, N., Grimes, S.T. APPLICATION OF TRACE ELEMENTS (BA, SR, ZN) TO PALEOECOLOGICAL RECONSTRUCTION OF MIDDLE MIOCENE HERBIVORES AT SOMOSAGUAS SITE (MADRID, SPAIN)
22. Cote, S. PRIMATE DISTRIBUTIONS AND SAMPLE SIZE EFFECTS AT THREE EARLY MIOCENE SITES IN EAST AFRICA
23. Perry, J. THE MASTICATORY APPARATUS OF EUROPEAN EOCENE ADAPINAE (PRIMATES) UNDERSTOOD IN COMPARISON TO THAT OF EXTANT STREPSIRRHINE PRIMATES
24. Cope, D., Westgate, J., Beard, K.C. and Humphreys, L. PRIMATE DIVERSITY IN THE UINTAN CASA BLANCA COMMUNITY, LAREDO FORMATION, TEXAS
25. Strait, S., Smith, N. and Penkrot, T. THE PROMISE OF LOW COST 3D LASER SCANNERS
26. Evans, G., Evans, A., Fortelius, M. and Jernvall, J. THE UPLOADING CHALLENGE: STRATEGIES FOR EDITING AND UPLOADING DIGITAL 3D SHAPE DATA TO AN ONLINE DATABASE
27. Hohn, B., Preuschoft, H., Witzel, U. and Distler, C. FIRST 3-D FESS FINITE-ELEMENT STRUCTURE SYNTHESIS) OF THE SHOULDER GIRDLE OF A RECENT ARCHOSAUR UNDER CONSIDERATION OF ARCHOSAUR MUSCULATURE AND LOCOMOTION
28. Kubo, T. REEVALUATION OF FOOTPRINTS AS AN INDICATOR OF LOCOMOTORY LIMB POSTURE IN THE EVOLUTION FROM SPRAWLING TO ERECT GAIT
29. Krause, T. THE TYPES OF TAPHOFACIES IN THE LOWER PERMIAN TETRAPOD DEPOSIT "BROMACKER" (GERMANY)
30. Modesto, S. and Reisz, R. NEW MATERIAL OF THE PARAREPTILE *COLOBOMYCTER PHOLETER*; FROM THE LOWER PERMIAN OF OKLAHOMA
31. Säilä, L. THE OSTEOLOGY AND PHYLOGENETIC POSITION OF *ANOMOIODON LILLENSTERNI*, A PROCOLOPHONID REPTILE FROM THE MIDDLE TRIASSIC BUNDSANDSTEIN OF GERMANY
32. Richards, C., Sidor, C., O'Keefe, F.R., Steyer, J.S. and Tabor, N. THE MANDIBLE OF *MORADISAURUS GRANDIS* (REPTILIA: CAPTORHINIDAE) AND ITS IMPLICATIONS FOR HERBIVORY IN MORADISAURINES

33. Madalena, K., Sumida, S., Zeigler, K. and Rega, E. A NEW RECORD OF THE EARLY PERMIAN PELYCOSURIAN-GRADE SYNAPSID *DIMETRODON* (EUPELYCOSAURIA: SPHENACODONTIDAE) FROM THE LOWER CUTLER GROUP (EARLY PERMIAN) OF JEMEZ PUEBLO, NORTH-CENTRAL NEW MEXICO
34. Smiley, T., Sidor, C., Steyer, J.S. and Tabor, N. FIRST EVIDENCE FOR A THERAPSID IN THE UPPER PERMIAN MORADI FORMATION OF NIGER
35. Mueller, B. and Chatterjee, S. DICYNODONTS (SYNAPSIDA:THERAPSIDA) FROM THE LATE TRIASSIC DOCKUM GROUP OF TEXAS
36. Rowland, S. and Mercadante, J. GREGARIOUS BEHAVIOR RECORDED IN THE TRACKS OF A JURASSIC THERAPSID
37. Sakamoto, M. SCALING BITE FORCE IN PREDATORY TETRAPODS: BITE FORCE IS PROPORTIONAL TO BODY MASS <sup>2/3</sup>
38. Renesto, S., Spielmann, J. and Lucas, S. DREPANOSAURID FOSSILS FROM THE LATE TRIASSIC (ADAMANIAN) PLACERIAS QUARRY OF EASTERN ARIZONA AND THE BIOSTRATIGRAPHIC DISTRIBUTION OF THE DREPANOSAURIDAE
39. Spielmann, J., Lucas, S., Hunt, A. and Heckert, A. A REVISION OF THE TRILOPHOSAURIDAE (ARCHOSAUROMORPHA) FROM THE LATE TRIASSIC OF WESTERN NORTH AMERICA
40. Vineyard, D. A NEW EUCRYPTODIRAN TURTLE FROM THE EARLY CRETACEOUS GLEN ROSE FORMATION OF TEXAS
41. Hirayama, R. CRANIAL MORPHOLOGY OF *MESODERMOCHELYS* (CHELONIOIDEA; TESTUDINES) FROM THE LATE CRETACEOUS OF JAPAN
42. Danilov, I. NEW DATA ON SOFT-SHELLED TURTLES (TRIONYCHIDAE) FROM THE BISSEKTY FORMATION (LATE TURONIAN) OF DZHARAKUDUK, UZBEKISTAN
43. Corsini, J., Leite, M., Smith, T., and Leite, M. ABUNDANCE CHANGES AND TAPHONOMIC CONDITION OF OLIGOCENE TURTLES, NORTHWESTERN NEBRASKA
44. Jones, C. THE GOPHER TORTOISES OF SOUTHERN CALIFORNIA
45. Chinnery-Allgeier, B., Stucky, R. and Hardy, T. COMPARISON OF LOWER VERTEBRATE FAUNAS FROM THE BRIDGER AND WIND RIVER FORMATIONS (EARLY TO MIDDLE EOCENE), WYOMING
46. Bourque, J., Hulbert, R. and Bloch, J. AN EXTINCT PAINTED TURTLE (TESTUDINES: EMYDIDAE) FROM THE LATE PLIOCENE (BLANCAN) OF FLORIDA
47. Caldwell, M., Breithaupt, B. and Bamforth, E. THE OLIGOCENE ERYCINE SNAKES, *OGMOPHIS* AND *CALAMAGRAS*: NEW MATERIAL CLARIFIES VERTEBRAL-FORM SPECIES
48. Scanferla, A. NEW EVIDENCES ABOUT THE EARLY EVOLUTION OF DERIVED MACROSTOMATANS (SQUAMATA, SERPENTES)
49. Lamm, K., Conrad, J., Ingram, C. and Norell, M. IGUANIAN PHYLOGENY AS INFERRED FROM MORPHOLOGY, NUCLEAR AND MITOCHONDRIAL DNA: A NOVEL PLACEMENT OF CRETACEOUS TAXA
50. Moreno, K., Wroe, S., McHenry, C., Clausen, P. and D'Amore, D. KOMODO DRAGON CRANIAL MECHANICS AND KINESIS AS REVEALED BY HIGH-RESOLUTION FINITE ELEMENT ANALYSIS
51. Hall, J. and Polcyn, M. FUNCTIONAL IMPLICATIONS OF ONTOGENETIC CHANGES IN JAW MORPHOLOGY ASSOCIATED WITH DUROPHAGY IN *VARANUS NILOTICUS* AND INFERRED DUROPHAGY IN THE MOSASAUR *GLOBIDENS ALABAMAENSIS*
52. Barr, B. and Caldwell, M. A NEW NECROSAURID (SQUAMATA: ANGUIMORPHA) LIZARD FROM THE LATE CRETACEOUS OF SOUTHERN SASKATCHEWAN, CANADA
53. Nydam, R., Flanagan, B. and Hickman, M. ANGUIMORPHAN AND NON-BORIOTEIIOID SCINCOMORPHAN LIZARDS FROM THE KAIPAROWITS FORMATION (MID-CAMPANIAN), SOUTHERN UTAH
54. Jiang, D.-Y., Motani, R., Hao, W.-C., Tintori, A. and Rieppel, O. MARINE REPTILE HORIZONS IN THE ANISIAN (MIDDLE TRIASSIC) OF GUIZHOU, CHINA AND THEIR IMPLICATION TO MARINE REPTILE EVOLUTION AFTER END-PERMIAN EXTINCTION
55. Adams, T. A NEW MARINE VERTEBRATE FAUNA FROM THE LATE TRIASSIC (MIDDLE NORIAN) OF SOUTHEAST ALASKA
56. Konishi, T., Caldwell, M. ECOLOGICAL AND EVOLUTIONARY IMPLICATIONS OF ONTOGENETIC CHANGES IN THE MARGINAL DENTITION OF *TYLOSAURUS PRORIGER* (SQUAMATA: MOSASAURIDAE)
57. Robbins, J., Ferguson, K., Polcyn, M., Jacobs, L. and Rick, T. LIFE HISTORY PATTERNS OF MOSASAURS INFERRED FROM STABLE CARBON ISOTOPES
58. Martin, J., Kihm, A., Fernandez, M., Reguero, M. and Case, J. A JUVENILE MOSASAUR (*TANIWHASAUROS ANTARCTICUS*) FROM THE LATE CRETACEOUS OF ANTARCTICA
59. Polcyn, M., Jacobs, L., Schulp, A. and Mateus, O. *HALISAURUS* (SQUAMATA:MOSASAURIDAE) FROM THE MAASTRICHTIAN OF ANGOLA

60. Gallagher, W., McKee, J., Mulder, E., and Schulp, A. THE LAST MOSASAURS
61. Castanhinha, R. and Mateus, O. A REVIEW ON THE MARINE REPTILES OF PORTUGAL: ICHTHYOSAURS, PLESIOSAURS AND MOSASAURS
62. Bickelmann, C. and Sander, M. POSTCRANIAL MATERIAL OF *NOTHOSAURUS* FROM THE LOWER MUSCHELKALK OF WINTERSWIJK, NETHERLANDS: THE SYSTEMATIC VALUE OF HUMERUS MORPHOLOGY
63. Wahl, W. THE MOST COMPLETE PLESIOSAUR FROM THE SUNDANCE FORMATION (JURASSIC), HOT SPRINGS COUNTY, WYOMING
64. Glen, C. and McHenry, C. PRELIMINARY REPORT ON A PLESIOSAUR FROM THE EARLY CRETACEOUS OF CENTRAL QUEENSLAND, AUSTRALIA
65. Street, H., O'Keefe, F.R. and Lockwood, R. DESCRIPTION OF THE PLESIOSAUR *TATENECTES LARAMIENSIS* FROM THE SUNDANCE FORMATION (WYOMING, USA) AND ITS POSITION IN THE CRYPTOCLEIDOID LINEAGE
66. Massare, J. and Blasioli, M. INTERVERTEBRAL SPACING IN A JURASSIC ICHTHYOSAUR
67. Kennedy, A. and Bhullar, B.-A. PRELIMINARY ANALYSIS OF THE FOSSIL HERPETOFAUNA FROM THE KOANAKA HILLS SITE, NGAMILAND, BOTSWANA
68. Lovelace, D. TRAMPLED BY TURTLES: TURTLE TRACKS FROM THE TRIASSIC RED PEAK FORMATION (SOUTHERN BIG HORN BASIN, WYOMING)
69. Tanke, D. and Henderson, D. SOMETHING LOST, SOMETHING GAINED: EFFECTS OF 14,000+ YEARS OF EROSION ON DINOSAUR FOSSIL RESOURCES, DINOSAUR PROVINCIAL PARK, ALBERTA, CANADA
70. Roberts, E., O'Connor, P., Hieronymus, T., Gottfried, M. and Stevens, N. TAPHONOMY OF TWO CRETACEOUS DINOSAUR QUARRIES, TANZANIA, AFRICA: NEW INSIGHTS INTO REGIONAL PALEOCLIMATE, PALEOENVIRONMENTS AND PALEOGEOGRAPHY
71. Orcutt, J., Sahney, S. and Lloyd, G. TETRAPOD EXTINCTION ACROSS THE JURASSIC-CRETACEOUS BOUNDARY
72. Johnson, E., Varricchio, D. RAPID MINERALIZATION OF COPROLITES
73. Suarez, C., Macpherson, G., Wolfe, M., Gonzalez, L. and Grandstaff, D. LAM-ICP-MS ANALYSIS OF FOSSIL BONE: SOME UNEXPECTED RESULTS AND IMPLICATIONS FOR INTERPRETATION OF RARE EARTH ELEMENTS IN FOSSIL BONE
74. Downs, J., Daeschler, E., Shubin, N. and Jenkins, Jr., F. NEW DETAILS ON A LATE DEVONIAN TOP PREDATOR: *LACCOGNATHUS* SP. (SARCOPTERYGII, POROLEPIFORMES) FROM ELLESMERE ISLAND, NUNAVUT, CANADA
75. Klein, N., Bussert, R. and Enkurie, D. MESOZOIC VERTEBRATES FROM THE ADIGRAT FORMATION OF ETHIOPIA
76. Garcia, W. *TRANODIS CASTRENSIS* FROM THE MISSISSIPPIAN (CHESTERIAN) OF KENTUCKY AND ITS RELEVANCE TO MISSISSIPPIAN VERTEBRATE PALEOBIOGEOGRAPHY
77. Lerner, A., Lucas, S. and Ivanov, A. VERTEBRATE PALEONTOLOGY OF THE TINAJAS LOCALITY, UPPER PENNSYLVANIAN (MISSOURIAN) ATRASADO FORMATION, SOCORRO COUNTY, NEW MEXICO
78. Sun, Z.-Y., Tintori, A., Jiang, D.-Y., Hao, W.-C. and Lombardo, C. NEW SUBHOLOSTEANS FROM THE MIDDLE TRIASSIC OF WESTERN GUIZHOU, SOUTHWESTERN CHINA
79. Spears, S., Milner, A. and Kirkland, J. FOSSIL FISH FROM THE EARLY JURASSIC (HETTANGIAN) MOENAVE FORMATION IN SOUTHWESTERN UTAH
80. Bermúdez-Rochas, D. and Poyato-Ariza, F. NEW FOSSILIFEROUS SITES WITH FISH FAUNA FROM THE BASQUE-CANTABRIAN AND CAMEROS BASINS, EARLY CRETACEOUS OF SPAIN
81. Fielitz, C. and Irwin, K. RECORDS OF ICHTHYODECTIFORM FISHES FROM THE UPPER CRETACEOUS (CAMPANIAN) OF ARKANSAS
82. Murray, A., Wilson, M. and Chatterton, B. A LATE CRETACEOUS ACTINOPTERYGIAN FAUNA FROM MOROCCO
83. Parris, D., Grandstaff, B. and Banks, N. DENTAL FUNCTION IN LUNGFISHES (CERATODONTIDAE) FROM THE CRETACEOUS OF NORTH TEXAS
84. Gottfried, M., Stevens, N., O'Connor, P., Roberts, E. and Ngasala, S. A NEW FOSSIL RECORD FOR THE AFRICAN LUNGFISH *PROTOPTERUS* FROM THE PALEOGENE OF TANZANIA
85. Everett, A. and Stidham, T. STONE CITY REVISITED: A DIVERSE FISH OTOLITH FAUNA FROM THE MIDDLE EOCENE CROCKETT FORMATION, BURLESON COUNTY, TEXAS
86. Stringer, G. and Cicimurri, D. FISH OTOLITHS FROM THE EOCENE CLINCHFIELD FORMATION OF GEORGIA WITH NOTE OF A HAEMULID (GRUNT) OF GIGANTIC PROPORTIONS

87. Newbrey, M., Murray, A., Wilson, M. and Cumbaa, S. PALATINE MORPHOLOGY AND THE PRESENCE OF FIXED CANINE TEETH IN CENOZOIC *ESOX* (TELEOSTEI: ESOCIDAE) OF NORTH AMERICA
88. Gallo, V. and Petra, R. PRESENCE OF AN UNPAIRED VOMER IN JUVENILE AND ADULT INDIVIDUALS OF *LEPIDOTES PIAUHYENSIS* (NEOPTERYGII, SEMIONOTIDAE) AND A REAPPRAISAL OF THIS BONE IN SEMI-ONOTID FISHES
89. Phillips, G. and Stringer, G. PAIRED FISH OTOLITHS FROM POSSIBLE COPROLITES IN THE GLENDON LIMESTONE (OLIGOCENE, RUPELIAN) OF CENTRAL MISSISSIPPI

THURSDAY MORNING, OCTOBER 18, 2007

SYMPOSIUM: FOSSILS, MOLECULES AND MORPHOLOGY-  
EVOLUTIONARY HISTORY OF BATS

GOVERNOR'S BALLROOM SALON A

**MODERATORS: GREGG GUNNELL, NANCY SIMMONS, AND THOMAS EITING**

- 8:00 Dumont, E. FLIGHT AND THE EVOLUTION OF FEEDING IN BATS
- 8:15 Baker, R., Bininda-Emonds, O., Van Den Bussche, R., Porter, C. and Hofer, S. MOLECULAR BASED GEOLOGICAL TIMESCALE ON FLIGHT FROM INSECTIVORY TO FEEDING ON BLOOD, VERTEBRATES, FRUIT, NECTAR: PHYLLOSTOMID BATS
- 8:30 Teeling, E. and Miller-Butterworth, C. MOLECULAR PHYLOGENETICS INVESTIGATES THE BAT FOSSIL RECORD
- 8:45 Eiting, T. and Gunnell, G. REGIONAL AND GLOBAL PERSPECTIVES ON THE QUALITY OF THE FOSSIL RECORD OF BATS
- 9:00 Hand, S., Beck, R., Worthy, T., Archer, M. and Sigé B. AUSTRALIAN AND NEW ZEALAND BATS: THE ORIGIN, EVOLUTION, AND EXTINCTION OF BAT LINEAGES IN AUSTRALASIA
- 9:15 Morgan, G. and Czaplewski, N. EVOLUTIONARY HISTORY OF THE NEOTROPICAL CHIROPTERAN FAUNA
- 9:30 Gunnell, G., Eiting, T., Simons, E. and Seiffert, E. BACK TO THE FUTURE – AFRICAN VESPERTILIONOIDEA (CHIROPTERA) AND THE ANTIQUITY OF MYOTINAE
- 9:45 Van Den Bussche, R., Bogdanowicz, W., Gajewska, M. and Postawa, T. ANCIENT DNA SHEDS LIGHT ON THE HISTORY OF MOUSE-EARED BATS (MYOTIS) IN EUROPE
- 10:00 BREAK
- 10:15 Sigé, B., Maitre, E. and Hand, S. THE PRIMITIVE CONDITION OF LOWER MOLARS AMONG BATS
- 10:30 Horacek, I. DEVELOPMENTAL DYNAMICS OF CHIROPTERAN MOLARS: ON VARIATION AND CONSTRAINTS
- 10:45 Hutcheon, J. EVOLUTIONARY TRENDS IN THE CHIROPTERAN BRAIN: A COMPARATIVE ANALYSIS OF BAT SENSORY ECOLOGY
- 11:00 Pedersen, S. CEPHALOMETRY & EVOLUTIONARY CONSTRAINT WITH RESPECT TO THE MODE OF ECHOLOCATION IN BATS
- 11:15 Czaplewski, N. and Morgan, G. NEW BASAL NOCTILIONOID BATS FROM THE OLIGOCENE OF FLORIDA, USA
- 11:30 Maitre, E., Sigé, B. and Hand, S. *NECROMANTIS*: NEW DATA AND RELATIONSHIPS
- 11:45 Habersetzer, J., Storch, G., Schlosser-Sturm, E., Sigé, B. SHOULDER JOINTS AND INNER EARS OF *TACHYPTERON FRANZENI*, AN EMBALLONURID BAT FROM THE MIDDLE EOCENE OF MESSEL
- 12:00 Simmons, N., Seymour, K. and Gunnell, G. A NEW PRIMITIVE BAT FROM THE EARLY EOCENE OF WYOMING: FOSSILS, PHYLOGENETICS, AND THE EVOLUTION OF ECHOLOCATION AND FLIGHT



ROMER PRIZE SESSION  
AUSTIN GRAND BALLROOM SALON H  
MODERATORS: DAVID FOX AND PAUL BARRETT

- 8:00 Terry, R. HOLOCENE SMALL MAMMALS OF THE GREAT BASIN: RECENT RICHNESS DECLINES AND LIVE-DEAD ANALYSIS OF ECOLOGICAL FIDELITY
- 8:15 Gates, T. EVOLUTION OF NORTH AMERICAN HADROSAURID DINOSAURS (ORNITHISCHIA: ORNITHOPODA)
- 8:30 Finarelli, J. EVOLUTIONARY DYNAMICS OF BODY SIZE EVOLUTION IN TERRESTRIAL CANIFORMIA (CARNIVORA, MAMMALIA)
- 8:45 Sipla, J. THE SEMICIRCULAR CANALS OF BIRDS AND NON-AVIAN THEROPOD DINOSAURS
- 9:00 Adam, P. NEW TOOLS FOR PREDICTING BODY SIZE OF FOSSIL MARINE MAMMALS AND SIZE OF THEIR PREY YIELD INCREASED RESOLUTION FOR INTERPRETATION OF EVOLUTION IN THE CARNIVOROUS MARINE MAMMAL FEEDING GUILD THROUGH THE CENOZOIC
- 9:15 Jones, M. EVOLUTION AND DIVERSIFICATION OF FEEDING APPARATUS IN THE RHYNCHOCEPHALIA (REPTILIA: LEPIDOSAURIA)
- 9:30 Boyer, D. A TEST OF THE VISUAL PREDATION HYPOTHESIS OF EUPRIMATE ORIGINS USING DIET-CORRELATED MEASURES OF TOOTH SHAPE
- 9:45 Smith, K. LIZARD BIOGEOGRAPHY DURING THE WARMEST PART OF THE CENOZOIC: A DIACHRONIC PERSPECTIVE ON MODERN PATTERNS OF SPECIES DIVERSITY
- 10:00 BREAK
- 10:15 Porro, L. FEEDING AND JAW MECHANISM IN *HETERODONTOSAURUS TUCKI* USING FINITE ELEMENT ANALYSIS
- 10:30 Bever, G. VARIATION, VARIABILITY, AND PROBABILITY IN ASSESSING THE EVOLUTIONARY HISTORY OF VERTEBRATE FOSSILS BASED ON DISCRETE SKELETAL CHARACTERS
- 10:45 Hinic-Frlog, S. AQUATIC LOCOMOTION IN BASAL ORNITHURAE AND THEIR TRANSITION FROM AQUATIC TO TERRESTRIAL HABITATS
- 11:00 Lee, A. HOW DINOSAURS GREW AND THE RELATIONSHIP BETWEEN GROWTH RATES AND BONE VASCULAR ORGANIZATION
- 11:15 Sansom, R. ORIGIN AND EARLY LOSS OF PAIRED FINS: THE PROBLEMS OF CHARACTER POLARITY IN STEM-GNATHOSTOMES
- 11:30 Samman, T. ASSESSING CRANIOCERVICAL FUNCTIONAL MORPHOLOGY IN COELUROSAURIAN THEROPODS
- 11:45 Ksepka, D. THE EVOLUTION OF AQUATIC FLIGHT: PHYLOGENY, HISTOLOGY AND FUNCTIONAL MORPHOLOGY OF FOSSIL PENGUINS (SPHENISCIFORMES)
- 12:00 Triche, N. PHYLOGENETICS, ORIGIN AND EVOLUTIONARY HISTORY OF EXTINCT AND EXTANT PENGUINS (AVES, SPHENISCIFORMES)
- 12:15 Noto, C. EXPERIMENTAL TAPHONOMY AND ENVIRONMENTAL CONTROL OF VERTEBRATE PRESERVATION

PREPARATORS' SESSION  
GOVERNOR'S BALLROOM SALON B  
MODERATORS: BILL SANDERS AND LINDA DECK

- 8:00 Thompson, K., Agenbroad, L., Potapova, O. and Holte, S. FROM SALVAGE OPERATION TO *IN SITU* PRESERVATION: TECHNIQUES USED IN CONSERVATION AT THE MAMMOTH SITE OF HOT SPRINGS, SOUTH DAKOTA
- 8:15 Supplee, J. UNSTABLE MATRIX: EXAMPLES OF FIELD AND LAB TECHNIQUES FOR FOSSILS IN A WET, ORGANIC-RICH CLAY FROM THE LATE MIOCENE GRAY FOSSIL SITE IN NORTHEAST TENNESSEE
- 8:30 Bover, P., Gracia, F., Crespi, M. and Clamor, B. DISCOVERY, RECOVERY AND PREPARATION OF BONES COLLECTED UNDER SALT WATER IN CAVES FROM MALLORCA (BALEARIC ISLANDS, SPAIN)
- 8:45 Davidson, A. PREPARING TO PREPARE YOUR FOSSIL VERTEBRATE: SET-UPS TO MAXIMIZE SPEED AND CONTROL

- 9:00 Groenke, J., Farke, A. and Georgi, J. DIGITAL PREPARATION FOR THE ANALOG PREPARATOR
- 9:15 Cavigelli, J.-P. AIR ABRASIVE 101
- 9:30 Kaye, T. FULLY AUTOMATED SORTING OF MICRO-FOSSILS FROM SEDIMENT USING LASER-STIMULATED FLUORESCENCE
- 9:45 Newman, K., Winkler, D. and Polcyn, M. LASER SCANNING & 3D RECONSTRUCTION AS A TOOL FOR PREPARATION AND ARCHIVAL DOCUMENTATION
- 10:00 BREAK
- 10:15 Smith, M. VERTEBRATE MICROFOSSIL STORAGE, THE BASICS, AND A NEW TECHNIQUE
- 10:30 Shaw, A. WHO WANTS THE WHITE MEAT? PREPARATION, RESTORATION, MOLDING, AND CASTING OF AN EXCEPTIONALLY PRESERVED *TYRANNOSAURUS REX* CRANIUM USING A NEWLY-DEVELOPED APPARATUS
- 10:45 Fox, M. and Fitzgerald, V. THE PREPARATION, MOLDING, CASTING, AND DISARTICULATION OF *POPOSAURUS GRACILIS*, YPM 58100
- 11:00 Deck, L., Schlader, R., Clement, N., Gibbs, W. and Chapman, R., ESPECIALLY DURABLE PROTOTYPES OF FOSSIL SPECIMENS AND REPLICAS FOR USE IN PUBLIC PROGRAMMING
- 11:15 Stoehr, H. DUPLICATION, THREE-DIMENSIONAL RECONSTRUCTION, AND MOUNTING OF THE SKELETONS OF THREE TRIASSIC TETRAPODS USING EPOXY-RESIN AND ACRYLIC GLASS
- 11:30 Brown, M., Parker, W., Williams, T. and Dorn, K. DAWN OF THE DINOSAURS: DESIGN, CONSTRUCTION, AND INSTALLATION OF A TRIASSIC PALEONTOLOGY EXHIBIT HALL
- 11:45 Stevens, L., Shaw, A., Pickering, D. and Wuerthele, N. THE RESTORATION AND RECONSTRUCTION OF MULTIPLE ORNITHISCHIAN DINOSAUR SKELETONS AT THE CARNEGIE MUSEUM OF NATURAL HISTORY: TECHNIQUES, SURPRISES, PROBLEMS, AND RESOLUTIONS
- 12:00 Brown, G. BASIC PRINCIPLES OF CONSERVATION AND THEIR APPLICATION TO PALEONTOLOGICAL COLLECTIONS: PREPARATION AND COLLECTION CARE WITH PURPOSE

## THURSDAY AFTERNOON, OCTOBER 18, 2007

### TECHNICAL SESSION VI

GOVERNOR'S BALLROOM SALON A

**MODERATORS: MATTHEW MIHLBACHLER AND ANDREW CLIFFORD**

- 1:30 Foss, S. A FUNCTIONAL EXPLANATION FOR THE JUGAL FLANGES AND MANDIBULAR TUBERCLES ON THE ENTELODONT SKULL (MAMMALIA, ENTELODONTIDAE)
- 1:45 Holroyd, P. and Gunnell, G. NEW DATA ON ANTHRACOTHERIIDAE (ARTIODACTYLA) FROM THE PALEOGENE OF EGYPT
- 2:00 Brakora, K. and Padian, K. QUANTIFICATION AND PHYLOGENETIC CORRELATIONS OF SEXUAL MORPHOTYPES IN BOVIDAE (MAMMALIA)
- 2:15 Semprebon, G. and Rivals, F. HYPSONDONT BROWSING: CAMEL AND PRONGHORN DIETARY RECONSTRUCTION THROUGH DEEP TIME
- 2:30 Davis, E. MULTIVARIATE ANALYSIS OF ASTRAGALI INDICATES LITTLE DIVERGENCE BETWEEN *ILINGOCEROS* AND *SPHENOPHALOS* IN THE THOUSAND CREEK FORMATION, NEVADA
- 2:45 Macrini, T. and Ekdale, E. STUDY OF A LARGE SAMPLE OF NATURAL ENDOCRANIAL CASTS OF OREODONTS WITH IMPLICATIONS FOR APOMORPHY-BASED DIAGNOSIS OF ISOLATED ENDOCASTS AND THE STUDY OF INDIVIDUAL VARIATION
- 3:00 Clifford, A. EVOLUTION AND MECHANICS OF FOREFEET IN TERRESTRIAL CETARTIODACTYLS
- 3:15 Theodor, J. THE EAR REGION OF CAINOTHERES AND THEIR RELATIONSHIP TO TYLOPODA
- 3:30 Hooker, J., Dashzeveg, D. and Polly, P.D. LAMBDOOTHERIID PERISSODACTYLS: EVIDENCE OF AN ORIGIN AND MODEST RADIATION IN ASIA
- 3:45 Mhlbachler, M. SEXUAL DIMORPHISM AND MORTALITY BIAS IN EARLY MIOCENE RHINOS, *DICERATHERIUM* AND *MENOCERAS*, AND THEIR BEARING ON THE EVOLUTION OF SOCIALITY IN THE RHINOCEROTIDAE

TECHNICAL SESSION VII  
AUSTIN GRAND BALLROOM SALON H  
**MODERATORS: DANIEL GOUJET AND CATHERINE BOISVERT**

- 1:30 Chang, M., Zhang, J. and Miao, D. *MESOMYZON MENGAE*: NEW SPECIMENS AND MORE INFORMATION
- 1:45 Goujet, D. LUNGS IN PLACODERMS, A PERSISTENT MYTH RELATED TO ENVIRONMENTAL PRECONCEIVED INTERPRETATION
- 2:00 Daeschler, E. and Shubin, N. NEW DATA ON *HYNERIA LINDAE* (SARCOPTERYGII; TRISTICHOPTERIDAE) FROM THE LATE DEVONIAN OF PENNSYLVANIA, USA
- 2:15 Tissandier, S. and Larsson, H. EVOLUTION OF MODULAR MORPHOLOGY IN ACTINOPTERYGIAN PECTORAL FINS
- 2:30 Xu, G.-H. and Gao, K.-Q. EARLY TRIASSIC FRESHWATER FISHES FROM NORTHERN GANSU PROVINCE, CHINA, AND THE AGE OF THE BEISHAN BEDS
- 2:45 Woodward, A. and Stringer, G. TAXONOMY, PALEOECOLOGY, AND EVOLUTION OF THE OTOLITH-BASED FISHES OF THE UPPER CRETACEOUS KEMP CLAY, HUNT COUNTY, TEXAS
- 3:00 Ostrowski, S. MICROSTRATIGRAPHIC ANALYSIS OF A RAPID REPLACEMENT EVENT IN MIOCENE STICKLEBACKS (*GASTEROSTEUS DORYSSUS*)
- 3:15 Ahlberg, P., Johanson, Z., Ericsson, R., Sutija, M., Boisvert, C. and Joss, J. ARE DIGITS NEOMORPHIC STRUCTURES? NEW DATA FROM FIN DEVELOPMENT IN *NEOCERATODUS*.
- 3:30 Boisvert, C. and Ahlberg, P. GETTING A HAND FROM NEW TECHNOLOGY: THE PECTORAL FIN SKELETON OF THE NEAR-TETRAPOD *PANDERICHTHYS* REVEALED BY CT SCANNING
- 3:45 da Silva, H. and Gallo, V. CLADISTIC ANALYSIS OF THE ENCHODONTOIDEI (TELEOSTEI: AULOPIFORMES)

TECHNICAL SESSION VIII  
GOVERNOR'S BALLROOM SALON B  
**MODERATORS: CHRIS BROCHU AND ALEXANDER HASTINGS**

- 1:30 Hieronymus, T. and Witmer, L. SKINNING DINOSAURS: BONY CORRELATES AND PATTERNS OF CEPHALIC SKIN EVOLUTION IN ARCHOSAURIA
- 1:45 Dufeu, D. and Witmer, L. ONTOGENY AND PHYLOGENY OF THE TYMPANIC PNEUMATIC SYSTEM OF CROCODYLIFORM ARCHOSAURS
- 2:00 Holliday, C. and Witmer, L. THE EPIPTERYGOID OF CROCODYLIFORMS AND ITS SIGNIFICANCE IN THE EVOLUTION OF THE ORBITOTEMPORAL REGION OF EUSUCHIANS
- 2:15 Owerkowicz, T. and Crompton, F. HIGH LEVELS OF THYROID HORMONES INDUCE A DETERMINATE GROWTH PATTERN IN JUVENILE CROCODYLIANS
- 2:30 Sadleir, R. MORPHOMETRIC ANALYSIS OF CROCODYLIAN CRANIAL ECCOMORPHOLOGY AND ONTOGENETIC SHAPE CHANGE
- 2:45 Drumheller, S. EXPERIMENTAL TAPHONOMY AND MICROANALYSIS OF CROCODYLIAN BITE MARKS
- 3:00 Stanton, K. and Carlson, S. OXYGEN AND CARBON ISOTOPES FROM EXTANT CROCODYLIAN AND RATITE BIRD BIOMINERALS: AN INTERPRETIVE MODEL FOR FOSSIL DINOSAUR ISOTOPIC DATA?
- 3:15 Wheatley, P. and Koch, P. EVOLUTION OF SALT-WATER TOLERANCE IN CROWN CLADE CROCODYLIANS
- 3:30 Hastings, A. and Bloch, J. NEW SHORT-SNOUDED DYROSAURID (CROCODYLOMORPHA) FROM THE PALEOCENE OF NORTHERN COLOMBIA
- 3:45 Brochu, C. SYSTEMATICS AND PHYLOGENETIC RELATIONSHIPS OF HOOFED CROCODILES (PRISTICHAMPSINAE)

## POSTER SESSION II

Authors must be present from 4:00–6:00 p.m.

Posters must be removed by 6:15 p.m.

1. Williams, S., Henderson, M., May, W. and Reisz, R. FOSSIL PREPARATION TECHNIQUES FOR SMALL PERMIAN TETRAPODS FROM RICHARD'S SPUR, OKLAHOMA
2. Hanks, H., Hoganson, J., Woodward, B. MEGA MOVERS: ENORMOUS FIELD JACKETS
3. Person, J. and Baker, C. METHODS FOR LABELING SILICONE MOLDS
4. Cureton, J., Lewis, P. and Thies, M. A METHODOLOGY FOR REMOVING FOSSILS FROM THE KOANAKA HILLS DEPOSIT
5. Jackson, G. A DISSOLVABLE SUPPORT JACKET FOR PREPARATION OF THIN ARTHRODIRE AND SHARK SPECIMENS FROM THE UPPER DEVONIAN CLEVELAND AND BEDFORD SHALES UTILIZING CARBOWAX 4000
6. Heard, A., Graf, F. and Sanders, W. A MULTI-MEDIA SOLUTION TO COMPLEX MOLDING AND CASTING OF INTERNAL AND EXTERNAL SURFACES OF A FOSSIL *HOMO ERECTUS* CRANIUM FROM JAVA
7. Fitzgerald, V. and Milam, M. REPRODUCTIVE HEALTH AND SAFETY FOR FEMALE EMPLOYEES WORKING IN VERTEBRATE PALEONTOLOGY LABORATORIES
8. Shinya, A. and Bergwall, L. PYRITE OXIDATION: REVIEW AND PREVENTION PRACTICES
9. Davies, K. SILICONE CAULK MOLDS: A 25 YEAR RETROSPECTIVE
10. Keillor, T. RECONSTRUCTING A NEW MESOZOIC CROCODILE SKULL USING BASIC TECHNIQUES, ADVANCED TECHNOLOGY, AND ARTISTIC FINESSE
11. Mason, J., Hulbert, R. and Poyer, A. CONTINUITY AND REANIMATION OF A FOSSIL PREPARATION LABORATORY: A REPORT FROM FLORIDA.
12. Schlader, R., Breithaupt, B., Clement, N., Chapman, R. and Petersen, C. HIGH-RESOLUTION VIRTUALIZATION OF DINOSAUR FOOTPRINTS AND ROCK ART IN THE FIELD USING A LOW-COST, HIGH-RESOLUTION LASER-SCANNER
13. Peterson, N. "FLY THROUGH THE GROUND" SUBSURFACE TOMOGRAPHY OF DINOSAUR QUARRIES USING A COMBINATION OF LIDAR AND PHOTOGRAMMETRY
14. Shoup, B. THERE'S A WHOLE LOTTA SHAKIN' GOIN' ON - PALEONTOLOGICAL RESOURCE MANAGEMENT IMPLICATIONS FOR 3-D GEOPHYSICAL EXPLORATION: CASE STUDY FROM THE WIND RIVER BASIN, FREMONT COUNTY, WYOMING
15. Morton, R., Huntley, K., Morton, N., Larson, P. and Bergmann, U. ARCHIMEDES' GIFT: X-RAY FLUORESCENCE IMAGING, A NEW PALEONTOLOGICAL TOOL FOR SOFT TISSUE ANALYSIS AND A TEST FOR FOSILIZATION PROCESS HYPOTHESES
16. Van Regenmorter, J., Anemone, R., Dirks, W., Watkins, R. and Moore, W. CREATING A SEARCHABLE GEOGRAPHIC INFORMATION SYSTEMS (GIS) DATABASE OF FOSSIL LOCALITIES AND SPECIMENS: AN EXAMPLE FROM THE EOCENE OF SOUTHWESTERN WYOMING
17. Boyd, A. 2D AND 3D RETRODEFORMATION TECHNIQUES USING FINITE ELEMENT ANALYSIS WITH APPLICATION TO TRILOBITES AND *HERRERASAURUS*
18. Moore, J., Marron, A. and Redfern, S. IDENTIFYING THE CAUSES OF TAPHONOMIC VARIATION IN FOSSIL BONES USING X-RAY DIFFRACTION: A CASE STUDY FROM THE OLIGOCENE OF SOUTH DAKOTA
19. Senter, P. PALEOZOIC AND MESOZOIC ANIMAL SOUNDS

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## STUDENT POSTER COMPETITION

20. Cook, T. TWO LATE CENOMANIAN ELASMOBRANCH ASSEMBLAGES FROM THE NORTHERN REGIONS OF THE WESTERN INTERIOR SEAWAY
21. Matsumoto, R. THE EARLY CRETACEOUS CHORISTODERAN REPTILE, *MONJUROSUCHUS*, IN CHINA AND JAPAN
22. Curran, S. CERVID ECOMORPHOLOGY AND HOMININ PALEOECOLOGY
23. Yonas, J., Deméré, T. and Berta, A. EVOLUTION OF LOCOMOTION IN ODOBENIDAE

24. Lyson, T. VARIATION, GROWTH, AND ALPHA TAXONOMY OF BAENID TURTLES: INSIGHTS FROM A LATE CRETACEOUS DEATH ASSEMBLAGE
  25. Hagge, M. COMPARATIVE ONTOGENETIC ANALYSIS OF *TELEOCERAS* AND EXTANT RHINOS
  26. Strauss, J. A TAXONOMIC REVIEW OF LATE CRETACEOUS CIMOLESTIDS
  27. Frampton, E. TOOTH MORPHOLOGY AND PLACEMENT OF A NEW SPECIES OF *MYLEDAPHUS* FROM THE MILK RIVER VALLEY, FOREMOST FORMATION (CAMPANIAN), ALBERTA, CANADA, WITH COMPARISON TO *MYLEDAPHUS BIPARTITUS*
  28. Bates, K. DYNAMIC SIMULATIONS OF THEROPOD DINOSAUR (*ALLOSAURUS FRAGALIS*) LOCOMOTION
  29. Blackbeard, M. THE TAPHONOMY OF AN EARLY JURASSIC DINOSAUR BONE-BED IN THE NORTHERN FREE STATE (SOUTH AFRICA).
  30. Anquetin, J. A NEW (STEM?) TURTLE FROM THE MIDDLE JURASSIC OF SKYE, SCOTLAND
  31. Coulson, A. PALEOENVIRONMENTAL RECONSTRUCTION OF THE LATE CRETACEOUS WESTERN INTERIOR SEAWAY OF NORTH AMERICA USING OXYGEN ISOTOPES FROM MARINE VERTEBRATE FOSSILS
  32. Wilborn, B. DEFORMATION OF DINOSAUR BONES: DIAGENETIC AND TECTONIC EFFECTS
  33. Eddy, D. RESULTS FROM A PRELIMINARY STUDY OF THE BONE HISTOLOGY OF THE EARLY CRETACEOUS ALLOSAURID *ACROCANTHOSAURUS ATOKENSIS*
  34. Young, M. THE EVOLUTION AND INTERRELATIONSHIPS OF METRIORHYNCHIDAE (CROCODYLIFORMES, THALATTOSUCHIA)
  35. Whitlock, J. DIETARY INFERENCES FROM STUDIES OF SKULL SHAPE AND ENAMEL MICROWEAR IN DIPLODOCOID SAUROPODS
  36. Williams, D. AVIAN TAPHONOMY IN NATURAL TRAP CAVE (LATE PLEISTOCENE-HOLOCENE), WYOMING
  37. Bai, B. SEXUAL DIMORPHISM AND ADDITIONAL DENTOCRANIAL FEATURES IN THE EOCENE CHALICOTHERE *LITOLOPHUS* (PERISSODACTYLA, MAMMALIA)
  38. Burns, M. IDENTIFYING ANKYLOSAUR TAXA USING OSTEODERM MORPHOLOGY
  39. Redelstorff, R. THE HISTOLOGY OF *STEGOSAURUS* LONG BONES: IMPLICATIONS FOR GROWTH AND LIFE HISTORY
  40. Allen, E. RE-DESCRIPTION AND SYSTEMATIC REANALYSIS OF THE GONIOPHOLIDID CROCODILE *GONIOPHOLIS STOVALLI* FROM THE MORRISON FORMATION OF OKLAHOMA
  41. Muchlinski, M. ECOLOGICAL CORRELATES OF INFRAORBITAL FORAMEN SIZE: EXPLORING DIETARY DIVERSITY AMONG EUROPEAN ADAPIFORMES
  42. Jin, X. MESONYCHIDS FROM THE EARLY PALEOGENE OF ERLIAN BASIN, CHINA
  43. Arbour, V. VARIABLE CERVICAL HALF RING MORPHOLOGY IN THE ANKYLOSAURID DINOSAUR *EUOPLOCEPHALUS*
  44. Gutierrez, M. and Rasmussen, D. LATE OLIGOCENE MAMMALS FROM NORTHERN KENYA
  45. Levitt, C. PRELIMINARY REPORT ON THE VERTEBRATES OF THE WESTPHAL QUARRY, WYOMING (MORRISON FORMATION:LATE JURASSIC), WITH SPECIAL ATTENTION TO THE HYSILOPHODONTID MATERIAL
  46. Carroll, N. TOOTH STRUCTURE FUNCTIONALITY OF *TYRANNOSAURUS REX* VS. *CROCUTA CROCUTA*
  47. Bennett, G. CROCODILE POPULATION STRUCTURE IN THE UPPER CRETACEOUS HELL CREEK FORMATION, EASTERN MONTANA
  48. Masters, S. *ALLOSAURUS* HUMERUS MORPHOLOGY: FUNCTION OR PHYLOGENY?
  49. Bell, P. THE DANEK BONEBED: AN UNUSUAL DINOSAUR ASSEMBLAGE FROM THE HORSESHOE CANYON FORMATION, EDMONTON, ALBERTA
  50. Redman, C. THE EFFECTS OF TAXONOMIC-LEVEL OF IDENTIFICATION ON BIOGEOGRAPHIC STUDIES.
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51. MacKenzie, L. DENTITION OF THE EUGNATHOSTOMATA FROM THE EARLY DEVONIAN OF THE MACKENZIE MOUNTAINS, NORTHWEST TERRITORIES, CANADA
  52. Criswell, K., Downs, J. and Daeschler, E. MASS MORTALITY OF JUVENILE PLACODERMS (*BOTHRIOLEPIS* SP.) FROM THE CATSKILL FORMATION (UPPER DEVONIAN), TIOGA COUNTY, PENNSYLVANIA
  53. Shin, J.-Y. and Motani, R. BITE FORCE ANALYSIS OF THE PTYCTODONT PLACODERMS, THE EARLIEST VERTEBRATE DUROPHAGE

54. Snively, E. and Ryan, M. ONTOGENY OF BITE STRESS IN *DUNKLEOSTEUS*
55. Elliott, D. and Rowland, S. A COCHLIODONT LOWER JAW (CHONDRICHTHYES, HOLOCEPHALI) WITH ARTICULATED TOOTH PLATES FROM THE CARBONIFEROUS BIRD SPRING FORMATION OF NEVADA
56. Ivanov, A., Lucas, S., Rinehart, L., and Spielmann, J. PETALODONT CHONDRICHTHYANS FROM THE PENNSYLVANIAN-PERMIAN OF SOUTHERN NEW MEXICO
57. Mutter, R. FISH REMAINS FROM THE MIDDLE-UPPER PERMIAN CORUMBATAI AND TERESINA FORMATIONS IN THE STATE OF SAO PAULO (SOUTHERN BRAZIL)
58. Shimada, K., Kim, S. and Rigsby, C. PARTIAL SKULL OF LATE CRETACEOUS DUROPHAGOUS SHARK, *PTYCHODUS ANONYMUS* (PTYCHODONTIDAE), FROM NEBRASKA
59. Kim, S., Shimada, K. and Rigsby, C. COMPARATIVE ANATOMY OF CAUDAL FIN SKELETON IN A LATE CRETACEOUS SHARK (*CRETOXYRHINA MANTELLI*) AND MODERN LAMNIFORM SHARKS
60. Gonzalez-Barba, G., Pasch, A., May, K. and White, T. TURONIAN SHARKS FROM THE MATANUSKA FORMATION SOUTH-CENTRAL ALASKA
61. Murphy, J., Lucas, S. and Spielmann, J. CRETACEOUS SELACHIANS FROM THE BRIDGE CREEK MEMBER OF THE MANCOS SHALE (UPPER CENOMANIAN), SOCORRO COUNTY, NEW MEXICO
62. Tulu, Y. TAPHONOMIC INFLUENCES ON SHARK FAUNAL ASSEMBLAGES FROM THE JUDITH RIVER FORMATION (CAMPANIAN) OF MONTANA
63. Kriwet, J., Aberhan, M., and Kiessling, W., Scasso, R. and Medina, F. CHONDRICHTHYANS AND ACTINOPTERYGIANS ACROSS THE K-PG BOUNDARY IN PATAGONIA, ARGENTINA
64. Schwimmer, D. MARINE REWORKING IN EASTERN NORTH AMERICA CAMOUFLAGES AN AFRICAN SPECIES OF *SQUALICORAX* (NEOSELACHII, LAMNIFORMES)
65. Alexander, N. and Stidham, T. A DIVERSE SHARK FAUNA FROM THE EARLY EOCENE CLAVERT BLUFF FORMATION IN BASTROP COUNTY, TEXAS
66. Claeson, K. and Stidham, T. FIRST FOSSIL BATOIDS (ELASMOBRANCHII) FROM THE CALVERT BLUFF FORMATION (EOCENE), BASTROP, TEXAS.
67. Ehret, D., Hubbell, G. and MacFadden, B. PALEOBIOLOGY OF AN EXCEPTIONALLY WELL PRESERVED FOSSIL OF THE MODERN WHITE SHARK (*CARCHARODON CARCHARIAS*) FROM THE PISCO FORMATION (NEOGENE) OF PERU
68. Purdy, R. THE ANCESTRY OF *CARCHARODON CARCHARIAS* REVISITED
69. Orliac, M. 'A PIG'S TALE': MORPHOLOGY, PHYLOGENY AND SYSTEMATICS OF THE LISTRIODONTINAE (SUIDAE, MAMMALIA).
70. Levering, D. GETTING A LEG UP ON THE COMPETITION: DECIPHERING THE DIFFERENCES AND SIMILARITIES OF LIMB PROPORTIONALITY IN OLIGOCENE AND MODERN MAMMALS.
71. Bales, G. HORN FUNCTION IN BRONTOTHERIIDS (PERISSODACTYLA; CERATOMORPHA) RECONSIDERED
72. Ludtke, J. PRELIMINARY REVISION OF AGRIOCHOERID OREODONTS OF TRANS-PECOS TEXAS AND CHIHUAHUA
73. DeBlieux, D., Kirkland, J., Biek, R., Kuehne, P. and Willis, G. NEW LATE EOCENE FOSSIL PERISSODACTYLS FROM THOUSAND LAKE MOUNTAIN, CENTRAL UTAH
74. Cuddahee, R. and Bobe, R. MULTIVARIATE ECOMORPHOLOGICAL ANALYSIS OF FEEDING BEHAVIOR IN AFRICAN SUIDAE (ARTIODACTYLA, MAMMALIA)
75. Holbrook, L. RHINOCEROTOID AFFINITIES OF DEPERETELLIDAE (MAMMALIA, PERISSODACTYLA) BASED ON ENAMEL MICROSTRUCTURE
76. Cuesta, M. Á. and Badiola, A. A NEW ANOPLOTHERIINE ARTIODACTYL FROM THE MIDDLE EOCENE OF THE IBERIAN PENINSULA
77. Martin, L. and Beatty, B. AN ANTILOCAPRID FROM THE LATE ARIKAREEAN (LATE MIOCENE) OF WYOMING
78. Thies, M. and Lewis, P. A DESCRIPTION OF NEW PLIESTOCENE BAT SPECIMENS FROM SOUTHERN AFRICA
79. McCartney, J. and Hill, R. ON DYROSAURID (CROCODYLIFORMES: MESOEUCROCODYLIA) POSTCRANIAL REMAINS FROM THE LATE CRETACEOUS AND PALEOCENE OF MALI
80. Rezvyi, A. CROCODYLIFORMS FROM THE LATE CRETACEOUS (TURONIAN) BISSEKTY LOCAL FAUNA OF KYZYLKUM DESERT, UZBEKISTAN

81. Calvo, J., Santos, D., Porfiri, J. and Kellner, A. ON A POSSIBLE NEW COMAHUESUCHIDAE (CROCODYLOMORPHA) FROM THE LATE CRETACEOUS PORTEZUELO FORMATION, PATAGONIA
82. Moreno-Bernal, J. SIZE AND PALAEOECOLOGY OF GIANT MIOCENE SOUTH AMERICAN CROCODILES (ARCHOSAURIA: CROCODYLIA)
83. Hicks, J. HYPOXIA, BUT NOT HYPEROXIA, CONSTRAINS EMBRYONIC GROWTH OF THE AMERICAN ALLIGATOR
84. Ikejiri, T. ONTOGENETIC AND INTRACOLUMNAR VARIATION IN COMPLEXITY OF THE NEUROCENTRAL SUTURE IN DWARF AND LARGE CROCODILIAN SPECIES

FRIDAY MORNING, OCTOBER 19, 2007

SYMPOSIUM: THE DISSOROPHOIDEA —  
FOCUS ON AN EARLY AMPHIBIAN RADIATION

GOVERNOR'S BALLROOM SALON A

**MODERATORS: ANDREW MILNER AND JASON ANDERSON**

- 8:00 Carroll, R. DISSOROPHOIDS AS A UNIQUELY INFORMATIVE MODEL FOR THE STUDY OF PATTERNS, PROCESSES, AND RATES OF VERTEBRATE EVOLUTION
- 8:15 Witzmann, F., Schoch, R. and Milner, A. THE ORIGIN OF THE DISSOROPHOIDEA – AN ALTERNATIVE PERSPECTIVE
- 8:30 Reisz, R. TERRESTRIAL VERTEBRATE FAUNA OF THE LOWER PERMIAN CAVE DEPOSITS NEAR RICHARDS SPUR OKLAHOMA WITH EMPHASIS ON DISSOROPHOIDS
- 8:45 Lillich, R. and Schoch, R. FINALLY GROWN UP - THE SIGNIFICANCE OF ADULT *MICROMELERPETON*
- 9:00 Milner, A. *MORDEXLATICEPS* AND THE BASE OF THE TREMATOPIIDAE
- 9:15 Berman, D. and Henrici, A. A NEW, LATE PENNSYLVANIAN TREMATOPIID (TEMNOSPONDYLI: DISSOROPHOIDEA) FROM WESTERN PENNSYLVANIA
- 9:30 Maddin, H., Anderson, J. and Reisz, R. BRAINCASE ONTOGENY OF A NEW LARGE TREMATOPIID (TEMNOSPONDYLI: DISSOROPHOIDEA) FROM RICHARDS SPUR, OKLAHOMA
- 9:45 Dilkes, D. NEW DATA ON THE VERTEBRAE AND OSTEODERMS OF *CACOPS ASPIDEPHORUS* AND *DISSOROPHUS MULTICINCTUS* (TEMNOSPONDYLI; DISSOROPHIDAE)
- 10:00 BREAK
- 10:15 Werneburg, R. and Lucas, S. "*MILNERERPETON*" FROM THE LATE PENNSYLVANIAN OF NEW MEXICO IS THE FIRST TRULY "EUROPEAN BRANCHIOSAURID" FROM NORTH AMERICA
- 10:30 Sanchez, S., Steyer, J.S., De Ricqlès, A. and Schoch, R. LIFE-HISTORY TRAITS OF *APATEON* (LOWER PERMIAN OF EUROPE), A KEY-GENUS AMONG DISSOROPHOIDS, REVEALED BY BONE HISTOLOGY
- 10:45 Clack, J. and Milner, A. THE AMPHIBAMID *PLATYRHINOPS*, MORPHOLOGY AND METAMORPHOSIS
- 11:00 Fröbisch, N. and Reisz, R. A NEW LOWER PERMIAN AMPHIBAMID (DISSOROPHOIDEA, TEMNOSPONDYLI) FROM THE FISSURE FILL DEPOSITS NEAR RICHARDS SPUR, OKLAHOMA
- 11:15 Bolt, J. and Anderson, J. PALATAL BICUSPID TEETH IN AMPHIBAMIDS (TEMNOSPONDYLI: DISSOROPHOIDEA) FROM THE EARLY PERMIAN OF OKLAHOMA
- 11:30 Sigurdson, T. THE BRAINCASE AND OTIC REGION OF THE AMPHIBAMID *DOLESERPETON* (TEMNOSPONDYLI), AND ITS IMPLICATIONS FOR THE ORIGIN OF FROGS
- 11:45 Anderson, J., Scott, D., Reisz, R. and Sumida, S. A NEW STEM BATRACHIAN (TEMNOSPONDYLI: AMPHIBAMIDAE) FROM THE EARLY PERMIAN OF TEXAS
- 12:00 Baez, A. ANURAN REMAINS FROM THE BARREMIAN OF LAS HOYAS, SPAIN: UNDERSTANDING THE EARLY DIVERSIFICATION OF PIPOIDS

TECHNICAL SESSION IX  
AUSTIN GRAND BALLROOM SALON H  
**MODERATORS: DAVID VARRICCHIO AND DAVID EVANS**

- 8:00 Mateus, O. NOTES AND REVIEW OF THE ORNITHISCHIAN DINOSAURS OF PORTUGAL
- 8:15 Boyd, C. and Clarke, J. TAXONOMIC CHIMERAS AND STRATIGRAPHIC INCONGRUENCE RESOLVED: A NEW PHYLOGENY OF THE BASAL ORNITHISCHIA
- 8:30 Richter, A., Wings, O., Richter, U. and Knötschke, N. "HAPPY FEET": A NEW LOWER CRETACEOUS DINOSAUR TRACKSITE FROM MÜNCHENHAGEN, GERMANY
- 8:45 Schulp, A. and Al Wosabi, M. THE FIRST DINOSAUR TRACKSITE FROM THE ARABIAN PENINSULA
- 9:00 Butler, R., Barrett, P., Kenrick, P. and Penn, M. PALEOENVIRONMENTAL CONTROLS ON THE DISTRIBUTION OF CRETACEOUS HERBIVOROUS DINOSAURS
- 9:15 Knoll, F., De Ricqlès, A. and Padian, K. THE GROWTH TRAJECTORY AND ADULT SIZE OF *LESOTHO SAURUS DIAGNOSTICUS* (DINOSAURIA: ORNITHISCHIA): TAXONOMIC IMPLICATIONS
- 9:30 Makovicky, P., Sadlier, R., Dodson, P., Erickson, G. and Norell, M. LIFE HISTORY OF *PROTOCERATOPS ANDREWSI* FROM BAYN ZAG, MONGOLIA.
- 9:45 Varricchio, D., Martin, A. and Katsura, Y. BURROWING BEHAVIOR IN A NEW ORNITHOPOD DINOSAUR FROM THE MID CRETACEOUS OF MONTANA
- 10:00 BREAK
- 10:15 Weishampel, D. and Cheney, D. VIRTUAL HADROSAUROID MASTICATION
- 10:30 Cuthbertson, R. PLEUROKINESIS REVISITED, KINETIC LIMITATIONS OF CRANIAL JOINTS IN HADROSAURINE DINOSAURS
- 10:45 Gangloff, R. and Fiorillo, A. TAPHOMOMY AND PALEOECOLOGY OF A REMARKABLY RICH UPPER CRETACEOUS HIGH LATITUDE BONEBED FROM THE PRINCE CREEK FORMATION, NORTH SLOPE ALASKA
- 11:00 Evans, D. PHYLOGENY OF LAMBEOSAURINE DINOSAURS USING PARSIMONY AND BAYESIAN LIKELIHOOD APPROACHES
- 11:15 Horner, J., Goodwin, M. and Woodward, H. SYNONYMY CONSEQUENCES OF DINOSAUR CRANIAL ONTOGENY
- 11:30 Sullivan, R. DOMING, HETEROCHRONY, AND PAEDOMORPHOSIS IN THE PACHYCEPHALOSAURIDAE (ORNITHISCHIA: DINOSAURIA): TAXONOMIC AND PHYLOGENETIC IMPLICATIONS
- 11:45 Yates, A., Bonnan, M. and Neveling, J. A NEW DIVERSE DINOSAUR ASSEMBLAGE FROM THE EARLY JURASSIC OF SOUTH AFRICA
- 12:00 Barrett, P., Page, V. and McGowan, A. DINOSAUR DIVERSITY THROUGH TIME: THE INFLUENCE OF THE ROCK RECORD

TECHNICAL SESSION X  
GOVERNOR'S BALLROOM SALON B  
**MODERATORS: AMY CHEW AND TONYA PENKROT**

- 8:00 Kemp, T. CORRELATED PROGRESSION AS A REALISTIC AND USABLE MODEL FOR THE THE ORIGIN OF MAJOR VERTEBRATE TAXA
- 8:15 Kilbourne, B. ONTOGENETIC LIMB BONE ALLOMETRY: A RELIABLE PREDICTOR OF METABOLIC RATE IN EXTINCT TAXA?
- 8:30 Williamson, T. EXCEPTIONAL PRESERVATION OF MAMMALS, A BIRD, AND LIZARDS FROM THE LOWER PALEOCENE OF NEW MEXICO
- 8:45 Missiaen, P. and Smith, T. THE LATE PALEOCENE SUBENG MAMMALS OF INNER MONGOLIA, CHINA AND THE GASHATAN-BUMBANIAN TURNOVER
- 9:00 Wang, Y.-Q., Meng, J., Ni, X.-J. and Beard, K.C. EARLY EOCENE BUMBANIAN FAUNA FROM THE ERLIAN BASIN, INNER MONGOLIA, CHINA AND ITS BIOCHRONOLOGICAL IMPLICATIONS
- 9:15 Bajpai, S., Thewissen, J.G.M., Kay, R., Colbert, M. and Kapur, V. AN OVERVIEW OF TERRESTRIAL MAMMALS FROM EARLY EOCENE CAMBAY SHALE, VASTAN LIGNITE MINE, GUJARAT (WESTERN INDIA), WITH NEW TAXA AND AGE CONSTRAINTS



- 9:30 Stucky, R. and Krishtalka, L. MULTITUBERCULATES AND OTHER MAMMALS FROM WA4 (EARLY LYSITEAN, EARLY EOCENE) OF THE WIND RIVER FORMATION, HELL'S HALF ACRE, WYOMING
- 9:45 Wood, A. and Zelditch, M. MEASURING DENTAL WEAR AND TOOTH SHAPE: CONTRASTING MULTIVARIATE RESULTS FROM TWO SPECIES OF THE EARLY EOCENE EQUID *HYRACOTHERIUM*
- 10:00 BREAK
- 10:15 Croft, D. and Weinstein, D. USING MESOWEAR TO TEST WHETHER HYPSONOT NOTOUNGULATES WERE GRAZERS
- 10:30 Colbert, M. and Eberle, J. THE SKULL OF *THULIADANTA*, A SURPRISINGLY DERIVED TAPIROID FROM THE EARLY EOCENE (WASATCHIAN) OF THE CANADIAN HIGH ARCTIC, AS REVEALED BY HIGH-RESOLUTION CT SCANNING
- 10:45 Clyde, W. TIMING AND CORRELATION OF THE SHANGHUAN-NONGSHANIAN ASIAN LAND MAMMAL AGE BOUNDARY
- 11:00 Walsh, S. and Murphey, P. DOCUMENTING THE UINTAN/DUCHESNEAN TRANSITION IN THE DUCHESNE RIVER FORMATION, UTAH
- 11:15 Chew, A. and Oheim, K. TEASING APART THE EFFECTS OF TAPHONOMIC AND SAMPLING BIAS ON SPECIES DIVERSITY ESTIMATES USING GIS
- 11:30 Smith, T. and Gingerich, P. RAPID MAMMALIAN FAUNAL TURNOVER AT THE ONSET OF THE PALEOCENE-EOCENE CARBON ISOTOPE EXCURSION (CIE) IN THE BIGHORN BASIN, WYOMING
- 11:45 Penkrot, T. NORTH AMERICAN CONDYLARTH DIETS ACROSS THE PALEOCENE-EOCENE BOUNDARY: PALEOECOLOGICAL RESPONSE OF ONE ARCHAIC GROUP OF MAMMALS TO GLOBAL WARMING
- 12:00 Secord, R., Gingerich, P. and Lohmann, K. A NEW CONTINENTAL RECORD OF WARMING DURING THE PALEOCENE-EOCENE THERMAL MAXIMUM IN NORTH AMERICA

FRIDAY AFTERNOON, OCTOBER 19, 2007

TECHNICAL SESSION XI  
GOVERNOR'S BALLROOM SALON A  
**MODERATOR: KEVIN SEYMOUR**

- 1:15 Zack, S. and Rose, K. NEW MATERIAL OF *GALECYON*, A RARE EARLY EOCENE HYAENODONTID (MAMMALIA: CREODONTA)
- 1:30 Tsubamoto, T., Watabe, M. and Tsogtbaatar, K. VERY SMALL *HYAENODON* AND HYAENODONTID CREODONT FAUNA FROM THE UPPER EOCENE ERGILIN DZO FORMATION OF MONGOLIA
- 1:45 Seymour, K. THE FIRST SKELETON OF A PLIOCENE CAT (FELIDAE) FROM NORTH AMERICA - A MISSING *LYNX*?
- 2:00 Tseng, Z., Wang, X. and Stewart, J.D. TOUGH NEW WORLD: DISCOVERY OF AN UNUSUAL IMMIGRANT MUSTELID WITH CRUSHING DENTITION FROM THE MIDDLE MIOCENE OF COASTAL CALIFORNIA
- 2:15 Wang, X. and Carranza-Castañeda, Ó. A BASAL HOG-NOSED SKUNK, *CONEPATUS* (MEPHITIDAE, CARNIVORA), FROM LATE MIOCENE TO EARLY PLIOCENE OF CENTRAL MEXICO AND ORIGIN OF SOUTH AMERICAN SKUNKS
- 2:30 Meachen-Samuels, J. and Van Valkenburgh, B. PREY SIZE AND PREY-KILLING STRATEGIES IN THE FELIDAE
- 2:45 Wallace, S. and Wang, X. FIRST MANDIBLE AND LOWER DENTITION OF *PRISTINAILURUS BRISTOLI* WITH COMMENTS ON LIFE HISTORY AND PHYLOGENY
- 3:00 Spaulding, M. THE IMPACT OF POSTCRANIAL CHARACTERS ON RECONSTRUCTING THE PHYLOGENY OF CARNIVORAMORPHA

TECHNICAL SESSION XII

AUSTIN GRAND BALLROOM SALON H

**MODERATORS: CAROLINE STRÖMBERG AND LARISA DESANTIS**

- 1:15 Clementz, M. and Holroyd, P. USING STABLE ISOTOPE ANALYSIS TO TEST INFERRED SEMI-AQUATIC HABITS IN FOSSIL HERBIVORES FROM THE EARLY OLIGOCENE OF EGYPT
- 1:30 Bibi, F. DIETARY NICHE PARTITIONING AMONG FOSSIL BOVIDS IN LATE MIOCENE C3 HABITATS: CONSILIENCE OF FUNCTIONAL MORPHOLOGY AND STABLE ISOTOPE ANALYSIS
- 1:45 Biasatti, D., Wang, Y. and Deng, T. RECONSTRUCTION OF PALEOECOLOGIES AND PALEOCLIMATES OF CENOZOIC MAMMALS FROM NORTHWEST CHINA BASED ON STABLE ISOTOPES
- 2:00 DeSantis, L. and MacFadden, B. FOSSIL TAPIRS AS INDICATORS OF FORESTED ENVIRONMENTS: EVIDENCE FROM EVOLUTIONARY MORPHOLOGY AND STABLE ISOTOPES
- 2:15 Strömberg, C. and Smith, F. TOWARDS CALIBRATING THE LATE MIOCENE C3/C4 SHIFT IN THE GREAT PLAINS, NORTH AMERICA: A COMBINED RECORD OF PHYTOLITH ASSEMBLAGE COMPOSITION AND STABLE CARBON ISOTOPES
- 2:30 Belmaker, M., Nelson, S., Morgan, M., Barry, J. and Badgley, C. MESOWEAR ANALYSIS OF UNGULATES IN THE MIDDLE TO LATE MIOCENE OF THE SIWALIKS, PAKISTAN: DIETARY AND PALEOENVIRONMENTAL IMPLICATIONS
- 2:45 Matson, S. and Fox, D. STABLE ISOTOPIC RECORD OF MESSINIAN MAMMALS FROM THE CIRCUM-MEDITERRANEAN REGION
- 3:00 Alroy, J. MAXIMUM LIKELIHOOD BUBBLES AND MAMMALIAN BIOGEOGRAPHY
- 3:15 Fahlke, J. THE PLEISTOCENE/HOLOCENE TRANSITION IN CENTRAL EUROPE - A CLEAR CUT OR SLOW PROCESS? NEW INSIGHTS INTO THE MECHANISMS INFLUENCING MAMMALIAN FAUNAS
- 3:30 Fox, D., Passey, B., Cerling, T. and Martin, R. HABITAT PATCHINESS DURING THE TRANSITION TO THE MODERN GRASSLAND ECOSYSTEM IN THE GREAT PLAINS
- 3:45 Koch, P., Hall, B., Baroni, C., Newsome, S. and Salvatore, M. THE DISTRIBUTION AND ECOLOGY OF SOUTHERN ELEPHANT SEALS AND ADELIE PENGUINS ON THE HOLOCENE ROSS SEA COAST

TECHNICAL SESSION XIII

GOVERNOR'S BALLROOM SALON B

**MODERATOR: JULIA CLARKE**

- 1:15 Li, Q. and Gao, K.-Q. LOWER CRETACEOUS VERTEBRATE FAUNA FROM THE SINUIJU BASIN, NORTH KOREA AS EVIDENCE OF GEOGRAPHIC EXTENSION OF THE JEHOL BIOTA INTO THE KOREAN PENINSULA
- 1:30 Hutson, J. A COMPARISON AND TEST OF THE VALIDITY OF RANGE-OF-MOTION STUDIES ON FOSSIL ARCHOSAUR FORELIMBS USING WHOLE AND SKELETONIZED EXTANT ARCHOSAURS
- 1:45 Maxwell, E. THE PHYLOGENETIC SIGNIFICANCE OF OSSIFICATION SEQUENCE DATA IN BIRDS, AND ITS RELEVANCE TO FOSSIL TAXA
- 2:00 Gishlick, A. DEVELOPMENTAL PATTERN OF WRIST ELEMENTS IN PALAEOGNATHS AND ITS BEARING ON THE EVOLUTION OF THEROPOD CARPALS
- 2:15 Rayfield, E. BEYOND THE BEAK: CAN WE DETECT ECOMORPHOTYPES IN THE AVIAN SKULL?
- 2:30 Knight, T. and Bingham, P. LARGEST COLLECTION OF FEATHERS FROM MESOZOIC STRATA OF NORTH AMERICA, INGERSOLL SHALE, EUTAW FORMATION, EASTERN ALABAMA.
- 2:45 Clarke, J. and Middleton, K. QUANTITATIVE APPROACHES TO THE STUDY OF MORPHOLOGICAL EVOLUTION USING DISCRETE CHARACTERS AND A BAYESIAN PHYLOGENETIC APPROACH TO INVESTIGATING MOSAICISM IN AVIALAN EVOLUTION
- 3:00 Stidham, T. and Williamson, T. A UNIQUE DERIVED POSSIBLY ZYGODACTYL BIRD SKELETON FROM THE PALEOCENE (TORREJONIAN) OF NEW MEXICO

### POSTER SESSION III

Authors must be present from 4:00–6:00 p.m.

Posters must be removed by 6:15 p.m.

1. Buckley, L. and McCrea, R. A TECHNIQUE USING A SODIUM HYPOCHLORITE (BLEACH) SOLUTION TO REMOVE LICHEN FROM VERTEBRATE TRACK SURFACES
2. Codd, J. and Manning, P. UNCINATE PROCESSES: A UNIQUE SYNAPOMORPHY FOR MANIRAPTORAN AND AVIAN THEROPODS?
3. Schmitz, L., Motani, R. and Milner, A. DIEL ACTIVITY PATTERN OF *ARCHAEOPTERYX*
4. Hartman, S. RE-EVALUATING WING SHAPE IN *ARCHAEOPTERYX*: INFORMATION FROM THE THERMOPOLIS SPECIMEN
5. Rensberger, J., Collier, S. and Lee, T. CANALICULAR DENSITY IN SAURISCHIANS AND ITS IMPLICATIONS FOR RATES OF BONE OSTEOGENESIS
6. Lockley, M., Chin, K., Matsukawa, M. and Kukihara, R. NEW INTERPRETATIONS OF *IGNOTORNIS*, THE FIRST BIRD TRACK EVER REPORTED FROM THE MESOZOIC
7. Tykoski, R. and Fiorillo, A. AVIAN REMAINS AND OTHER VERTEBRATES FROM A NEW LOCALITY IN THE WOODBINE FORMATION (MIDDLE CENOMANIAN) OF NORTH-CENTRAL TEXAS
8. Leggitt, V., Biaggi, R. and Buchheim, H. AVIAN EGG SHELL FROM A CARBONATE MUDFLAT SHORELINE OF EOCENE FOSSIL LAKE
9. Habib, M. PREDICTING WING SHAPE AND FLIGHT DYNAMICS FROM OSTEOLOGICAL STRUCTURES IN BIRDS AND PTEROSAURS
10. Smith, A. TAXONOMIC REVISION OF GENUS *ALCA* (AVES, ALCIDAE): AND A NOVEL MORPHOMETRIC AND PHYLOGENETIC APPROACH FOR ASSESSING DIVERSITY AMONG TAXA KNOWN FROM ISOLATED SPECIMENS
11. Pelletier, V., Sumida, S., Walliser, J. and Berman, D. HINDLIMB STRUCTURE OF THE RARE LOWER PERMIAN DIADECTOMORPH *TSEAJAJA CAMPI* VAUGHN
12. Small, B. and Sanders, F. EARLY PERMIAN *ICHNIOTHERIUM*-DOMINATED FOOTPRINT ASSEMBLAGES FROM THE MAROON FORMATION, COLORADO
13. Martens, T., Berman, D., Henrici, A. and Sumida, S. THE BROMACKER QUARRY - THE MOST IMPORTANT LOCALITY OF LOWER PERMIAN TERRESTRIAL VERTEBRATE FOSSILS OUTSIDE OF NORTH AMERICA
14. Fillmore, D., Lucas, S. and Simpson, E. MISSISSIPPIAN TETRAPOD FOOTPRINTS FROM THE MAUCH CHUNK FORMATION IN EASTERN PENNSYLVANIA, USA
15. Carter, G., Wilson, G., Piekarski, T. and Poltenovage, M. AMPHIBIAN PALEOCOMMUNITIES AS ECOLOGICAL INDICATORS DURING THE LAST 2 MILLION YEARS OF THE CRETACEOUS IN NORTHEASTERN MONTANA
16. Henrici, A. BARSTOVIAN ANURANS FROM THE MADISON VALLEY FORMATION NEAR ANCENEY, MONTANA
17. Olori, J. and Bell, C. APOMORPHIC IDENTIFICATION OF FOSSIL CAUDATE VERTEBRAE FROM OREGON AND CALIFORNIA: FUTILE OR FRUITFUL?
18. Liu, J. FIRST DISCOVERY OF FACULTATIVE PAEDOMORPHOSIS IN AMPHIBIAN FOSSILS
19. Germain, D. ANATOMY OF LEPOSPONDYLS AND ORIGIN OF LISSAMPHIBIANS
20. Verma, O. and Prasad, G. LATE CRETACEOUS MAMMAL FAUNA FROM THE DECCAN VOLCANO-SEDIMENTARY SEQUENCES OF CENTRAL INDIA
21. Rankin, B. and Fox, R. A NEW EARLY PALEOCENE MAMMAL LOCALITY FROM SOUTHERN ALBERTA
22. McGee, E., Turnbull, W. and Simpson, W. *CORYPHODON LOBATUS* (MAMMALIA: PANTODONTA) FROM DEARDORFF QUARRY, PICEANCE BASIN, COLORADO: ADDITIONAL EVIDENCE OF A *CORYPHODON* PAUCISPECIFIC DEATH ASSEMBLAGE
23. Johnson, M. and Clementz, M. PALEOCLIMATE RECONSTRUCTION THROUGH STABLE ISOTOPE ANALYSIS OF SOIL CARBONATE NODULES FROM THE SOUTHWESTERN WYOMING WASHAKIE BASIN
24. Anemone, R., Dirks, W., Watkins, R., Nachman, B. and Van Regenmorter, J. A LATE WASATCHIAN MAMMALIAN FAUNA FROM THE STEAMBOAT MOUNTAIN-FREIGHTER GAP AREA, GREAT DIVIDE BASIN, SOUTHWESTERN WYOMING
25. Gelfo, J. and Tejedor, M. THE DIVERSITY OF BUNODONT UNGULATES DURING THE EARLY EOCENE IN CENTRAL-WESTERN PATAGONIA, ARGENTINA
26. Miyata, K. PHYLOGENETIC ANALYSIS OF TROGOSINAE (TILLODONTIA, MAMMALIA)
27. Townsend, B. MIDDLE EOCENE MAMMALIAN ECOLOGICAL DIVERSITY IN THE UINTA FORMATION, UINTA BASIN, UTAH

28. Suzuki, S., Watabe, M., Tsubamoto, T., Saneyoshi, M. and Tsogtbaatar, K. DISCOVERY OF MAMMALIAN FOOT-PRINTS FROM THE MIDDLE EOCENE OF MONGOLIA
29. Minkler, H. PALEOFAUNA FROM THE LATEST EOCENE CHADRON FORMATION, HIGHWAY 44 LOCALITY, IN SOUTHWESTERN SOUTH DAKOTA, AND ITS IMPLICATIONS CONCERNING THE EOCENE/OLIGOCENE TRANSITION
30. Dewar, E. THE TAXONOMIC STABILITY OF LARGE MAMMALS IN THE WHITE RIVER CHRONOFAUNA MASKED THEIR CHANGING DIETARY ECOLOGY
31. Evanoff, E. THE STRATIGRAPHIC DISTRIBUTION OF FOSSIL SITES IN THE BRULE FORMATION IN BADLANDS NATIONAL PARK, SOUTH DAKOTA
32. Barton, M. and Stucky, R. DIVERSITY OF MAMMALIAN PALEOECOLOGICAL ASSEMBLAGES IN THE EARLY OLIGOCENE SCENIC MEMBER OF THE BRULE FORMATION, WHITE RIVER GROUP, BADLANDS NATIONAL PARK, SOUTH DAKOTA
33. Strganac, C. PALEOGENE TERRESTRIAL MAMMALS IN THE TIETON RIVER AREA, SOUTH-CENTRAL WASHINGTON
34. Fukuchi, A., Ratanasthien, B., Songtham, W., Nakaya, H. and Suzuki, S. EXPANSION OF GRASSLAND IN THE EARLY LATE MIOCENE IN NORTHERN THAILAND
35. MacLatchy, L., Cote, S., Kingston, J., Rossie, J. and Winkler, A. NEW EARLY MIOCENE LOCALITIES AT NAPAK, UGANDA
36. Prothero, D. and Davis, E. MAGNETIC STRATIGRAPHY OF THE UPPER MIOCENE (EARLY HEMPHILLIAN) THOUSAND CREEK FORMATION, NORTHWESTERN NEVADA
37. Michalies, S. RESULTS OF RECENT PALEONTOLOGICAL FIELDWORK IN THE MIDDLE MIOCENE ANCENEY LOCAL FAUNA, (BARSTOVIAN NALMA) GALLATIN VALLEY, MONTANA
38. Coombs, M. DIVERSITY OF NORTH AMERICAN MIOCENE CHALICOTHERES (MAMMALIA, PERISSODACTYLA): *MOROPUS MERRIAMII* FROM LATE HEMINGFORDIAN AND EARLY BARSTOVIAN FAUNAS OF NEVADA
39. Reynolds, R., Milner, A., Hunt, G. and Brinton, J. MAMMAL TRACKWAYS FROM MIDDLE MIOCENE (LATE BARSTOVIAN NALMA) VOLCANICLASTIC SEDIMENTS IN SOUTHWESTERN UTAH
40. Pagnac, D. and Pappas, J. A RETURN TO BIJOU HILL: NEW INVESTIGATIONS IN THE MIDDLE MIOCENE FORT RANDALL FORMATION OF SOUTH DAKOTA
41. Eshelman, R., Beatty, B. and Domning, D. TERRESTRIAL MAMMAL REMAINS FROM THE MIOCENE CHESAPEAKE GROUP OF CALVERT CLIFFS, MARYLAND, AND COMPARISONS WITH MIOCENE TERRESTRIAL MAMMAL FAUNAS OF THE MID-ATLANTIC COAST
42. Domingo, M. S., Sánchez, I., Morales, J. and Alberdi, M. T. MIOCENE PREY AND PREDATORS: DIVERSITY OF THE MOSCHIDAE (RUMINANTIA; PECORA) FROM THE CARNIVORE-TRAP SITE OF BATALLONES-1 (LATE VALLESIAN; MN 10; MADRID BASIN; SPAIN) AND EVIDENCE OF CARNIVORE TROPHIC ACTIVITY ON MOSCHIDS
43. Lambert, W.D. ARE THE SHOVEL-TUSKED GOMPHOTHERES (PROBOSCIDEA, GOMPHOTHERIIDAE) MONOPHYLETIC OR POLYPHYLETIC?
44. Boessenecker, R. NEW RECORDS OF FOSSIL FUR SEALS AND WALRUSES (CARNIVORA:PINNIPEDIA) FROM THE LATE NEOGENE OF NORTHERN CALIFORNIA
45. Atterholt, J., Jefferson, G. and Schachner, E. NEW MARINE VERTEBRATES FROM THE YUHA MEMBER OF THE DEGUYNOS FORMATION OF ANZA-BORREGO DESERT STATE PARK
46. Murray, L. EFFECTS OF DATA IMPROVEMENT TECHNIQUES ON FOSSIL TAXONOMIC DISTRIBUTION IN VALLECITO CREEK-FISH CREEK, CALIFORNIA
47. Naples, V., Spearing, K., Molokwu, R., Babiarz, J. and Martin, L. RECONSTRUCTION OF THE MUSCULATURE OF THE HIND LIMB OF *XENOSMILUS HODSONAE* AS COMPARED TO THE DOMESTIC CAT, *FELIS CATUS*
48. Lofgren, D., Cripe, J. and Everhart, D. PRELIMINARY RESULTS OF A LONG-TERM SURVEY OF PALEONTOLOGICAL RESOURCES OF THE KAIPAROWITS FORMATION WITHIN GRAND STAIRCASE-ESCALANTE NATIONAL MONUMENT
49. Cavin, J. and Kirkland, J. PRELIMINARY INTERPRETATIONS OF THE ANDREW'S SITE QUARRIES AND THE INTERRELATION OF VERTEBRATE FOSSIL SITES IN THE CEDAR MOUNTAIN FORMATION IN THE YELLOW CAT TYPE AREA OF EAST-CENTRAL, UTAH
50. Oreska, M., Carrano, M. and Lockwood, R. PALEOECOLOGY OF THE CLOVERLY FORMATION (LOWER CRETACEOUS) VERTEBRATE FAUNA FROM MICROVERTEBRATE SITES IN THE BIGHORN BASIN, WYOMING
51. DeMar, D., Clementz, M. and Breithaupt, B. STABLE ISOTOPE RATIOS OF VERTEBRATE MICROFOSSILS OF THE MESAVERDE FORMATION, WYOMING; EVIDENCE FOR PALEOECOLOGICAL RECONSTRUCTIONS

52. King, L., Foster, J. and Heckert, A. NEW LIFE FOR OLD FOSSILS: MICROVERTEBRATE FOSSILS FROM THE GARDEN PARK FOSSIL AREA (LATE JURASSIC, MORRISON FORMATION)
53. Rivera-Sylva, H., Guzman-Gutierrez, J. R., Palomino-Sánchez, F. J., Lopez-Espinosa, J. and De La Peña-Oviedo, I. NEW VERTEBRATE FOSSIL LOCALITIES FROM THE LATE CRETACEOUS OF NORTHERN COAHUILA, MEXICO
54. Sellers, W. and Manning, P. "WHAT IF" TESTING IN DINOSAUR FUNCTIONAL ANATOMY USING EVOLUTIONARY ROBOTICS
55. Machado, E. and Kellner, A. FROM AN ISCHIUM TO A RIB: REVIEW OF THE OSTEOLOGICAL EVIDENCE OF THE SUPPOSED ORNITHISCHIAN DINOSAUR FROM THE ARARIPE BASIN, BRAZIL
56. Pine, S. and Wedel, M. INCREASES IN SACRAL VERTEBRAE IN NON-AVIAN DINOSAURS: A PERVERSIVE, HOMOPLASTIC, DRIVEN EVOLUTIONARY TREND
57. Falkingham, P., Manning, P. and Margetts, L. FINITE ELEMENT ANALYSIS OF DINOSAUR TRACKS
58. Engelmann, G., Chure, D. REPEATED HORIZONS OF DINOSAURIAN MASS TURBATION IN THE LOWER JURASSIC GLEN CANYON GROUP, DINOSAUR NATIONAL MONUMENT, AND THEIR PALEOENVIRONMENTAL IMPLICATION
59. Mathews, J., Henderson, M. and Williams, S. TAPHONOMY AND SEDIMENTOLOGY OF THE FIRST KNOWN *TRICERATOPS* BONEBED, CARTER COUNTY MONTANA
60. Lepore, T. NEW THEROPOD AND ORNITHISCHIAN FOOTPRINTS AT THE DINOSAUR FOOTPRINT STATE RESERVATION (EARLY JURASSIC, PORTLAND FORMATION), HOLYOKE, MASSACHUSETTS, USA
61. Huh, M., Paik, I.S., Lockley, M., Kim, J-Y. and Lim, J.D. CURRENT STUDIES ON KOREAN DINOSAURS AND VERTEBRATE FOOTPRINTS
62. Moratalla, J. and Hernan, J. DINOSAUR ICNOCENOSIS AND THE CAMEROS BASIN AS AN OBLIGE PASS AREA DURING THE LOWER CRETACEOUS OF THE IBERIAN PLATE
63. Watabe, M. and Fastovsky, D. MASS BURIAL EVENT OF PINACOSAURUS (ANKYLOSAURIA, DINOSAURIA) IN ALAG TEG, A FLUVIAL FACIES OF THE DJADOKHTA FORMATION (LATE CRETACEOUS), GOBI DESERT, MONGOLIA
64. McCrea, R. and Buckley, L. PRELIMINARY INVESTIGATIONS ON THE VERTEBRATE ICHNOFAUNA OF THE LOWER CRETACEOUS (VALANGINIAN) GORMAN CREEK FORMATION, NORTHEASTERN BRITISH COLUMBIA: FILLING THE GAP IN THE TERRESTRIAL VERTEBRATE TRACK RECORD OF WESTERN CANADA
65. Martin, A., Vickers-Rich, P., Rich, T. and Kool, L. POLAR DINOSAUR TRACKS IN THE CRETACEOUS OF AUSTRALIA: THOUGH MANY WERE COLD, FEW WERE FROZEN
66. Hall, L. and Goodwin, M. A PRELIMINARY ANALYSIS OF DINOSAUR TEETH FROM THE MUGHER MUDSTONE OF ETHIOPIA
67. Maidment, S. and Porro, L. HOMOLOGY AND FUNCTION OF THE ORNITHISCHIAN DINOSAUR PALPEBRAL
68. Norman, D., Porro, L. and Butler, R. A JUVENILE SKULL OF *HETERODONTOSAURUS TUCKI* FROM THE 'STORMBERG' OF SOUTH AFRICA
69. Southwell, E. and Breithaupt, B. THE TALE OF THE LOST *STEGOSAURUS LONGISPINUS* TAIL
70. Hayashi, S. and Carpenter, K. DIFFERENT GROWTH PATTERNS BETWEEN THE BODY SKELETON AND OSTEODERMS OF *STEGOSAURUS* (ORNITHISCHIA: THYREOPHORA)
71. Mallon, J., Ryczynski, N., Vickaryous, M. and Anderson, J. DENTAL MICROWEAR AND ITS IMPLICATIONS FOR NODOSAURID FEEDING MECHANICS AND PALEOECOLOGY
72. Lü, J., Xu, L., Zhang, X. and Ji, Q. NEW NODOSAURID ANKYLOSAUR FROM THE CRETACEOUS OF HENAN PROVINCE, CHINA
73. Miyashita, T. and Arbour, V. NEW INFORMATION ON THE INTERNAL CRANIAL ANATOMY OF *EUOPLOCEPHALUS* (ORNITHISCHIA, ANKYLOSAURIDAE)
74. Tanoue, K., You, H. and Dodson, P. MANDIBULAR ANATOMY IN BASAL CERATOPSIDS
75. Zhou, C., Fox, R. and Du, X.-K. ENDOCRANIAL MORPHOLOGY OF A BASAL CERATOPSID, *PSITTACOSAURUS*
76. Smith, D., Wolfe, D. and Sanders, R. THE ENDOCRANIUM AND ASSOCIATED STRUCTURES OF THE CERATOPSID *ZUNICERATOPS CHRISTOPHERI* (TURONIAN, NEW MEXICO)
77. Brown, C., Russell, A. and Ryan, M. THE DEVELOPMENTAL PATTERNS OF SURFICIAL BONE TEXTURE ON THE SKULLS OF CENTROSAURINE DINOSAURS

78. Gasaway, S., Sankey, J., Ortiz, N. and Meredith, V. PALEOECOLOGY OF A *CHASMOSAURUS MARISCALENSIS* BONEBED, LATE CRETACEOUS (LATE CAMPANIAN), BIG BEND NATIONAL PARK, TEXAS
79. Larson, P., Larson, M., Ott, C. and Bakker, R. SKINNING A *TRICERATOPS*
80. Poole, K. A NEW IGUANODONTID SPECIMEN FROM THE CEDAR MOUNTAIN FORMATION, GRAND COUNTY, UTAH
81. Guenther, M. MAXIMIZING UTILITY OF LARGE ISOLATED HADROSAURID POSTCRANIAL ELEMENTS FOR GENERIC DIVERSITY AND POPULATION VARIABILITY
82. Hohloch, A. PITCH, YAW AND, ROLL - HADROSAURIAN LOCOMOTION KINETICS INVESTIGATED WITH CAE
83. Barrick, R., Bartlett, J. and Bird, J. GROWTH RATES AND LIFE HISTORY OF *EOLAMBIA CAROLEJONESA*
84. McDonald, A., Wolfe, D. and Kirkland, J. A NEW BASAL HADROSAUROID (DINOSAURIA: ORNITHOPODA) FROM THE TURONIAN (LATE CRETACEOUS) OF NEW MEXICO
85. Campione, N., Evans, D. and Cuthbertson, R. ANATOMY OF THE ATLAS-AXIS COMPLEX OF HADROSAURID DINOSAURS
86. Prieto-Marquez, A., Gaete, R. and Galobart, A., V. Riera, O. Oms NEW DATA ON EUROPEAN HADROSAURIDAE (DINOSAURIA: ORNITHOPODA) FROM THE LATEST CRETACEOUS OF SPAIN
87. Ikegami, N. and Tomida, Y. OCCURRENCE OF A HADROSAURID CRANIAL MATERIAL FROM THE UPPER CRETACEOUS MIFUNE GROUP IN KYUSHU, JAPAN
88. Barsbold, R., Kobayashi, Y. and Kubota, K. NEW DISCOVERY OF DINOSAUR FOSSILS FROM THE UPPER CRETACEOUS BAYANSHIREE FORMATION OF MONGOLIA

SATURDAY MORNING, OCTOBER 20, 2007

SYMPOSIUM: CARNIVORA: PHYLOGENY, FORM AND FUNCTION

GOVERNOR'S BALLROOM SALON A

**MODERATORS: ANJALI GOSWAMI AND ANTHONY FRISCIA**

- 8:00 Wolsan, M. and Sato, J. PINNIPED AND RED PANDA AFFINITIES ELUCIDATED USING EXON NUCLEOTIDE SEQUENCES OF FIVE NUCLEAR GENES
- 8:15 Veron, G. PHYLOGENY OF THE VIVERRIDAE AND THE VIVERRID-LIKE FELIFORMS
- 8:30 Flynn, J., Finarelli, J. and Spaulding, M. PHYLOGENY OF THE CARNIVORA AND CARNIVORAMORPHA, AND THE USE OF THE FOSSIL RECORD TO ENHANCE UNDERSTANDING OF EVOLUTIONARY TRANSFORMATIONS
- 8:45 Goswami, A. PHYLOGENETIC SIGNALS IN CARNIVORAN CRANIAL MODULES AND IMPLICATIONS FOR PHYLOGENETIC ANALYSES
- 9:00 Holliday, J. EVOLUTION OF HYPERCARNIVORY: CONVERGENCE AND CHARACTER STATE BIAS IN CARNIVORA
- 9:15 Benoit, M. WHAT'S THE DIFFERENCE?: A MULTIPHASIC ALLOMETRIC ANALYSIS OF FOSSIL AND LIVING LIONS
- 9:30 Friscia, A. and Koepfli, K.-P. MUSTELIDAE: A MODEL FAMILY IN A MODEL ORDER
- 9:45 Kawakami, A. AUDITORY BULLA VOLUME IN HERPESTIDS AND ITS RELATION TO ECOLOGY, MORPHOLOGY, AND PHYLOGENY
- 10:00 BREAK
- 10:15 Werdelin, L. and Wesley-Hunt, G. THE GEOGRAPHY OF CARNIVORAN DISPARITY
- 10:30 Wesley-Hunt, G., Dehghani, R. and Werdelin, L. COMPARATIVE ECOMORPHOLOGY AND BIOGEOGRAPHY OF THE HERPESTIDAE AND VIVERRIDAE
- 10:45 Yeakel, J., Koch, P. and Dominy, N. MODERN, HISTORICAL, AND FUTURE CARNIVORE COMMUNITIES IN SUB-SAHARAN AFRICA: IMPLICATIONS FOR CONSERVATION AND CLIMATE CHANGE
- 11:00 Polly, P.D. TIPTOEING THROUGH THE TROPHICS: MEASURING DIGITIGRADY IN CARNIVORA FOR PALAEOENVIRONMENTAL INFERENCE
- 11:15 Lewis, M. and Lague, M. FUNCTIONAL SIGNIFICANCE OF SKELETAL ALLOMETRY IN CARNIVORA: IMPLICATIONS FOR MACHAIRODONT FELIDS

- 11:30 Morlo, M., Gunnell, G. and Nagel, D. MORPHOLOGY OF *PATRIOFELIS* AND *SARKASTODON*: TRENDS IN LARGE-BODIED OXYAENIDAE (CREODONTA)
- 11:45 Slater, G., Dumont, E. and Van Valkenburgh, B. IMPLICATIONS OF CRANIOFACIAL FORM FOR PERFORMANCE OF THE CANID SKULL DURING PREY KILLING AND FEEDING
- 12:00 Wroe, S., Clausen, P., McHenry, C. and Moreno, K. FINITE ELEMENT MODELING OF FEEDING BEHAVIOR IN THE THYLACINE AND WOLF: A NOVEL TEST FOR CONVERGENCE

TECHNICAL SESSION XIV  
AUSTIN GRAND BALLROOM SALON H  
**MODERATORS: XING XU AND MAX LANGER**

- 8:00 Stocker, M., Parker, W. and Irmis, R. REEXAMINATION OF AN AETOSAUR FROM THE TECOVAS FORMATION (DOCKUM GROUP) OF TEXAS: IMPLICATIONS FOR AETOSAUR DIVERSITY, ONTOGENY, BIOCHRONOLOGY, AND BIOSTRATIGRAPHY
- 8:15 Parker, W., Brown, M., Nesbitt, S., Stocker, M. and Irmis, R. REVISED OSTEOLOGY OF *REVUELTOSAURUS CALLENDERI* (ARCHOSAURIA: PSEUDOSUCHIA) BASED ON NEW MATERIAL FROM PETRIFIED FOREST NATIONAL PARK, ARIZONA
- 8:30 Kellner, A., Wang, X., Zhou, Z. and Campos, D. ON A NEW TAPEJARID (PTEROSAURIA, PTERODACTYLOIDEA) FROM THE CRETACEOUS YIXIAN FORMATION (JEHOL BIOTA, CHINA): THE OLDEST TOOTHLESS PTEROSAUR
- 8:45 Langer, M., Bittencourt, J. and Schultz, C. THE INCLUSIVITY AND PHYLOGENETIC POSITION OF *GUAIBASAURUS CANDELARIENSIS*: A BASAL DINOSAUR FROM THE LATE TRIASSIC OF BRAZIL
- 9:00 Nesbitt, S., Irmis, R., Parker, W. and Rowe, T. BASAL DINOSAURIFORMS FROM NORTH AMERICA AND THEIR IMPLICATIONS FOR ARCHOSAUR PHYLOGENY
- 9:15 Gignac, P., Makovicky, P., Erickson, G. and Walsh, R. THE EFFECT OF TOOTH MORPHOLOGY ON INDENTATION FORCE IN NON-AVIAN THEROPOD DINOSAURS
- 9:30 Manning, P., Ali, J., McDonald, S., Mummery, P. and Sellers, W. BIOMECHANICS OF DROMAEOSAURID CLAWS: APPLICATION OF X-RAY MICROTOMOGRAPHY, NANOINDENTATION AND FINITE ELEMENT ANALYSIS.
- 9:45 Tsuihiji, T., Watabe, M., Witmer, L., Tsubamoto, T. and Tsogtbattar, K. A JUVENILE SKELETON OF *TARBOSAURUS* WITH A NEARLY COMPLETE SKULL AND ITS IMPLICATIONS FOR ONTOGENETIC CHANGE IN TYRANNOSAURIDS
- 10:00 BREAK
- 10:15 Shychoski, L., Rayfield, E. and Sakamoto, M. THE BIOMECHANICS OF SCALE: A PHYLOGENETIC AND ONTOGENETIC INVESTIGATION OF TYRANNOSAUROID DINOSAURS USING GEOMETRIC MORPHOMETRICS AND THE FINITE ELEMENT METHOD
- 10:30 Smith, N. and Makovicky, P. EARLY THEROPOD EVOLUTION AND PARAPHYLY OF THE COELOPHYSOIDEA
- 10:45 Brusatte, S. and Sereno, P. PHYLOGENY OF ALLOSAUROIDEA (DINOSAURIA: THEROPODA): NEW ANALYSIS, COMPARISONS, AND SOURCES OF DISAGREEMENT
- 11:00 Xu, X. and Zhao, Q. COELUROSAURIAN PHYLOGENY REVISITED: RECOVERING PHYLOGENETIC SIGNALS FROM SUBTLE MORPHOLOGICAL VARIATIONS
- 11:15 Balanoff, A., Xu X., Matsufune, Y., Kobayashi, Y. and Norell, M. ENDOCRANIAL ANATOMY OF A PRIMITIVE OVIRAPTOROSAUR, *INCISIVOSAURUS GAUTHIERI*, (THEROPODA: DINOSAURIA)
- 11:30 Turner, A., Pol, D., Clarke, J. and Norell, M. THE BASAL-MOST DROMAEOSAURID: A NEW SPECIES FROM TUGRUGYIN SHIREH, MONGOLIA
- 11:45 Lamanna, M., You, H., Li, D., Peng, C. and Harris, J. A NEW LARGE-BODIED THERIZINOSAUROID (DINOSAURIA: THEROPODA) FROM THE EARLY CRETACEOUS OF NORTHWESTERN CHINA
- 12:00 Milner, A., Buffetaut, E. and Suteethorn, V. A TALL-SPINED SPINOSAURID THEROPOD FROM THAILAND AND THE BIOGEOGRAPHY OF SPINOSAURS

TECHNICAL SESSION XV  
GOVERNOR'S BALLROOM SALON B  
**MODERATORS: CHRISTIAN GEORGE AND THOMAS MARTIN**

- 8:00 Luo, Z.-X. DEVELOPMENTAL HETEROCHRONY AND TRANSFORMATION OF THE DEFINITIVE MAMMALIAN MIDDLE EAR AMONG MESOZOIC MAMMALS
- 8:15 Martin, T., Averianov, A. and Pfretzschner, H.-U. JURASSIC MAMMALS OF CENTRAL ASIA
- 8:30 Wilson, G., Das Sarma, D. and Anantharaman, S. ENDEMICS, RELICTS, AND DISPERSALISTS: NEW MAMMALS FROM THE LATE CRETACEOUS OF INDIA
- 8:45 Giallombardo, A. NEW CRETACEOUS EUTHERIAN FROM THE GOBI DESERT
- 9:00 Weil, A., Pignataro, F. DIETARY INFERENCES FROM DENTAL MICROWEAR IN MULTITUBERCULATE MAMMALS FROM THE HELL CREEK AND TULLOCK FORMATIONS OF EASTERN MONTANA
- 9:15 Case, J. and Martin, J. MAMMALS FROM RED OWM QUARRY, FOX HILLS FORMATION, SOUTH DAKOTA: AN "EDMONTONIAN" LOCAL FAUNA?
- 9:30 Archibald, J.D. and Averianov, A. ZHELESTIDS: STEM EUTHERIANS OR BASAL LAURASIATHERIANS, BUT NO EVIDENCE FOR PLACENTAL ORDERS IN THE CRETACEOUS
- 9:45 Wood, C. B. and Moyer, B. FITS OVER FITS: HOW CAN CORRESPONDENCE IN SHAPE BETWEEN UPPER AND LOWER TRIBOSPHENIC MOLARS BE QUANTIFIED, AND WHY WOULD WE WANT TO KNOW?
- 10:00 BREAK
- 10:15 George, C. AN EXPLICIT EXAMINATION OF SHREW IDENTIFICATION AND THE POTENTIAL FOR PALEOECOLOGY WITHOUT SPECIES-LEVEL IDENTIFICATIONS
- 10:30 Beck, R., Godthelp, H., Archer, M. and Hand, S. PETROSALS AND TARSALS OF THE EARLY EOCENE AUSTRALIAN METATHERIAN *DJARTHIA MURGONENSIS*: THE OLDEST CROWN-GROUP MARSUPIAL FROM AUSTRALASIA AND ITS IMPLICATIONS FOR THE EVOLUTION AND BIOGEOGRAPHY OF AUSTRALIDELPHIA
- 10:45 Rowe, T., Rich, T., Vickers-Rich, P., Springer, M. and Woodburne, M. FOSSIL EVIDENCE ON DIVERGENCE TIMING OF THE PLATYPUS AND ECHIDNA CLADES
- 11:00 Maga, M. FOSSIL MARSUPIALS OF CENTRAL ANATOLIA AND THEIR BIOGEOGRAPHICAL SIGNIFICANCE
- 11:15 Roberts, K. and Archer, M. A MORPHOLOGICAL APPROACH TO UNRAVELLING THE RELATIONSHIPS OF RINGTAIL POSSUMS (PSEUDOCHEIRIDAE, MARSUPIALIA)
- 11:30 Weisbecker, V., Goswami, A., Sánchez-Villagra, M. and Wroe, S. POSTCRANIAL SEQUENCE HETEROCHRONY AND THE MARSUPIAL-PLACENTAL DICHOTOMY
- 11:45 Crompton, A., Owerkowicz, T. and Lieberman, D. MOTOR CONTROL OF MASTICATORY MUSCLES IN PLACENTAL AND MARSUPIAL HERBIVORES
- 12:00 Ruf, I., Luo, Z.-X., Martin, T. and Wible, J. CT SCANNING INVESTIGATION OF THE PETROSAL BONE AND THE INNER EAR OF *HENKELOTHERIUM GUIMAROTAE* (PAURODONTIDAE, DRYOLESTOIDEA)

SATURDAY AFTERNOON, OCTOBER 20, 2007

TECHNICAL SESSION XVI  
GOVERNOR'S BALLROOM SALON A  
**MODERATORS: LAWRENCE FLYNN AND ROSS MACPHEE**

- 1:15 Flynn, L. EVOLUTION AT THE BASE OF CROWN GROUP MUROIDEA
- 1:30 Samuels, J. SKELETAL PREDICTORS OF BODY MASS IN RODENTS
- 1:45 McGuire, J. GEOMETRIC MORPHOMETRICS ENABLES DISCRIMINATION AMONGST FIVE MICROTINES AND ALLOWS REASSESSMENT OF CALIFORNIA'S QUATERNARY PALEOECOLOGY
- 2:00 MacPhee, R., Wyatt, K., Greenwood, A., Gilbert, T. and Hynes, W. HYPERDISEASE REDUX: INTRODUCED TRY-PANOSOMIASIS AND EXTINCTION OF ENDEMIC MURINES ON CHRISTMAS ISLAND



- 2:15 Winkler, A., Tomida, Y. and Flynn, L. THE FOSSIL RECORD OF LAGOMORPHS FROM NORTHERN PAK-ISTAN
- 2:30 Evans, A., Fortelius, M. and Jernvall, J. HOW DOES TOOTH WEAR AFFECT DENTAL COMPLEXITY? IMPLICATIONS FOR TOOTH FUNCTION AND DIETARY RECONSTRUCTION
- 2:45 Green, J. INTER-TOOTH VARIATION OF MICROWEAR FEATURES IN THE DENTINE OF EXTANT XENARTHANS AND IT'S IMPORTANCE IN RECONSTRUCTING PALEODIET
- 3:00 Kalthoff, D. and Tütken, T. STABLE ISOTOPE AND ELEMENTAL COMPOSITIONS OF EXTANT XENARTHAN TEETH AND THEIR POTENTIAL AS DIET AND HABITAT PROXIES IN FOSSIL XENARTHANS (MAMMALIA)
- 3:15 Seiffert, E., Simons, E., Ryan, T. and Bown, T. NEW RECORDS OF EOCENE AND OLIGOCENE AFROSORICIDA FROM THE FAYUM DEPRESSION, EGYPT
- 3:30 Barrow, E., Seiffert, E. and Simons, E. CRANIODENTAL AND POSTCRANIAL MORPHOLOGY OF THE OLDEST FAYUM HYRACOID
- 3:45 Sanders, W. TAXONOMY, BIOCHRONOLOGY, AND PALEOECOLOGY OF LATE MIOCENE-EARLY PLIOCENE PROBOSCIDEANS FROM LANGEBAANWEG, SOUTH AFRICA

## TECHNICAL SESSION XVII

AUSTIN GRAND BALLROOM SALON H

**MODERATORS: SARAH WERNING AND KRISTINA CURRY ROGERS**

- 1:15 Wings, O., Sander, P., Tütken, T., Fowler, D. and Sun, G. GROWTH AND LIFE HISTORY OF ASIA'S LARGEST DINOSAUR
- 1:30 Curry Rogers, K. and Imker, M. NEW DATA ON 'MALAGASY TAXON B,' A TITANOSAUR FROM THE LATE CRETACEOUS OF MADAGASCAR
- 1:45 Werning, S. and Lee, A. "TEENAGE PREGNANCY" IN NON-AVIAN DINOSAURS AND ITS RELEVANCE TO GROWTH
- 2:00 Erickson, G., Curry Rogers, K., Varricchio, D., Norell, M. and Xu, X. GROWTH PATTERNS IN BROODING DINOSAURS REVEALS THE TIMING OF SEXUAL MATURATION IN NON-AVIAN DINOSAURS AND GENESIS OF THE AVIAN CONDITION
- 2:15 Gatesy, S. and Middleton, K. EXPLORING FOOTPRINT MORPHOSPACE BY 3-D COMPUTER-ANIMATED TRACK SIMULATION
- 2:30 Jackson, F., Varricchio, D., Jackson, R. and Vila, B. UNCOVERING SAURISCHIAN EGGS: POTENTIAL RATES OF WATER VAPOR CONDUCTANCE IN SAUROPOD AND THEROPOD EGGS
- 2:45 Winkler, D., Lee, Y.-N., Lü, J.-C. and Kobayashi, Y. PRESERVATION OF A VERTEBRATE MICROFAUNA AT ULAN KHUSHU, NEMEGT FORMATION (LATE CRETACEOUS), MONGOLIA
- 3:00 Sankey, J., Driese, S., Nordt, L. and Dworkin, S. DINOSAURS AND DIRT: DINOSAUR PALEOECOLOGY, PALEOSOL STRATIGRAPHY, AND ISOTOPE GEOCHEMISTRY FROM THE UPPER AGUJA FORMATION (LATE CRETACEOUS: LATE CAMPANIAN - EARLY MAASTRICHTIAN), BIG BEND NATIONAL PARK, TEXAS
- 3:15 Britt, B., Burton, D., Gehrels, G., Christiansen, E., Chure, D. LASER ABLATION ZIRCON U-PB GEOCHRONOLOGY OF THE CEDAR MOUNTAIN AND DAKOTA FORMATIONS OF DINOSAUR NATIONAL MONUMENT, UTAH
- 3:30 Jinnah, Z., Deino, A., Gates, T. and Roberts, E. THE FIRST 40AR/39AR AGE DATE FROM THE WAHWEAP FORMATION (LATE CRETACEOUS OF UTAH): IMPLICATIONS FOR FAUNAL CORRELATIONS
- 3:45 Holtz, T. DINOSAURS OUT OF THIN AIR: PHYLOGENETIC PERSPECTIVES ON WARD'S ATMOSPHERE/EVOLUTION HYPOTHESES

TECHNICAL SESSION XVIII  
GOVERNOR'S BALLROOM SALON B  
MODERATORS: MARK UHEN AND NICHOLAS PYENSON

- 1:15 Zalmout, I. and Gingerich, P. CRANIAL AND SKELETAL CHARACTERISTICS OF *EOTHEROIDES* (MAMMALIA, SIRENIA) FROM THE EOCENE OF EGYPT
- 1:30 Beatty, B. DENTAL MICROWEAR AS AN INDICATOR OF SUBSTRATE AND SUSPENDED SEDIMENT INTERACTION: TOWARDS A FINER VIEW OF MARINE MAMMAL PALEOECOLOGY
- 1:45 Thewissen, J.G.M. and Bajpai, S. EVOLUTION OF THE SENSORY LANDSCAPE IN EOCENE CETACEANS
- 2:00 Bebej, R., Ul-Haq, M., Zalmout, I. and Gingerich, P. FUNCTIONAL INTERPRETATION OF THE NECK IN EOCENE *REMYNGTONOCETUS* FROM PAKISTAN (MAMMALIA, CETACEA, ARCHAECETI)
- 2:15 Gingerich, P., Attia, Y., Al-Bedawi, F. and Sameeh, S. KHASHM EL-RAQABA: A NEW LOCALITY YIELDING MIDDLE EOCENE WHALES AND SEA COWS FROM WADI TARFA IN THE EASTERN DESERT OF EGYPT
- 2:30 Uhen, M. THE EARLIEST TOOTHLESS MYSTICETE: A CHAETOMYSTICETAN FROM THE EARLY OLIGOCENE ALSEA FORMATION, TOLEDO, OREGON
- 2:45 Pyenson, N. and Brudvik, K. RARE FOSSIL BALEEN FROM THE PURISIMA FORMATION OF CALIFORNIA: IMPLICATIONS FOR SOFT TISSUE PRESERVATION IN SHALLOW MARINE ENVIRONMENTS
- 3:00 Racicot, R., Deméré, T. and Rowe, T. MORPHOLOGY OF A BIZARRE NEW FOSSIL PORPOISE (CETACEA: PHOCOENIDAE) FROM THE PLIOCENE SAN DIEGO FORMATION OF SOUTHERN CALIFORNIA, USA
- 3:15 Werth, A., Beatty, B. and Pyenson, N. DO ODONTOCETES MASTICATE? INVESTIGATING EVIDENCE FROM TOOTH WEAR, HOMODONTY, AND ENAMEL MICROSTRUCTURE
- 3:30 Armfield, B., Vinyard, C., Horton, W. and Thewissen, J.G.M. DEVELOPMENTAL DIFFERENTIATION IN A HOMOGENEOUS DENTITION: EVIDENCE FOR TOOTH CLASSES IN DOLPHINS
- 3:45 Churchill, M., Berta, A. and Deméré, T. THE SYSTEMATICS AND BIOGEOGRAPHY OF RIGHT WHALES (BALAENIDAE: MYSTICETI)

POSTER SESSION IV

Authors must be present from 3:15–5:30 p.m.  
Posters must be removed by 5:45 p.m.

1. Ryan, M., Ostrom, P., Cappellini, E., Buckley, M. and Humpala, J. TRANSLATING ORGANIC INFORMATION IN FOSSILS INTO PHYLOGENETICALLY INFORMATIVE DATA
2. McKean, A., Britt, B., Nelson, S. and Scheetz, R. THE RELATIONSHIP OF GEOTHERMAL ALTERATION AND RELICT ORGANICS TO THE COLOR OF FOSSIL BONE
3. Mirzaie Ataabadi, M. and Hairapetian, V. FOSSIL VERTEBRATES OF IRAN
4. Kuizon, L. A HISTORY OF UNITED STATES PALEONTOLOGICAL LEGISLATION
5. Benton, R. and Baker, P. UNDERSTANDING PALEONTOLOGICAL RESOURCE MANAGEMENT ISSUES AND PARTNERSHIPS WITH LOCAL INDIAN TRIBES: A CASE STUDY AT BADLANDS NATIONAL PARK
6. Bradley, L. PALEONTOLOGY RESOURCE DISPOSSESSION OF THE GREAT SIOUX NATION
7. Simmons, B., Veatch, S. and Lockley, M. ARTHUR LAKES WAS ALSO A DINOSAUR TRACKER: ARCHIVAL EVIDENCE EMERGES OF A 1902, CRETACEOUS DAKOTA GROUP DISCOVERY IN COLORADO
8. Ekdale, E. THE BONY LABYRINTH OF *KULBECKIA* (MAMMALIA, ZALAMBDALESTIDAE)
9. Ladevèze, S. COMBINED MORPHOMETRIC AND PHYLOGENETIC STUDIES OF NEW METATHERIAN PETROSAL BONES FROM THE LATE PALEOCENE OF ITABORÁ (BRAZIL): EVIDENCE OF THE EARLY EVOLUTION OF THE AUSTRALDELPHIA (METATHERIA, MAMMALIA) IN SOUTH AMERICA
10. Badiola, A., Canudo, J. I. and Cuenca-Bescó, G. MULTITUBERCULATE FOSSILS FROM THE EARLY CRETACEOUS OF LA CANTALERA (TERUEL, SPAIN)
11. Davis, B. MAMMALIAN FAUNA OF THE EAGLE FORMATION (LATE CRETACEOUS: UPPER SANTONIAN), NORTH CENTRAL MONTANA
12. Graham, T. and Bryant, H. MARSUPIALS OF THE RODENT HILL LOCALITY, CYPRESS HILLS FORMATION, SOUTHWEST SASKATCHEWAN

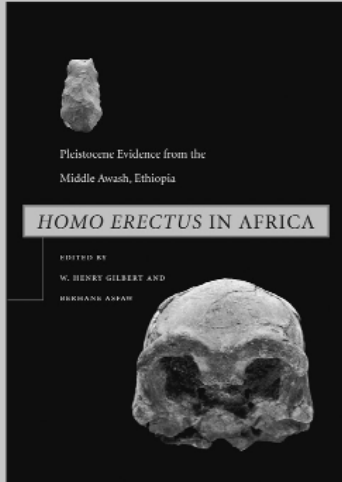
13. Gordon, C., Cifelli, R. and Eaton, J. NEW EUTHERIAN MAMMALS FROM THE KAIPAROWITS FORMATION (JUDITHIAN), UTAH
14. Zhang, Y., Archibald, J. D. LATE CRETACEOUS MAMMALIAN FAUNA FROM THE HELL CREEK FORMATION, SOUTHEASTERN MONTANA
15. Chester, S., Sargis, E., Szalay, F., Archibald, J. D. and Averianov, A. FUNCTIONAL ANALYSIS OF MAMMALIAN HUMERI FROM THE LATE CRETACEOUS OF UZBEKISTAN
16. Rougier, G. and Páez, N. *PELIGROTHERIUM TROPICALIS*: CRANIOMANDIBULAR MORPHOLOGY OF THE SOUTH AMERICAN DRYOLESTOIDS
17. McAfee, R. and Householder, M. BITE ME: INVESTITIONS OF SLOTH BITE FORCES AND FEEDING STRATEGIES
18. Maslin, A., Stepien, C. and Buchholtz, E. MORPHOLOGICAL AND MOLECULAR ANALYSIS OF VERTEBRAL VARIANTS IN THE TWO-TOED SLOTHS *CHOLOEPUS HOFFMANNI* AND *CHOLOEPUS DIDACTYLUS*
19. Raymond, K. and Prothero, D. VARIATION AND SEXUAL SIZE DIMORPHISM IN PLEISTOCENE GROUND SLOTHS (XENARTHRA)
20. Hordijk, K. and van der Meulen, A. PRESENCE AND ABUNDANCE PATTERNS OF MIDDLE MIOCENE PIKAS FROM NORTH CENTRAL SPAIN
21. Bair, A. CURVATURE OF LAGOMORPH UPPER CHEEK TEETH
22. Ruez, D. STRATIGRAPHIC CHANGES IN THE LEPORIDS FROM HAGERMAN FOSSIL BEDS NATIONAL MONUMENT, IDAHO
23. Tomida, Y. and Jin, C. EXTANT AFRICAN LEPORIDS, *CAPROLAGUS* AND *PENTALAGUS* REVISITED: PALEONTOLOGICAL VIEWS ON DENTAL AND CRANIAL CHARACTERS
24. Dawson, M., Farlow, J. and Argast, A. *HYPOLAGUS* (MAMMALIA, LAGOMORPHA, LEPORIDAE) FROM THE PIPE CREEK SINKHOLE, LATE NEOGENE, GRANT COUNTY, INDIANA, USA
25. Smith, K., Cifelli, R. and Czaplewski, N. *PSEUDOTRIMYLUS* (SORICOMORPHA: HETEROSORICIDAE) FROM THE EASTGATE FAUNA, NEVADA
26. Lopez-Antonanzas, R. FIRST *POTWARMUS* (MUROIDEA) FROM THE MIOCENE OF SAUDI ARABIA AND NEW INSIGHTS INTO THE ORIGIN OF MURIDS
27. Martin, R., Tesakov, A. and Marcolini, F. PRELIMINARY EXAMINATION OF SELECT ARVICOLID RODENT SEQUENCES: RECOGNIZING GLOBAL AND REGIONAL PATTERNS
28. Gobetz, K. and Hannum, A. BURROW CONSTRUCTION BY JUVENILE *RATTUS NORVEGICUS*: EVOLUTIONARY IMPLICATIONS OF "PUP DENS"; AND ADAPTIVE DIGGING BEHAVIOR FOR THE FOSSIL RECORD
29. Jass, C. ARVICOLINE RODENTS AND CHRONOLOGIC COMPLEXITY AT SMITH CREEK CAVE, NEVADA
30. Culver, T., Chin, K. and Lockley, M. UNUSUAL TRACKS OF SMALL JUMPING RODENTS FROM THE TERTIARY OF COLORADO
31. Goodwin, H. ODONTOMETRIC PATTERNS IN THE RADIATION OF NORTH AMERICAN GROUND-DWELLING SQUIRRELS, TRIBE MARMOTINI
32. Stevens, N., O'Connor, P., Gottfried, M., Roberts, E. and Ngasala, S. A HYRACOID FROM THE RUKWA RIFT BASIN OF SOUTHWESTERN TANZANIA
33. Ogino, S., Nakaya, H., Takai, M., Maschenko, E. and Kalmikov, N. A LATE PLIOCENE LARGE MUSTELID *FERINESTRIX* FROM THE UDUNGA FAUNA, TRANSBIKAL AREA, RUSSIA
34. Hodnett, J.-P. A REVIEW OF THE *PANTHERA ONCA* (MAMMALIA; CARNIVORA; FELIDAE) FROM THE CURTIS RANCH LOCAL FAUNA (BLANCAN), SOUTHEASTERN ARIZONA
35. Muldoon, K. and Simons, E. THE HOLOCENE DISTRIBUTION OF THREE CARNIVORANS (EUPLERIDAE: GALIDIINAE) ON MADAGASCAR
36. Schaal, S., Morlo, M. and Chen, Y. and Li, C. FIRST ASIAN *SINOPA* (PROVIVERRINAE, HYAENODONTIDAE, CREODONTA) FROM THE LATE MIDDLE EOCENE OF NORTHERN CHINA
37. Nishida, Y., Polcyn, M., Jacobs, L. and Fiorillo, A. A JUVENILE DESMOSTYLID DENTARY FROM UNALASKA ISLAND, ALASKA, AND AN APPLICATION OF THREE-DIMENSIONAL LASER SCANNING
38. Samonds, K., Zalmout, I., Irwin, M. and Raharivony, L. SIRENIAN POSTCRANIA FROM NOSY MAHAKAMBY, NORTHWESTERN MADAGASCAR
39. Geisler, J. and Beatty, B. A PROTOSIRENID (PROTOSIRENIDAE, SIRENIA) INNOMINATE FROM THE CROSS MEMBER OF THE TUPELO BAY FORMATIO (BARTONIAN, LATE MIDDLE EOCENE) OF SOUTH CAROLINA
40. Slivensky, K. and Gingerich, P. FUNCTIONAL INTERPRETATION OF THE PROXIMAL FEMUR IN EOCENE *RODHOCETUS* (MAMMALIA, ARCHAEOCETI)
41. Murakami, M., Shimada, C. and Hikida, Y. SOME DELPHINOIDS (MAMMALIA: CETACEA) FROM THE UPPER MIOCENE THROUGH THE UPPER PLIOCENE OF HOKKAIDO, NORTHERN JAPAN

42. Martz, J. LITHOSTRATIGRAPHY AND VERTEBRATE BIOSTRATIGRAPHY OF THE UPPER TRIASSIC DOCKUM GROUP, SOUTHERN GARZA COUNTY, WEST TEXAS
43. Lucas, S., Hunt, A., Heckert, A. and Spielmann, J. THE TRIASSIC TIMESCALE BASED ON TETRAPOD EVOLUTION
44. Rinehart, L., Lucas, S. and Heckert, A. SKULL ALLOMETRY OF THE LATE TRIASSIC PHYTOSAUR GENUS *PARASUCHUS* AND ITS ONTOGENETIC AND PHYLOGENETIC IMPLICATIONS
45. Hunt, A., Lucas, S., Rinehart, L., Heckert, A. and Spielmann, J. AN ARTICULATED PES OF THE LATE TRIASSIC AETOSAUR *TYPOTHORAX* FROM NEW MEXICO AND THE TRACKMAKER OF *BRACHYCHIROTHERIUM*
46. Bennett, S.C. EVOLUTION OF THE PTEROSAUR WING
47. Harris, J., Lockley, M., Breithaupt, B. and Mitchell, L. NEW PTEROSAUR TRACKSITES IN THE WESTERN USA: IMPLICATIONS FOR GLOBAL PTEROSAUR ICHNOLOGY
48. Schouten, R., Dyke, G., Ibrahim, N., Jalil, N.-E. and Zouhri, S. VERTEBRATE PALEONTOLOGY AND GEOLOGICAL SETTING OF THE KEM KEM BEDS, MOROCCO
49. Saneyoshi, M. and Watabe, M. PALEOENVIRONMENTS AND DINOSAUR HABITATS OF THE UPPER CRETACEOUS NEMEGT FORMATION IN THE SOUTHWESTERN GOBI DESERT, MONGOLIA
50. Salisbury, S., Agnolin, F., Ezcurra, M. and Pias, D. A CRITICAL REASSESSMENT OF THE CRETACEOUS NON-AVIAN DINOSAUR FAUNAS OF AUSTRALIA AND NEW ZEALAND
51. Lewis, C., Heckert, A., Lucas, S. and Williamson, T. A DIVERSE NEW MICROVERTEBRATE FAUNA FROM THE UPPER CRETACEOUS (LATE SANTONIAN-EARLY CAMPANIAN) MENEFFEE FORMATION OF NEW MEXICO
52. Lim, J.-D., Huh, M. and Yang, S.-Y. TWO DINOSAUR MUSEUMS AS SUCCESS AND HEYDAY OF KOREAN VERTEBRATE PALEONTOLOGY
53. Farlow, J., Deschner, E., Solis, R. and Ward, W. AN UNUSUAL TRACKWAY OF A MEDIUM-SIZED DINOSAUR FROM THE GLEN ROSE FORMATION (LOWER CRETACEOUS, COMAL COUNTY, TEXAS)
54. Dececchi, T. and Larsson, H. TEMPOS AND MODES OF THEROPOD EVOLUTION
55. Fowler, D. RECENTLY REDISCOVERED BARYONYCHINE TEETH (DINOSAURIA: THEROPODA): NEW MORPHOLOGIC DATA, RANGE EXTENSION & SIMILARITY TO CERATOSAURUS
56. Chure, D., Britt, B. and Scheetz, R. SICKLE-CLAW THEROPOD DINOSAURS OF THE LOWER CRETACEOUS CEDAR MOUNTAIN FORMATION FROM THE DALTON WELLS QUARRY AND DINOSAUR NATIONAL MONUMENT, UTAH
57. Zanno, L. A NEW TROODONTID THEROPOD FROM THE LATE CAMPANIAN KAIPAROWITS FORMATION, SOUTHERN UTAH
58. Kubota, K. and Barsbold, R. NEW DROMAEOSAURID (DINOSAURIA: THEROPODA) FROM THE UPPER CRETACEOUS BAYANSHIREE FORMATION OF MONGOLIA
59. Garcia, B., Erickson, G., Curry Rogers, K. and Norell, M. LONGEVITY AND GROWTH PATTERNS IN THE DROMAEOSAURID *VELOCIRAPTOR MONGOLIENSIS* INFERRED FROM LONG BONE HISTOLOGY
60. Therrien, F. and Zelenitsky, D. EW NEST OF A MANIRAPTORAN THEROPOD FROM THE UPPER CRETACEOUS TWO MEDICINE FORMATION OF MONTANA
61. Parsons, W. and Parsons, K. AVIAN-LIKE MANUAL PHALANX FOUND WITHIN GUT CONTENTS OF LOWER CRETACEOUS DROMAEOSAURID: NEW DATA ON THE FEEDING BEHAVIOR OF *DEINONYCHUS ANTIRRHOPUS* (SAURISCHIA: THEROPODA)
62. Casal, G., Martinez, R., Candeiro, C.R., Lamanna, M. and Ibiricu, L. FIRST RECORD OF DROMAEOSAURIDAE (DINOSAURIA: THEROPODA) IN THE EARLY LATE CRETACEOUS BAJO BARREAL FORMATION OF CHUBUT PROVINCE, ARGENTINA
63. Trujillo, K., DeMar, D., Breithaupt, B., Hall, D. and Bilbey, S.A. THE REX PIPELINE DINOSAURS: PARTNERSHIPS FOR SCIENCE
64. **Benson, R.** A NEW JURASSIC TYRANNOSAUROID FROM THE TITHONIAN (LATE JURASSIC) OF DORSET, UK, REPRESENTING A LARGE-BODIED SPECIES OF THE AMERICAN GENUS *STOKESOSAURUS*
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66. Peterson, J., Henderson, M., Vittore, C. and Scherer, R. FACE BITING ON A JUVENILE TYRANNOSAURID
67. Carr, T., De Santis, C., Wojahn, A., Brown, C. and Ogle, A. THE SMALLEST ASSOCIATED SKULL AND POST-CRANIAL BONES OF A JUVENILE TYRANNOSAURID (THEROPODA: COELUROSAURIA) FROM THE HELL CREEK FORMATION (UPPER MAASTRICHTIAN) OF SOUTHEASTERN MONTANA
68. Schachner, E., Lyson, T., Atterholt, J. and Hanks, H. A PRELIMINARY REPORT OF A NEW SPECIMEN OF *CHIROSTENOTES* (OVIAPTOROSAURIA: THEROPODA) FROM THE HELL CREEK FORMATION OF NORTH DAKOTA

69. Kobayashi, Y., Bronowicz, R. and Barsbold, R. ORNITHOMIMIDS (THEROPODA: DINOSAURIA) FROM THE NEMEGT FORMATION (MAASTRICHTIAN) OF MONGOLIA
70. Norell, M. and Bever, G. THE BRAINCASE OF *GALLIMIMUS BULLATUS* (COELUROSAURIA: ORNITHIMIMIDAE)
71. Neabore, S., Loewen, M., Zanno, L., Getty, M. and Claessens, L. THREE-DIMENSIONAL SCANNING AND ANALYSIS OF THE FIRST DIAGNOSTIC ORNITHOMIMID FORELIMB MATERIAL FROM THE LATE CRETACEOUS KAIPAROWITS FORMATION
72. Milner, A., Harris, J., Martin, L., Kirkland, J. and Matthews, N. BIRD-LIKE BEHAVIOR AND ANATOMY IN AN EARLY JURASSIC (MOENAVE FORMATION: HETTANGIAN) THEROPOD DINOSAUR EXHIBITED BY A WELL-PRESERVED CROUCHING TRACE IN SOUTHWESTERN UTAH
73. Breithaupt, B., Green, T., Southwell, E. and Matthews, N. FOOTPRINTS AND GROWTH RATES OF EMUS AND THEROPODS: ICHNOLOGICAL EVIDENCE FOR FAMILY GROUPS OF MIDDLE JURASSIC DINOSAURS IN WYOMING
74. Alicea, J., Farke, A. and Nesbitt, S. CAN CROSS-SECTIONAL PROPERTIES OF THE FEMUR BE USED TO INFER POSTURE IN NON-AVIAN THEROPODS?
75. Kambic, R. INFERRING BEHAVIOR FROM PEDAL PHALANGEAL MORPHOLOGY IN THEROPODS
76. Myhrvold, C., Sidor, C. and Daniel, T. WHAT GOOD IS HALF A FEATHER? A NEW HYPOTHESIS FOR THE EVOLUTIONARY ORIGIN OF EPIDERMAL STRUCTURES
77. Birkemeier, T. and Swor, E. A NEW *APATOSAURUS CF. AJAX* SKELETON WITH SKULL MATERIAL FROM WARM SPRINGS RANCH, WYOMING
78. Wilhite, R. MORPHOLOGICAL INDICATORS OF STANCE AND GATE IN SAUROPODS
79. Goussard, F., Läng, E., Allain, R. and Wilson, J. ZERO, ONE, TWO, THREE... OR MORE : HOW MANY CARPAL ELEMENTS IN SAUROPODOMORPHS? NEW EVIDENCES ON CARPUS EVOLUTION AMONG SAUROPODOMORPHA
80. Ishigaki, S. FOOTPRINT EVIDENCE OF EXTREME OUTWARD ROTATION OF THE MANUS OF SAUROPOD DINOSAUR FROM MIDDLE JURASSIC OF WESTERN MOROCCO
81. Trotta, M., Campos, D. and Kellner, A. MORPHOLOGICAL VARIATION IN TITANOSAURIAN SCAPULAE (DINOSAURIA, SAUROPODA) FROM THE LATE CRETACEOUS OF MINAS GERAIS, BRAZIL
82. Tidwell, V. and Carpenter, K. FIRST DESCRIPTION OF CERVICAL VERTEBRAE FOR AN EARLY CRETACEOUS TITANOSAUR FROM NORTH AMERICA
83. D'Emic, M., Wilson, J. and Chatterjee, S. THE FIRST DEFINITIVE TITANOSAUR (SAUROPODA) OSTEODERM FROM INDIA AND THE NATURE OF THE TITANOSAUR OSTEODERM RECORD
84. Schwarz, D., Wings, O. and Meyer, C. REVISION OF *CETIOSAURISCUS GREPPINI*: THE REVIVAL OF A LATE JURASSIC SAUROPOD FROM SWITZERLAND
85. Lang, E. EVIDENCE OF EARLY RADIATION IN SAUROPODA: NEW DATA ON MIDDLE JURASSIC EUSAUROPODS

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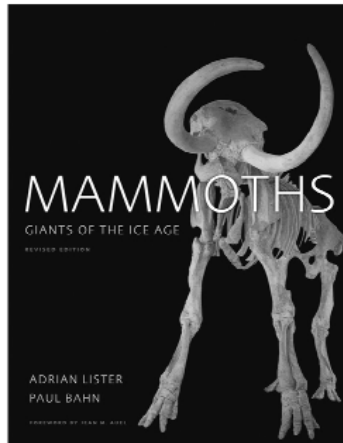
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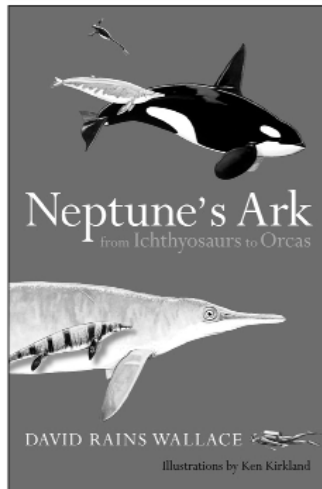
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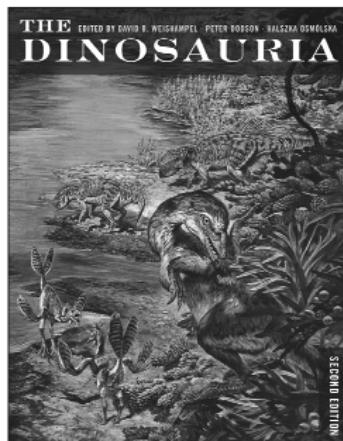
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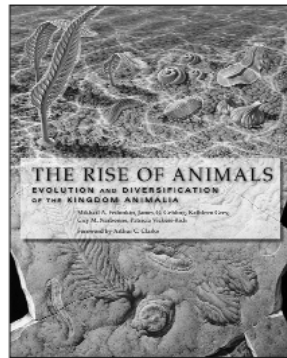
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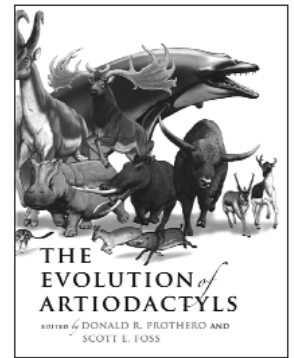


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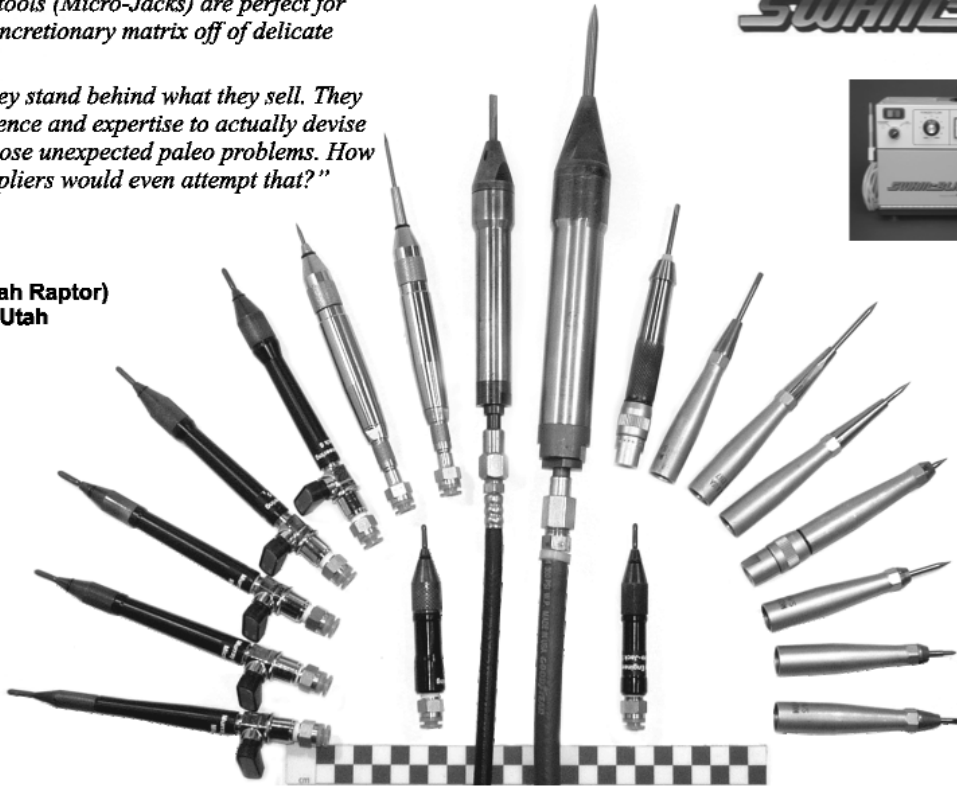
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NEW TOOLS FOR PREDICTING BODY SIZE OF FOSSIL MARINE MAMMALS AND SIZE OF THEIR PREY YIELD INCREASED RESOLUTION FOR INTERPRETATION OF EVOLUTION IN THE CARNIVOROUS MARINE MAMMAL FEEDING GUILD THROUGH THE CENOZOIC

ADAM, Peter, UCLA, Dept. Ecology and Evolutionary Biology, Los Angeles, CA, USA

Carnivorous marine mammals constitute a paraphyletic group that includes cetaceans, pinnipeds, and sea otters. Although evolution of this charismatic group has captured considerable attention from both the scientific community and general public, much of our current knowledge is limited to their systematics and biogeography. I examined evolution of Cenozoic carnivorous marine mammals using a feeding guild paradigm. Although some members have easily recognized morphologies associated with suction, filter, and masticatory feeding, inferring paleoecological roles of most fossil marine mammals has been limited owing to their generalist feeding strategies. Generalists are typically characterized by homodont dentition and unspecialized feeding apparatus and are often lumped together as simple predators of fish and squid. To better interpret roles of generalists, I first developed previously unavailable allometric methods for determining body size (length and mass) of fossil taxa from different marine mammal lineages using multiple measures of the skull (including bicondylar width, foramen magnum area, and occipital condyle area). Methods for predicting body size were based on a sample of >3200 adult skulls representing all extant species, and models were confirmed by comparing predicted values to known values of body size (skeletal length) in numerous fossil specimens for which complete postcrania are known. Second, I revealed a strong correlation between predator and prey body sizes in extant taxa using allometric methods and an exhaustive survey of diet (>10 000 individual prey of known body size) from the literature. Established correlations between predator and prey sizes, coupled with the ability to predict size of fossil taxa, allow for prediction of prey size taken by fossil taxa and increased resolution of ecological roles among generalist feeders. To demonstrate the utility of predator and prey body size prediction, I characterize the carnivorous marine mammal guilds of the Miocene-Pliocene of Peru (Pisco Formation) and Belgium (Antwerp deposits), and Miocene of California and Oregon, and compare these to modern faunas from the same areas.

Poster Session I (Wednesday)

A NEW MARINE VERTEBRATE FAUNA FROM THE LATE TRIASSIC (MIDDLE NORIAN) OF SOUTHEAST ALASKA

ADAMS, Thomas, Southern Methodist University, Dallas, TX, USA

A new faunal assemblage of marine vertebrates from the Late Triassic (middle Norian) of Hound Island, Southeast Alaska, contains vertebrae, teeth, skull material, and rib fragments identified as Thalattosauria and Ichthyosauria, including a new occurrence of the genus *Shonisaurus*. Rare Osteichthyes and Chondrichthyes teeth are also present. Invertebrate material found within the bone-rich layers includes abundant shells of the bivalve *Halobia fallax*, along with fragments of ammonoids, cidarid echinoids, and bryozoans. These fossils occur in the Hound Island Volcanics exposed within the intertidal zone on the eastern shore of Hound Island in the Keku Straits. The lithology comprises alternating layers of calcareous shale and volcanoclastic-rich bioclastic limestone transported by debris flows that resulted from slumping and redeposition of slope sediments. Vertebrate remains were found within nineteen of the limestone layers. Bones are frequently disassociated and show pre-depositional abrasion and breakage, demonstrating transport and reworking prior to burial. Less common are several large associated elements, representing a single individual, found parallel to bedding and draped by shale. This fossil assemblage occurs within a volcanic island-arc complex associated with the allochthonous Alexander Terrane prior to its northern translation from sub-equatorial latitudes to its present position.

Technical Session VII, Thursday 3:30

GETTING A HAND FROM NEW TECHNOLOGY: THE PECTORAL FIN SKELETON OF THE NEAR-TETRAPOD *PANDERICHTHYS* REVEALED BY CT SCANNING

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The elpistostegids *Tiktaalik* and *Panderichthys*, members of the tetrapod stem group, are the closest known relatives of limbed vertebrates and thus have potential to illuminate the origin of digits. The pectoral fin skeleton of *Tiktaalik*, which has been figured and described in detail on the basis of uncrushed material, contains a number of small distal bones that have been interpreted as digit precursors. This agrees well with the condition in certain other less crownward stem tetrapods such as the rhizodont fish *Sauripterus*, and is consonant with developmental and molecular evidence that digit precursors are present in the lungfish *Neoceratodus* and the primitive actinopterygian *Polyodon*. However, *Panderichthys* has been described, on the basis of flattened material illustrated by schematic drawings, as lacking any equivalent of digits. Here we present the first x-ray CT study of the pectoral fin of *Panderichthys*, based on an unflattened specimen from Tallinn Technical University in which the right pectoral fin is complete, untouched and buried in matrix beneath the body. The distal "ulnare" of previous

reconstructions proves to be a compound structure comprising a real, small, ulnare and an array of distal radials comparable to those of *Tiktaalik* or *Sauripterus*. Other elements compare reasonably well with the published descriptions, though the humerus is considerably more three-dimensional than previously thought. Overall, the pectoral fin skeleton of *Panderichthys* compares closely with that of *Tiktaalik*, except that the latter has a longer axis (two additional axial elements distal to the ulnare). Digit precursors appear to be present throughout the "fish" part of the tetrapod stem group as well as in more distantly related osteichthyans. Interestingly, the fin skeleton of *Tiktaalik* appears autapomorphic with respect to the extended axis. The shorter skeleton of *Panderichthys*, in which the ulnare is the last axial element, may be a better representative of the ancestral condition for limbs.

Ernie Lundelius Symposium (Faunal Dynamics and Extinction), Wednesday 9:15  
THE JAGUAR CAVE ENTRANCE FAUNA: ~ 40,000 BP HIGH ALTITUDE MICROVERTEBRATES NEAR THE CONTINENTAL DIVIDE IN EASTERN IDAHO

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All interior sediments in Jaguar Cave (at the foot of the Beaverhead Mountains and an elevation of 2250 meters) were excavated by Hind Sadek in 1961-1962 but she left an area at the entrance. She recovered late Quaternary vertebrates and interpreted the cave as a human occupation site even though only several pieces of flaked stone were recovered. Subsequent work shows that the cave was actually a carnivore den. The Idaho Museum of Natural History excavated about two cubic meters from the entrance area in 1989-90. Recent BLM support resulted in dating, sorting, and preliminary identification of a rich microfauna between 39,120 and >48,400 BP (Beta Analytic AMS bone collagen). Raptors and mammalian carnivores appear to be the primary agents of accumulation. Microvertebrates recovered include unidentified fish, natricine snake, *Phrynosoma*, *Sorex*, *Thomomys*, *Perognathus*, *Peromyscus*, *Neotoma*, *Phenacomys*, *Microtus*, *Lemmys*, *Dicrostonyx*, *Marmota*, *Spermophilus* (4+ sp.), *Ochotona*, *Brachylagus*, and *Lepus/Sylvilagus*. Megafaunal remains are sparse and fragmentary. The fish indicate open water in the area (now 6 km from the nearest stream) a substantial portion of the year. *Phrynosoma* can withstand fairly cold winter temperatures. Pleistocene *Dicrostonyx* is not necessarily a tundra obligate but probably required snow cover and relatively cold winter conditions. The lack of obligate arboreal rodents suggests that little, if any, forest was nearby. Overall, the microfauna is very similar to that of today plus *Dicrostonyx* and minus forest forms. We interpret the fauna as indicative of an *Artemesia* steppe in a climate somewhat colder than today with arid summers and snowy winters. The dates fall within the latter part of Marine Isotope Stage 3 (MIS3), a period of abrupt climatic changes. However, pollen of the same age in a core from Grays Lake (elevation 1950 m) 175 km southeast also indicates continuous cold and arid conditions with *Artemesia* predominating. If the lack of MIS3 climate perturbation evidence in both the core and the Jaguar Cave entrance fauna was not due to sampling, this region may have been less affected by MIS3 climate shifts.

Student Poster Session (Thursday)

A DIVERSE SHARK FAUNA FROM THE EARLY EOCENE CLAVERT BLUFF FORMATION IN BASTROP COUNTY, TEXAS

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A recently located storm bed horizon in the Calvert Bluff Formation has produced the first Wasatchian age fauna from eastern Texas. This approximately 60 cm thick storm bed is in the lower part of the formation and near the Paleocene-Eocene Boundary. Fossils of mollusks, bony fish, rays, turtle, and crocodylians, and a diverse assemblage of shark teeth have been recovered from both surface collecting and screenwashing. Hundreds of individual shark teeth have been collected so far, and they represent all regions of the mouth, as well as different age classes. The most common genera identified from the locality are *Cretolamna* (mackerel shark) and *Alopias* (thresher shark). The next most common teeth identified are *Carcharias* and *Odontaspis* (sand tiger shark). A few specimens represent *Carcharodon* (white shark) and *Hemipristis* (snaggletooth shark). Among the remaining teeth, another 10-15 genera likely are present. Eight teeth belonging to *Cretolamna* (*Serratolamna*) *ascheroni* have been identified at this site. This species also has been identified at sites in Morocco and Mississippi. The stratigraphic range of the shark genera present (with *Alopias* and *Hemipristis* not known prior to the Eocene) reinforces the stratigraphic placement of the locality in the earliest Eocene based on other geological data. The mixture of shark taxa occurring in the Calvert Bluff Formation that also occur at other Gulf Coast sites and sites in the eastern Atlantic is interesting and may indicate a more cosmopolitan shark fauna during this relatively warm climatic interval.

Poster Session IV (Saturday)

CAN CROSS-SECTIONAL PROPERTIES OF THE FEMUR BE USED TO INFER POSTURE IN NON-AVIAN THEROPODS?

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Osteological and experimental evidence have been used to infer a change in femoral posture between non-avian theropods (in which the femora presumably were carried in a relatively erect position) and birds (in which the femur is held nearly horizontal during most phases of terrestrial locomotion). In this study, we utilized a broad comparative sample to see if cross-sectional properties of the femur record any evidence for this presumed change in posture. From CT scans and thin sections of the femora of five species of non-avian theropods (including *Masiakasaurus*, a small dromaeosaur, *Troodon*, *Coelurus*, and an undescribed basal theropod or saurischian) and 32 species of flightless or primarily terrestrial birds (including the basal bird *Rahonavis* and the basal ornithuromorph *Vorona*), a variety of properties were measured using Moment/MacroJ. These included  $I_{\max}$  and  $I_{\min}$  (second moment of area, related to resistance to bending) and J (polar moment of area, measuring resistance to torsion). It was predicted that birds should have more eccentrically shaped femoral mid-shafts as measured by  $I_{\max}/I_{\min}$  and higher average values for J (reflecting greater bending and torsion and less axial compression). No significant differences in the  $I_{\max}/I_{\min}$  ratios occurred between non-avian theropods and birds. Although J (normalized for femur length) was slightly lower on average in the non-avian theropods, the differences were not significant. Thus, cross-sectional properties cannot be used to infer differences in femoral posture between the two groups. This could be because postures were not actually different; perhaps small non-avian theropods adopted a relatively flexed femoral posture. Alternatively, the results are due to a disconnect between the loading of the bone during life and the bone's morphology (as has been experimentally demonstrated). Thus, cross-sectional properties should be used with caution in determining the posture and behaviors of extinct animals, and only in conjunction with other morphological information.

Student Poster Session (Thursday)

RE-DESCRIPTION AND SYSTEMATIC REANALYSIS OF THE GONIOPHOLIDID CROCODYLE *GONIOPHOLIS STOVALLI* FROM THE MORRISON FORMATION OF OKLAHOMA

ALLEN, Eric, University of Iowa, Iowa City, IA, USA

Goniopholididae are some of the most common and distinctive crocodyliforms of the Late Jurassic and Early Cretaceous, and are among the first crocodyliforms to superficially resemble extant crocodiles. Putative goniopholidids from Eurasia and North America have been referred to *Goniopholis* Owen, 1841, but the monophyly of *Goniopholis* remains untested. A re-description of the type material of *Goniopholis stovalli* from the Morrison Formation (Upper Jurassic) of Cimarron County, western Oklahoma, reveals several characters in that species more similar to other North American goniopholidids such as *Eutetaurannosuchus* and *Calsoyasuchus* than to *Goniopholis* of Europe, particularly in regard to the expression of the nasal passages and primary choanae on the secondary palate. A phylogenetic analysis incorporating *G. stovalli* as a terminal taxon with individual coding separate from other *Goniopholis* reveals that *G. stovalli* plots as part of a monophyletic group with *Eutetaurannosuchus* and *Calsoyasuchus*. These results lend credence to the observation that North American members of *Goniopholis* may be distinct from European members of the genus. As such, further re-description and re-analysis of other North American goniopholidids is in order.

Technical Session XII, Friday 3:00

MAXIMUM LIKELIHOOD BUBBLES AND MAMMALIAN BIOGEOGRAPHY

ALROY, John, University of California, Santa Barbara, CA, USA

Quantitative analyses of biogeography are confounded by sampling variation, the arbitrary and noisy nature of similarity coefficients, and the difficulty of visualizing cluster dendrograms or ordinations as geographic patterns. These problems are mitigated with a new method that distorts paleogeographic maps to represent patterns of provincialism. The first step is to select a subset of all collections that forms an approximately even spaced grid. The algorithm starts with the most widely spaced points and grabs more until the ones not selected are too tightly clustered, and then substitutes more diverse assemblages for nearby selected points. An overall similarity versus distance relationship is then defined by fitting an exponential decay model that maximizes the likelihood of the observed counts of shared taxa for all pairs of collections. Physical distances are modulated with exponential functions that are centered either at the equator, creating latitudinal gradients, or at exact coordinates, creating what look like bubbles. These features are added sequentially until no improvement in fit is indicated by the Akaike and Bayesian information criteria. The method is demonstrated with global data on medium- large-sized mammals taken from the Paleobiology Database and binned at the subepoch scale. Rates of turnover were generally lower within North America than within Eurasia. A substantial latitudinal gradient only developed in the Pleistocene, presumably in response to glacial cycles. Before then, barriers such as the

Atlantic or Pacific created strong longitudinal variation in turnover. The Atlantic had more of an effect at first, but became a weak or non-existent barrier relative to its width by the late Miocene. In other words, similarity between North American and European faunas was by then no more than one would expect given their physical distance. This new method presents a powerful tool for showing whether supposed environmental gradients and barriers are real, or instead a reflection of sampling hiatuses superimposed on globally uniform distance vs. similarity relationships.

The Dissorophioidea - Early Amphibian Radiation Symposium, Friday 11:45

A NEW STEM BATRACHIAN (TEMNOSPONDYLID: AMPHIBAMIDAE) FROM THE EARLY PERMIAN OF TEXAS

ANDERSON, Jason, University of Calgary, Calgary, AB, Canada; SCOTT, Diane, University of Toronto at Mississauga, Mississauga, ON, Canada; REISZ, Robert, University of Toronto at Mississauga, Mississauga, ON, Canada; SUMIDA, Stuart, California State University at San Bernardino, San Bernardino, CA, USA

The on-going controversy over lissamphibian origins is fueled by their highly derived morphology with respect to archaic fossil forms. Here we report a new specimen that bridges the gap between amphibamid temnospondyls and basal frogs and salamanders. The specimen is missing the zeugopods, most of the manus, and the ventral-most portion of the skull. The skull is broad and rounded, but it has a lighter, more strut-like construction than is typical for temnospondyls. The extremely large interpterygoid vacuities are bordered by a pterygoid that just fails to reach the lateral skull margin except by a dorsal projection, a palatine, and a narrow vomer that bears denticles arranged in three rows on a ridge along the medial margin of the large choana. Marginal teeth are tiny, monocuspid, pedicellate cones. A very large otic notch, with articulation scars for the tympanic annular cartilage, closely approaches the orbital margin and creates a narrow postorbital bar. There are 17 presacral vertebrae, and the caudal vertebrae are poorly ossified and rapidly taper out. Ribs are short, laterally projecting elements with spatulate distal tips. The olecranon is ossified. A basale commune is present in the pes, which has a phalangeal formula of ?-2-3-4-3. This specimen has a mosaic of amphibamid characters and synapomorphies of both frogs and salamanders. The overall impression of the skull is frog-like, except the frontals are not coossified with the parietals. Pedicellate teeth are known only from lissamphibians, amphibamids, and possibly one branchiosaur. The vomers, with the lack of fang-pit pairs and raised patch of denticles in rows are especially batrachian. The vertebral count is transitional between *Amphibamus* (21) and *Triadobatrachus* (14). The tail appears to be in the process of being lost and the phalangeal count suggests that this specimen may be the most basal frog; however, the basale commune is unique to salamanders. The presence of a basale commune in an amphibamid suggests that preaxial digital development was more widespread among batrachian sister groups, and may have been primitively present in frogs.

Poster Session III (Friday)

A LATE WASATCHIAN MAMMALIAN FAUNA FROM THE STEAMBOAT MOUNTAIN-FREIGHTER GAP AREA, GREAT DIVIDE BASIN, SOUTH-WESTERN WYOMING

ANEMONE, Robert, Western Michigan University, Kalamazoo, MI, USA; DIRKS, Wendy, Newcastle University, Newcastle-upon-Tyne, United Kingdom; WATKINS, Ron, Curtin University of Technology, Perth, Australia; NACHMAN, Brett, Washington University, St Louis, MO, USA; VAN REGENMORTER, John, Western Michigan University, Kalamazoo, MI, USA

Recent paleontological and geological work has yielded a substantial late early Eocene (late Wasatchian) mammalian fauna from the Steamboat Mountain-Freighter Gap area of the Great Divide Basin in northern Sweetwater County, Wyoming. We have collected, identified, and catalogued more than 2100 vertebrate, mostly mammalian specimens from 40 localities in sedimentary deposits of the Wasatch formation. Each of these mammal-bearing localities has been tied into a detailed stratigraphic section resulting from intensive geological mapping of the exposures to the east and west of Freighter Gap. Two lithologically distinctive and laterally extensive marker beds of lacustrine origin represent intertonguing units of the Green River formation (probably the Luman and Tipton members) and provide useful datums for determining the vertical relations of the mammal localities. In addition, deposits of the Bridger formation outcrop upsection, just to the north of Freighter Gap. The base of the Bridger section provides a capping unit to the fossil-bearing deposits of the Wasatch formation on the south side of the Gap. We measured the vertical distance from each of our 40 localities to at least one of these three stratigraphic markers in order to develop an overall biostratigraphic zonation of this late Wasatchian fauna. Lysitean (Wa6) and Lostcabinian (Wa7) faunas predominate at most localities, as is evidenced by the presence of distinctive taxa such as the perissodactyls *Heptodon* and *Lambdaotherium*. When considered in conjunction with the latest Clarkforkian and early Wasatchian mammals we have collected from the southern part of the basin, this latest Wasatchian mammalian fauna indicates that the fossil mammal deposits of the Great Divide Basin may encompass the entire Wasatchian NALMA. One of the major goals of our current and future fieldwork is to provide evidence in support of this suggestion.

Technical Session II, Wednesday 12:00

DOES EXTINCTION RESISTANCE EXPLAIN CHANGES IN TROPHIC NETWORK STRUCTURES IN TERRESTRIAL VERTEBRATE COMMUNITIES?

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ROOPNARINE, Peter, California Academy of Sciences, San Francisco, CA, USA;  
WANG, Steve, Swarthmore College, Swarthmore, PA, USA

Everett Olson examined trophic interactions between members of Carboniferous through Triassic terrestrial communities. He found that the structure of these trophic networks changed over time. Early communities were dominated by carnivores; most herbivores were aquatic and almost all primary productivity came from aquatic sources. This resulted in a complex trophic network with strong ties to the aquatic realm. Starting in the Middle Permian, trophic network structures changed. Terrestrial herbivores became diverse and abundant, making terrestrial producers the main source of productivity and simplifying terrestrial food webs. This community structure persists to the Recent, whereas Carboniferous-style community structures become very rare after the Permian. Here we examine whether this turnover was caused by characteristics of species in the communities or emergent properties of the communities themselves. We used a probabilistic trophic network model to examine how much secondary extinction can be caused within a community by perturbations of various sizes, and applied the model to a series of eight Permian and Triassic terrestrial communities from South Africa. Seven of the communities have structures similar to those of modern communities, whereas the earliest Triassic *Lystrosaurus* Assemblage Zone community resembles Carboniferous communities. The seven communities of modern aspect are resistant to perturbation, requiring large disturbances to cause high levels of secondary extinction. In contrast the *Lystrosaurus* zone community is very vulnerable: even small perturbations causing large amounts of secondary extinction. Therefore, terrestrial communities with Carboniferous-style organization may not have persisted because they were unstable and liable to collapse after minor disturbances. Our results also suggest that the properties that make communities resistant to extinction are a complex mix of characteristics at both the species and community levels. Finally, these findings imply that the end-Permian extinction reset terrestrial communities to a more primitive state, much as it did for marine communities.

Student Poster Session (Thursday)

A NEW (STEM?) TURTLE FROM THE MIDDLE JURASSIC OF SKYE, SCOTLAND

ANQUETIN, Jérémy, London, United Kingdom

The Middle Jurassic (Bathonian) Kilmaluag Formation at Cladach a'Ghlinne, Isle of Skye, Scotland, has yielded a rich tetrapod fauna consisting of salamanders, turtles, lepidosauromorphs, choristoderes, crocodiles, pterosaurs, dinosaurs, tritylodontids and mammals. Although most of the material is disarticulated, several articulated specimens, including turtles, have been recovered. The turtle material from Skye is currently under study and the first results are presented herein. A nicely preserved partial skull allows consideration of the phylogenetic position of the Skye turtle. The absence of contact between the pterygoid and basioccipital and especially the absence of flooring of the cavum acustico-jugulare strongly support the hypothesis that this turtle is less derived than the stem turtles *Meiolania platyceps*, *Mongolochelys efremovi*, *Kallokibotion bajazidi* and all Testudines (crown turtles). However, the position of the foramen posterius canalis carotici interni (fpcci) might contradict the previous statement. In the skull from Skye, the fpcci is formed entirely by the pterygoid and opens at the posterior end of this bone. This morphology is similar to the derived morphology of Eucryptodira, though this is probably homoplastic (as also occurs in the stem turtle *Meiolania platyceps*). Recent studies suggest that the evolution of the carotid artery system is more complex than previously thought and this new specimen confirms these conclusions. The turtle material from Cladach a'Ghlinne is abundant and at least two complete shells are now known. The study of the shell and postcranial anatomy will help to resolve the phylogenetic relationships of this new turtle and confirm whether it is a stem turtle or not.

Student Poster Session (Thursday)

VARIABLE CERVICAL HALF RING MORPHOLOGY IN THE ANKYLOSAURID DINOSAUR *EUOPLOCEPHALUS*

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UALVP 31 was collected in 1921 by G. F. Sternberg from southern Alberta, Canada, and was the first well-preserved skull referred to the ankylosaurid dinosaur *Euoplocephalus tutus*. Sternberg also collected abundant postcranial material, including two cervical half rings, vertebrae, ribs, limb elements, part of the sacrum, the right ilium, and osteoderms. Surprisingly, all of the postcranial material has remained in the unopened field jackets since 1921. The type specimen of *E. tutus*, NMC 0210, consists only of the first cervical half ring and a non-diagnostic cranial fragment. Observation of the first cervical half ring of UALVP 31 is needed in order to assign this specimen to *E. tutus*. The first cervical half ring of UALVP 31 differs substantially from that of NMC 0210. In NMC 0210, there are five keeled osteoderms on an underlying band of bone, with a broken area presumably representing a sixth osteoderm. In contrast,

UALVP 31 has only four osteoderms on the first cervical half ring. The outer, distal osteoderms are keeled, while the inner, medial osteoderms are more conical. This morphology is also present in several other specimens referred to *E. tutus*. The first cervical half rings in *Pinacosaurus mephistocephalus* and *Saichania chulsanensis* have six osteoderms, while two are present in *Talarurus plicatospineus* and none are present in juvenile *P. grangeri*. Intraspecific variation is not the best explanation for the different half ring morphologies referred to *E. tutus*. Based on cervical half ring morphology, it appears that two species of *Euoplocephalus* are represented by material currently assigned to *E. tutus*. Comparison of UALVP 31 with other first cervical half rings referred to *Euoplocephalus* also provides insight on half ring development. The UALVP 31 first half ring band is smaller in length and thickness than UALVP 45931 and TMP 1991.36.321, yet the osteoderms in UALVP 31 are larger and have sharper keels. The osteoderms in UALVP 31 do not appear strongly fused to the underlying band, in contrast to UALVP 45931 and TMP 1991.36.321. Osteoderms on the first cervical half ring appear to have been resorbed as the half ring band grew larger.

Technical Session XV, Saturday 9:30

ZHELESTIDS: STEM EUTHERIANS OR BASAL LAURASIATHERIANS, BUT NO EVIDENCE FOR PLACENTAL ORDERS IN THE CRETACEOUS

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Zhelestidae are best known by as many as ten species from the Cenomanian through Campanian of Uzbekistan and Kazakhstan. At the best-known sites at Dzharakuduk, four species are known (*Aspanlestes aptap*, *Parazhelestes mynbulakensis*, *P. robustus*, and *Zhelestes temirkazyk*) and an additional very small and very large species may be present. At the Cenomanian Sheikhdzheili sites to the west, two (*Eozhelestes mangit* and *Sheikhdzheilia rezvyii*) and maybe three species are present. These are the oldest published zhelestids. From Kazakhstan, "*Sorlestes*" *kara* is Turonian and cf. *Aspanlestes* is Campanian. Other species from the Coniacian through Paleocene of Japan ("*Sorlestes*" *miifunensis*), Europe (*Lainodon oruetebarriai*, *Labes quintanillensis*, *L. garimondi*), and North America (*Alostera saskatchewanensis*, *Gallolestes pachymanibularis*, *G. agujaensis*, *Avitotherium utahensis*) have been ascribed to this clade. Most taxa are known from fragmentary dental remains, but some of those from Uzbekistan are now known from associated cranial and dental remains. From the same localities ear regions and referred tarsal elements are known, although there is debate as to which tarsal elements belong to zhelestids. In all but a few phylogenetic analyses zhelestids cluster with early Tertiary archaic ungulates, largely because of dental characters. If these archaic ungulates are crown eutherians (placentals), then zhelestids are also crown eutherians (placentals). Most studies have used too few Cenozoic placentals or too few Cretaceous eutherians to determine whether this is the case, but for now zhelestids are probably best considered to be basal laurasiatherian placentals. These are, however, not members of extant placental orders, and thus counter to recent molecular studies, there is no evidence that members of extant placental ordinal clades existed in the Cretaceous.

Technical Session XVIII, Saturday 3:30

DEVELOPMENTAL DIFFERENTIATION IN A HOMOGENEOUS DENTITION: EVIDENCE FOR TOOTH CLASSES IN DOLPHINS

ARMFIELD, Brooke, Northeastern Ohio Universities College of Medicine, Rootstown, OH, USA; VINYARD, Christopher, Northeastern Ohio Universities College of Medicine, Rootstown, OH, USA; HORTON, Walter, Northeastern Ohio Universities College of Medicine, Rootstown, OH, USA; THEWISSEN, J.G.M., Northeastern Ohio Universities College of Medicine, Rootstown, OH, USA

Among living and extinct vertebrates, dentitions have extensively been analyzed for phylogenetic relationships, feeding behavior, and life history. Although morphological analysis of dental traits has provided a wealth of results, these can be enriched by studying the genes responsible for development of form. A developmental approach will elucidate such issues as tooth classes (e.g. molar, incisor) and cusp formation. Due to vertebrate paleontology's great interest in teeth, it stands to benefit significantly from the integration of developmental and morphological studies on tooth form. Cetaceans are excellent candidates to study developmental mechanisms because they have one of the most unique mammalian dentitions. Specifically, most odontocetes have increased their tooth number, lost their deciduous dentition and reduced each of their teeth to a single cusp. We studied developmental pathways that resulted in the unique dentition of *Stenella attenuata*, the spotted dolphin, using embryos from Carnegie stages 16-20 (11.2-161.0 mm in length, CRL). With immunohistochemical methods we determined the expression patterns of the signaling molecules FGF8 and BMP4 in the dental lamina, the tooth-forming region. FGF8 and BMP4 in mice have been shown to play a role in establishing whether a tooth becomes a molar (FGF8) or incisor (BMP4) at early stages of development when individual teeth are not yet recognizable but tooth classes can be determined by relative position along the dental lamina. We found that *Stenella* does not have these distinctive patterns of FGF8 and BMP4 signaling. Instead, FGF8 and BMP4 signaling pathways overlap in both the rostral and caudal regions of the dental lamina. In conclusion, early tooth development in *Stenella* differs significantly from the accepted mammalian model.

Poster Session III (Friday)

NEW MARINE VERTEBRATES FROM THE YUHA MEMBER OF THE DEGUYNOS FORMATION OF ANZA-BORREGO DESERT STATE PARK

ATTERHOLT, Jessie, Borrego Springs, CA, USA; JEFFERSON, George, California State Parks, Borrego Springs, CA, USA; SCHACHNER, Emma, University of Pennsylvania, Philadelphia, PA, USA

The paleontologic history of Anza-Borrego Desert spans a critical 25 million year period of Earth's history (Miocene to Pleistocene), and the fossils here found represent an un-paralleled North American paleoenvironmental resource. An unusual assemblage of new marine invertebrate and vertebrate as well as terrestrial mammalian fossils have recently been discovered in the marine part of the ancestral Colorado River delta deposits of Anza-Borrego Desert State Park. The specimens were recovered from the Yuha member of the Deguyunos Formation, Imperial Group, located in the southern part of the Park near Fish Creek. This mid-Pliocene formation, which records the terminal marine to terrestrial transition, is approximately 4.4 to 4.1 Ma in age, and will be more precisely bracketed by further paleomagnetic work the area. Local sediments include delta front and delta plain lens-shaped sandstone beds, sandstone coquinas, and massively bedded silty fine sandstones, which interfinger with fossil wood bearing sandstones. The marine fossils support paleoenvironmental reconstructions. These exposures of the Deguyunos Formation crop out in a region of the Park previously unexplored for fossils, and many of the specimens thus far recovered are representative of very rare or new taxa for the local record, including members of Istiophoridae, Cheloniidae, Dugongidae, Odontoceti, and Pinnipedia. Of particular interest is a potentially new species of *Valenictus*, based on nearly complete, curiously small humerus, femur and tibia. In addition, several *Odontaspis* teeth have been identified, indicative of warm, shallow waters, and *Squalus*, a deeper water form. The role of this study aids the reconstruction of the local paleoenvironments, and is thus crucial to understanding the paleontologic history of the ancestral Colorado River and the Salton Trough rift valley.

Poster Session IV (Saturday)

MULTITUBERCULATE FOSSILS FROM THE EARLY CRETACEOUS OF LA CANTALERA (TERUEL, SPAIN)

BADIOLA, Ainara, University of Zaragoza, Zaragoza, Spain; CANUDO, José Ignacio, University of Zaragoza, Zaragoza, Spain; CUENCA-BESCÓS, Gloria, University of Zaragoza, Zaragoza, Spain

The Early Cretaceous is a critical period for the evolution of multituberculates and of mammals in general. When Pangaea broke up at the end of the Jurassic, significant separation of Laurasia and Gondwana occurred and their respective faunas became more distinct than they had been earlier. However, little is known about the evolutionary and palaeobiogeographic history of multituberculate faunas over the course of this long epoch. The most abundant and diverse Early Cretaceous multituberculate fossils are recorded in Western Europe, from the Berriasian of Portugal and England; to the Barremian of Spain. However, relatively little is known about the Valanginian and Barremian of England and no Hauterivian specimens have been described. We describe here multituberculate fossils from the upper Hauterivian-lowermost Barremian of La Cantalera, a site in the Iberian Range in Teruel, Spain. The vertebrate fauna of this site consists of fishes, frogs, lizards, crocodiles, turtles, dinosaurs, pterosaurs and mammals; study of the fauna is still in progress. The multituberculate fossils have been assigned to Paulchoffatioidea (tentatively Pinheirodontidae) and Plagiaulacoidea (Eobaataridae and probably Plagiaulacidae) on the basis of the P4/5, P5, and P1/3 and p4, respectively. The i1 and i2 are described as Plagiaulacida indet. Some of the multituberculate fossils from La Cantalera (Pinheirodontidae and ?Plagiaulacidae) are restricted to what is now Europe, which was made up of one or several islands in the Early Cretaceous, whereas others (Eobaataridae) have been described also from Barremian and Aptian/Albian deposits of Asia, indicating that some interchange was possible between the two areas at these times.

The Dissorophoidea - Early Amphibian Radiation Symposium, Friday 12:00  
ANURAN REMAINS FROM THE BARREMIAN OF LAS HOYAS, SPAIN:  
UNDERSTANDING THE EARLY DIVERSIFICATION OF PIPOIDS

BAEZ, Ana, Universidad de Buenos Aires, Buenos Aires, Argentina

Recent analyses based on morphological, developmental, and molecular evidence have substantiated the monophyly of the anuran group composed of the crown taxa Pipidae and Rhinophrynidae, for which the node-based name Pipoidea is usually applied. A number of fossil taxa, including palaeobatrachids, appear as stem-rhinophrynids and stem-pipids, although their taxonomic placements are still unstable. The alluvial-lacustrine deposits of the La Huérguina Limestone Formation at the locality of Las Hoyas (Iberian Ranges, Spain) have yielded numerous remains of plants, invertebrates, and vertebrates, including anurans. Articulated specimens from this fossil site document the presence of a small pipimorph pipoid, in addition to previously reported discoglossid relatives, which is described herein. The morphology and proportions of the skeleton are strongly reminiscent of corresponding elements of *Neusibatrachus wilferti* Seiffert from the late Berriasian- early Valanginian lithographic limestones of Santa Maria de

Meià (Montsec Range, northeastern Spain), thus suggesting that these specimens might represent a closely related taxon. In recent analyses the position of the latter species fluctuates between being the sister-taxon of the pipoids and that of the pipimorphs; this tends to confirm the pipoid affinities of *Neusibatrachus* suggested by several workers. The new specimens from Las Hoyas belong to individuals of several growth stages and illustrate plesiomorphic traits, such as six or five pairs of ribs in the course of development, which have not been described in the Early Cretaceous pipoids from western Gondwana known to date nor are present in living pipids. The phylogenetic placement of this taxon in the context of recent phylogenetic hypotheses and evolutionary morphological trends of pipoids are discussed in this contribution.

Student Poster Session (Thursday)

SEXUAL DIMORPHISM AND ADDITIONAL DENTOCRANIAL FEATURES IN THE EOCENE CHALICOTHERE *LITOLOPHUS* (PERISSODACTYLA, MAMMALIA)

BAI, Bin, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China

Chalicotheria is a unique perissodactyl group characterized by clawed ungual phalanges instead of hoofs. Although the group persisted from the Eocene to the Pleistocene, their fossils are relatively rare, especially for the Eocene forms. Abundant cranial and postcranial specimens of *Litolophus gobiensis*, a primitive Eocene chalicotherid, were unearthed recently from the basal Arshanto Formation, Erlan Basin, Inner Mongolia, China. The new specimens reveal sexual dimorphism and additional skull features of the species. There are three mature skulls, judging from their teeth, and more than ten mandibles in the new collection. One skull is larger with a more robust zygomatic arch in terms of height and thickness. Two other distorted skulls are comparatively smaller and have a more slender zygomatic arch. In addition, the parietal crests converge to the sagittal crest at a nearly right angle on the larger skull, whereas the same angle is much smaller, with the convergent point located slightly posteriorly on the small skulls. We interpret that the large skull belongs to a male individual and the smaller ones to female individuals. Of the mandibles, eight specimens bearing erupted m3 can be divided into two groups. Specimens in Group 1 have a longer molar row and stronger canines and are interpreted as male; those in Group 2 are interpreted as female. The new specimens of *Litolophus* show that the paroccipital process is slender and is completely separated from the relatively broader and larger postsymphyseal process, the parietal crests do not contract abruptly behind postorbital processes, there is no supraorbital foramen, and the protoloph and metaloph connect to the base of the ectoloph on little-worn premolars.

Poster Session IV (Saturday)

CURVATURE OF LAGOMORPH UPPER CHEEK TEETH

BAIR, Andrea, University of Colorado Boulder, Boulder, CO, USA

Distinguishing ancient members of the two families comprising Lagomorpha, Leporidae (rabbits and hares) and Ochotonidae (pikas), is often difficult, particularly as known fossils are primarily fragmentary skull and jaw material and isolated teeth. Degree of curvature of upper cheek teeth and the relationship between upper cheek teeth and skull elements has been considered useful characters in distinguishing leporids from ochotonids. Ochotonid upper cheek teeth are observed to be more strongly curved than those of leporids, and (if tall-crowned enough) the alveolar ends extend into the zygoma. In leporids, the alveolar ends of upper cheek teeth extend into the orbit. However, a quantitative evaluation of tooth curvature in Lagomorphs has not yet been reported. I present preliminary results from a survey of upper cheek tooth curvature in Lagomorphs designed to: (1) quantify curvature, (2) assess interspecific variation, and (3) assess its systematic utility. P4s (upper cheek teeth with curvature most confined to a single plane) were sampled for several lagomorph taxa, representing both "modernized" and "primitive" tooth morphologies. Curvature is characterized by three parameters: (1) radius of curvature of the circle approximating the outer curve of the tooth; (2) radius of curvature of the circle approximating the inner curve of the tooth; and (3) the linear distance between the circle centers. Preliminary results indicate that a quantifiable difference in tooth curvature likely exists between leporids and ochotonids. However, interspecific variation and modeling inner tooth curvature as a circle present some challenges to utilization of this method.

Technical Session X, Friday 9:15

AN OVERVIEW OF TERRESTRIAL MAMMALS FROM EARLY EOCENE CAMBAY SHALE, VASTAN LIGNITE MINE, GUJARAT (WESTERN INDIA), WITH NEW TAXA AND AGE CONSTRAINTS

BAJPAI, Sunil, Indian Institute of Technology, Roorkee, India; THEWISSEN, J.G.M., Northeastern Ohio Universities, Rootstown, OH, USA; KAY, Richard, Duke University, Durham, NC, USA; COLBERT, Matthew, University of Texas at Austin, Austin, TX, USA; KAPUR, Vivesh, Department of Earth Sciences, Roorkee, India

A diverse terrestrial mammal fauna has been discovered recently in the early Eocene Cambay Shale strata of near-shore lagoonal setting in an open cast lignite mine at Vastan, near Surat, western India. As presently known, the assemblage is dominantly

holarctic and now comprises members of at least 10 placental orders including Proteutheria, Insectivora, Artiodactyla, Perissodactyla, Primates and Chiroptera. New, as yet unnamed taxa include a primate, tapiroid, hyaenodontid, condylarth and rodents. Perissodactyls belonging to the recently named family Cambaytheriidae dominate the medium/large-sized mammals from Vastan, both taxonomically and numerically. Cambaytheriidae (type genus *Cambaytherium*) is distinct from anthracobunids and also differ significantly from phenacodontid and quettacyonid condylarths. Ongoing investigations show considerable similarity between *Cambaytherium* and the nearly contemporaneous *Hallensia*. New data indicates that the Vastan mammals are significantly older than the previous assessment of ca. 52 Ma, based on benthic foraminifer *Nummulites burdigalensis*. This species, now reidentified as *N. globulus*, forms part of the Shallow Benthic Zone 8, corresponding to planktic foraminiferal zone P6. Associated dinoflagellate assemblage includes an age diagnostic taxon *Muratodinium fimbriatum*. Combined, these species constrain the age of the Vastan mammals to between 53 to 54 Ma, or approximately 53.5 Ma. This new assessment makes the Vastan mammal fauna possibly one of the oldest known in the South Asian Cenozoic. The fauna is potentially of great biogeographic importance in testing current hypotheses for the dispersal (direction and timing) of mammals around the P-E boundary, particularly in the context of the early Tertiary collision between India and Asia. This major event tectonic may have allowed bilateral migrations in both pre- and postcollisional settings, first through the accretion of Ladakh-Kohistan island arc and other intervening crustal blocks in the Neotethys, and subsequently by firm suturing of the Indian and Asian landmasses.

Evolutionary History of Bats Symposium, Thursday 8:15  
MOLECULAR BASED GEOLOGICAL TIMESCALE ON FLIGHT FROM  
INSECTIVORY TO FEEDING ON BLOOD, VERTEBRATES, FRUIT, NECTAR:  
PHYLLOSTOMID BATS

BAKER, Robert, Texas Tech University, Lubbock, TX, USA; BININDA-EMONDS, Olaf, Technical University of Munich, 07743 Jena, Germany; VAN DEN BUSSCHE, Ron, Oklahoma State University, Stillwater, OK, USA; PORTER, Calvin, Xavier University of Louisiana, New Orleans, LA, USA; HOOFFER, Steven, Texas Tech University, Lubbock, TX, USA

Only 2 of the 19 bat families have evolved to feeding on plant material. We use a well-supported phylogenetic tree built from nuclear and mitochondrial genes to estimate both time and order of diversification to an array of feeding strategies. The primitive feeding strategy for the common ancestor of phyllostomid and mormoopid bats was strict insectivory, but the basal diet for all extant phyllostomid bats was primarily insectivory with some plant material, as is characteristic for the extant genera *Macrotus*, *Micronycteris*, and *Glyptonycteris*. We hypothesize that the dietetic adaptation to some plant material was critical to diversification to feeding on blood, nectar, vertebrates, or fruit. The initial diversification within phyllostomid bats is estimated to be in the early Oligocene (~30 mya). We hypothesize that morphological and dietary condition of primarily insectivory and plant material as in *Macrotus* and *Micronycteris* was typical of the last common ancestor of the respective lineages that gave rise to blood, carnivory, nectar, and fruit eaters. The lineage giving rise to blood feeding diverged from all other phyllostomids 28.1-25.3 mya and became an apparent obligate blood feeder by 22.0-21.4 mya. Two independent lineages of nectar feeders diverged from other phyllostomids 22.3-18.4 and 21.4-20.2 mya, respectively. The lineage that gave rise to frugivory diverged 19.7-17.6 mya. The latter time agrees well with the only other instance of the evolution of frugivory in bats (Old World Pteropodidae, estimated to have diverged 24 mya, suggesting that a global, transtropical floral shift facilitated bat frugivory in these two families). Successful sanguivory, nectivory, and frugivory require extensive evolutionary change in morphology and physiology to accommodate the necessary suite of adaptive phenotypes. That so many alternative feeding strategies could evolve from a single common ancestor (26 mya), and in a comparatively short timeframe, must have required exceptional genetic mechanisms to facilitate change. We discuss how a phylogenetic tree can interface with genomics to understand change over time.

Technical Session XIV, Saturday 11:15  
ENDOCRANIAL ANATOMY OF A PRIMITIVE OVIRAPTOROSAUR, *INCISIVOSAURUS GAUTHIERI*, (THEROPODA: DINOSAURIA)

BALANOFF, Amy, American Museum of Natural History, New York, NY, USA; XU, Xing, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; MATSUFUNE, Yusuke, Hokkaido University, Sapporo, Hokkaido, Japan; KOBAYASHI, Yoshitsugu, Hokkaido University, Sapporo, Hokkaido, Japan; NORELL, Mark, American Museum of Natural History, New York, NY, USA

Oviraptorids are an interesting clade of theropod dinosaurs that possess a very avian-like appearance in a number of skeletal features. These similarities have resulted in contention regarding the phylogenetic position of Oviraptorosauria within Coelurosauria. Competing hypotheses place them either as part of a restricted clade closely related to therizinosaurids outside of paravians, or as a group closely related to birds to the exclusion of the remainder of Theropoda. Detailed descriptions of the oviraptorid braincase that include both internal and external features largely are not available reflecting a broader trend in the study of theropod dinosaurs, in which despite historic and wide-

spread interest, relatively few published studies deal explicitly with the evolution of neurocranial features. Even fewer studies present this information within the context of a broader synthetic analysis. In this study we describe the neurocranial anatomy of *Incisivosaurus*, the basal-most diverging clade within Oviraptorosauria, as well as other oviraptorids and maniraptorans. We then optimize several of the endocranial characters on the maniraptoran tree to assess whether they are shared exclusively between avialans and oviraptorosaurs or rather are plesiomorphic or convergent features. Results indicate that the striking resemblance between derived oviraptorids and avialans extends to features of the braincase and endocranial cast, including expanded cerebral hemispheres, a well-defined cerebellum, a ventrally displaced optic tectum, and reduced olfactory bulbs (amongst others). The inclusion of more basal oviraptorosaurs in these comparisons, however, documents a complicated history of neurocranial evolution within this clade and highlights that a number of morphological trends result in convergences between oviraptorids and avialans.

Student Poster Session (Thursday)  
HORN FUNCTION IN BRONTOTHERIIDS (PERISSODACTYLA; CERATOMORPHA) RECONSIDERED

BALES, Gerald, Western University of Health Sciences, Pomona, CA, USA

Morphological evolution in Brontotheriidae (Osborn's "titanotheres") included attainment of large body sizes and paired, frontonasal bony horns. Incipient horns (mere elevations) appeared in tapir-sized taxa then lengthened with positive allometry. Other horn features are the degrees of rostral migration, basal fusion, and angulation. A priori assumption of intraspecific combat led to proposed horn functions including lateral butting, vertical tossing, and forward ramming. Horn lengthening (post orthogenesis) required a strongly selectionist interpretation. Dramatic function was a focus to explain a greatly over-estimated positive allometry in selection terms. Battering ram proponents analyzed long horn features in terms of mechanical needs to validate the behavioral assumption. The attractive qualities of the battering ram - horn change scenario combined with routine propagation of short-to-long horn diagrams give a lop-sided view of brontothere evolution. The "long" horned form was one of several lineages in a bushy phylogeny persisting near extinction. Terminal genera show a diversity of lengths and shapes including (1) long, basally fused and (sometimes) recurved, (2) long, narrowly divergent, and without basal fusion (3), short and conical (4), medium length, rounded, and widely divergent (5), short, irregular flanges (6), and doubly-bifurcate (branched) [in an as yet not officially named AMNH brontothere]. A universal battering ram function might argue for evolution more convergent than divergent. Size - shape diversity notwithstanding, problems with the battering ram hypothesis include (1) what biomaterials were impacting skin? (2) what forces would be generated and was surface area adequate to withstand them? (3) what damage would occur and is this seen in the fossils? Paleobehavior inference is aided by Rudwickian plausibility where the morphology is shown to be mechanically sufficient for the performance. Preliminary calculation of ramming forces based on estimates of running speed, body mass, and impact area for opposing males of a large brontothere suggest that the forces exceed that of known compressive strengths of bone.

Poster Session I (Wednesday)  
A NEW NECROSAURID (SQUAMATA: ANGUIMORPHA) LIZARD FROM  
THE LATE CRETACEOUS OF SOUTHERN SASKATCHEWAN, CANADA  
BARR, Braden, University of Alberta, Edmonton, AB, Canada; CALDWELL,  
Michael, University of Alberta, Edmonton, AB, Canada

Consistently nested within the Varanoidea, the Necrosauridae is an enigmatic group of lizards whose monophyly or positive paraphyly has yet to be clearly demonstrated. North American necrosaurids are represented by highly fragmentary material with most generic diagnoses relying on maxillary and mandibular characters. A new necrosaurid lizard specimen is here presented. Collected in the spring of 1997, RSM\_P 2622.2 is the only articulated lizard known from the Frenchman Formation (Late Maastrichtian) of southern Saskatchewan, and may represent the most complete specimen known of a North American necrosaur. Preserved elements include, a nearly complete parietal, right and left pterygoids, numerous cervical and dorsal vertebrae, basioccipital, basisphenoid, right and left prootics and the right surangular. Elements of the rostrum, limbs and limb girdles are also present but are highly fragmented. The lack of maxillary and mandibular elements of RSM\_P 2622.2 makes direct comparison with other North American necrosaurids difficult. Nonetheless the unusual anatomy of the parietal, basisphenoid and toothed pterygoids will doubtless improve our current understanding of necrosaur morphology and concomitantly inform future phylogenetic analyses of the group.

Technical Session IX, Friday 12:00

#### DINOSAUR DIVERSITY THROUGH TIME: THE INFLUENCE OF THE ROCK RECORD

BARRETT, Paul, The Natural History Museum, London, United Kingdom; PAGE, Victoria, Imperial College, London, United Kingdom; MCGOWAN, Alistair, The Natural History Museum, London, United Kingdom

Patterns of species-richness can provide important information on the macroevolutionary history of a clade, demonstrating the timing and magnitude of extinctions and adaptive radiations. Diversity curves for Mesozoic (usually non-avian) dinosaurs have been compiled and used to investigate the end-Cretaceous extinction, the effects of sea level on preservation potential, the potential for clade-clade competition, and the influence of vegetational changes on herbivore communities. Many of these studies use simple counts of standing diversity, others use rarefaction techniques, and some incorporate information on phylogenetic ghost lineages. Work on the marine realm has demonstrated that outcrop area has a strong influence on patterns of species-richness, but similar corrections have rarely been applied to terrestrial habitats. We have reconstructed patterns of dinosaur diversity during the Mesozoic, both for dinosaurs as a whole (inclusive of birds) and for various subclades (e.g., Ornithischia). Diversity curves for species and genera were compiled on the basis of counts of taxa present per time interval (using subdivisions of standard European stages); phylogenetically corrected versions of these were also produced. Strong positive correlations between the species/genus level curves and the taxic/phylogenetically corrected curves indicate that the same signals were being sampled in each case. A model of the expected species-richness was constructed for each clade on the basis of the number of dinosaur bearing formations (DBFs) present at each time interval (as a proxy for outcrop area); this model was compared with the observed patterns and diversity residuals were calculated. This indicated that apparent patterns in ornithischian and theropod diversity can be explained largely as a result of changes in the number of DBFs, although in the Late Cretaceous it would appear that theropods are rarer than would be expected. In contrast, the sauropodomorph record bears little resemblance to that expected on the basis of the geological record, suggesting that many of the features of this diversity curve result from genuine biological signals.

Poster Session III (Friday)

#### GROWTH RATES AND LIFE HISTORY OF *EOLAMBIA CAROLEJONESA*

BARRICK, Reese, College of Eastern Utah, Price, UT, USA; BARTLETT, Jeff, College of Eastern Utah, Price, UT, USA; BIRD, John, College of Eastern Utah, Price, UT, USA

Several localities within the Mussentuchit Member (~98 Ma) of the Early Cretaceous Cedar Mountain Formation of southeastern Utah have revealed a range of juvenile body sizes of the derived iguanodontian/primitive hadrosaurine, *Eolambia carolejonesa*. The *Eolambia* 2 site includes disarticulated remains of over 30 juveniles. The Willow Springs 8 site includes four partially articulated to disarticulated individuals that include the smallest and largest individuals from both quarries. Body mass estimates are calculated using the mid-diaphyseal femoral circumferences and an accepted interspecific regression equation for bipedal animals. Results indicate a size range from 30 kg to 330 kg. The lone adult *Eolambia* has a body mass estimate of over 1600 kg. Study of long bone histology reveal annual growth lines indicating that juvenile *Eolambia* individuals reached around 90 kg in the first year and 300 kg by age two and adult size of 1600 kg between ages four and five. These results indicate an exponential growth curve with maximum growth rates of over between 400 and 600 kg/yr. These maximal growth rates are, however, well below those reported for Late Cretaceous hadrosaurs such as *Maiasaura*.

Technical Session XVI, Saturday 3:30

#### CRANIODENTAL AND POSTCRANIAL MORPHOLOGY OF THE OLDEST FAYUM HYRACOID

BARROW, Eugenie, University of Oxford, Oxford, United Kingdom; SEIFFERT, Erik, Stony Brook University, Stony Brook, NY, USA; SIMONS, Elwyn, Duke University Primate Center, Durham, NC, USA

Recent paleontological work in late Eocene (~37 million year old) sediments of the Birket Qarun Formation (Fayum Depression, northern Egypt) has led to the recovery of a new genus and species of fossil hyracoid represented by a relatively well preserved cranium as well as dentary fragments, isolated teeth and postcranial bones. The Birket Qarun sites are about 3 million years older than the next oldest hyracoid-yielding Fayum locality (quarry L-41), making the new genus the oldest known Fayum hyracoid. The new genus shares with older *Microhyrax* and *Seggeurius* some primitive features such as small size, brachydont and bunodont molars, and very simple premolars. The upper molars are similar to those of *Thyrohyrax*, but the lower molar hypocristsids are incomplete as in *Pachyhyrax*, *Geniohyus*, *Bunohyrax*, *Brachyhyrax* and *Seggeurius*. There is no evidence for an internal mandibular fenestra, but a coronoid canal is present as in younger hyracoids. In overall appearance the new cranium is comparable to those of other small Paleogene hyracoids, except that the orbits are positioned above the premolars (rather than above the molars) as in early sirenians, proboscideans, and

living and extinct procaviids. The few known postcranial bones suggest that the new genus was similar in form to procaviids and the small Paleogene genera *Saghatierium* and *Thyrohyrax*, and lacked the cursorial adaptations of *Antilohyrax* and *Afrohyrax*. Phylogenetic analysis indicates that younger hyracoids, including procaviids, form a clade to the exclusion of the new genus, *Microhyrax*, and *Seggeurius*. Despite considerable exploration, the Birket Qarun localities have produced evidence for only this one, very generalized, hyracoid genus. Subsequent climate change and competition with other herbivorous mammals has had dramatic effects on hyracoid diversity and the new specimens are of great importance for understanding the adaptations of the group's most basal members.

Poster Session III (Friday)

#### NEW DISCOVERY OF DINOSAUR FOSSILS FROM THE UPPER CRETACEOUS BAYANSHIREE FORMATION OF MONGOLIA

BARSBOLD, Rinchen, Mongolian Academy of Sciences, Ulaan Baatar, Mongolia; KOBAYASHI, Yoshitsugu, Hokkaido University, Sapporo, Japan; KUBOTA, Katsuhiko, University of Tsukuba, Tsukuba, Japan

An excavation by Mongolian Academy of Sciences in 2005 and 2006 discovered dinosaur materials from the Bayanshiree Formation (suggested as the early Late Cretaceous) of Shine Us Khuduk locality in southeastern Mongolia. These discoveries include an articulated ornithomimosaur and semi-articulated sauropodomorph skeletons and disarticulated specimens from at least four theropod (ornithomimosaur, deinonychosaur, therizinosauroid, and tyrannosauroid) and an ornithopod dinosaurs. Ornithomimosaur materials are rich from this area. The articulated skeleton shows a derived condition in metatarsals (arctometatarsalian condition and lack of pedal digit I) as in members of Ornithomimidae but unlike a primitive ornithomimosaur, *Garudimimus*, known from the same formation. It also shows some different features from the other ornithomimosaur such as a depression at the anterior end of the intercondylar groove of the femur and thick shaft of metatarsal V. Among isolated elements from a deinonychosaur, a pedal phalanx II-2 displays some features (unconstricted shaft and triangular shape in proximal view), similar to *Achillobator*, known from the same formation, and *Troodon*. A partial skeleton of a sauropodomorph was recovered, which is the first discovery of sauropodomorphs from the formation. The neural spine of a posterior cervical or anterior dorsal vertebra is divided and is U-shaped in anterior view, and anterior caudal vertebrae are opisthocelous, showing affinities with *Opisthocoelicaudia*, known from early Maastrichtian (Late Cretaceous) of Mongolia. Although ornithopods are not rich from this area, an isolated surangular of an ornithopod was discovered. It lacks the surangular foramen, suggesting that it is a derived iguanodontian (possibly a hadrosaurid). These discoveries may add two new taxa (ornithomimosaur and sauropodomorph) and suggest greater dinosaur diversity in the early Late Cretaceous of Mongolia, including the presence of multiple ornithomimosaur taxa (*Garudimimus* and an ornithomimid) and an *Opisthocoelicaudia*-like sauropodomorph.

Poster Session III (Friday)

#### DIVERSITY OF MAMMALIAN PALEOECOLOGICAL ASSEMBLAGES IN THE EARLY OLIGOCENE SCENIC MEMBER OF THE BRULE FORMATION, WHITE RIVER GROUP, BADLANDS NATIONAL PARK, SOUTH DAKOTA

BARTON, Melissa, University of Colorado-Boulder, Colorado Springs, CO, USA; STUCKY, Richard, Denver Museum of Nature & Science, Denver, CO, USA

The White River Group of South Dakota has been famous since the early 1800s for its abundant and well-preserved mammal fossils, which make it an ideal locality to study paleoecological assemblages during the Eocene-Oligocene cooling event. This study is based on over 4600 specimens of teeth and jaws collected in the 1990s from 20 sites within the Scenic Member of the Brule Formation (33.5-32.0 Ma) in Badlands National Park. Specimens are identified to the genus level and separated by site to examine ecological assemblages. At least four major mammal faunas can be identified: a *Merycoidodon-Leptomeryx-Mesohippus* fauna, a *Leptomeryx-Palaeolagus* fauna, a *Mesohippus-Merycoidodon* fauna, and a *Mesohippus-Leptomeryx* fauna. The first three faunas are similar to what Clark, Beerbower, and Kietzke identified, based on lithology and faunal assemblage, as swamp or swampy plains, open plains, and near-stream gallery forest. These sites are likely near-shore lacustrine to upland habitats. The single *Mesohippus-Leptomeryx* site contains a high frequency of associated skeletal remains. Sites that could be matched with the 1967 localities studied by Clark, Beerbower, and Kietzke showed good agreement in faunal ratios, although our sample contains a greater variety of small rodents and insectivores, perhaps due to collecting methods. This survey confirms that local ecologies in the early Oligocene are already very distinct, even allowing for taphonomic and collecting bias. Although no sites produced a large enough sample of carnivores and creodonts to clarify a relationship between carnivore and herbivore faunas, the relative ratios of carnivore groups provide some information. Further work will focus on analyzing the faunal assemblages in more detail and identifying specimens to the species level where possible for rarefaction analysis. The predator/herbivore relations and the role of small and rare species also merit additional study.

Student Poster Session (Thursday)  
DYNAMIC SIMULATIONS OF THEROPOD DINOSAUR (*ALLOSAURUS FRAGALIS*) LOCOMOTION

BATES, Karl, University of Manchester, Manchester, United Kingdom

Computer processing capabilities now makes it possible to perform dynamic simulation of dinosaur locomotion using a digital musculoskeletal model. To create stable running in a model, an appropriate muscle activation pattern can be developed by a distributed, parallel Genetic Algorithm (GA) optimization system. The GA control systems can be designed to search for muscle activation patterns that maximize performance according to specific fitness criteria (e.g. maximum running speed, metabolic cost) thereby producing explicit quantitative predictions of gait and performance based on morphology. In fossil species this alleviates the need to subjectively infer joint kinematics or rely on extant taxa as dubious locomotor analogues. However, the accuracy of the simulated gait ultimately relies on the bio-fidelity of the anatomical model, which necessarily includes estimation of soft tissue parameters rarely available in the fossil record. An existing bipedal simulator shown to produce accurate information on speed, gait and metabolic energy costs of locomotion in humans has been used to analyze maximum running velocity and energy expenditure in the theropod *Allosaurus fragalis*. In order to quantitatively test the predictive value of the model a 'one-at-a-time' sensitivity analysis was performed, in which the values of specific parameters were altered individually to isolate their effect on gait and performance. Muscle parameters (e.g. maximum muscle contraction velocity) were varied over the range observed in extant vertebrates, while various mass related parameters (e.g., center of mass) were altered within the range of published estimates for *Allosaurus fragalis*. Statistical analysis of the variation produced by each input parameter indicates the relative importance of each on the models predictions. Results indicate the importance of sensitivity analysis to evaluate confidence in dynamic simulations of extinct taxa, particularly where it may serve to constrain higher-level ecological and evolutionary inferences drawn from their predictions of locomotor performance.

Technical Session I, Wednesday 9:15  
THE OLDEST NORTH AMERICAN EUPRIMATES (OMOMYIDAE: *TEILHARDINA* SP. NOV.) AND MAMMALIAN BIOGEOGRAPHY NEAR THE PALEOCENE-EOCENE BOUNDARY

BEARD, K. Christopher, Carnegie Museum of Natural History, Pittsburgh, PA, USA

Detailed studies of mammalian biostratigraphy and carbon isotope stratigraphy in the Bighorn Basin of northwestern Wyoming suggest that *Teilhardina brandti* from zone Wa-0 postdates the earliest occurrences of *Teilhardina* in Asia (*T. asiatica*) and Europe (*T. belgica*) by roughly 25 kyr. Morphological analyses of dental characters agree with this apparent chronological sequence, because *T. asiatica* retains several primitive characters that are successively transformed in *T. belgica* and *T. brandti*. These observations led to the hypothesis that *Teilhardina* dispersed from Asia to Europe to North America at the beginning of the Eocene, and that dispersal from Europe to North America was facilitated by a major episode of marine regression at that time. Here, I report the occurrence of a new species of *Teilhardina* from earliest Wasatchian strata of the uppermost Tuscaloosa Formation on the Gulf Coastal Plain of Mississippi. This new species of *Teilhardina* retains certain primitive characters, including low-crowned m1-2 and distinctive aspects of p4 morphology, in common with *T. asiatica*. It appears to be phylogenetically nested within *Teilhardina* as follows: (*T. asiatica*(*T. sp. nov.*(*T. belgica*, *T. brandti*))). The new species of *Teilhardina* from Mississippi is demonstrably older than *T. belgica* on the basis of sequence stratigraphy. As such, it appears to be the oldest North American euprimate. Its provenance supports initial euprimate dispersal from Asia to North America to Europe. Euprimates seemingly required 10<sup>4</sup> yrs or more to colonize intermontane basins of the Rocky Mountain region after they successfully crossed Beringia and invaded coastal areas of North America. Marine regression near the Paleocene-Eocene boundary may have facilitated dispersal of *Teilhardina* from North America to Europe, not vice versa.

Technical Session XVIII, Saturday 1:30  
DENTAL MICROWEAR AS AN INDICATOR OF SUBSTRATE AND SUSPENDED SEDIMENT INTERACTION: TOWARDS A FINER VIEW OF MARINE MAMMAL PALEOECOLOGY

BEATTY, Brian, New York College of Osteopathic Medicine, Old Westbury, NY, USA

Causes of abrasive dental microwear in terrestrial mammals can come from dietary and/or extrinsic sources (sediment). Of marine mammals, few taxa thoroughly consume their foods and those that do mostly consume plant foods that lack abrasives such as phytoliths. Thus, sources of dental wear in many cases may have an extrinsic source. In order to assess the role of substrate and suspended sediment in dental wear, observations of relative amounts and directions of occlusal, non-occlusal, and tusk wear were compared among modern Sirenia and Cetacea. Within taxa or closely related taxa, comparisons were made among those with similar diets feeding in environments with different substrate compositions (carbonate or siliclastic) and/or suspended sediment loads (marine vs. riparian; though in some cases, different tributaries of the Amazon with different sediment loads). This was then compared to wear found in several fossil

taxa, including fossil dugongids, platanistids, and the Desmostylia. The most conclusive and regularly recognized signal of sediment interactions came from non-occlusal wear on tusks and molars of modern and fossil Sirenia and Desmostylia, which indicate various degrees of substrate interactions related to how they fed and on what parts (rhizomes or leaves) of aquatic plants they fed on. Dental wear in cetaceans appears to be polarized to either much more subtle microwear or complete cusp breakage. Whereas gross dental wear of cetaceans is a complex continuum, cusp breakage is most likely related to dietary differences. Microwear appears to relate most to extrinsic sources, including the few rare modern cases of strand feeding.

Technical Session XVIII, Saturday 2:00  
FUNCTIONAL INTERPRETATION OF THE NECK IN EOCENE *REMLINGNOCETUS* FROM PAKISTAN (MAMMALIA, CETACEA, ARCHAEOCETI)

BEBEJ, Ryan, University of Michigan, Ann Arbor, MI, USA; UL-HAQ, Munir, Geological Survey of Pakistan, Quetta, Pakistan; ZALMOUT, Iyad, University of Michigan, Ann Arbor, MI, USA; GINGERICH, Philip, University of Michigan, Ann Arbor, MI, USA

A well-preserved specimen of *Remingtonocetus*, including a partial skull and much of an articulated vertebral column, was recovered in 2004 from the upper Domanda Formation (late Lutetian; early middle Eocene) in the Kunvit area of Balochistan, Pakistan. Remingtonocetids are semiaquatic archaeocetes endemic to Pakistan and India that are characterized by long narrow rostra, small orbits, relatively long necks, sacra with three to four fused vertebrae, and hind limbs capable of bearing weight. The new specimen includes a series of complete cervical vertebrae with centra longer (relative to width and height) than those of all previously described cetaceans, which is counter to the trend of cervical shortening seen in most mammals secondarily adapted for an aquatic lifestyle. The third to fifth cervical vertebrae possess exceptionally large, plate-like transverse processes extending ventrolaterally from the centra, unlike those of any known cetacean. The largest of these processes are present on C4, where the anteroposterior length of each process is nearly twice the length of the centrum and the dorsoventral height of each process is nearly twice the height of the centrum. These expanded processes served as attachment surfaces for epaxial musculature including the longissimus cervicis, iliocostalis, scalenus, longus capitis, and intertransversarii. These muscles are paired laterally, flexing or extending the head/neck when both sides act together and rotating the head/neck to one side when they act unilaterally. Great expansion of these transverse processes indicates that the associated musculature was massive and implies that remingtonocetids had a strong neck that was likely exceptionally flexible in the lateral plane. While such flexibility would have been inefficient hydrodynamically during swimming, it almost certainly played a role in the capture and manipulation of prey. Reconstruction and interpretation of functional capability is being investigated using 3-D imaging and animation.

Technical Session XV, Saturday 10:30  
PETROSALS AND TARSALS OF THE EARLY EOCENE AUSTRALIAN METATHERIAN *DJARTHIA MURGONENSIS*: THE OLDEST CROWN-GROUP MARSUPIAL FROM AUSTRALASIA AND ITS IMPLICATIONS FOR THE EVOLUTION AND BIOGEOGRAPHY OF AUSTRALIDELPHIA

BECK, Robin, University of New South Wales, Sydney, Australia; GODTHELP, Henk, University of New South Wales, Sydney, Australia; ARCHER, Michael, UNSW, Sydney, Australia; HAND, Suzanne, University of New South Wales, Sydney, Australia

The origins and early evolution of Australasia's iconic marsupial fauna remain poorly understood, in large part because of a lack of Australasian mammal fossils of appropriate age (Late Cretaceous and early Palaeogene). Indeed, pre-Oligocene Australasian metatherians are currently known only from highly fragmentary remains (largely isolated teeth) from a single site, the early Eocene Tingamarra Local Fauna. Neither of the two metatherian taxa so far described from Tingamarra - the dilambdodont 'marsupiacarnivore' *Djarthia* and the bunodont *Thylacotinga*, both known only from dental remains - could be confidently referred to a known order. Here we describe additional, non-dental material - isolated petrosals and tarsals - from Tingamarra that we tentatively refer to *Djarthia*, based on relative abundance and size. This new material indicates that *Djarthia* is a member of the clade Australidelphia, and hence the oldest crown-group marsupial known from Australasia. Most notably, the tarsals show the 'continuous lower ankle joint' and subdivided calcaneocuboid joint characteristic of australidelphians. The australidelphian affinities of *Djarthia* are supported by morphological, molecular scaffold and total evidence phylogenetic analyses. The presence of at least one undoubted australidelphian in the early Eocene of Australia contrasts with the equivocal evidence for members of this clade in similarly aged deposits in South America, and provides critical new information on the morphology, phylogeny and biogeography of crown-group Marsupialia.

Ernie Lundelius Symposium (Faunal Dynamics and Extinction), Wednesday 11:45  
APOMORPHIES, PRECONCEPTIONS, THE PULL OF THE RECENT, AND  
CIRCULARITY: A CRITICAL LOOK AT NORTH AMERICAN QUATERNARY  
VERTEBRATE FAUNAL DYNAMICS

BELL, Christopher, University of Texas at Austin, Austin, TX, USA

As with most paleontological endeavors, assessments of major patterns of faunal dynamics during the Quaternary ultimately are based on the reliability of taxonomic identifications of preserved fossils. Identification of Quaternary faunal remains using a global apomorphy-based approach is exceedingly uncommon. The consequences of such an approach remain only preliminarily explored, but universally result in a less-refined taxonomic resolution than is attained using more traditional approaches to specimen identification. Thus far, these approaches were adopted and published only for the amphibian and squamate reptile components of the North American Quaternary vertebrate fauna. It is clear from those studies that the North American Quaternary Herpetofaunal Stability hypothesis is seriously impacted when fossils are interpreted in a strict apomorphy-based context. Using fossil specimens collected by Ernie Lundelius in Australia, I demonstrate additional complications in attempting to apply an apomorphy-based approach to the identification of Australian squamate reptiles. Explorations of apomorphy-based identifications of Quaternary mammals in North America are now sufficiently advanced to permit preliminary conclusions about the impact of this approach on other faunal dynamics hypotheses. I focus on the Great American Biotic Interchange as an example hypothesis, and explore the consequences of apomorphy-based approaches for some of the mammalian taxa involved in the interchange. The Biotic Interchange hypothesis is significantly less impacted than the Herpetofaunal Stability hypothesis, but the additional complications of intercontinental dispersal reveal new insights into the role played by perceived spatial and temporal biogeographic patterns in assessment of taxonomic affinity of Quaternary mammals.

Student Poster Session (Thursday)

THE DANEK BONEBED: AN UNUSUAL DINOSAUR ASSEMBLAGE FROM  
THE HORSESHOE CANYON FORMATION, EDMONTON, ALBERTA

BELL, Phil, Edmonton, AB, Canada

*Edmontosaurus* and *Saurolophus* occur in the Lower and Upper reaches of the Horseshoe Canyon Formation, respectively, with no apparent overlap. The co-occurrence of these genera is reported here for the first time from the multigeneric Danek Bonebed, near Edmonton, Alberta. The tyrannosaurine *Daspletosaurus* is identified for the first time as occurring in association with these two hadrosaur genera. This specimen represents the first definitive record of *Daspletosaurus* from the Horseshoe Canyon Formation, and may also represent the latest occurrence of this genus. Analysis of old and new material collected by the Royal Tyrrell Museum and the University of Alberta indicate at least five individuals are present in the bonebed. Four dinosaur taxa are identified: *Edmontosaurus* sp., *Saurolophus* sp., *Daspletosaurus* sp., and cf. *Sauromitholestes*. Hadrosaurs dominate theropods in minimum number of individuals (MNI) by a ratio of 4:1. Hadrosaurs are represented by postcranial and rare cranial material. A femur tentatively assigned to *Edmontosaurus* measures a record 127 cm. *Daspletosaurus* is identified from rare cranial elements including a complete maxilla. Shed *Daspletosaurus* teeth are very common; however a single shed tooth is attributable to cf. *Sauromitholestes*. Non-dinosaurian taxa are conspicuously absent thus far. Preliminary taphonomic assessment suggests these animals were entombed following a catastrophic, possibly drought-related, event.

Technical Session XII, Friday 2:30

MESOWEAR ANALYSIS OF UNGULATES IN THE MIDDLE TO LATE  
MIOCENE OF THE SIWALIKS, PAKISTAN: DIETARY AND PALEOENVIRONMENTAL IMPLICATIONS

BELMAKER, Miriam, Harvard University, Cambridge, MA, USA; NELSON, Sherry, Boston University, Boston, MA, USA; MORGAN, Michèle, Harvard University, Cambridge, MA, USA; BARRY, John, Harvard University, Cambridge, MA, USA

BADGLEY, Catherine, University of Michigan, Ann Arbor, MI, USA; The Siwalik Group of northern Pakistan contains a long sequence of terrestrial deposits dating from ca. 18-1 Ma. Isotopic evidence from paleosol carbonates indicates an expansion in C<sub>4</sub> grasses after 8 Ma and local extinctions of *Sivapithecus* and other forest-dependent taxa. The aim of this study is to test whether mesowear can detect a shift in the diet of Siwalik ungulates after 8.0 Ma and to compare the results with dietary reconstructions from other proxies. Mesowear records the height and shape of upper molar paracones. Previous studies demonstrated that mesowear might be used to distinguish browsers from grazers, but not frugivores from grazers. Principle Component Analysis (PCA) was applied to percent graze, browse, and fruit in diets of modern ungulates and correlated with mesowear data from modern populations. Percent of high paracones decreases as percent graze increases in the diet and percent round paracones increases as percent fruit increases in the diet. Thus, mesowear data offers a new method to distinguish between grazers and frugivores. Mesowear was recorded on a suite of common Siwalik ungulate taxa from 10 to 7 Ma. For the Siwalik record, mesowear results indicate that taxa respond differently to the vegetation before and after 8.0 Ma. Mesowear results

combined with isotopic analyses suggest that equids were largely C<sub>3</sub> grazers before incorporating C<sub>4</sub> graze into their diet beginning at 8.7 Ma. Medium-sized bovids, mostly *Tragoptax* spp., consumed mostly browse before 8.0 Ma. After 8.0 Ma, mesowear results indicate that some medium-sized bovids were predominantly browsers, while others appear to have incorporated significant amounts of fruit and graze in the diet. The large bovids, mostly *Selenoptax* spp., are interpreted to have had a frugivorous diet that did not change throughout the time interval studied. These results show that mesowear provides complementary data to other proxies. They offer additional evidence for the significant presence of C<sub>3</sub> grasses well before the appearance of C<sub>4</sub> grasses and suggest that fruit may have continued to contribute importantly to the diet of some Siwalik mammals after the expansion of grasses thereby emphasizing the heterogeneity of habitats across the Miocene Siwalik landscape.

Student Poster Session (Thursday)

CROCODILE POPULATION STRUCTURE IN THE UPPER CRETACEOUS  
HELL CREEK FORMATION, EASTERN MONTANA

BENNETT, George, Shenandoah Valley Discovery Museum/George Mason University, Winchester, VA, USA

Modern crocodile populations display a distinct size-class frequency distribution, with each size-class corresponding roughly to age. Hatchlings constitute the largest size-class group, with each successive size-class containing fewer individuals. This pattern reflects the continuous growth and natural mortality rate in crocodylians, and contrasts with the normal frequency distribution of mammals and other animals with a fixed adult size range. Screenwashing of vertebrate microsites in the Hell Creek Formation of eastern Montana has produced several hundred crocodile teeth. Microsites are separated laterally by up to 4 kilometers and stratigraphically by less than 20 meters. The samples represent a temporally averaged and spatially constrained population of crocodiles. The effects of short-term disasters, such as hurricanes, that affect hatching rates during a single season are muted. Measurements were taken of the crown height (CH), fore-aft basal length (FABL), and basal width (BW) of the anterior conical teeth. Two species of crocodiles with indistinguishable anterior teeth, *Borealosuchus sternbergi* and *Brachychampsia montana*, are present in the Hell Creek Formation and have been lumped together in this study. Posterior molariform teeth were not included because of their different relative dimensions. Teeth were divided into nine equal size classes and range from 1.5 mm to 22.1 mm in crown height. The smallest size-class (CH < 4.0 mm; FABL < 3.0 mm; BW < 2.0 mm) contains the greatest number of teeth, tripling the next largest size class. As tooth size increases, the number of teeth in each class decreases, mirroring the trend in modern American alligators as confirmed by chi-squared analysis. Results suggest that 1) the population age structures of ancient and extant crocodiles are similar; and 2) provided adequate sample size and isotaphonomic techniques, the population structures of other extinct vertebrates can be determined from screenwashed vertebrate microsites.

Poster Session IV (Saturday)

EVOLUTION OF THE PTEROSAUR WING

BENNETT, S. Christopher, Fort Hays State University, Hays, KS, USA

The manner of evolution of the flight-adapted forelimb of pterosaurs, with its three small digits flexing anteriorly and one large wingfinger flexing posteriorly in flight position, has long puzzled pterosaur workers. The prevailing opinion seems to be that the wingfinger rotated ~180° about its long axis, but little or no work has been done to explain how that might have happened. A reconstruction of the forelimb musculature of *Anhanguera* using the Extant Phylogenetic Bracket method provides evidence against wingfinger rotation and suggests that the range of motion of the metacarpophalangeal (McP) joint of digit IV was shifted posteriorly such that when the wingfinger was directed laterally to spread the patagium the MCP joint was fully 'flexed' and when the wingfinger was folded posteriorly to lie close to metacarpal IV and fold the patagium the MCP joint was 'hyperextended'. Whereas it is difficult to explain how rotation of the wingfinger might have been selected for, there are three reasons why a posterior shift in the range of motion of the MCP joint might have been selected for in a pterosaur ancestor as digit IV was enlarged to spread the patagium: 1) swinging digit IV posteriorly (homological hyperextension) in flight would slacken the patagium, altering its shape and providing aerodynamic control; 2) swinging digit IV posteriorly would permit more compact folding of the patagium than an anterior swing (homological flexion); and 3) permitting digit IV to swing posteriorly in flight would prevent damage to the wing skeleton and undesirable yaw when the wingtip struck an immovable object. This may also explain why digit IV lost its ungual, because the ungual would curve anteriorly and catch on immovable objects rather than slide past them. An ungual catching on an immovable object in flight would produce undesirable yaw and might cause the animal to lose airspeed and control and fall to the ground, resulting in strong selection to lose the ungual as soon as the pterosaur ancestor began to fly.



Carnivora: Phylogeny, Form and Function Symposium, Saturday 9:15  
WHAT'S THE DIFFERENCE?: A MULTIPHASIC ALLOMETRIC ANALYSIS  
OF FOSSIL AND LIVING LIONS

BENOIT, Matthew, Yale University, New Haven, CT, USA

The modern-day range of lions (*Panthera leo*) is restricted to Africa and a small section of Asia. In historic times, they were known through the Mediterranean. However, in the fossil record, paleontologists have found lion remains from Europe, Asia, and the Americas. Such a widespread distribution results in inter-populational differences, and, with fossil specimens, leads to discussion and argument about the species' status of different groups. The American Lion (referred to as *Panthera atrox* or *Panthera leo atrox*) has been the subject of such discussion and argument for the better part of a century. *P. atrox* lived in the Americas until roughly 10Kya. While all researchers seem to agree that *P. atrox* was larger than the modern lion, several authors have claimed that different cranial characteristics also distinguish the American Lion. To examine these claims, I performed multiphasic allometric analyses to determine if the change in these cranial characteristics was simply a by-product of the increased size of *P. l. atrox*. I examined nine cranial measurements from 93 modern lions and compared them with those same measurements from 45 specimens of *P. l. atrox*. Using F-distribution analyses, I tested the significance of the differences between the allometric slopes for the two groups. When multiphasic allometric relationships were considered, none of the proposed cranial characters was found to be significantly different ( $P < .05$ ) between the two groups, indicating that the cranial features examined are no different than expected from the change in size. However, one feature did show a difference in y-intercept while maintaining the same allometric slope. The size of the auditory bullae was substantially smaller in *P. l. atrox* than it is in the modern lion. This may be the result of different social structures or communicative behaviors in the American Lion. While this analysis does not prove that the American lion and the modern African lion were undoubtedly the same species, it does allow us to discuss the differences in their various features independently of the difference in their overall sizes.

Poster Session IV (Saturday)

A NEW JURASSIC TYRANNOSAURID FROM THE TITHONIAN (LATE JURASSIC) OF DORSET, UK, REPRESENTING A LARGE-BODIED SPECIES OF THE AMERICAN GENUS *STOKESOSAURUS*

BENSON, Roger, University of Cambridge, Cambridge, United Kingdom

A partial postcranial skeleton from the Late Jurassic (Tithonian) of Dorset, England represents a new species of the theropod dinosaur genus *Stokesosaurus*. The specimen provides additional anatomical evidence in support of the tyrannosauroid affiliation of *Stokesosaurus*: a distinct median vertical ridge on the lateral surface of the ilium, a concave anterior outline of the pubic peduncle of the ilium in lateral view, a distinct shelf medial to the preacetabular notch, an ischium that is short and slender compared to the pubis and a pronounced ischial tubercle. It is one of only two Jurassic tyrannosauroids known from more than isolated elements and, with an estimated mass of 350kg, is substantially larger than other known Jurassic tyrannosauroids, providing evidence for a basal radiation of small to medium-sized tyrannosauroids in Asia, North America and Europe during the Late Jurassic. The occurrence of *Stokesosaurus* in the UK supports the hypothesis of a paleobiogeographic link between North America and Europe during the Late Jurassic.

Technical Session II, Wednesday 12:15

MASS EXTINCTION OF TETRAPODS AT THE PERMO-TRIASSIC BOUNDARY IN RUSSIA

BENTON, Michael, University of Bristol, Bristol, United Kingdom; RUTA, Marcello, University of Bristol, Bristol, United Kingdom; TWITCHETT, Richard, University of Plymouth, Plymouth, United Kingdom; VALENTIN, Tverdokhlebov, Saratov Geological Institute, Saratov, Russia; SURKOV, Mikhail, Saratov State University, Saratov, Russia

The Permo-Triassic (PT) mass extinction had as profound an effect on tetrapod diversity as on life in the sea. Studies on the PT sequences in South Africa and Russia have revealed some detail of the magnitude and pattern of ecosystem destruction and recovery, but these studies are dogged with major problems. The dating is disputed: according to current geological time scales, the Russian Tatarian, formerly the terminal stage of the Permian, has been moved down to the Middle Permian (Guadalupian, Capitanian). If this is true, the Vyatskian (upper Tatarian) fauna of Russia, comprising temnospondyls, procolophonids, therocephalians, dicynodonts, pareiasaurs, and gorgonopsians, and the equivalent Dicynodon Assemblage Zone of the Karoo must lie well below the PT boundary. Our fieldwork in Russia in 2006 included studies of palaeomagnetism and stable isotopes (measured from carbonate paleosols) through the entire PT succession, and these more or less confirm the classic view. Quantitative studies of the Russian faunas shows the catastrophic collapse of tetrapod ecosystems at the PT boundary, and that they had not recovered to a fully stable condition 20 Myr later at the end of the Middle Triassic. In such studies of recovery after mass extinctions, overall diversity may appear to bounce back rather rapidly, but some major sectors of the ecosystem, such as large herbivores and carnivores, did not reappear until

much later. Sedimentological studies of the Russian sections confirm major climate and environmental changes at the PT boundary: global warming, removal of plants and soils, change in fluvial regime from meandering to braided streams, and a negative carbon isotope shift. These confirm the generally accepted model of extinction following a concatenation of processes triggered by repeated eruption of the Siberian traps.

Poster Session IV (Saturday)

UNDERSTANDING PALEONTOLOGICAL RESOURCE MANAGEMENT ISSUES AND PARTNERSHIPS WITH LOCAL INDIAN TRIBES: A CASE STUDY AT BADLANDS NATIONAL PARK

BENTON, Rachel, Badlands National Park, Interior, SD, USA; BAKER, Paige, Badlands National Park, Interior, SD, USA

The South Unit at Badlands National Park is located on 133,300 acres of the Pine Ridge Indian Reservation. Since 1976, this parcel of land has been managed under the guidelines outlined in a Memorandum of Agreement between the National Park Service (NPS) and the Pine Ridge Indian Reservation. The South Unit contains some of the most spectacular geologic and paleontological deposits within the White River Badlands and has been an important center for paleontological research. Over the years, limited attempts have been made to manage this area for paleontological resources through surveys, research permits and a proposed research quarry. During this time, the NPS involved the Tribe peripherally through the government to government consultation process required by legislation and NPS policy, but did not include tribal members in these projects. Portions of the South Unit where the surveys took place are considered sacred by the Tribe. The procedures used by the NPS were regarded by some tribal members as insensitive and invasive. In 2002 many of these programs were stopped because of opposition by the Tribe. The management issues of the South Unit are steeped in the history, culture and social issues of the original ownership of the land now within the South Unit. To understand these management issues is to understand the complexities facing the Oglala. Some of these tenets include an understanding of what treaties are with the United States government, colonialism and dependency theory (mercantilism). These underpinnings form the essence, the theoretical framework, the starting point from which to begin to frame the partnership and management issues surrounding paleontological resources in the South Unit. The NPS now recognizes the need to include the Tribe directly in the planning and carrying out of all activities in the South Unit. At present, a team comprising National Park Service staff and Oglala Sioux Tribe members is developing a General Management Plan, which will guide the management of the South Unit for the next 15-20 years. The General Management Plan is scheduled for completion in the next two years.

The Dissorophoidea - Early Amphibian Radiation Symposium, Friday 9:15

A NEW, LATE PENNSYLVANIAN TREMATOPOID (TEMNOSPONDYLI: DISSOROPHOIDEA) FROM WESTERN PENNSYLVANIA

BERMAN, David, Carnegie Museum of Natural History, Pittsburgh, PA, USA; HENRICI, Amy, Carnegie Museum of Natural History, Pittsburgh, PA, USA

In March, 2004, Adam Striegel, a senior at the University of Pittsburgh, while on a field trip in an introductory geology class, discovered a superbly preserved skull of a new species of Late Pennsylvanian (early Virgilian) trematopid amphibian about 15 mi northwest of Pittsburgh. The skull was found at the base of a large, recently excavated road cut that exposes a significant part (ca. 115 m) of the Casselman Formation, Conemaugh Group; it is likely that the origin of the skull is the Clarksburg Limestone, typically 100 m above the Ames Limestone. Most commonly an Early Permian group, this is only the third record of a Pennsylvanian species of trematopid. The skull exhibits numerous autapomorphies that distinguish it easily from all other dissorophoids, whereas placement well within the Trematopidae is verified by several synapomorphies. Most importantly, the skull of the new Pennsylvanian trematopid possesses several characters previously viewed as unique to dissorophids. Prompted mainly by the latter characters a preliminary cladistic analysis of the dissorophids was conducted that is based exclusively on cranial characters and focuses on the relationships of the trematopids (5 taxa, including the new species) and dissorophids (3 taxa). Also included in the analysis was the problematical *Ecolsonia cutlerensis*, which has been argued to be either a trematopid or dissorophid. The cladogram, though weakly supported by the CI and Bremer Support, yielded interesting but not totally unexpected results: 1) the Trematopidae and Dissorophidae form monophyletic sister clades; 2) the new, undescribed trematopid falls within the Trematopidae; 3) *Ecolsonia* and *Dissorophus* form the terminal dichotomy of the *Dissorophidae*.

Poster Session I (Wednesday)

NEW FOSSILIFEROUS SITES WITH FISH FAUNA FROM THE BASQUE-CANTABRIAN AND CAMEROS BASINS, EARLY CRETACEOUS OF SPAIN  
BERMÚDEZ-ROCHAS, David, Museo Geominero (IGME), Madrid, Spain; POYATO-ARIZA, Francisco, Universidad Autónoma de Madrid, Madrid, Spain

Recent field works have provided fish remains from new fossiliferous sites from the Early Cretaceous of the Basque-Cantabrian Basin (Cantabric Range) and Cameros Basin (Northwest of Iberian Range) in Spain, from the Berriasian-Aptian interval,

which was poorly documented in this area in the past. The fish remains consist mostly of ganoid scales, teeth, and dentitions, and represent taxa that are typical from Mesozoic continental environments. They mainly include: 1) euselachian chondrichthyans assessed to the order Hybodontiformes, and 2) neopterygian actinopterygians assessed to three orders: Semionotiformes, Pycnodontiformes and Amiiformes. More than two thirds of the specimens are ganoid scales assessed to the Semionotiformes. Among the rest, pycnodont and Hybodontiformes teeth are the most abundants. No teleost remains have been identified so far, but this is probably due to an ecomorphologic and taphonomic bias rather than to real absence in the original communities. Most taxa collected are identified for the first time in these basins. There are remarkable differences between both basins in the number of Berriasian-Aptian localities that have provided fish remains. In the Basque-Cantabrian Basin they have been found, to date, in a single outcrop, located at the Viviparus Bed Member of the Vega de Pas Formation (Hauterivian-Barremian). In the Cameros Basin, remains have been collected from fifteen different sites found within the Oncala Group (Tithonian-Berriasian), Urbión Group (uppermost Berriasian-lower Aptian) and Enciso Group (Aptian). These fish assemblages show general similarities with the ichthyofaunas from the Purbeck and Weald of Europe. The Cameros Basin faunas are the most similar to those previously known from the Early Cretaceous of Spain: Galve (Teruel, Maestrazgo Basin), Las Hoyas (Cuenca, Iberian Basin), and Montsec (Lérida, South Pyrenean Zone), although all these localities present a high percentage of endemic taxa, at least at specific level. In addition to the overall faunistic similarities, the new ichthyofaunas from both basins show evidence of endemisms as well, involving several new taxa currently under study.

Romer Prize Session, Thursday 10:30

#### VARIATION, VARIABILITY, AND PROBABILITY IN ASSESSING THE EVOLUTIONARY HISTORY OF VERTEBRATE FOSSILS BASED ON DISCRETE SKELETAL CHARACTERS

BEVER, Gabe, American Museum of Natural History, New York, NY, USA

Although the geological record provides us the only direct window into the evolutionary history of Life, it often does not supply us with the specimens necessary to recognize the full complexity of the morphological transformations that it preserves. Developmental biology combined with phylogenetic systematics is broadening our perspectives on the role of intraspecific variation in the evolution of morphology and its applications to the fossil record. These perspectives include conceptualizing variability as a reflection of the evolutionary history of underlying developmental pathways rather than solely the result of population-level phenomena working largely independent of phylogenetic history. This view provides a theoretical context for studying variability as synapomorphy, which in turn provides not only the means to objectively estimate variability in extinct lineages but also the emphasis to do so. Unfortunately, our current understanding of variation in the skeleton of extant vertebrates and its distribution through space and time is largely inadequate to support meaningful conclusions with regards to what degree the evolution of variability affects our perception of evolutionary history based on the fossil record. I undertook a series of studies, using cryptodire turtles as a model, which examined variation in discrete skeletal characters to determine how that variation is distributed across a range of hierarchical levels. Results indicate that variation data are not randomly distributed through space and time and therefore informative patterns do exist. These patterns, not surprisingly, are often complex and closely related to postnatal trajectories of growth and skeletal remodeling. The presence of phylogenetic information in variation data supports the notion that meaningful phylogenetic brackets can be used to infer variability in extinct lineages and to assess confidence in the phylogenetic position of a fossil specimen. Such confidence also is applicable to the inference of all secondary biological properties dependent on tree topology and therefore can be used to strengthen the contribution of paleontological data to broader biological questions.

Technical Session V, Wednesday 3:15

#### THE ENIGMATIC FOSSILS *EXOSTINUS* AND *RESTES*: RESOLVING THE STEM AND THE CROWN OF *XENOSAURUS*, THE KNOB-SCALED LIZARDS

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Two lizard clades, Xenosauridae (Pan-*Xenosaurus*) and Shinisauridae, both with extensive fossil records and relict extant distributions, are important in reconstructing relationships within Anguimorpha, an ancient clade whose composition and internal relationships remain controversial. Xenosauridae and Shinisauridae preserve plesiomorphic characters within Anguimorpha that are lost in the highly derived Anguidae and Varanoidea. In the course of my work on Anguioidea (Xenosauridae + Anguidae), and with the aid of CT scans, I examined the anatomy of all extinct and most extant Xenosauridae in an attempt to produce the first phylogeny of the clade. These taxa included the extinct *Exostinus lancensis* (Cretaceous), *Exostinus serratus* (Oligocene), and *Restes rugosus* (Paleocene), the latter two known from substantial but inadequately described cranial material, and eight species within the crown clade *Xenosaurus*. Phylogenetic resolution of the clade is complicated by the derived nature of putative outgroups. Nevertheless, my results suggest that *R. rugosus* is sister to the others, resolv-

ing a polytomy with other Anguimorpha recovered by previous work. Its anterior skull roof osteoderms are primitively platey, but its posterior osteoderms filled apomorphic "knob-scales," demonstrating the early appearance of this characteristic feature. *E. lancensis* is problematic in that referred specimens may represent several distinct taxa. One of these appears to be sister to *E. serratus* + *Xenosaurus*, making *Exostinus* paraphyletic. *Exostinus serratus* emerges as sister to *Xenosaurus*; however, it is autapomorphic in its shortened rostrum and narial elongation. Finally, *Xenosaurus* comprises flattened, crevice-dwelling lizards whose distribution follows the great mountain ranges of southern North America. For parts of a group until recently thought to include but three species, the eight examined species are remarkably distinct. A northern clade comprises *X. newmanorum* and *X. platyceps*; the remaining taxa are united as a southern clade. North-south splits within Xenosauridae mirror those of several other lizard clades and may be the legacy of the equatorial contraction of early Tertiary tropical forests

Technical Session XII, Friday 1:45

#### RECONSTRUCTION OF PALEOECOLOGIES AND PALEOCLIMATES OF CENOZOIC MAMMALS FROM NORTHWEST CHINA BASED ON STABLE ISOTOPES

BIASATTI, Dana, Florida State University, Tallahassee, FL, USA; WANG, Yang, Florida State University, Tallahassee, FL, USA; DENG, Tao, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

The Linxia Basin is located in Gansu Province, China, on the NE margin of the Tibetan Plateau and the present-day climate is strongly influenced by the East Asian monsoon system. The uplift of the Tibetan Plateau during the Cenozoic is considered to be the driving force in the development of the Asian monsoons, and the timing of this development is important to the understanding of mammalian evolution in China. The sedimentary sequences in the Linxia Basin span almost continuously from the L. Oligocene to the Holocene and contain abundant and well-preserved mammalian fossils. Bulk carbon and oxygen isotope analyses of teeth from 160 mammalian individuals, including bovids, horses, rhinos, cervids, giraffes, pigs, and elephants, and serial analyses of tooth enamel from 38 of those individuals ranging in age from 25 Ma to the present, have allowed reconstruction of the paleoecologies of those taxa and seasonality in the region throughout the late Cenozoic. Bulk and serial  $\delta^{13}\text{C}$  values for samples older than 2.5 Ma indicate a pure C3 diet for all individuals. A positive shift in bulk  $\delta^{13}\text{C}$  values after 2.5 Ma, indicating a change to a mixed C3/C4 diet, suggests that C4 grasses may have not spread into the basin until after 2.5 Ma, which is much later than the proposed global C4 expansion during the Late Miocene. It was hypothesized that the late C4 expansion into the Linxia Basin was driven by the strengthening of the East Asian Summer Monsoon after ~2-3 Ma, as C4 plants require summer precipitation. The serial  $\delta^{13}\text{C}$  values show greater ranges after 2.5 Ma, indicating a seasonal shift in diet from a C4-based or mixed C3/C4 diet during summer months to a C3-based diet in winter months. The seasonal patterns from individuals younger than 2.5 Ma are consistent with the seasonal isotopic patterns in modern precipitation in the summer monsoon region of East Asia, whereas the seasonal patterns from individuals older than 2.5 Ma correspond to modern precipitation records outside the summer monsoon region. This change in seasonal isotopic patterns recorded in individual teeth provides strong evidence indicating a strengthening of the East Asian summer monsoon after ~2-3 Ma.

Technical Session XII, Friday 1:30

#### DIETARY NICHE PARTITIONING AMONG FOSSIL BOVIDS IN LATE MIOCENE C<sub>3</sub> HABITATS: CONSILIENCE OF FUNCTIONAL MORPHOLOGY AND STABLE ISOTOPE ANALYSIS

BIBI, Faysal, Yale University, New Haven, CT, USA

Teeth of late Miocene Bovini (bovid clade including living oxen, buffaloes, and bison) possess morphology-larger size, higher crowns, increased enamel surface area- that is reflective of feeding on a rougher diet, probably graze. In contrast, teeth of fossil "Boselaphini" bear simpler, more plesiomorphic dental morphology indicative of a diet with a greater reliance on softer food items such as browse. A paleoecological implication of the comparative dental morphology is that late Miocene bovines inhabited drier, more open habitats than did boselaphines. In order to test this hypothesis, I analyzed the stable carbon isotopes from fossil teeth from well-dated localities between 7.9 and 8.3 Ma in age from the Siwalik deposits, Pakistan. All  $\delta^{13}\text{C}$  values (PDB) lie between -9.5‰ and -12.5‰, indicating that both bovines and boselaphines at this time had pure C<sub>3</sub> diets. The mean  $\delta^{13}\text{C}$  for bovine teeth (-10.4‰) is more positive than that for boselaphines (-10.9‰), and the differences between these two series is statistically significant. Fossil bovine and boselaphine  $\delta^{13}\text{C}$  values for the most part do not overlap, separating at -10.7‰. Stable isotope analysis results support the hypothesis developed on the basis of dental functional morphology that early bovines evolved inhabiting more open habitats than did contemporaneous boselaphines. The scenario whereby the bovine clade owes its origins to a boselaphine lineage that adapted to drier, more open habitats is supported by the general context of climatic and faunal change

in Eurasia in the late Miocene, particularly between 11-8 Ma, when faunal assemblages from many sites exhibited significant turnover events through which open-habitat taxa become present in increasing proportions at the expense of closed-habitat taxa.

Poster Session I (Wednesday)

POSTCRANIAL MATERIAL OF *NOTHOSAURUS* FROM THE LOWER MUSCHELKALK OF WINTERSWIJK, NETHERLANDS: THE SYSTEMATIC VALUE OF HUMERUS MORPHOLOGY

BICKELMANN, Constanze, Museum für Naturkunde, Humboldt-Universität zu Berlin, Berlin, Germany; SANDER, Martin, Institut für Paläontologie, Universität Bonn, Bonn, Germany

Currently, the species of the abundant Middle Triassic sauropterygian *Nothosaurus* from the Germanic Muschelkalk (Middle Triassic) are diagnosed exclusively by cranial characters because most species are known from isolated skulls only. However, the Muschelkalk also has yielded numerous isolated postcranial bones and rare skeletons. Four of these are from the Lower Muschelkalk locality of Steengroeve Winterswijk at Winterswijk, The Netherlands. The first discovery was briefly described in 1959 as *Nothosaurus* sp. This specimen lacks the skull but includes an anterior dorsal vertebral column with ribs, pectoral girdle elements, and most of the forelimbs. To assign the specimen to a valid species, we focused on the humerus because this bone shows a complex morphology in Lower Muschelkalk *Nothosaurus*. This led to the discovery of three different humerus morphotypes among the material from Winterswijk, which were also recognized among the humeri from the classical Lower and lowermost Middle Muschelkalk localities of Rüdersdorf near Berlin, Oberdorla in Thuringia (both in Germany), and Gogolin (Poland). Morphotype I is characterized by a slender appearance with a bulky proximal end and distinct preaxial and postaxial edges of the shaft. Morphotype II is rather small and gracile, and has a slightly fan-shaped distal end. Morphotype III is rather large and has a massive appearance, especially the proximal end. The distal end is thick and shovel-like. There is some ontogenetic variation within the morphotypes. One small humerus from Oberdorla is that of a juvenile and cannot be assigned to a specific morphotype. A partial skeleton of *N. winterswijkensis* from Winterswijk and a partial skeleton of *N. marchicus* from Rüdersdorf both have type II humeri, indicating that this morphotype belongs to the *N. winterswijkensis*-*N. marchicus* clade. However, the 1959 specimen bears a type I humerus, the affinity of which remains unclear, as does that of type III. Type I and type III humeri may either represent sexual morphs of type II humeri, or new species of *Nothosaurus*, or may pertain to the nothosaurian *Germanosaurus* and/or the eosauroptrygian *Cymatosaurus*. Thus, the first Winterswijk discovery may not belong to *Nothosaurus* but to one of these taxa.

Poster Session IV (Saturday)

A NEW *APATOSAURUS* CF. *AJAX* SKELETON WITH SKULL MATERIAL FROM WARM SPRINGS RANCH, WYOMING

BIRKEMEIER, Tristan, Wyoming Dinosaur Center, Thermopolis, WY, USA; SWOR, Emily, Wyoming Dinosaur Center, Thermopolis, WY, USA

In 1877, Marsh described an unknown dinosaur and named it *Apatosaurus ajax*. Subsequently, four partial skeletons have been assigned to this species along with a myriad of isolated bones. Here, we present a preliminary description of a partial fifth skeleton of *A. cf. ajax* from Warm Springs Ranch, Thermopolis, Wyoming. The specimen includes a partial skull, assorted cervical, dorsal, and caudal vertebrae, dorsal ribs, sternal ribs, and limb material. The skull consists of a nearly complete braincase, right quadrate, and a right dentary with associated teeth. *Apatosaurus* autapomorphies include: 1) slight distal expansion of the basiptyergoid processes 2) an absent basisphenoid/basiptyergoid recess and 3) the angle between the basiptyergoid processes is approximately 60 degrees. Due to the current state of preparation on the postcranial skeleton, the amount of depositional distortion, and the incompleteness of isolated bones, species level diagnostic material is limited. Currently, there is one character that refers the specimen to *A. ajax*: the dorsal portion of the lateral distal condyle of Mt.I produces a process that contacts Mt.II. Numerous characters can be observed that make this specimen unusual. The posterior processes of the cervical ribs are long and slender, most likely extending beyond the termination of the centrum. The postzygophyseal lamina of a posterior dorsal vertebra is very prominent, similar to *Amphicoelias altus*. The proximal processes of the ulna are unequal. Comparison of the cranial material to other diplodocid specimens includes: expansion of the basiptyergoid processes is more similar to *Diplodocus* than *Apatosaurus* but may be due to depositional distortion. The absence of the basisphenoid/basiptyergoid recess suggests this character may not be diagnostic at the species level, since it can be observed in the *A. louisae* skull but not in other *A. ajax* braincases.

Student Poster Session (Thursday)

THE TAPHONOMY OF AN EARLY JURASSIC DINOSAUR BONEBED IN THE NORTHERN FREE STATE (SOUTH AFRICA).

BLACKBEARD, Marc, University of the Witwatersrand, Johannesburg, South Africa; YATES, Adam, University of the Witwatersrand, Johannesburg, South Africa

The taphonomy of a paucispecific bone-bed in the upper Elliot Formation (Early Jurassic) on the farm Spioenkop (Senekal District, Free State) is described and discussed. The bone bed was excavated, gridded and mapped by a team from the Bernard Price Institute during the 2006 and 2007 field seasons. All bones were numbered and collected. Well over 95% of the bones in this bed can be attributed to a new taxon of large (juvenile femur length = 700 mm) basal sauropod. The sauropodomorph bones can be attributed to two juvenile individuals shown by the lack of closure of the braincase and neurocentral sutures. The other taxa present are a large theropod represented by isolated tooth crowns. A partial skeleton of a *Coelophysis rhodesiensis* is present, as are isolated pterosaur bones and thyreophoran scutes. The bones are buried in an upwardly-fining lens of sand and are of limited lateral extent (6m). This package is interpreted as the fill of a small-scale channel. The bones are densely packed with 300 bones being recovered from an area of 12 m<sup>2</sup>. The bones are often lying on top of each other but there is generally no sign of articulation, or association (except for the *Coelophysis*). The lack of articulation indicates some degree of transport by water and this is supported by a preferred orientation to the long bones (strike: 301°-121°, dip: 007°S). Nevertheless, transport of the bones is likely to have been minimal, as the bones have pristine surfaces that show no sign of extended water transport, including delicate skull bones. The pristine bone surfaces, on both upper and lower surfaces, also indicate that exposure at the surface was limited. Nevertheless there is some evidence of in situ modification before final burial. A few fully buried bones were cleanly broken and ended abruptly. Highly localized bending of a few bones suggests that the site was trampled before final burial. Other signs that large theropods visited the site are shed tooth crowns and tooth-marked ribs. The agent that killed the individuals is unknown but other channels at the same level also contain bones with the same taphonomic signature and may indicate a large-scale event.

Technical Session I, Wednesday 9:45

THE OLDEST NORTH AMERICAN RODENT SKELETON: EVALUATION OF THE COMPETITION HYPOTHESIS IN PALEOCENE PRIMATE EVOLUTION

BLOCH, Jonathan, Florida Museum of Natural History, Gainesville, FL, USA; BOYER, Doug, Stony Brook University, Stony Brook, NY, USA

It has been suggested that the immigration of rodents from Asia into North America during the Late Paleocene (57 Mya) led to competition with endemic plesiadapoid primates. Evidence marshaled in support of this hypothesis includes an inverse relationship in taxonomic richness and relative abundance patterns between plesiadapoids and rodents, and similarities in body size and activity patterns. Prior to this study, paromyid postcrania were best known from Bridgerian and later taxa, with some description of earlier Eocene Wasatchian specimens. Acid etching of a late Paleocene (Clarkforkian) limestone block from the Clarks Fork Basin of Wyoming yielded an almost complete, dentally associated skeleton of a paromyid rodent, *Acritoparamys atavus*. Here we present results from analyses of diet and locomotion and compare them to recently described plesiadapoid skeletons in order to further test the rodent-plesiadapoid competition hypothesis. Measures of tooth shape derived from 3D models of teeth generated using ultra high resolution x-ray computed tomography scans, show paromyid rodents and late Paleocene plesiadapoids to be similar to each other and extant omnivorous mammals. Functional analyses of the postcranium show that Paleocene North American rodents were similar to those previously described from the early Eocene in being capable of locomotion in arboreal habitats, suggesting a behavioral shift from more primitive Asian terrestrial rodentiaforms (i.e., Alagomyidae and Eurymylidae). These results are consistent with rodent-plesiadapoid competition hypothesis and suggest that the first rodents to enter North America competed directly with arboreal plesiadapiforms for some food and habitat resources. Competition with rodents may have played a pivotal role in the evolution of primates during the late Paleocene.

Poster Session I (Wednesday)

MAMMALIAN RESPONSE TO QUATERNARY CLIMATE CHANGE IN NORTHERN CALIFORNIA

BLOIS, Jessica, Stanford University, Stanford, CA, USA; HADLY, Elizabeth, Stanford University, Stanford, CA, USA

Understanding how climatic change will affect species and communities is the main challenge facing conservation biologists today. The Quaternary fossil record has much to offer conservation biologists as the species remaining on the landscape today survived the significant Quaternary glacial-interglacial cycles and end-Pleistocene extinction event. Specifically, the Pleistocene-Holocene transition is perhaps the most relevant period to today for understanding how a combination of environmental changes such as climatic and ecosystem change, including the expansion of human populations, affect mammalian communities. In order to determine how environmental change

across the Pleistocene-Holocene transition affected mammalian communities, we initiated an excavation of a Holocene deposit within Samwel Cave in Shasta County, CA. We present an initial analysis of the Holocene mammalian community in this region and compare the Holocene fauna to late Pleistocene localities previously excavated from two caves in the region (Samwel and Potter Creek Caves). Additionally, we document changes in several small mammal species abundant in the late-Pleistocene deposits to understand how individual species responded to environmental change across the Pleistocene-Holocene boundary. Our results demonstrate mammalian community change across the boundary and within the Holocene, and provide us a powerful tool with which to predict mammalian responses to ongoing environmental change in the region.

Poster Session III (Friday)

NEW RECORDS OF FOSSIL FUR SEALS AND WALRUSES (CARNIVORA:PINNIPEDIA) FROM THE LATE NEOGENE OF NORTHERN CALIFORNIA

BOESSENECKER, Robert, Bozeman, MT, USA

While pinniped fossils are generally rare, their late Neogene record is extensive in Southern California. However, few late Neogene fossils have previously been noted farther north. New finds from Northern California yield biogeographic data and elucidate phylogenetic relationships. One such new find is a partial walrus (Pinnipedia:Odobenidae) skeleton consisting of an associated left forelimb from the latest Miocene (6.0-6.2Ma) St. George Formation near Crescent City, California. The stocky nature of these bones is matched only by a similar forelimb questionably referred to *Dusignathus santacruzensis*, from the base of the contemporaneous Purisima Formation. Analysis of this fossil indicates that previous finds questionably referred to *D. santacruzensis* actually represent at least two morphotypes of odobenids. Current knowledge of fossil odobenid postcrania is in need of revision. New fossils of *Callorhinus gilmorei* (Pinnipedia:Otariidae) from the latest Pliocene (2.48-2.01Ma) Rio Dell Formation near Scotia, California include several postcranial bones and a pair of associated dentaries. These dentaries are characterized by single-rooted p1-p2 and double-rooted p3-m1. *C. gilmorei* has previously been collected from southern California and Japan; this new record extends its range several hundred miles north. Additional bones from a late Pliocene portion of the Purisima Formation south of Half Moon Bay, California, are referred to *C. gilmorei* and an unidentified walrus. An isolated dentary from the top of the Rio Dell Formation (1.6-1.3ma) possibly represents a new early Pleistocene species of *Callorhinus*. It is characterized by single-rooted p1-p4 and a double-rooted m1. Modern otariids are characterized by possessing all single-rooted postcanine teeth, while most fossils possess double-rooted p2-m1. This specimen is morphologically and temporally intermediate between extinct *C. gilmorei* and extant *C. ursinus*. This new fossil supports the interpretation of *C. gilmorei* and *C. ursinus* as end members of a late Pliocene-Holocene lineage.

Technical Session VII, Thursday 3:15

ARE DIGITS NEOMORPHIC STRUCTURES? NEW DATA FROM FIN DEVELOPMENT IN *NEOCERATODUS*

AHLBERG, Per, Uppsala University, Uppsala, Sweden; JOHANSON, Zerina, Natural History Museum, London, United Kingdom; ERICSSON, Rolf, Macquarie University, Sydney, Australia; SUTJIA, Margareta, Hubrecht Laboratory, Utrecht, Netherlands; BOISVERT, Catherine, Uppsala University, Uppsala, Sweden; JOSS, Jean, Macquarie University, Sydney, Australia

The evolution of the digitated limbs is one of the most important events in tetrapod evolution and, despite the amount of research done on the developmental genetics involved in the patterning of the tetrapod hands and feet (autopods), most of it has been done on zebrafish and "higher" tetrapods such as mice and chicken, giving only a partial idea of what might have happened at the transition. Presence of distal elements of the fin in *Tiktaalik* as well as other sarcopterygians can be interpreted as precursor of fingers but without a clear idea of how sarcopterygians, basal actinopterygians and less derived tetrapods develop their limbs distally, the homology cannot be clearly established. *Neoceratodus forsteri* is the closest living relative of tetrapods and the only living sarcopterygian of which a research colony has been established. Clearing and staining of the developing fin of *Neoceratodus* show a developmental discontinuity between the central fin elements and the distal radials, a pattern observed in urodeles, where the digits develop prior to the elements of the palm (mesopodium) and in the earliest tetrapods like *Acanthostega* and *Ichthyostega*, having fully developed fingers but lacking wrists and most of the mesopodium. This suggests that fingers are not neomorphic structures in tetrapods but would have been derived from sarcopterygian (lobe-finned fishes) distal radials. Hoxd13 is a gene involved in polarizing the anterior to posterior (thumb to little finger) axis of the developing hand and in digital arch formation. In situ hybridizations of Hoxd13 were performed on the developing fins of *Neoceratodus* and the late phase of expression corresponds to what has been demonstrated in tetrapods and, more recently, the basal actinopterygian *Polyodon*. These data, combined with the redescription of the pectoral fin of *Panderichthys*, shed new light on the transformation of between non-tetrapodomorph fishes and tetrapods.

The Dissorophioidea - Early Amphibian Radiation Symposium, Friday 11:15  
PALATAL BICUSPID TEETH IN AMPHIBAMIDS (TEMNOSPONDYL: DISSOROPHOIDEA) FROM THE EARLY PERMIAN OF OKLAHOMA

BOISVERT, Catherine, Uppsala University, Uppsala, Sweden; AHLBERG, Per, Uppsala University, Uppsala, Sweden

The ongoing controversy over lissamphibian origins stems partly from alternative tree topologies arising from multiple "loss" features rather than positive shared, derived features. Among the numerous characters uniting modern amphibians, few are based on hard tissue structures directly observable in the fossil record. We will examine one of these, the presence and morphology of bicuspid palatal teeth, in light of new amphibamid material from the rich temnospondyl fauna of Ft. Sill, Oklahoma. Distinctly bicuspid (two cusps separated by a sulcus) marginal-jaw teeth of *Tersomius*, *Amphibamus* and *Doleserpeton* have been described in the past, but no amphibamid (or any other non-lissamphibian tetrapod) has a similar palatal dentition. A new palatine and vomers identified as *Doleserpeton* show strongly bicuspid marginal-sized teeth in situ in the usual position of "fangs"—a lissamphibian-like feature. One vomer shows a bicuspid replacement crown. A larger amphibamid (SkL=25mm) attributed to *Tersomius* but probably generically distinct shows a bicuspid palatal fang in the process of implanting. The sulcus on this tooth is much shallower than on the (smaller) *Doleserpeton* specimens, and with wear would rapidly disappear. Both findings suggest that the presence of bicuspidity may be underappreciated among amphibamids. A further complication is strong ontogenetic variation in modern amphibian teeth, where at different stages a single individual can have monocuspid conical, monocuspid bladed, and bicuspid teeth present or absent. Restriction of strongly bicuspid palatal teeth to the smallest specimens suggests a similar ontogenetic trajectory there; however, the smallest specimens could belong to distinct species. We urge caution against overly simplistic interpretations of character states in phylogenetic analysis given the state of our current knowledge.

Technical Session II, Wednesday 11:00

EVIDENCE OF SOCIAL AGGREGATION IN A PALEOZOIC BASAL SYNAPSID ('PELYCOSAU') FROM SOUTH AFRICA

BOTHA-BRINK, Jennifer, National Museum, Bloemfontein, South Africa; MODESTO, Sean, Cape Breton University, Sydney, NS, Canada

Sociality is common in living amniotes, particularly among mammals and birds. Although there is ample fossil evidence for this phenomenon from the Mesozoic and Cenozoic eras, the evolution of sociality in the earliest amniotes of the Paleozoic Era is comparatively rare. Here, we present a new specimen of varanopid 'pelycosaur', from the upper Middle Permian *Tapinocephalus* Assemblage Zone of South Africa. The specimen presented here is the fourth varanopid specimen to be collected in South Africa, and is the first to show evidence of social aggregation in a basal synapsid. The specimen is an aggregation, consisting of five articulated individuals preserved in undisturbed, close, lifelike, dorsal up, sub-parallel positions, indicating burial in 'life position'. Two size classes are represented. One is 50 percent larger than the others, is well ossified, and distinguished by a coat of dermal ossifications that covers the neck and shoulder regions. We regard this individual to be an adult. The remaining four skeletons are approximately the same size, are less well ossified, and lack dermal ossifications. We regard these smaller individuals to be juveniles. Aggregates of juvenile amniotes are usually siblings. Extant analogues of adult and juvenile groupings suggest that the adult is one of the parents, leading us to regard the aggregation as a family group.

Poster Session I (Wednesday)

AN EXTINCT PAINTED TURTLE (TESTUDINES: EMYDIDAE) FROM THE LATE PLIOCENE (BLANCAN) OF FLORIDA

BOURQUE, Jason, Florida Museum of Natural History, Gainesville, FL, USA; HULBERT, Richard, Florida Museum of Natural History, Gainesville, FL, USA; BLOCH, Jonathan, Florida Museum of Natural History, Gainesville, FL, USA

Haile 7G is a recently discovered late Blancan fossil locality in Alachua Co., Florida. The paleoenvironment is interpreted as a sinkhole lake surrounded by subtropical forest. The diverse chelonian fauna consists of (in order of abundance): *Trachemys platymarginata*, *Chrysemys* sp. nov., *Chelydra* sp., *Terrapene* sp., *Kinosternon* sp. (*baurii*-like form), *Apalone* sp., cf. *Hesperotestudo*, and *Pseudemys* sp. Preservation of entire shells is common, frequently with associated limbs, vertebrae, and skulls. A new species of painted turtle, *Chrysemys* sp. nov., is known from 27 nearly complete shells from Haile 7G, 3 with associated cranial material. The new taxon is also present at two other Florida Blancan localities (Haile 7C, Alachua Co., and the St. Petersburg Times site, Pinellas Co.). It is a small species (mean straight-line carapace length = 129.5 mm, N=5) diagnosable in having: domed carapace and ventrally bowed plastron; anteriorly projecting epiplastron with serrated gular; visceral margin of gular scale relatively long at midline, ending posteriorly in an abrupt step; nuchal moderately to highly angled at the cervical/Marginal Set 1-Vertebral 1 sulcus; and slightly expanded triturating surfaces along the lingual ridges of the mandible. The new species exhibits sexual dimorphism, with females being larger proportionately as in extant deirochelyines. Males have a lesser domed carapace and plastron, tend to be more ornamented with elongate

anteriorly projecting nuchal processes for Marginal Scute Set 1 (nuchal horns), and often have more significantly projecting, sharply dentated gular processes. Extant members of the *Chrysemys picta* complex are some of the most cold-tolerant chelonians and peculiarly absent from subtropical regions of North America, such as most of Texas and Florida. Localities with *Chrysemys* sp. nov. are all located south of the geographic range of *C. picta*. *Chrysemys* sp. nov. was likely warm-climate adapted, as it co-existed with such taxa as *Alligator mississippiensis*, cf. *Hesperotestudo*, *Tapirus* sp., *Holmesina floridanus*, *Eremotherium eomigrans*, and *Hydrochoerus* sp.

Preparators' Session, Thursday 8:30

DISCOVERY, RECOVERY AND PREPARATION OF BONES COLLECTED UNDER SALT WATER IN CAVES FROM MALLORCA (BALEARIC ISLANDS, SPAIN)

BOVER, Pere, Mammalogy/American Museum of Natural History, New York, NY, USA; GRACIA, Francesc, Grup Nord de Mallorca, Pollença, Spain; CRESPI, Marina, Dept Identitat Cultural-Seccio Arqueologia/Consell de Mallorca, Palma de Mallorca, Spain; CLAMOR, Bernat, Grup Nord de Mallorca, Pollença, Spain

Underwater galleries in caves in Mallorca (Balearic Islands, Spain) have been recently explored and excavated by cave divers. Recovery of fossil bones (mainly the Pleistocene-Holocene bovid *Myotragus balearicus*, but also late Miocene tortoises) submerged in the salt water of these narrow galleries has posed problems, not only of the excavation, but the preservation of the bones. Salt damages the bone if it's not carefully removed and fast drying can promote breakage. In this presentation we discuss the different techniques of recovery-excavation, drying, and salt elimination that we used. To date, three caves have yielded *Myotragus balearicus* bones in the salt water of flooded galleries, far from any terrestrial entrance. One, Cova Genovesa, was excavated to prevent breakage and collection of bones by tourists. Mostly surface materials were removed due to the difficulties of digging in underwater cave sediments (dangerous for both divers and bones). The recovery was accomplished by divers placing bones in plastic boxes covered with foam. The boxes were transported to the laboratory where the bones were then soaked in a series of water baths of decreasing salinity until ion concentrations reached fresh water values. Drying was accomplished by placing the bones inside plastic containers along with a small plastic container filled with water. These were covered with plastic wrap then placed in a dark and closed vault for nearly 2 months. This slow drying allowed for complete dessication of the bones without cracking. Although some experiments of consolidation where performed in wet bones with Primal (Rhoplex) AC33, the consolidation of dry bones with Paraloid B72 yielded very satisfactory results.

Poster Session II (Thursday)

2D AND 3D RETRODEFORMATION TECHNIQUES USING FINITE ELEMENT ANALYSIS WITH APPLICATION TO TRILOBITES AND *HERRERASAURUS*

BOYD, Alec, University of California, Davis, Davis, CA, USA

Almost all fossils have been deformed during burial and subsequent fossilization. Deformation can make specimens unsuitable for systematics, morphometrics and functional morphology analyses. Techniques have been created to remove this deformation from fossils. However, all of these techniques are insufficient in different ways. Most of these techniques rely on simple mathematical transformations that are strictly linear and fail to account for the presence of non-linear deformation. Other techniques use nonlinear methods by removing deformation from parts of the fossil individually but fail to recognize overall patterns of deformation. No method has yet been proposed that uses geological modeling techniques that can account for non-linear deformation. Using the method of finite element analysis (FEA) I have developed a technique that takes into account the material properties of the fossils and their surrounding matrix. This model can approximate conditions under which the fossil was originally deformed. Two-dimensional images, three-dimensional surface scans and CT scans of deformed fossils can be transformed into finite element mesh files. Using these meshes I can systematically apply forces to the fossil until the linear and/or non-linear deformation is corrected. However, great care is necessary in using this method because the Finite Element mesh model can greatly impact the outcome. I have produced methods to remove plastic deformation in both two and three dimensions. The two dimension methods were applied to tectonically deformed trilobite fossils. The three dimensional method was applied to the skull of the *Herrerasaurus ischigualastensis*. The results were promising with the majority of the tests. The deformed trilobites regained a shape that closely resembled un-deformed specimens of the same species. The *Herrerasaurus* skull mesh regained bilateral symmetry. With additional research this method has the potential to retrodeform almost any fossil.

Technical Session IX, Friday 8:15

TAXONOMIC CHIMERAS AND STRATIGRAPHIC INCONGRUENCE RESOLVED: A NEW PHYLOGENY OF THE BASAL ORNITHISCHIA

BOYD, Clint, North Carolina State University, Raleigh, NC, USA; CLARKE, Julia, North Carolina State University, Raleigh, NC, USA

Basal ornithischian relationships have remained contentious. Further, certain "hypsilophodontid" ornithopod taxa appear to disproportionately impact inference of these relationships and, strikingly, also possess the longest ghost lineages within Dinosauria. Whether these long ghost lineages reflect undersampling of the ornithischian fossil record or poor estimation of their phylogenetic relationships has remained unresolved. To address this question, all previously published characters for Ornithischia were evaluated and new characters identified to produce a dataset of more than five-hundred characters, the largest yet assembled to address basal ornithischian relationships. Taxonomic sampling was significantly increased to include four newly recognized basal ornithopod taxa from the Cretaceous of North America. Additionally, new information indicates that the terminal taxon "*Thescelosaurus*" included in prior analyses actually combined data from two distinct species. Phylogenetic analysis of the new dataset recovers novel relationships within and among the major ornithischian taxa and supports the non-monophyly of the Hypsilophodontidae and the Ornithopoda. The latter result is consistent with the findings of several recently published analyses. The topology recovered from the new analysis, when compared to previously proposed phylogenies of the basal Ornithopoda using measures of stratigraphic fit (i.e., MSM\* range, GER range, SCI), is found to be significantly more congruent with the stratigraphic record. A novel method for resolving polytomies when calculating these metrics allowed competing phylogenies containing polytomies to be fully evaluated and the preferred phylogeny accurately selected for the first time. The recognition of exceptionally long "hypsilophodontid" ghost lineages and issues encountered in estimation of the phylogenetic relationships of basal Ornithischia appear to have been the result of limited prior taxonomic sampling and the inclusion of the chimeric terminal taxon to represent *Thescelosaurus*.

Romer Prize Session, Thursday 9:30

A TEST OF THE VISUAL PREDATION HYPOTHESIS OF EUPRIMATE ORIGINS USING DIET-CORRELATED MEASURES OF TOOTH SHAPE

BOYER, Doug, Stony Brook University, Stony Brook, NY, USA

Stem members of Primates ("plesiadapiforms") can be distinguished from contemporary insectivores by their relatively low-crowned teeth reflecting a more omnivorous diet, as well as postcranial features indicating a more arboreal way of life. It has been hypothesized that a secondary shift towards reliance on the visual system to locate and catch insect prey resulted in the acquisition of features that characterize the last common ancestor of extant primates (Euprimates). If the common ancestor of Euprimates and its sister taxon, Plesiadapoidea, was omnivorous, then the teeth of the euprimate morphotype should reflect more insectivory. This hypothetical dietary shift is tested here by mapping changes in diet-correlated measures of tooth shape of fossil euprimates and stem primates onto a cladogram. A relief index (3-D crown area divided by 2-D crown area) is a form of the shearing quotient calculated without explicit assumptions regarding homology of tooth cusps and crests. This index was calculated from surface reconstructions of high resolution x-ray computed tomography scans of a sample of more than 360 lower second molars of extant and fossil primates. When grouped by diet category, distributions of logged index values from teeth of 18 species of extant prosimian primates and treeshrews (n=61) show normality. ANOVA and GT2 comparisons of means show that insectivores and folivores have significantly higher indices than omnivores, which in turn have higher indices than frugivores/gumivores and graminivores (p<0.0001). Most "plesiadapiforms" sampled plot with omnivores. Basal paromomyoids are similar to *Tarsius* and *Galago demidovii*, appearing mainly insectivorous. Basal plesiadapoids are similar to omnivores such as *Microcebus* and *Nycticebus*. Dietary proclivities at the euprimate node appear to be omnivorous, although they are difficult to reconstruct at this stage of analysis. Further, the first known euprimates in the early Eocene of North America are reconstructed as omnivores and folivores, overlapping with the plesiadapoids they replaced. This evidence does not support a dietary shift towards greater insectivory, or the visual predation hypothesis.

Poster Session IV (Saturday)

PALEONTOLOGY RESOURCE DISPOSSESSION OF THE GREAT SIOUX NATION

BRADLEY, Lawrence, University of Nebraska, Lincoln, NE, USA

The emergence of vertebrate paleontology as a steadfast, scientific discipline can in part be attributed to large vertebrate fossils found on land dispossessed from indigenous populations from around the world. Specifically, geographic locations of the North American continental interior are known to yield fossiliferous stratigraphic sequences. The Great Sioux Nation's boundaries were initially defined in the 1851 Ft. Laramie Treaty. The boundaries basically included land west of the Missouri River in South Dakota; north of the Platte River of western Nebraska; east of the Powder River Wyoming. Small areas of southeast corner Montana and southwest North Dakota were

also included. On April 29, 1868 another treaty was concluded and reaffirmed the borders for the Great Sioux Nation (GSN). I argue that vertebrate fossils are another natural resource dispossessed from the subjugated native peoples within the central plains of the United States. Throughout history valuable fossils have been collected from the GSN and used to promote museum exhibits and create university departments. Founding fathers of American paleontology built their careers with fossils taken within treaty boundaries. Recent fossil disputes between various tribes and paleontologists have a better chance of being resolved when studying the historical geography of paleontology resources. Furthermore, a comparative studies approach within Native American geography may expose indigenous paleontology resource dispossession and allow paleontology to conscientiously advance into the twenty-first century.

Technical Session IV, Wednesday 2:30

#### EXPLORING THE ORIGINS OF MICROFOSSIL BONEBEDS

BRADY, Mara, University of Chicago, Chicago, IL, USA; ROGERS, Raymond, Macalester College, St. Paul, MN, USA

The accumulation of vertebrate skeletal material in microfossil bonebeds (concentrations of predominantly disarticulated and dissociated small bones, teeth, scales, bone pebbles) is generally ascribed to either: (1) a scatological mode of formation, with bone assemblages processed by carnivores, or (2) a fluvial mode of origin, with bones and teeth sorted and deposited locally by alluvial processes. These two scenarios, which are not mutually exclusive, have guided the taphonomic interpretation of microfossil bonebeds for decades. Here we take a two-fold approach in our study of microfossil bonebeds by (1) analyzing sites found in lacustrine and fluvial facies of the Judith River Formation (JRF), and (2) conducting flume experiments in which an active flow is directed through a bed of sediment with a known component of dispersed bone material. Our study focused on 25 microfossil bonebeds in the terrestrial portion of the JRF. Fourteen of these bonebeds are preserved in facies indicative of low-energy floodbasin ponds or lakes (Type 1). The remaining microfossil bonebeds (n=11) are channel-hosted concentrations associated with basal and internal scour surfaces (Type 2). Flume experiments conducted to determine transport behavior of fossils found in the JRF sites indicate that erosional flow processes readily sort and transport common elements, and winnow fine bioclasts from the proximal end of the flume. These preliminary experiments coupled with field data indicate that Type 1 microfossil bonebeds are autochthonous and did not experience hydrodynamic sorting. Data further indicate that Type 2 bonebeds formed as remnant lags subject to fluvial winnowing. The sandstone beds that preserve Type 2 bonebeds are intercalated with facies that host abundant Type 1 bonebeds, and direct evidence of incision and reworking has been documented. Therefore, we propose that Type 2 microfossil bonebeds in fluvial facies of the JRF are not the product of piecemeal accumulation of bone material from different point sources over time, but are rather the product of local reworking and minor winnowing of preexisting Type 1 microfossil bonebeds embedded in surrounding facies.

Technical Session VI, Thursday 2:00

#### QUANTIFICATION AND PHYLOGENETIC CORRELATIONS OF SEXUAL MORPHOTYPES IN BOVIDAE (MAMMALIA)

BRAKORA, Katherine, University of California, Berkeley, Berkeley, CA, USA; PADDIAN, Kevin, University of California, Berkeley, Berkeley, CA, USA

Ecologists have long recognized that factors of morphology, ecology and behavior, including body size, feeding strategy, social structure, and sexual dimorphism, are highly correlated in bovids. Surprisingly, sexual dimorphism has never been quantified or phylogenetically evaluated in these ecological contexts. We introduce a method to quantify different types of sexual dimorphism in bovids and compare them phylogenetically and ecologically. Over 1000 adult individuals from more than 35 African bovid species were measured for horn length and basal horn circumference. Body mass data were taken from the literature. Two measures of sexual dimorphism were devised: percentage mass difference (%MD) and difference in horn volume by mass (HVD); these were plotted against maximum male mass (MMM). Multivariate analysis recovered five statistically significant groups. (1) Cape buffalo and elands had the largest average MMM, largest average %MD, and lowest HVD. (2) "Neotragines" and cephalophines had very low MMM, negative %MD, and average HVD. (3) A mainly alcelaphine group had large average MMM, low %MD, and moderate HVD. (4) A broadly polyphyletic group had smaller MMM, low %MD, and high HVD. (5) A second polyphyletic group had moderate MMM, high %MD, and very high HVD. Several phylogenetically robust clades were strongly correlated with sexual dimorphism. Extremes in both MMM and %MD were phylogenetically linked, and mid-ranges of MMM and %MD appeared in the polyphyletic groupings. All five HVD group values clustered, suggesting more discrete convergence on several types of horn dimorphism in these taxa. Differences between these quantified categories and the classic identification of five ecological "classes" in African bovids show that aspects of sexual dimorphism in body size and horn morphology evolved several times, and that phylogenetic and ecological factors are both involved. Hence, sexual dimorphism in bovids did not evolve in a single ecological or behavioral context.

Poster Session I (Wednesday)

#### PRELIMINARY INVESTIGATION ON THE ANCIENT DIETARY REGIME OF PLEISTOCENE HORSES FROM THE STATE OF HIDALGO, CENTRAL MEXICO

BRAVO-CUEVAS, Victor, Centro de Investigaciones Biológicas, Museo de Paleontología, Universidad Autónoma del Estado de Hidalgo, Pachuca, Hidalgo, Mexico; PRIEGO-VARGAS, Jaime, Licenciatura en Biología, Universidad Autónoma del Estado de Hidalgo, Pachuca, Hidalgo, Mexico

Current paleontological work in the southeastern region of the State of Hidalgo, has yielded an important assemblage of Pleistocene vertebrate remains. The fossils are derived from strata of poorly consolidated light brown clays and silts deposited in a fluvial environment. The presence of *Bison* suggests a Rancholabrean age. Isolated horse teeth are particularly abundant, and can be referred to the Pleistocene Mexican horse *Equus conversidens*. Hence, we present a preliminary investigation of the diet of this horse by examining the buccal apices of P4-M3's teeth cusps - a technique known as the extended mesowear method. We analyzed 22 upper cheek teeth in moderate wear stage, and scored the conventional mesowear variables of occlusal relief and cusp shape for each specimen. To investigate dietary regimes of the fossil horses, we employed cluster analysis with complete linkage and a comparative set of 15 extant species with dietary preferences of browser, grazer, or mixed feeder. The cluster analysis places *E. conversidens* with the grazer species *Ceratotherium simum* (white rhinoceros), *Damaliscus lunatus* (topi), *E. burchelli* (Burchell's zebra), *E. grevyi* (Grevy's zebra), and *Bison bison* (bison). Histograms of the variables evaluated show that the mesowear signature of the fossil horse population is more similar to *Bison bison* in having high low relief and blunt cusp shape score frequencies of 100% and 70% respectively. In this scenario, *E. conversidens* specimens from the Pleistocene of the State of Hidalgo would be considered grazers with a dietary regime comparable to the American plains bison. The present study provides new insight into the existence of open vegetation environments during the Pleistocene of Central Mexico.

Poster Session IV (Saturday)

#### FOOTPRINTS AND GROWTH RATES OF EMUS AND THEROPODS: ICHNOLOGICAL EVIDENCE FOR FAMILY GROUPS OF MIDDLE JURASSIC DINOSAURS IN WYOMING

BREITHAUPT, Brent, University of Wyoming, Laramie, WY, USA; GREEN, Todd, Geological Museum, Laramie, WY, USA; SOUTHWELL, Elizabeth, University of Wyoming, Laramie, WY, USA; MATTHEWS, Neffra, University of Wyoming, Laramie, WY, USA

The Red Gulch Dinosaur Tracksite and other sites within the Sundance Vertebrate Ichnofaunal Province (SVIP) preserve the activities of a monotonomic community of hundreds of Middle Jurassic (Bathonian) carnivorous dinosaurs on the shores of the ancient Sundance Sea. In the Lower Sundance Formation of the eastern Bighorn Basin, Wyoming, thousands of tridactyl pes impressions (assigned to the ichnotaxon *Carmelopodus*) are arranged into hundreds of trackways, providing evidence for the family structure and community dynamics of gregarious dinosaurs. As the result of extensive documentation and analysis, the current interpretation is that the tracks were made by primitive, tetanuran theropod dinosaurs (ranging in age from yearling to adult) traveling together and possibly exhibiting parental care. Evidence of gregarious, family groups of theropods implies proximity to a nesting area and a precocial nature for young, carnivorous dinosaurs. To better understand the meaning of the ontogenetic and behavioral implications of the fossil footprints, the tracks of modern emus (*Dromaius novaehollandiae*) have been studied. As emus have a tridactyl foot morphology similar to that of theropods, are gregarious, nest on the ground, and have precocial young, they are excellent modern analogues for studying growth and community dynamics of small- to medium-sized carnivorous dinosaurs; such as those that left their tracks in the SVIP. By collecting ichnological data from emus of various ages, growth curves for footprints have been developed and compared to previously established growth rate curves for theropod dinosaurs. By integrating these curves, the approximate ages of theropod dinosaurs represented only by their footprints can be determined for the first time. In addition, not only are emus useful in establishing the ages of extinct trackmakers, observations of their activities and the associated tracks or traces provide valuable information in the understanding of the behaviors preserved in the ichnological record of theropod dinosaurs.

Technical Session XVII, Saturday 3:15

LASER ABLATION ZIRCON U-PB GEOCHRONOLOGY OF THE CEDAR MOUNTAIN AND DAKOTA FORMATIONS OF DINOSAUR NATIONAL MONUMENT, UTAH

BRITT, Brooks, Brigham Young University, Provo, UT, USA; BURTON, Darrin, Brigham Young University, Provo, UT, USA; GEHRELS, George, University of Arizona, Tucson, AZ, USA; CHRISTIANSEN, Eric, Brigham Young University, Provo, UT, USA; CHURE, Daniel, Dinosaur National Monument, Jensen, UT, USA

Terrestrial deposits that host vertebrate faunas are difficult to date unless they contain discrete beds of volcanic ash. For example, most of the dinosaur-rich Cedar Mountain Formation of eastern Utah lacks distinct volcanic ash beds and has been notoriously difficult to date. Lacking ash beds, we used euhedral detrital zircons to obtain U-Pb ages using laser ablation multi-collector inductively coupled plasma mass spectrometry analyses of about 100 crystals/sample. This method yielded 11 ages from silty mudstone and sandstone beds from the top of the Morrison through the Cedar Mountain and Dakota Sandstone formations at Dinosaur National Monument, UT. Zircons from the top of the Morrison give an age of  $164.3 \pm 5.7$  Ma, suggesting that this unit is dominated by zircons recycled from ash beds in the Carmel Formation (Moab & Hanksville, UT & Cody, WY - give detrital zircon ages of ~148 Ma for the top of the Morrison). Samples from 2 and 6 m above the base of the Cedar Mountain Formation yield ages of  $154.5 \pm 6.3$ ,  $152.5 \pm 6.4$  -  $4.7$  that are statistically the same as previously reported 148 Ma sanidine  $^{40}\text{Ar}/^{39}\text{Ar}$  ages for the top of the Morrison. These ages corroborate lithologic evidence that the basal Cedar Mountain consists primarily of reworked Morrison regolith. A sample 10 m above the base of the Cedar Mountain gives an age of  $124.0 \pm 2.0$  -  $2.8$ , (early Aptian), matching ages for this horizon near Moab, UT. A fluvial sandstone at the base of a paleovalley fill, that we interpret to be the base of the Ruby Ranch Mbr. of the Cedar Mountain Fm., contains a new brachiosaurid sauropod and yields an age of  $116.7 \pm 1.7$  -  $2.4$  Ma. The thin basal sandstone of the Dakota Sandstone dates to  $109.4 \pm 4.7$  -  $3.5$  Ma. The middle and top of the thick, upper Dakota Sandstone bed yields ages of  $103.6 \pm 1.8$  -  $2.0$  Ma and  $97.5 \pm 1.5$  -  $3.3$  Ma, respectively. These ages indicate (1) the basal Yellow Cat Mbr is about 124 Ma, (2) the base of the Ruby Ranch Member is ~117 Ma, (3) the Cedar Mountain Fm. at Dinosaur National Monument spans ~15 Ma, and (4) in the absence of recognizable ash beds detrital zircons yield maximum depositional ages for clastic rocks that accumulate behind volcanic arcs.

Technical Session VIII, Thursday 3:45

SYSTEMATICS AND PHYLOGENETIC RELATIONSHIPS OF HOOFED CROCODILES (PRISTICHAMPSINAE)

BROCHU, Christopher, University of Iowa, Iowa City, IA, USA

Pristichampsines are deep-snouted crocodylians with labiolingually compressed (and sometimes serrated) teeth and blunt, hoof-like pedal terminal phalanges. They have sometimes been thought to represent an archosaurian attempt to remain the dominant nonaquatic predators after extinction of nonavian dinosaurs. Clade membership has been controversial, variously including fossils from throughout the Cenozoic from nearly every continent, and Eocene fossils from North America and Europe have recently been viewed as belonging to a single wide-ranging species (*Pristichampus rollinatti*). Reexamination indicates that Pristichampsinae is restricted to fossils known from the Paleocene and Eocene of North America and Eurasia, though on phylogenetic grounds the lineage must have existed since at least the Campanian. At least two distinct species (and possibly as many as five) are known from the Eocene of North America and Europe. A distinctive quadrate condyle with a prominent dorsal peak between medial and lateral hemicondyles is limited to the most derived and geologically youngest species, and although the teeth of the earliest known forms (*Planocrania*) are flattened, they are not serrated. Other fossils previously allied with Pristichampsinae are unrelated crocodyloids (e.g. the mekosuchine *Quinkana*) or known from insufficient material to allow reliable assignment to the clade. Pristichampsines were evidently not large crocodylians, and they share morphological similarities to living smooth-fronted caimans (*Paleosuchus*) and dwarf crocodiles (*Osteolaemus*), which raises questions about their presumed terrestrial predatory behavior. They currently maintain a phylogenetic position as the sister group to Crocodyloidea + Alligatoroidea, and discovery of older, more primitive pristichampsines will help resolve conflicts on the phylogenetic relationships of extant crocodylian lineages.

Poster Session III (Friday)

THE DEVELOPMENTAL PATTERNS OF SURFICIAL BONE TEXTURE ON THE SKULLS OF CENTROSAURINE DINOSAURS

BROWN, Caleb, University of Calgary, Calgary, AB, Canada; RUSSELL, Anthony, University of Calgary, Calgary, AB, Canada; RYAN, Michael, Cleveland Museum of Natural History, Cleveland, OH, USA

Distinct textures occur on the surface of many skull bones of centrosaurine dinosaurs, and are particularly well-expressed on the elements of the frill (parietals and squamosals). Initially these textures were interpreted as products of erosional water wear. More recently, several authors have suggested that they record ontogenetic processes. To

investigate texture and pattern we mapped the position and type of texture on an ontogenetic series of skulls, and characterized transitional surface topography using SEM and 3D surface reconstructions. This revealed a distinct and consistently transgressive pattern of textural distribution, from juvenile "long-grained texture" to "mottled" and "adult texture", suggestive of sequential bone remodeling in association with growth and expression of cranial ornamentation. Putative sub-adult skulls (of intermediate size) exhibit a co-occurrence of both "long-grained" and "mottled" texture, often segregated by a distinct and step-like contact. Sub-adult skulls reveal two areas on the parietal at which textural transition occurs. Firstly at the dorsal surface of the midline parietal bar, isolated patches of the "mottled texture" develop, corresponding to the position of midline scallops, and disrupt the "long-grained texture". These "islands" start at the anterior aspect of the parietal bar and progress posteriorly, increase in size, and eventually coalesce to form a continuum in the midline. This conjoined pattern subsequently expands laterally. Second, bordering the lateral and dorsal margins of the parietal fenestrae the "mottled texture" appears to originate as a continuous area, expanding as a front, both laterally and posteriorly. Both of these trends appear to continue until the "long-grained texture" is replaced by "mottled" and "adult texture" across the entire element. This pattern of development of surficial bone texture provides new insights into the investigation of ceratopsian cranial ontogeny, from both systematic and ecological standpoints.

Preparators' Session, Thursday 12:00

BASIC PRINCIPLES OF CONSERVATION AND THEIR APPLICATION TO PALEONTOLOGICAL COLLECTIONS: PREPARATION AND COLLECTION CARE WITH PURPOSE

BROWN, Gregory, University of Nebraska State Museum, Lincoln, NE, USA

Paleontology is perhaps the last collection-based discipline to fully embrace the principles of conservation. Within traditional museum settings, it is unlikely that a curator, collection manager or preparator will have formal conservation training, but that fact should not prevent them from adopting a conservation-minded approach to preparation and collection care. To do so, however, they must understand the basic principles of conservation. Both paleontologists and conservators view fossils as objects that contain valuable data, however their treatment strategies and goals are not identical. A preparator's principle goal is to expose and stabilize the object, making it, and its data, available for research, education or display, but it is important to understand that virtually every preparation technique we employ can also *destroy* data. A conservator's principle goal is to preserve, with as little alteration as possible, an object and *all* of the data contained within. A fundamental premise of conservation is that objects (and collections) degrade in response to specific agents of deterioration. These agents include physical forces, improper temperature and humidity, light and contamination, among others. Ideally, limiting deterioration and damage to a specimen should be accomplished by controlling the agents of deterioration (preventive conservation) rather than by altering the specimen itself (interventive conservation). If interventive treatment is necessary, the techniques and materials used should alter the specimen as little as possible and be fully documented. By selecting preparation and collection care techniques and materials based upon sound conservation principles, preparators can minimize data loss and maximize the long-term stability of the fossil as well as its future research value.

Preparators' Session, Thursday 11:30

DAWN OF THE DINOSAURS: DESIGN, CONSTRUCTION, AND INSTALLATION OF A TRIASSIC PALEONTOLOGY EXHIBIT HALL

BROWN, Matthew, Petrified Forest National Park, Petrified Forest, AZ, USA; PARKER, William, Petrified Forest National Park, Petrified Forest, AZ, USA; WILLIAMS, T., Petrified Forest National Park, Petrified Forest, AZ, USA; DORN, Karen, Petrified Forest National Park, Petrified Forest, AZ, USA

Petrified Forest National Park preserves an amazing assemblage of vertebrates, invertebrates, and plants from the Upper Triassic Chinle Formation. Recent iterations of exhibited material in museums and visitors centers included elements of text and graphics last updated in the 1980s and 1990s, some of which was grossly inaccurate, and very few adequately explained the diversity of ancient life present in the park. Modernization of the exhibits space was therefore critical to expand the park visitor's education and entertainment experience, and to satisfy our conscience as scientists. Primarily utilizing existing resources, the challenge was to complete this project as quickly and at as low a cost as possible, while maintaining professional output and a high standard of accessible scientific content. All exhibits were designed to be quickly and easily updated as the scientific information changes. Display cases were mounted on the walls describing the taxa preserved in the park using a combination of text, graphics, cast and real fossil elements. Graphics design and hall layout were accomplished with popular computer software packages and case backgrounds and interpretive panels were printed on our departmental plotter. Existing skeletal mounts were accentuated with the construction of a landform to elevate the animals and arrange them into a more attractive tableau. Installation took place in phases, so that the muse-

um could remain open with limited disruption to visitors. A high level of enthusiasm and personal interest in the project ensured that we met our goals within 3 months of the plan being approved.

Technical Session XIV, Saturday 10:45

PHYLOGENY OF ALLOSAUROIDEA (DINOSAURIA: THEROPODA): NEW ANALYSIS, COMPARISONS, AND SOURCES OF DISAGREEMENT

BRUSATTE, Stephen, University of Bristol, Bristol, United Kingdom; SERENO, Paul, University of Chicago, Chicago, IL, USA

Allosauroidae, a large-bodied clade of theropod dinosaurs ranging from the Middle Jurassic to the Late Cretaceous, has been the subject of several phylogenetic studies that have reached little consensus. We present a comparative cladistic analysis that attempts to integrate data from previous studies with new characters revealed by the description of several new allosauroid taxa from Africa and South America and the redescription of *Neovenator salerii* from the Early Cretaceous of England. First we review twelve previous studies of allosauroid phylogeny and discuss areas of topological disagreement. Second we compare our dataset to those of previous studies and evaluate the degree of overlap using novel comparative metrics that quantify shared character data. Our comparisons show that scoring differences, character choice, and taxonomic sampling are all major sources of incongruence. Importantly, numerous scoring differences highlight currently conflicting observations that must be resolved. Then we evaluate the status of the current understanding of allosauroid phylogeny and discuss the importance of rigorous comparative techniques in studies of dinosaur phylogeny. Finally we present our new analysis, based on 102 characters scored in 10 ingroup taxa, which represents the most extensive analysis of allosauroid phylogeny yet undertaken. The analysis strongly supports positioning *Sinraptor* as the basal-most allosauroid, *Neovenator* as the basal-most member of Carcharodontosauridae, and *Acrocanthosaurus* as a derived member of Carcharodontosauridae rather than a close relative of *Allosaurus*. This topology shows a strong overall match with the stratigraphic record, and cladistic biogeographic analysis suggests that the distribution of allosauroids is congruent with the breakup sequence of Pangaea.

Poster Session III (Friday)

A TECHNIQUE USING A SODIUM HYPOCHLORITE (BLEACH) SOLUTION TO REMOVE LICHEN FROM VERTEBRATE TRACK SURFACES

BUCKLEY, Lisa, Peace Region Palaeontology Research Centre, Tumbler Ridge, BC, Canada; MCCREA, Richard, Peace Region Palaeontology Research Centre, Tumbler Ridge, BC, Canada

Vertebrate ichnological specimens that have been exposed in the field for long periods of time may be covered with extraneous biological material (cyanobacteria, bryophytes, lichen, etc.). In the alpine regions of northeastern British Columbia it is not uncommon to find fossil vertebrate track specimens covered with lichen. Removal of the lichen is necessary to complete the detailed studies of track features, but the process of removal must not be detrimental to the track surface. A non-destructive technique was developed to remove lichen from a consolidated fine-grained sandstone surface containing natural casts of small theropod prints and several small avian prints using a sodium hypochlorite solution (bleach). A modified "solvent-soak method" was used by applying the bleach solution (1:1 household bleach to distilled water by volume) to the area of the track surface encrusted with lichen and covering the treated area with plastic wrap to prevent the solution from evaporating. After removing the plastic a small amount of mechanical action with a toothbrush dislodged any lichen remnants that had not been broken down by the bleach. The bleach and lichen residues were then rinsed from the track surface using liberal amounts of distilled water and the slab was allowed to dry. Many more avian prints and two more theropod prints became visible after the lichen was removed. Furthermore, some of the theropod tracks were found to contain patches of very fine skin impressions that were not previously visible due to the lichen cover. No ill effects were observed on the specimen shortly after treatment. In the year and a half since the initial treatment there have been no deleterious effects observed on the specimen. It is unknown what effects this treatment would have on other footprint specimens or on other types of fossil specimens with lichen encrustations (i.e. skeletal remains). As with any chemical treatment, it is recommended that a small test area be treated before this technique is used on any fossil specimen to ensure the treatment is non-damaging.

Ernie Lundelius Symposium (Faunal Dynamics and Extinction), Wednesday 9:30  
MAMMALIAN FAUNAL DYNAMICS IN LATE PLEISTOCENE ALBERTA, CANADA: "I KNOW THEY CAME THIS WAY, WHICH WAY DID THEY GO?"

BURNS, James, Royal Alberta Museum, Edmonton, AB, Canada

As a conduit for the passage of faunal and human species into the New World, the much-abused concept of the "Ice-free Corridor" has served its purpose. The corridor concept has had an important bearing on discussions of zoogeography and paved the way for theories about the recolonization of North America by mammalian species from Asia. The province of Alberta—situated along the eastern slopes of the western Cordillera adjacent to the northern Great Plains—was long hailed as the ideal route for

late Pleistocene migrations into the New World's heartland. Yet, a temporal hiatus in the large suite of bone and wood dates from central Alberta indicates that no corridor could have existed during the full-glacial, from about 22,000-12,000 y BP. DNA, isotopic, and other studies of equids, bovids, cervids, ursids, mustelids and others confirm that, through time, a two-way traffic of animals flowed through Alberta. Mid-Wisconsinan examples of disharmonious faunas in Alberta emphasize movements from both south and north, reflecting the absence of ice sheets during that interstadial. Migrations during the Last Glacial Maximum, on the other hand, were precluded because the Cordilleran and Laurentide ice masses had coalesced to cause total closure of the corridor. Finally, with the postglacial reopening of the passage, late-surviving proboscideans, ovibovines, horses and camels—facing imminent extinction by agency or agencies still poorly understood—formed a northwesterly bound megafaunal vanguard. Simultaneously, a thriving population of moose and wapiti drove southward from Beringia towards mid-continent.

Student Poster Session (Thursday)

IDENTIFYING ANKYLOSAUR TAXA USING OSTEODERM MORPHOLOGY

BURNS, Michael, University of Alberta, Edmonton, AB, Canada

Osteoderms have been used in the past to identify some fossil reptile and non-reptile taxa. However, although it has been suggested as a possible way to identifying some dinosaurs, specifically ankylosaurs (nodosaurids and ankylosaurids), to date this has not been adequately tested. Despite the fact that some osteoderm shapes are similar among genera, all dorsal osteoderms from a single taxon are likely to have similar surface texture. A new specimen (SMP VP-1580), identified as the nodosaurid *Glyptodontopelta mimus*, was collected from the Naashoibito Member, Ojo Alamo Formation, San Juan Basin, New Mexico (SMP VP-1580). This specimen consists of numerous osteoderms of various sizes and shapes from different dorsal region of the body. Thus, it allows for the comparison of osteoderm shape and sculpturing within a single individual as well as among different ankylosaur taxa. The nodosaurid *Edmontonia australis* Ford, 2000, also from the Naashoibito Member, is considered a subjective junior synonym of *G. mimus* based on having the same surface texture and shape of the medial cervical osteoderms. The Stegopeltinae remains equivocal because the removal of *G. mimus* coupled with the uncertain familial assignment of *Aletopelta coombsi* would make the subfamily redundant. The armor of *G. mimus* has a unique dorsal surface texture characterized by a pronounced dendritic pattern along with irregular pits and pores. This differentiates it from other Upper Cretaceous ankylosaurids (*Ankylosaurus*, *Euoplocephalus*, and *Nodocephalosaurus*) and nodosaurids (*Edmontonia* and *Panoplosaurus*). Osteoderm sculpturing of *Ankylosaurus* is very smooth (lacking pits and pores) usually with a weak dendritic pattern. *Euoplocephalus* and *Nodocephalosaurus* generally have rugose armor without dendritic patterns. The surface texture of *Edmontonia* lacks the characteristic sculpturing of *G. mimus*, and the armor of *Panoplosaurus* is moderately rugose, also lacking a dendritic pattern. Ankylosaur osteoderms are distinctive to at least the genus level and are commonly found in Upper Cretaceous strata, thus they have great biostratigraphic utility.

Technical Session IX, Friday 9:00

PALEOENVIRONMENTAL CONTROLS ON THE DISTRIBUTION OF CRETACEOUS HERBIVOROUS DINOSAURS

BUTLER, Richard, The Natural History Museum, London, United Kingdom; BARRATT, Paul, The Natural History Museum, London, United Kingdom; KENRICK, Paul, The Natural History Museum, London, United Kingdom; PENN, Malcolm, The Natural History Museum, London, United Kingdom

Most attempts to assess paleoenvironmental preferences for dinosaurs have assessed distribution within a single formation. Here we use a global relational database of Cretaceous herbivorous dinosaur occurrences to test hypotheses of broad environmental preferences at the level of supraspecific clades. This database is part of a broader project on Cretaceous dinosaur and plant distribution; currently it contains geographic, taxonomic, geological and paleoenvironmental data for c8500 dinosaur and plant occurrences at 1750 localities. The current analyses utilized a query containing the dinosaur occurrences (1790) and associated environment and taxonomic information. The detailed environmental data was simplified into broad depositional categories of marine (6% of localities), coastal (12%), terrestrial (75%) and unknown/ambiguous (7%). Chi-squared tests were used to test specific hypotheses of associations. A significant positive association was found between Nodosauridae and marine depositional environments ( $p=0.005$ ); by contrast, their sister-clade Ankylosauridae are positively associated with terrestrial environments ( $p=0.05$ ). The overrepresentation of nodosaurid specimens in marine environments suggests that they occupied a broader environmental range, including coastal areas, than did ankylosaurids. Hadrosaurids are overrepresented relative to other herbivores in marine environments ( $p=0.001$ ), consistent with suggestions that they preferred coastal plain environments. However, existing evidence does not support the hypothesis that hadrosaurine hadrosaurs were more abundant in marine sediments than lambeosaurines. Both ceratopsians and pachycephalosaurs show positive associations ( $p=0.005$ ) with terrestrial environments, supporting interpretations of inland environmental preferences. Sauropods show little evidence for broad environmental associations; a significant negative association between



Macronaria and coastal environments may be a result of taphonomic processes. Our results provide quantitative support for previous qualitative hypotheses of paleoenvironmental preferences, emphasizing the potential of large databases in broad paleoecological analyses.

Poster Session I (Wednesday)

THE OLIGOCENE ERYCINE SNAKES, *OGMOPHIS* AND *CALAMAGRAS*: NEW MATERIAL CLARIFIES VERTEBRAL-FORM SPECIES.

CALDWELL, Michael, University of Alberta, Edmonton, AB, Canada; BREITHAAPT, Brent, University of Alberta, Edmonton, AB, Canada; BAMFORTH, Emily, Queens University, Kingston, ON, Canada

The modern boiine subfamily Erycinae is represented by three genera of small, semi-fossorial snakes with blunt heads and tails. Based on the number of extinct species assigned to the Oligocene-Miocene genera *Ogmophis* and *Calamagras*, it would appear that erycine diversity was significantly higher in the middle part of the Cenozoic. *Ogmophis* and *Calamagras* contain twelve species (six each), defined and diagnosed on the basis of subtle features of vertebral morphology; all of these vertebral characters are recognized from isolated vertebrae. Recognizing the problems inherent in the naming and diagnosis of form taxa, we have attempted to clarify the distinctions between these two genera and twelve species by comparisons to the vertebral variation present in three articulated erycine skeletons found in sediments of the White River Formation (Oligocene) outcropping near Douglas, Wyoming. These three specimens present the vertebral variation of all species of *Ogmophis* and *Calamagras* such that it is clear that *Calamagras* species appear to be diagnosed using anterior trunk vertebrae, while *Ogmophis* species are diagnosed based on posterior trunk vertebrae. At this point, it is clear that these two genera are no distinct from each other than are the different parts of the vertebral column within one individual Oligocene erycine. We recommend that *Ogmophis* be considered the junior synonym as *Calamagras* has priority. While significant problems remain in determining the generic distinction of Miocene species such as *Ogmophis micropactus* it is clear from our current study that the 'hibernaculum' assemblage from the Wyoming White River Formation, can be considered as *Calamagras*; assignment of these three specimens to a new species is likely warranted as the diagnoses provided by existing species fall short of characterizing the complete and articulated erycines present on this block.

Student Poster Session (Thursday) (Thursday)

ON A POSSIBLE NEW COMAHUESUCHIDAE (CROCODYLIFORMS) FROM THE LATE CRETACEOUS PORTEZUELO FORMATION, PATAGONIA

CALVO, Jorge, Centro Paleontológico Lago Barreales, Universidad Nacional del Comahue, Neuquén, Argentina; SANTOS, Domenica, Centro Paleontológico Lago Barreales, Universidad Nacional del Comahue, Neuquén, Argentina; PORFIRI, Juan, Centro Paleontológico Lago Barreales, Universidad Nacional del Comahue, Neuquén, Argentina; KELLNER, Alexander, Museu Nacional/UFRJ, Rio de Janeiro, Brazil

The Futalognko site, located at the northern coast of the Barreales Lake some 90 km northwest of the Neuquén City (Neuquén Province, Argentina), has yielded a large quantity of fossils, from giant dinosaurs to delicate fossilized fishes and leaves, making this one of the most interesting fossil *lagerstätte* from South America. Among the hundreds of specimens recovered from the outcrops of the Portezuelo Formation (Late Turonian -Lower Coniacian) in the last years is a very unusual crocodylomorph lower jaw, which is reported here. The material consists of an incomplete right dentary. Five small alveoli followed by a large "caniniform" tooth are preserved. The latter shows several denticles. In lateral view, the alveoli of the smaller teeth are positioned at a lower level compared to the larger tooth. The overall shape indicates that the Barreales specimen represents a Notosuchia. Up to date, this clade is represented in Cretaceous deposits of Patagonia by Notosuchidae, Araripesuchidae and Comahuesuchidae. The dentition the new specimen is more similar to *Comahuesuchus brachybuccalis*, the only member the Comahuesuchidae. From the preserved portion it is clear that the lower jaw was rather broad, an unusual condition among crocodyliforms also found in *Comahuesuchus*. The new specimen differs by having the dentary less sculptured, slightly twisted, more elongated ventrally. It further shows a thin lateral bone lamina that separates the lateral from the ventral margin and distinct ridge on the larger tooth. The features presented above suggest that the Barreales specimen represents a new species that is closely related *Comahuesuchus brachybuccalis*.

Poster Session III (Friday)

ANATOMY OF THE ATLAS-AXIS COMPLEX OF HADROSAURID DINOSAURS

CAMPIONE, Nicolas, University of Toronto at Mississauga, Mississauga, ON, Canada; EVANS, David, Royal Ontario Museum, Toronto, ON, Canada; CUTHBERTSON, Robin, University of Calgary, Calgary, AB, Canada

Morphology and variation in the atlas-axis complex of Hadrosauridae is poorly understood and has only been fully described in a few taxa. Given the cranial variability in hadrosaurids, the atlas-axis complex is expected to show intertaxic variation that may provide insight into the functional morphology and evolution of this structure. The

atlas is composed of a semi-lunate intercentrum, a pleurocentrum and paired neural arches. Ventrolaterally, the intercentrum has two small depressions that represent the parapophyses for an atlantal rib, as preserved in articulation in several specimens of hadrosaurines and lambeosaurines. The axis has a craniocaudally broad spine, and two morphotypes can be recognized: 1) Lambeosaurines exhibit the plesiomorphic morphology exemplified by *Iguanodon* and *Bactrosaurus*, in which a dorsally convex spine extends beyond the cranialmost region of the postzygapophyses; 2) several hadrosaurines (e.g. *Brachylophosaurus*) exhibit an apparently derived morphology of the axis neural spine, in which the lateral view is characterized by a cranial craniocaudally elongate protuberance, separated from the postzygapophyseal region by a prominent embayment. Interestingly, *Gryposaurus incurvimanus*, suggested to be a basal hadrosaurine, lacks this embayment and more closely resembles the plesiomorphic condition, although spine shape is variable and a larger sample size is still needed to confirm these patterns of variation. Recent publications conflict with regards to the presence or absence of ribs on the first two cervical vertebrae. This study confirms the presence of atlantal and axial ribs in Hadrosauridae. In all cases, the atlantal rib is single-headed, elongated, mediolaterally compressed and is the longest rib in the cranial half of the cervical series (approx. 10% longer than the axial rib). A dicephalic rib also articulates with the axis, and is observed in various hadrosaurids. The presence of atlantal and axial ribs in Hadrosauridae is consistent with the condition in *Iguanodon*, and the plesiomorphic archosaurian condition.

Poster Session IV (Saturday)

THE SMALLEST ASSOCIATED SKULL AND POSTCRANIAL BONES OF A JUVENILE TYRANNOSAURID (THEROPODA: COELUROSAURIA) FROM THE HELL CREEK FORMATION (UPPER MAASTRICHTIAN) OF SOUTH-EASTERN MONTANA

CARR, Thomas, Carthage College, Kenosha, WI, USA; DE SANTIS, Chris, Dinosaur Discovery Museum, Kenosha, WI, USA; WOJAHN, Alison, Carthage College, Kenosha, WI, USA; BROWN, Christy, Carthage College, Kenosha, WI, USA; OGLE, Adam, Carthage College, Kenosha, WI, USA

On July 26, 2006 associated bones (left frontal, partial radius (?), right tibia, pedal phalanx) of a small tyrannosaurid, Dinosaur Discovery Museum (DDM) 35, were collected from the Hell Creek Formation. The specimen was found during the joint Carthage College-DDM paleontological expedition to federally regulated lands in Carter County, Montana. This specimen is scientifically significant because it is the smallest tyrannosaurid specimen from the Hell Creek Formation represented by associated cranial and postcranial bones. The frontal bone is identified as a tyrannosaurid based on these diagnostic characters: a small contribution of the frontal to the orbital fenestra, an extensive dorsotemporal fossa on the dorsal surface of the bone, a long joint surface for the postorbital, and a long sagittal crest. The frontal is different from larger examples in that (1) the joint surface for the lacrimal is a shallow, dorsally facing facet; (2) the joint surface for the prefrontal is positioned rostrally; (3) the contribution to the orbital fenestra is long; (4) the joint surface for the postorbital is a series of laterally-facing slots that does not extend onto the dorsal surface of the bone; (5) the postorbital buttress, an abutting joint surface, is not differentiated from the joint surface; (6) the sagittal crest is a low ridge; (7) the laterosphenoid suture extends caudolaterally; and (8) the parietal suture is deeply concave between the lateral and medial edges of the bone. The small size of the specimen, the subdued expression of several features, and characteristics shared with juvenile tyrannosaurids, indicates DDM 35 is a small juvenile. Although the rostral end of the frontal is incomplete, the preserved portion indicates the nasal process was narrow, which is the condition in tyrannosaurines. Although the frontal does not possess any diagnostic characteristics of *Tyrannosaurus rex*, it is most parsimonious, based on the known Hell Creek fauna, to refer DDM 35 to cf. *Tyrannosaurus rex*.

Poster Session I (Wednesday)

THE EARLY BLANCAN - IRVINGTONIAN GLYPTODONTS FROM CENTRAL MEXICO

CARRANZA-CASTEÑEDA, Óscar, Universidad Nacional Autónoma de México, Queretaro, Mexico

Glyptodonts have been known in central Mexico since 1875, when *Glyptotherium mexicanus* was described from Pleistocene deposits of Valle de Mexico. In the following years, *G. cylindricum*, another valid Pleistocene species, was described from Ameca Jalisco. Recent fieldwork in 3.3 - 3.6 Ma strata in the San Miguel Allende basin yielded new glyptodont material. A fragment of a carapace was recovered at locality GTO 47, Arroyo Belén, and an almost complete carapace was recovered from locality GTO 86, Arroyo del Gliptodon. In both specimens the scutes and dentition resemble those of *G. texanum* from the late Blancan of Cita Canyon, Texas. A third locality in the Coecillos area, locality GTO 78, Arroyo de Emilio, yielded a shield and jaw of a single glyptodont individual. The dentition n/1 is ovoid, n/2 submolariform, in n/3 the anterior lobe is not quadrangular, and n/4-n/7 are trilobulate. The scutes are small with fused sutures. In the dorsal region the scutes are hexagonal and they are more square or pentagonal in the lateral rows. In the caudal notch eight scutes of pyramidal shape cover the aperture. The central structure and peripheral figures are almost the same size

as the more dorsal scutes. In the marginal row the central figure is always bigger. The central figure is weakly concave in the centrum and always raises over the peripheral figures, which are 6-8 in number but 8 is more common. The grooves between the peripheral figures are shallow, three or four hair foramina are constantly present. This specimen is referred to the *G. floridanum* and its age is considered as Irvingtonian age based on its concurrence with *Equus* and *Thomomys*. In the Tecolotlán basin, Jalisco, a large sample of isolated scutes and fragments of shields of glyptodonts are known. These scutes are similar to those of *G. cylindricum*. The central figure is always bigger than the peripherals, the number of peripheral figures are 9 or 12. The peripheral figures in the marginal scutes are not well differentiated from each other. The age of the fauna ranges from late Blancan to Irvingtonian.

Student Poster Session (Thursday)

#### TOOTH STRUCTURE FUNCTIONALITY OF TYRANNOSAURUS REX VS. CROCUTA CROCUTA

CARROLL, Nathan, Ekalaka, MT, USA

Many Late Cretaceous theropods possessed laterally compressed, knife-like teeth suitable for shearing or scraping flesh from bone. In contrast, the high bite-force (6410-13,400 N) of the long, sub-ovoid *Tyrannosaurus rex* teeth are hypothesized to have crushed or fractured bone upon impact. However, the majority of confirmed *T. rex* bite marks are punctures inconsistent with bone crushing. The causes of bone fractures in the fossil record are difficult to identify as predation marks or otherwise. Therefore, simulating predation marks allows for a better understanding of the bone crushing ability of *T. rex* teeth. Among modern taxa, the spotted hyena (*Crocuta crocuta*) differs markedly from other carnivores. The high bite force and short conical teeth provide the efficient bone crushing necessary for increasing surface area that facilitates digestion. Actualistic experiments allow comparison of bite impact of spotted hyena and *Tyrannosaurus rex* teeth, thus allowing examination of functional morphology of their respective dentition. A bronze-cast of the right maxillary and dentary of a *T. rex* and the maxillary and mandible of a spotted hyena were used to simulate bite marks on extant bovine bones, encased in flesh. The bronze cast of the *T. rex* and hyena teeth were positioned for proper jaw-alignment and placed in a hydraulic apparatus designed to exert a force of 11,120 N. Comparison of bone damage between the fossil and extant taxa revealed that the hyena teeth produced numerous bone splinters, the largest fragments not exceeding two centimeters in size. Conversely, *T. rex* teeth provided little to no bone fracturing that resulted in small bone fragments. The majority of simulated *Tyrannosaurus rex* bite marks produced punctures rather than bone crushing and closely match hypothesized predation marks reported in the fossil record. Bone breakage, if present, resulted in shearing of the bone into two separate pieces and rarely produced fractured bone debris. The results of these experiments suggest that the functional morphology of *T. rex* teeth differs from that of the spotted hyena and the structure of the teeth were not adapted for bone crushing.

#### The Dissorophoidea - Early Amphibian Radiation Symposium, Friday 8:00 DISSORPHOIDS AS A UNIQUELY INFORMATIVE MODEL FOR THE STUDY OF PATTERNS, PROCESSES, AND RATES OF VERTEBRATE EVOLU- TION

CARROLL, Robert, McGill University, Montreal, QB, Canada

Dissorophoids are among the most anatomically diverse and speciose of Paleozoic tetrapods. The small body size of the species at the base of all lineages results in exceptional flexibility of anatomy and behavior leading toward each of the divergent families. Thousands of fossils of larval branchiosaurids and micromelerpetontids provide an unparalleled record of development from hatchlings to maturity, demonstrating the influence of ontogeny on the evolution of adult characters. Branchiosaurids' uniquely slow sequence of skull ossification forms the basis for the origin of the adult cranial morphology of Jurassic and modern salamanders. The unique capacity for genetic manipulation of the timing and sequence of ossification of individual bones is also reflected in the great diversity of dermal armor among the dissorophids. Such heterochrony may also apply to the disjunct appearance of pedicellate teeth in branchiosaurids and amphibamids. Dissorophoids also document the capacity for alternative modes of transforming at maturity, from progressive changes leading to primarily terrestrial adults to conspicuous metamorphic transformation, or remodeling of larval structures that are retained in obligatorily aquatic adults. All of these capacities are also expressed in modern salamanders. The rapid sequence of appearance of dissorophoid lineages in the fossil record and the convergent expression of similar derived characters make it difficult to establish the specific timing and sequence of divergence. Their phylogeny gives the appearance of a bush, with many small stems, rather than a well-defined tree, which may be a common feature among rapidly radiating groups with a fairly complete fossil record.

Poster Session III (Friday)

#### AMPHIBIAN PALEOCOMMUNITIES AS ECOLOGICAL INDICATORS DURING THE LAST 2 MILLION YEARS OF THE CRETACEOUS IN NORTH-EASTERN MONTANA

CARTER, Grace, Denver Museum of Nature & Science, Denver, CO, USA; WILSON, Gregory, Denver Museum of Nature Science, Denver, CO, USA; PIEKARSKI, Thomas, Denver Museum of Nature & Science, Denver, CO, USA; POLTENOVAGE, Michael, Denver Museum of Nature & Science, Denver, CO, USA

The Hell Creek Formation in Garfield County, Montana represents a key study system for understanding changes in terrestrial paleoecology leading up to the Cretaceous-Tertiary (K-T) boundary. Lithostratigraphic, magnetostratigraphic, and radiometric data have been integrated into a temporal framework for the Hell Creek Formation. The framework provides an estimated duration of 2.1 million years for the local deposition of the formation and a local K-T boundary at the Hell Creek-Tullock formation contact. Fieldwork has yielded over 85 fossil localities in local Hell Creek exposures. They span much of the 93-meter thickness of the section and have been tied into the temporal framework based on stratigraphic positional data. Surface collecting and screenwashing from these localities have recovered a large sample of microvertebrate fossils. The resulting temporally constrained succession of microvertebrate fossil assemblages may be used to infer paleocommunity dynamics leading up to the K-T boundary and test causal hypotheses of the extinction event. Previous work has focused on turtle, mammal, and plant communities leading up to the K-T boundary. However, amphibians, with their biphasic lifecycle, are commonly considered ecological indicators that reflect the overall health of an ecosystem. As such, they represent excellent models for examining ecological dynamics during the last two million years of the Cretaceous. Our database of Hell Creek amphibians consists of 250 catalogued specimens identifiable to genus. With this database, we have tracked patterns of paleocommunity structure, including taxonomic composition, richness, and relative abundances, through the formation. Preliminary results suggest that taxonomic composition changed little through the Hell Creek Formation, but relative abundances of some taxa (e.g., *Habrosaurus*, *Opisthotriton*) fluctuated during the last 500 ky of the Cretaceous. These changes are correlated with a warming trend or related climatic factors suggested by proxies. Nevertheless, there is no statistically significant evidence for declining ecosystem health leading up to the K-T boundary at current temporal resolution and sample sizes.

Poster Session IV (Saturday)

#### FIRST RECORD OF DROMAEOSAURIDAE (DINOSAURIA: THEROPODA) IN THE EARLY LATE CRETACEOUS BAJO BARREAL FORMATION OF CHUBUT PROVINCE, ARGENTINA

CASAL, Gabriel, Universidad Nacional de la Patagonia, Comodoro Rivadavia, Argentina; MARTÍNEZ, Rubén, Universidad Nacional de la Patagonia, Comodoro Rivadavia, Argentina; CANDEIRO, Carlos Roberto, Centro Universitário do Planalto do Araxá, Araxá, Brazil; LAMANNA, Matthew, Carnegie Museum of Natural History, Pittsburgh, PA, USA; IBIRICU, Lucio, Drexel University, Philadelphia, PA, USA

We report three teeth of dromaeosaurid theropods that constitute the first record of these dinosaurs in the Upper Cretaceous Bajo Barreal Formation of central Patagonia, Argentina. The teeth were recovered from the highest levels of the early Late Cretaceous (Cenomanian-Coniacian) Lower Member of the Bajo Barreal at the Estancia "Ocho Hermanos" in southern Chubut Province. The teeth are labiolingually compressed with curved mesial and distal carinae. In lingual view, the distal carina is rotated near its apex. Denticles are present but very fine on the distal carina, averaging 19 per 5 mm near its basoapical midpoint, and are absent on the mesial carina. The distal denticles are oriented perpendicular to the distal edge of the crown, and, as seen in labial view, are quadrangular in shape, measuring an average of 0.35 mm long by 0.40 mm wide. The denticles are even smaller toward the base of the crown, and are projected toward its apex. A series of wrinkles or concave undulations crosses the entire surface of the base of each crown. These structures occur on both the labial and lingual faces of each tooth, although they are better developed on the lingual face. The labiolingual section at the base of the crowns is characterized by its subrectangular form. The general morphology of the teeth and denticles is very similar to that described in the dromaeosaurid *Dromaeosaurus albertensis* from the Late Cretaceous (Campanian) of western North America. These teeth demonstrate the presence of Dromaeosauridae in the Bajo Barreal Formation, and supplement the record of these theropods in Argentine Patagonia during the Late Cretaceous. Moreover, the presence of Dromaeosauridae in the Bajo Barreal broadens the paleogeographic distribution of the clade, as it represents the most southerly occurrence of these theropods in South America. The nonavian theropod fauna of the Bajo Barreal Formation is now one of the most diverse known from the Southern Hemisphere, comprising abelisaurids such as *Xenotarsosaurus bonapartei* alongside a *Megaraptor*-like primitive tetanuran, the coelurosaur *Aniksosaurus darwini*, and the highly derived Dromaeosauridae.

Technical Session XV, Saturday 9:15

MAMMALS FROM RED OWL QUARRY, FOX HILLS FORMATION, SOUTH DAKOTA: AN "EDMONTONIAN" LOCAL FAUNA?

CASE, Judd, Eastern Washington University, Cheney, WA, USA; MARTIN, James, South Dakota School of Mines & Technology, Rapid City, SD, USA

Mammals from the Fox Hills Formation have been known for four decades and have been regarded as a Lancian-aged assemblage even though the Fox Hills Formation underlies both the Lance and Hell Creek Formations. Analysis of this local fauna indicates that marsupial taxa present are not the typical Lancian species and may in fact be the progenitors of the Lancian marsupial species. From Red Owl Q. comes a herpetotheriid marsupial, which is more plesiomorphic in its dental morphology than the widespread Lancian genus *Nortedelphys*. Two species of *Alphadon* are both more dentally plesiomorphic than either *A. marshi* or *A. wilsoni* which are Lancian in age. This local fauna also contains taxa, which are more typical of earlier NALMAs *Iqualadelphis* (Aquilian) and *Varalphadon* (Judithian). The Hell Creek Formation has an estimated duration of 1.46 million years prior to the K/T boundary age of 65.5 Ma (middle of Chron 29r). Thus the base of the Hell Creek Formation dates at about 66.71 Ma to 66.87 Ma. Lancian-aged assemblages also occur in the Scollard Formation in Alberta that occurs above the Kneehills Tuff, which has been dated at 66.8 Ma. Thus, Lancian assemblages are younger than 66.9 Ma and appear to be restricted to Chron 30n and 29r. The upper portion of the Fox Hills Formation correlates to the early portion of Chron 30n and a date of 67 Ma. The Timberlake Member of the Fox Hills Formation, which represents a lower unit of the formation in North Dakota and is equivalent to the level for Red Owl Quarry, has produced specimens of both marine and terrestrial vertebrates, which are associated with invertebrate taxa representing the *Jeletzkytes nebrascensis* Western Interior Ammonite Zone. This correlates all of the specimens (vertebrate and invertebrates alike) with the *Gansserina gansseri* Foraminiferal Zone suggesting an early late Maastrichtian age of 68 to 67 Ma for the unit. The Red Owl Q. Local Fauna resides in the temporal gap between Judithian and Lancian-aged paleofaunas; the Red Owl marsupial species could be used to help define an Edmontonian NALMA.

Poster Session I (Wednesday)

A REVIEW ON THE MARINE REPTILES OF PORTUGAL: ICHTHYOSAURS, PLESIOSAURS AND MOSASAURS

CASTANHINHA, Rui, Museu da Lourinhã, Lourinhã, Portugal; MATEUS, Octávio, Museu da Lourinhã, Lourinhã, Portugal

The presence of marine reptiles from Portugal was reported as early as 1897. Ichthyosaurs have been reported from the Lower and Middle Jurassic (Sinemurian to the Aalenian). *Ichthyosaurus* sp., was recognized from Cádima, Murte, Cantanhede and Figueira da Foz. *Ichthyosaurus intermedius* was reported from São Pedro de Muel (Lower Toarcian), Alvaiázere, Casal Comba, and Praia da Nossa Senhora da Vitória (Sinemurian) and *Stenopterygius* aff. *uniter* is present in Alhadas, Pentalheira, Praia de Nossa Senhora da Vitória and Tomar (Aalenian). The genus *Stenopterygius* was also reported in Condeixa and Tomar. In addition, we report two new ichthyosaur specimens from the Pliensbachian of Agua de Madeiros (São Pedro de Muel), one from the Domerian preserving a forelimb, vertebrae and teeth and a juvenile specimen dated as Carixian that preserves the cranial material and dorsal vertebrae and ribs. *Plesiosaur* material includes a partial skull of *Plesiosaurus* sp. and part of jaw ascribed to aff. *Plesiosaurus*, both from the Toarcian of Alhadas, near Figueira da Foz and an unpublished tooth from the Middle Cretaceous of São Pedro do Estoril. The Kimmeridgian/Tithonian of Lourinhã Formation yielded a possible plesiosaur vertebra (ML813). An isolated vertebra from the Late Cretaceous Cenomanian of Alcântara is assigned to "*Cimoliasaurus*". Mosasaurs are known from two teeth from the Late Cretaceous of Aveiro. One was ascribed to the genus *Mosasaurus* and the relatively large size may support that referral; however, it is difficult to assign teeth to genus but based on its general form and possession of smooth enamel surface it is possible to conservatively refer the specimen to the subfamily Mosasaurinae. Marine crocodiles and chelonians have also been recognized from the Late Jurassic of Portugal.

Preparators' Session, Thursday 9:15

AIR ABRASIVE 101

CAVIGELLI, Jean-Pierre, Tate Museum, Casper, WY, USA

Air abrasive machines have become common tools in paleontological preparation laboratories. These are tabletop "sand blasters" and can be used to effectively remove matrix from large dinosaur bones to small delicate vertebrate fossils. They work on the principle that matrix is often softer than the enclosed fossil. This presentation will discuss many aspects of air abrasive use in the prep lab including purchasing and setting up such a machine, the pros and cons and limitations of using one in fossil preparation, safety aspects, and a primer on how to use it which will be useful for novices as well as seasoned professionals. Air abrasive use in conjunction with other tools of the trade will also be discussed.

Poster Session III (Friday)

PRELIMINARY INTERPRETATIONS OF THE ANDREW'S SITE QUARRIES AND THE INTERRELATION OF VERTEBRATE FOSSIL SITES IN THE CEDAR MOUNTAIN FORMATION IN THE YELLOW CAT TYPE AREA OF EAST-CENTRAL, UTAH

CAVIN, Jennifer, Utah Geological Survey, Salt Lake City, UT, USA; KIRKLAND, James, Utah Geological Survey, Salt Lake City, UT, USA

The Andrew's Site quarries are in the upper part of the Yellow Cat Member of the Cedar Mountain Formation. Two superimposed bone horizons are separated by a 1 - 1.5 m interval that includes a sandstone splay around 25 cm thick, which laterally preserves iguanodontid and theropod tracks. In the lower horizon, scattered bone can be observed over a distance of more than 100 meters. Roughly 4m<sup>2</sup> of the lower horizon was excavated. The lower site predominantly preserves isolated scutes and spines of an ankylosaur, most likely *Gastonia*, in a purplish mudstone matrix. A hypsilophodontid foot was also found at this level about 100 meters away from the main quarry. The upper bone horizon is more restricted laterally than the lower, and the approximately eleven square meters of the upper horizon that was excavated may represent its entire extent. A large adult iguanodontid skeleton, cut by a drainage, was excavated from the upper site. After some months of preparation, the blocks collected from the upper site, in addition to the adult iguanodontid material, yielded remains of a juvenile iguanodontid (skull), a terrestrial crocodile (skull and skeleton), and a third skull, to be described in a later publication. With many months of preparation left, we are optimistic about possible future finds. The Yellow Cat type area is a hotbed of vertebrate paleontological sites. Within one square mile of the Andrew's Site quarries, five other sites containing five type specimens have been discovered. These sites are closely related stratigraphically and span the interval from the Lower Yellow Cat member to the basal-most Ruby Ranch member of the Cedar Mountain Formation. A future study will electronically map the vertebrate paleontological sites and their facies relationships in the Yellow Cat type area, using several correlative beds to stratigraphically tie the sites together. Mapping these sites is giving us a larger vision of what occurred here to preserve such a multitude of unique, important sites.

Technical Session VII, Thursday 1:30

MESOMYZON MENGAE: NEW SPECIMENS AND MORE INFORMATION

CHANG, Mee-mann, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; ZHANG, Jianguo, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; MIAO, Desui, Natural History Museum, Lawrence, KS, USA

More specimens of *Mesomyzon mengae* have been obtained from the same locality (Liutiaogou, Ningcheng, Inner Mongolia) where it was originally discovered. The new specimens provided new characters, confirmed a few characters we noticed before, and revealed new details of known characters. The new observations may help us better understand this Cretaceous lamprey. In the new specimens we were able to see the full body shape, the complete dorsal and caudal fins, the sucker and its structure in detail, the braincase, the nasal sac, and other characters. We also have specimens of ammonoites on which we saw several special characters. Our further detailed study of these specimens will shed light on the ontogeny of this Mesozoic lamprey as well as the relationships between jawless and jawed animals, both extant and extinct, and add another exquisitely preserved rare taxon onto the list of extraordinary fossil finds. In addition, it may be possible for us to look into the preservation processes of the soft parts.

Technical Session IV, Wednesday 1:30

THE PERILS OF PINOCCHIO: ROBUSTNESS AND METHOD SELECTION IN GEOMETRIC MORPHOMETRICS

CHAPMAN, Ralph, Idaho Virtualization Laboratory, Pocatello, ID, USA; SADLEIR, Rudyard, University of Chicago, Chicago, IL, USA

Over the past fifteen years, landmark-based geometric morphometrics has become the de facto standard for morphometric studies in the natural sciences. This is largely due to the adaptation of a series of powerful methods for studying and visualizing morphological variation, and the dissemination of these methods by its practitioners in a series of workshops. The default approaches utilize thin-plate spline analyses and eigenvector analyses (relative warp analyses) after the specimen landmarks are superimposed using the generalized least-squares Procrustes (GLS) algorithm. Often overlooked, GLS is the pivotal element in this approach as all subsequent work depends on the veracity of this superimposition. If this fit is nonsensical, then subsequent analyses provide a very elegant solution devoid of useful information for the hypotheses being studied. As a small group of researchers have pointed-out for over twenty years, the GLS algorithm is severely flawed when analyzing shape in many biological situations. By relying on a weak statistic (the mean), the GLS algorithm generates landmark superimpositions that are variable and biologically unrealistic when localized landmark variation is present. We show that this effect, dubbed the Pinocchio Effect, is grossly underappreciated by morphometricians who fail to recognize how common it is in biological examples. Further, we report on simulations that show that the GLS fit is also problematic when landmark numbers are degraded in simulated morphologies. We suggest that a critical

methodological addition is needed when applying geometric morphometrics to investigate natural science problems. Instead of always accepting and applying the GLS fit, each study must not only assess the existence of localized landmark change, but also demonstrate that the chosen approach is relevant given that assessment. We provide examples from various applications in vertebrate paleontology.

Poster Session I (Wednesday)

A PRELIMINARY REPORT ON THE LATE QUATERNARY VERTEBRATE FAUNA FROM SIERRA DIABLO CAVE, HUDSPETH COUNTY, TEXAS

CHAVEZ, Angela, The University of Texas at El Paso, El Paso, TX, USA

Relatively few Pleistocene sites are known from those portions of Trans-Pecos Texas outside of the Guadalupe Mountains. One site that may have the potential to provide significant information about the Pleistocene faunas of this region is Sierra Diablo Cave (UTEP site 107). This site is a small cave located on the edge of the Sierra Diablo Plateau in eastern Hudspeth County, Texas. A sample collected from the cave in the 1960s by William Strain of then Texas Western College, now the University of Texas at El Paso, consisted of numerous Holocene species still found in the area today as well as two extinct species of pronghorns (*Stockoceros* and *Capromeryx*), at least one species of horse (*Equus*), and the American lion (*Panthera atrox*). A second sampling trip conducted in March has greatly increased the number of species of smaller vertebrates from this locality, including the extinct Pleistocene rabbit *Aztlanolagus agilis* and Stock's vampire bat, *Desmodus stocki*. This presentation will provide a brief summary of the fauna collected from excavations conducted this spring and summer at the site.

Poster Session IV (Saturday)

FUNCTIONAL ANALYSIS OF MAMMALIAN HUMERI FROM THE LATE CRETACEOUS OF UZBEKISTAN

CHESTER, Stephen, Yale University, New Haven, CT, USA; SARGIS, Eric, Yale University, New Haven, CT, USA; SZALAY, Frederick, University of New Mexico, Albuquerque, NM, USA; ARCHIBALD, J. David, San Diego State University, San Diego, CA, USA; AVERIANOV, Alexander, Zoological Institute, Russian Academy of Sciences, Saint Petersburg, Russia

Mammalian humeri recovered from the Bissekty Formation, Dzharakuduk, Kyzylkum Desert, Uzbekistan (90 MYA) were analyzed from a functional perspective. Isolated elements were sorted into groups that likely correspond to species (or genera). These groups were allocated to taxa known mostly from the dentition, petrosals, and/or tarsals at this site. The multituberculate humerus has a semispherical radial condyle that is separated from a narrow, rounded ulnar condyle by an intercondylar groove; a very large medial epicondyle; and a deep, spiraling ulnar condyle. The terrestrial eutherian taxa have a trochlea that is continuous with the capitulum. The zalambdalestid humerus is extremely similar to that of the Late Cretaceous Mongolian zalambdalestid *Barunlestes* in possessing a large capitular tail separated from a cylindrical capitulum by a shallow groove, a large medial trochlear ridge, and a deep trochlea. Some eutherian humeri have been tentatively assigned to Zhelestidae based on their dissimilarity to zalambdalestids and the abundance of zhelestids in the dental record. These humeri differ from those of zalambdalestids in having a shorter capitulum (that is less spherical than in the metatherians), a shorter capitular tail, a smaller medial trochlear ridge, and a shallower trochlea. The two arboreal metatherian taxa, which have been differentiated by size and morphological characteristics, possess a spherical capitulum; a trochlea separated from the capitulum by a short, grooved zona conoidea; and a well-developed lateral epicondylar crest. The smaller metatherian has a short medial trochlear ridge; a narrow, shallow trochlea; and a large medial epicondyle. The medial side of the larger metatherian humerus is broken. Although the dental record suggests thirteen eutherian species and only one metatherian, crurotarsal evidence supports the presence of at least four metatherian species at Dzharakuduk. The humeri analyzed here also provide support for the presence of multiple metatherians in the fauna, further demonstrating that postcrania are critical to understanding the taxonomic diversity present at these Late Cretaceous localities.

Technical Session X, Friday 11:15

TEASING APART THE EFFECTS OF TAPHONOMIC AND SAMPLING BIAS ON SPECIES DIVERSITY ESTIMATES USING GIS

CHEW, Amy, SUNY Stony Brook, Stony Brook, NY, USA; OHEIM, Kathryn, Suffolk County Department of Planning, Hauppauge, NY, USA

Uneven fossil sampling distributions can be the result of different factors, including collection bias, changes in preservation rate, and changes in sampling area (the species-area bias). While the underlying source of variation may not always be possible to determine, uneven sampling distribution has a strong impact on perceived species diversity and is therefore usually corrected by range-through estimates or rarefaction analysis to standardize sample size. However, these methods may still lead to biased diversity estimates if large changes in area or preservation underlie the uneven sampling distribution. In this study, we use GIS to quantify preservation biases and test their effects on species diversity estimates in a fossil mammal sample from the Early Eocene Willwood Fm of the Bighorn Basin, WY. We used GIS to create individual polygons

for 1486 fossil localities, covering a total area of ~3000 km<sup>2</sup>. Each locality polygon is associated with specimen data and can be used to extrapolate locality area. Preliminary analyses were conducted on ~33000 surface-prospected specimens from 392 localities spanning 600m in vertical thickness and 2.5My. There is significant correlation between locality area (up to 1km<sup>2</sup>) and number of species, suggesting that the species-area bias is present at the scale of locality area. A temporal change in preservation rate is manifested in a significant increase in specimen density per locality that is correlated with paleosol development. Although raw species counts and range-through diversity estimates are affected, rarefaction analysis easily accounts for combined species-area and preservation bias at this scale. In most paleoecological analysis, locality data are combined to create temporally equivalent intervals. Using our preliminary data, localities were combined to create intervals of ~500Kyr (100m), in which area sampled ranged from 1-20 km<sup>2</sup>. Combined species-area and averaged preservation bias at this scale was not corrected by rarefaction analysis, suggesting that the source of underlying bias and the scale of analysis must be considered when correcting uneven sampling distribution.

Poster Session I (Wednesday)

COMPARISON OF LOWER VERTEBRATE FAUNAS FROM THE BRIDGER AND WIND RIVER FORMATIONS (EARLY TO MIDDLE EOCENE), WYOMING

CHINNERY-ALLGEIER, Brenda, University of Texas, Austin, TX, USA; STUCKY, Richard, Denver Museum of Nature and Science, Denver, CO, USA; HARDY, Tom, Denver Museum of Nature and Science, Denver, CO, USA

Faunal analyses of lower vertebrates are compared between study areas in the Bridger Formation and the Wind River Formation of Wyoming. This is a continuation of mammal faunal analyses recently described for these two areas, important as this time period is a period of maximum warming, and faunal transitions during such periods are a valuable addition to our understanding of climate change and global warming. Many of the common lower vertebrates found in these two areas have not been revised in decades, including anguillid lizards, which are represented by numerous jaws, teeth, scutes, and postcranial elements. Most recently studied in the 1980's, representatives of the following are included in the study area, many of them not fully described: *Xestops*, *Ophisaurus*, *Machaerosaurus*, *Glyptosaurus donohoei*, cf. *Gerrhonotus*, and *Anguinae* sp. These lizards were studied by Gilmore in the 1920's, and for the most part have not been revised since then. Xantusiid, xenosaurid, agamid, varanid, and iguanid lizards are also represented, among others. Other lower vertebrates found in the two study areas include snakes, primarily represented by vertebrae, various turtles known from carapace and plastron pieces as well as postcrania, *Crocodylus*, *Allognathosuchus*, *Leidyosuchus*, *Sebecus*, *Pristichampsus* and other crocodyliforms represented by jaws and teeth, and fish including amiid and lepisosteid fish, represented by teeth, tooth plates, and scutes, as well as catfish known from spines. In addition, many postcranial elements are present that represent amphibians and additional reptiles, currently in preparation. Lower vertebrate specimens are compared between the two basins, with the intention of discerning environmental, faunal, and taphonomic differences between the areas. In addition, new specimens are described to the extent possible, and the updated information of the lower vertebrate fauna in these two areas is an important addition to current knowledge of the fauna in general during the early to middle Eocene of Wyoming.

Ernie Lundelius Symposium (Faunal Dynamics and Extinction), Wednesday 10:30  
THE CAPE ZEBRA (*EQUUS CAPENSIS*) IN THE LATE PLEISTOCENE AND HOLOCENE OF AFRICA, AND THE NATURALLY RESTRICTED DISTRIBUTION OF EQUIDS IN AFRICA

CHURCHER, Charles 'Rufus', University of Toronto, Gabriola, BC, Canada

*Equus capensis* is a robust zebra that was identified as a horse when first reported in Southern Africa. Similar equid remains were found in Pleistocene and Holocene deposits in Central and East Africa north to southern Ethiopia. The East African form was named *E. oldowayensis* on materials recovered from Olduvai Gorge: this animal is also known from the Lake Turkana and Omo beds. The living Grevy zebra, *E. grevyi*, is considered the surviving relict of the East African population. Remains of a robust zebra have been recovered from late Middle Pleistocene and Holocene levels in Dakhleh Oasis, Egypt. These populations are considered to constitute a zebra species that for much of the Quaternary stretched from the Cape to Cairo: the name *Equus capensis* is used for the fossil form and *E. grevyi* is the name for the extant population. *E. capensis* occurs together with fossils of a small quagga-like, *E. quagga*, zebra throughout its distribution, which occupied a plains or tree savanna, accompanied by a typical African plains mammal fauna. No evidence of either zebras exists from sites in tropical West Africa (in the sahel from Nigeria to Senegal) and no equid from the Quaternary of the Maghreb (Tunisia, Algeria and Morocco) can be identified as conspecific with the Cape zebra. The natural absence of fossil or recent equids in the savannas of tropical West Africa is supported by the absence of rhinoceros, the other widespread African perissodactyl, in Holocene and modern faunas, and by the absence of hipparions in that region in the Early and Middle Pleistocene although these three-toed equids were present over similar North and East African areas during Miocene and Pliocene times.

Technical Session XVIII, Saturday 3:45

THE SYSTEMATICS AND BIOGEOGRAPHY OF RIGHT WHALES (BALAENIDAE: MYSTICETI)

CHURCHILL, Morgan, University of Wyoming, Laramie, WY, USA; BERTA, Annalisa, San Diego State University, San Diego, USA; DEMÉRE, Thomas, San Diego Natural History Museum, San Diego, CA, USA

Right whales are large, endangered baleen-bearing whales represented by four modern species, the arctic bowhead, *Balaena mysticetus*, and three species of temperate right whale, *Eubalaena glacialis* in the North Atlantic, *Eubalaena japonica* in the North Pacific, and *Eubalaena australis* in the Southern Hemisphere. Despite a limited diversity during the Holocene, right whales were common and speciose elements of Pliocene marine mammal faunas. However, the phylogenetic affinities of fossil right whales still remain uncertain. This study incorporates 22 taxa representing all major clades of living and fossil baleen whale and 118 morphological characters of the cranium and post-cranium in a phylogenetic analysis of fossil and extant balaenids. The fossil taxon *Morenocetus parvus* is recovered as the earliest diverging right whale, and two major clades of right whale are recognized. These clades include a poorly supported *Balaenula* clade, and a "crown" right whale clade, composed of two monophyletic groups, a *Balaena-Balaenella* clade, and a modern *Eubalaena* clade. Undescribed representatives of both *Balaenula* and "crown" right whales are present in the Pliocene of the North Pacific. Within *Eubalaena*, *E. glacialis* is recognized as sister to *E. japonica* and *E. australis*, congruent with previous molecular results. Relationships within *Balaena* remain unresolved. The phylogenetic affinities of *Eubalaena belgica* and an undescribed Pliocene San Diego Formation balaenid remain unresolved. Examination of the fossil record suggests a Southern Hemisphere origin for balaenids, with later dispersal to the Northern Hemisphere during the latest Miocene. During the Pliocene, balaenids were more diverse, with a variety of extinct dwarf taxa, as well as representatives of the modern genera *Eubalaena* and *Balaena*. Cyclic climate change during the Pleistocene led to changes in distribution for the modern *Balaena mysticetus* and contributed to allopatric speciation within *Eubalaena*.

Poster Session IV (Saturday)

SICKLE-CLAW THEROPOD DINOSAURS OF THE LOWER CRETACEOUS CEDAR MOUNTAIN FORMATION FROM THE DALTON WELLS QUARRY AND DINOSAUR NATIONAL MONUMENT, UTAH

CHURE, Daniel, Dinosaur National Monument, Jensen, UT, USA; BRITT, Brooks, Earth Science Museum, Provo, UT, USA; SCHEETZ, Rodney, Earth Science Museum, Provo, UT, USA

Although there has been an explosion in our knowledge of dinosaurs of the Cedar Mountain Formation, the theropod component remains relatively poorly known. The Dalton Wells Quarry near Moab, Utah is in the basal unit of the Cedar Mountain Formation, the Yellow Cat Member, which is dated at 124 Ma, based on detrital zircons (U-Pb). This site has produced more than 240 elements of *Utahraptor* belonging to 3 adults, 2 subadults, and 3 juveniles. Femoral length ranges from ~120-575 mm. Vertebrae suggest a maximum skeletal length of ~4 m. Bones of the arm and skull are rare. Pneumatic cervical and anterior dorsal vertebrae are coarsely camellate. The posterior dorsals lack pneumatic foramina on the centra. The robust tibia is 96% of the femur and the short tibia and stocky metatarsals suggest the leg was better adapted as a weapon than for speed. No astragalus is known but the contact on the tibia indicates the ascending process was asymmetrical, pointing to the lateral margin, and terminated slightly more than 1/4 the way up the tibia. *Utahraptor* is undoubtedly a dromaeosaurid based on pedicular parapophyses, a subglenoid fossa on the coracoid, and a raptorial pedal digit II. A second taxon of sickle-claw theropod is known from Dinosaur National Monument, but it is found in the Ruby Ranch Member of the Cedar Mountain Formation, which dates to 117 Ma, based on detrital zircons (U-Pb). This taxon is represented by a partial skeleton plus isolated elements of a second individual. Femoral length is ~290 mm. The single mid-dorsal bears a pneumatic foramen on its centrum. The Monument specimen differs from *Utahraptor* in the extreme height of the ascending process of the astragalus plus its symmetrical shape, with the apex at mid-width.

The Dissorophoidea - Early Amphibian Radiation Symposium, Friday 10:45

THE AMPHIBAMID *PLATYRHINOPS*, MORPHOLOGY AND METAMORPHOSIS

CLACK, Jennifer, University of Cambridge, Cambridge, United Kingdom; MILLNER, Andrew, The Natural History Museum, London, United Kingdom

Previously undescribed material from the Middle Pennsylvanian of Linton, Ohio and N\_rany, Czech Republic permits a reassessment of the morphology of the amphibamid *Platyrhinops lyelli*, sometimes assigned to the genus *Amphibamus*. New features of interest include the presence of bicuspid marginal teeth, anteriorly widened frontals, elongate choanae, a broad rhomboidal sphenethmoid, and a pair of flattened blade-like ectohyals, suggestive of a tongue-manipulation function. One specimen shows an unusual distribution of tooth sizes along the premaxillaries. A larval *Platyrhinops* specimen from N\_rany, previously assigned to *Branchiosaurus salamandroides*, shows charac-

teristic features of the palate, mandible and forelimb, combined with branchial ossicles modified as gill-rakers. It appears that *Platyrhinops* had a branchial system up to 10 mm skull length modified by metamorphosis to a tongue-manipulation system by 20 mm skull length. This suggests that *Platyrhinops*, like *Apateon gracilis* underwent relatively rapid and radical metamorphosis at some point between 10 and 20 mm skull length and that this may be at least an amphibamid-branchiosaurid feature.

Student Poster Session (Thursday)

FIRST FOSSIL BATOIDS (ELASMOBRANCHII) FROM THE CALVERT BLUFF FORMATION (EOCENE), BASTROP, TEXAS.

CLAESON, Kerin, The University of Texas, Austin, TX, USA; STIDHAM, Thomas, Texas A&M, College Station, TX, USA

Batoid tooth plates were recovered from the lower part of the Calvert Bluff Formation in Bastrop, Bastrop County, Texas. They represent the first vertebrate fossils from the formation. The Calvert Bluff is early Eocene in age and Wasatchian equivalent, approximately the same age as the Bashi Formation in Mississippi. Batoid remains come from a single sandy storm bed approximately 60 cm thick capped by a 10-15 cm thick sandstone. Fossil batoid remains from East Texas were previously known only as recently as the late Cretaceous. Additional vertebrate fauna recently recovered from the locality includes a diversity of sharks, bony fish, turtle, and crocodylia. Identification of partial fish teeth is often difficult despite an enormous literature. It is extremely evident when examining individual, disassociated batoid tooth plates. In the absence of a cladistic analysis, specimens from the Calvert Bluff were first assigned to the family Myliobatidae, according to criteria published by Nelson. Preliminary examination of these batoid remains indicates that specimens represent multiple myliobatid species. Thirty-two specimens of median tooth plates represent two species of *Rhinoptera*. A partial dental battery that consists of six median tooth plates and three lateral files represents *Myliobatis*. There are also eight fine-rooted, gracile-crowned tooth plates representing a third genus, tentatively assigned to *Aetomylaeus*.

Technical Session XIII, Friday 2:45

QUANTITATIVE APPROACHES TO THE STUDY OF MORPHOLOGICAL EVOLUTION USING DISCRETE CHARACTERS AND A BAYESIAN PHYLOGENETIC APPROACH TO INVESTIGATING MOSAICISM IN AVIALAN EVOLUTION

CLARKE, Julia, North Carolina State University/NCMNS, Raleigh, NC, USA; MIDDLETON, Kevin, California State University San Bernardino, San Bernardino, CA, USA

Relatively few quantitative methods have utilized discrete cladistic character data to investigate morphological evolution and hypotheses of anatomically disjunct, mosaic, change, although such hypotheses are common to the study of major vertebrate transitions. One previously employed method, summing unambiguously optimized synapomorphies, has been the basis for proposing disassociated and sequential 'modernizing' or 'fine-tuning' of pectoral and then pelvic locomotor systems after the origin of bird flight. We investigate properties of this method and propose a novel Bayesian phylogenetic approach to investigate hypotheses of disjunctive change in morphological evolution. Bayes factors and statistical comparisons of branch length estimates were used to assess character evolution across previously proposed anatomical partitions (e.g., pelvic and pectoral). Of 80 evaluated models, the models with morphologically partitioned data where branch lengths are allowed to vary independently among partitions are most strongly preferred. By contrast, 1,000 datasets with partitions the same size as those based on anatomical subregions but comprised of randomly selected characters performed worse than even the single partition equal rate model, suggesting that only partitioning by anatomical subregion increased model performance. Bayesian analyses resulted in supported clades with only minor differences from those recovered using a maximum parsimony estimator. However, these differences indicate potentially important effects that may be at issue specifically in Bayesian analyses including fossil data. The preference for all models with anatomical subregion partitions indicates that identifying these partitions improved model performance and is consistent with a disjunctive pattern of character change for the dataset investigated. Statistical tests of differences in estimated branch lengths from the pectoral and pelvic partitions did not support the specific hypothesis proposed from the summed apomorphy approach; however, there is limited support for some pectoral branch lengths being significantly longer closely following the origin of flight.

Technical Session XII, Friday 1:15

USING STABLE ISOTOPE ANALYSIS TO TEST INFERRED SEMI-AQUATIC HABITS IN FOSSIL HERBIVORES FROM THE EARLY OLIGOCENE OF EGYPT

CLEMENTZ, Mark, University of Wyoming, Laramie, WY, USA; HOLROYD, Patricia, University of California, Berkeley, CA, USA

Large-bodied herbivorous mammals inferred to be semi-aquatic have been a minor component of terrestrial ecosystems through most of the Cenozoic. Identification of these species in the fossil record has largely focused on morphological similarities with

present-day hippopotamids, leading to the designation of this pairing of body type and ecological niche as the hippo ecomorph. However, these morphological characters may not always be diagnostic of aquatic habits and are difficult to interpret in mammals with divergent phylogenetic histories. Here, we examine whether enamel  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  values from living hippopotamids can be used to define an isotopic signature unique to semi-aquatic herbivores. Although  $\delta^{13}\text{C}$  values do not support unique foraging habits for this ecomorph, living and fossil hippopotamids typically have low mean  $\delta^{18}\text{O}$  values relative to associated ungulates and fit a predictable pattern. Modeling of oxygen fluxes in large mammals suggests that high water turnover rates and/or increased water loss through feces and urine may account for this relationship. This model was then used to test inferred semi-aquatic habits in a suite of fossil mammals from the early Oligocene Jebel Qatrani Formation of Egypt. Taxa hypothesized to have been semi-aquatic in this fauna are the proboscidean *Moeritherium*, the anthracotheriid artiodactyl *Bothriogenys*, and the embriothopod *Arsinoitherium*. Inferences of a semi-aquatic habitat for *Moeritherium* and *Arsinoitherium* have previously been based on comparative postcranial morphology, and that of *Bothriogenys* from anecdotal taphonomic data suggesting a preference for riverine deposits. Only fossil specimens of *Moeritherium* and *Bothriogenys* were found to meet expected  $\delta^{18}\text{O}$  values for hippo ecomorphs;  $\delta^{18}\text{O}$  values for *Arsinoitherium* were not significantly different from associated proboscideans *Phiomia* and *Paleomastodon* or hyracoids. These results show that the mean  $\delta^{18}\text{O}$  composition of fossil specimens is an effective taxon-independent tool for assessing the aquatic habits of extinct species.

Technical Session VI, Thursday 3:00

#### EVOLUTION AND MECHANICS OF FOREFEET IN TERRESTRIAL CETARTIODACTYLS

CLIFFORD, Andrew, Brown University, Providence, RI, USA

The evolution of highly cursorial, elongated forelimbs in terrestrial cetartiodactyls is the result of two separate anatomical transitions. The likely primitive condition for all ferrungulates is a 5-toed digitigrade manus with a reduced pollex. Extant canids serve as adequate functional analogs for this ancestral anatomy. The first transition involves loss of the pollex and adoption of an unguligrade posture, yielding the primary unguligrade condition. Extant representatives of the primary unguligrade forefoot are in the Suidae, Tayassuidae, and Tragulidae. The most significant soft-tissue change involved the modification of intrinsic, interosseus muscles into stiff ligaments that maintain an elevated metacarpophalangeal (MCP) joint. Osteological correlates for the interosseus ligament can be found in other primary unguligrade, but extinct, groups like cainotheres and protoceratids. Primary unguligrade anatomy was then exapted in later terrestrial cetartiodactyls to give the didactyl, elongated forelimb typical of most extant species. Each of these secondary unguligrade groups is derived from a primary unguligrade ancestor. Osteological correlates of the interosseus ligament can be traced throughout terrestrial cetartiodactyls, shedding light on foot posture and potential mechanics of locomotion. In order to test the mechanical importance of these changes, I am using bi-planar cinefluoroscopy to describe foot kinematics in minipigs. *In vitro* mechanical testing compared with accurate *in vivo* kinematics of the MCP joint permits calculation of the passive torque supplied by the ligaments during stance. I hypothesize that the interosseus ligaments are a crucial means of energy-saving during stance in unguligrades. During locomotion, the MCP joint undergoes hyperextension, placing tension on the interosseus ligaments; these ligament then store strain energy, which is available to power toe-off. If interosseus ligaments provide passive torque at the MCP joint, then primary unguligrade forefeet provide an effective mechanical advantage over a digitigrade posture for taxa, like suids, not usually considered cursorial.

Technical Session X, Friday 10:45

#### TIMING AND CORRELATION OF THE SHANGHUAN-NONGSHANIAN ASIAN LAND MAMMAL AGE BOUNDARY

CLYDE, William, South China Paleogene Working Group, University of New Hampshire, Durham, NH, USA

The Asian Land Mammal Age (ALMA) framework is poorly correlated to the geological time scale making it difficult to evaluate hypotheses of intercontinental synchronicity of mammalian turnover. Here we report new paleomagnetic and isotopic results from a ~1000 meter thick Asian Paleocene stratigraphic section in the Chijiang Basin of China's Jiangxi Province that provide chronostratigraphic constraints on the Shanghuan-Nongshanian ALMA boundary. The Chijiang basin is an elongate graben containing a thick sequence of highly oxidized Paleogene fine- to coarse-grained clastic deposits of lacustrine and fluvial origin. Fossil mammals have been recovered from 21 localities throughout the Chijiang sequence and represent all three of the Paleocene ALMAs (Shanghuan, Nongshanian, and Gashatan). Paleomagnetic analysis of 121 sites (326 samples) reveals that the Shanghuan-Nongshanian boundary lies close to a normal to reverse polarity change. Stable carbon isotope analysis of dispersed organic matter and paleosol carbonates indicate a secular increase of 1-2‰ superimposed on higher frequency variations. Correlation of this magnetochemostratigraphic pattern to the global timescale suggests that the magnetic polarity reversal near the Shanghuan-

Nongshanian ALMA boundary represents the Chron C27n-C26r transition. The Torrejonian-Tiffanian North American Land Mammal Age boundary is closely correlated to this same polarity transition indicating nearly synchronous mammalian turnover on both continents at this time. Because both biostratigraphic boundaries are thought to be recording turnover of endemic taxa, it is unlikely that the synchronicity of faunal change is due to intercontinental dispersal as has been documented for other early Paleogene faunal transitions (e.g. Paleocene-Eocene boundary). Instead, these biotic changes may represent independent ecological or evolutionary responses to global climate change.

#### NEW DISCOVERIES FROM BEARSDEN: REASSESSING THE EARLY RECORD OF POST-DEVONIAN FISHES

COATES, Michael, University of Chicago, Chicago, IL, USA; GAVIN, Patrick, Clydebank, Clydebank, United Kingdom; NEIL, Clark, University of Glasgow, Glasgow, United Kingdom

The Mississippian (Serpukhovian) Bearsden fauna (Glasgow, Scotland) is known for the exceptional preservation of its fossil sharks. Although the equivalent horizon was known from sites in Ayreshire and Lanarkshire in the late 1800s, it was not until Stan Wood's discoveries that reports highlighted the quality of the chondrichthyan specimens from the Manse Burn Formation, as well as the diversity of the actinopterygian fishes and exquisitely preserved fossil crustaceans. Early surveys of the Bearsden fauna, two Ph.D. theses and subsequent publications have covered many of the taxa in depth. Although some of the outstanding fishes have yet to be described in detail, a reasonably clear picture of the faunal diversity has emerged, which, in general terms, resembles that of the slightly younger Bear Gulch fauna of Montana, USA. However, while Bear Gulch fossil fishes tend to be less well preserved than their Scottish counterparts, in terms of taxonomic and morphological diversity, they far exceed their Bearsden equivalents. The fossil record of marine fishes is poor throughout much of the Permian and Pennsylvanian, relative to flanking units in the geological column. Because of this, the Bear Gulch fauna is gaining significance as a marker for early representatives of clades known otherwise from more recent deposits. This raises questions about sampling error: whether Bear Gulch fishes are misinterpreted, and/or whether fish diversity at other localities, either contemporary or geologically older, has been overlooked. Here, we report new discoveries of fishes from the Manse Burn Formation, from lateral equivalents of the Bearsden locality. Discovered and prepared by Patrick Gavin, these fossils show that by increasing the search area, the diversity of the Bearsden data set overlaps that of the Bear Gulch fauna to an extent much greater than previously suspected, including groups until now known only from North America. These new discoveries are reinforcing the hypothesis that the diversity of Carboniferous fishes is significantly under-determined.

Poster Session III (Friday)

#### UNCINATE PROCESSES: A UNIQUE SYNAPOMORPHY FOR MANIRAPTORAN AND AVIAN THEROPODS?

CODD, Jonathan, University of Manchester, Manchester, United Kingdom; MAN-NING, Phillip, University of Manchester, Manchester, United Kingdom

Ossified uncinata processes are found in most species of extant bird. In Aves uncinata processes are discrete caudodorsal projections extending from the proximal surface at the midpoint of the thoracic (vertebral) ribs. These processes play an important role in the mechanics of ventilation and are ossified to the thoracic ribs, have a bell shaped base and taper distally. Cartilaginous or ossified uncinata processes are reported in crocodiles, early tetrapods and ornithischian dinosaurs. However, these structures are not discrete and are morphologically distinct. For example the ornithischian dinosaur *Thescelosaurus* possessed deep, plate-like intercostal structures attaching successive thoracic ribs that may be functionally analogous to, but quite different from true uncinates, which occur in Aves and Maniraptoran dinosaurs. Therefore the term uncinata should be restricted to discrete, morphologically distinct, caudodorsal bony projections attached by cartilage or fused to thoracic ribs. Their presence in the Maniraptorans represents another morphological character linking them to Aves, and further supports the model of an efficient avian-like air-sac respiratory system in theropod dinosaurs, prior to the evolution of flight. Here we examine the distribution and possible function of reported uncinata processes in the fossil record.

Technical Session X, Friday 10:30

#### THE SKULL OF *THULIADANTA*, A SURPRISINGLY DERIVED TAPIROID FROM THE EARLY EOCENE (WASATCHIAN) OF THE CANADIAN HIGH ARCTIC, AS REVEALED BY HIGH-RESOLUTION CT SCANNING

COLBERT, Matthew, University of Texas at Austin, Austin, TX, USA; EBERLE, Jaelyn, University of Colorado at Boulder, Boulder, CO, USA

High-resolution X-ray CT scans of a rare skull from Wasatchian strata of the Eureka Sound Group on Ellesmere Island in the Canadian High Arctic reveal unexpectedly derived cranial morphologies. The specimen is largely encased in an ironstone-cemented sandstone that obscures almost all external morphology, but CT data expose portions of a facial skeleton that is strikingly similar to the Bridgerian *Helalestes* from the

western interior of the United States. Although most of the teeth are missing, the specimen represents an immature individual, with an unerupted M3 and a spatulate I3 preserved within their crypts. Digital isolation of these teeth supports referral of the skull to *Thuliadanta*, known from other localities in the area. The preservation of the specimen is unusual in the amount and distribution of X-ray attenuating cements filling cavities and defining sedimentary structures. These cements highlight the conchal sinuses and provide information on the cryptic morphology of these delicate elements. The sediments filling the cranial cavities also include a substantial amount of plant debris, consistent with burial of the fossil in crevasse splay deposits or distributary mouth sands in a proximal delta front to lower delta plain environment. Preserved portions of the facial skeleton indicate a substantial retraction of the nasoincisive incisure. This degree of retraction, and the morphology surrounding the incisure, including flat, plate-like descending nasal processes of the nasal bones, are similar to the condition seen in *Helaletes*, and imply an earlier radiation for this clade of tapiroids than previously hypothesized.

Technical Session V, Wednesday 3:45  
SCINCID (SQUAMATA) PHYLOGENY AND SNAKE ORIGINS: LIFESTYLE  
NEED NOT EQUAL HOMOPLASY

CONRAD, Jack, American Museum of Natural History, New York, NY, USA;  
NORELL, Mark, American Museum of Natural History, New York, NY, USA

Scincoidea is an understudied clade of squamates with literally thousands of extant species inhabiting arboreal, terrestrial, and fossorial lifestyles. Despite this and long fossil history of scincoids, most analyses of squamate relationships treat them as a single terminal taxon. We re-analyzed squamate relationships using 394 morphological characters coded for 242 terminal taxa, including 12 scincoids. Our analysis found some limbless 'skinks' to be basal members of a limb-reduced clade of squamates including Dibamidae, Amphisbaenia, and Serpentes (snakes). Some of the character states supporting the grouping (e.g., loss of skull arches) have been attributed to fossoriality in the past and regarded as probable sources of homoplasy. We ran additional analyses in which we deleted limbed taxa and/or terrestrial taxa in order to help nullify the importance of fossoriality-related characters on the analysis. The limbless scincoid clade was recovered in these analyses as well. Fossoriality is interpreted as a product of shared ancestry in limbless skinks, dibamids, amphisbaenians, and snakes. This shared evolutionary history is expressed in some 'fossorial characters' similar to the expression of 'cursorial carnivore' character states seen in canids and 'terrestrial herbivore' character states seen in ruminants.

Student Poster Session (Thursday)  
TWO LATE CENOMANIAN ELASMOBRANCH ASSEMBLAGES FROM THE  
NORTHERN REGIONS OF THE WESTERN INTERIOR SEAWAY

COOK, Todd, University of Alberta, Edmonton, AB, Canada

During the late Cenomanian, the province of Alberta was situated in the cool temperate climatic zone of the northern region of the Western Interior Seaway. Despite this high paleolatitude, two northern Albertan assemblages have yielded a diverse array of elasmobranch taxa. To date, 19 taxa have been recovered from three localities near Watino, Alberta: *Hybodus* sp., *Ptychodus anonymus*, *Ptychodus decurrens*, *Carcharias amonensis*, *Carcharias saskatchewanensis*, *Carcharias tenuiplicatus*, *Synodontaspis lilliae*, *Johnlongia parvidens*, *Scapanorhynchus raphiodon*, *Cardabiodon* sp., *Archaeolamna kopingensis*, *Cretalamna appendiculata*, *Cretoxyrhina mantelli*, *Leptostyrax macrorhiza*, *Dallasiella willistoni*, *Squalicorax volgensis*, *Squalicorax curvatus*, *Squalicorax falcatus*, and *Rhinobatis incertus*. Three previously unreported taxa including *Carcharias* sp., *Protolamna* sp., and *Cretodus* sp. have also been identified. A second assemblage from the Dunvegan Formation is also diverse and includes the taxa *Hybodus* sp., *Carcharias amonensis*, *Johnlongia parvidens*, *Archaeolamna kopingensis*, *Cretodus semiplicatus* and *Squalicorax falcatus*. The locality also contains the first known report of the ray *Pseudohypolophus mcnultyi* from Canada. These assemblages represent one of the most northern described selachian faunas within the Western Interior Seaway. Not only do these assemblages extend the northern geographical range of the taxa: preliminary comparisons with temporally equivalent southern Cenomanian assemblages suggest similar lammiform diversity despite its northern location within the seaway. Of particular interest is the low diversity of batoids, with only two taxa reported from these northern localities. This is in contrast to the high batoid diversity in more southern seaway assemblages. Further investigations into endemism and bioprovincialism within the northern regions of the Western Interior Seaway will provide an expanded depiction of elasmobranch paleoecology throughout Cretaceous North America.

Poster Session III (Friday)  
DIVERSITY OF NORTH AMERICAN MIOCENE CHALICOTHERES (MAMMALIA, PERISSODACTYLA): *MOROPUS MERRIAMII* FROM LATE HEMINGFORDIAN AND EARLY BARSTOVIAN FAUNAS OF NEVADA  
COOMBS, Margery, University of Massachusetts, Amherst, MA, USA

Although *Moropus elatus* and *Tylocephalonys skinneri* are the best-known Miocene North American chalicotheres, we can also identify other species from relatively fragmentary specimens. One of the most tantalizing of these is *Moropus merriami*, named for material that noted and figured from the Virgin Valley and High Rock Canyon areas of northwest Nevada. *M. merriami* also is found in the early Barstovian Lower Snake Creek fauna in the Olcott Formation of Nebraska and is thus one of the earliest Great Basin - Columbia Plateau species to be found on the Great Plains. Although there is still no skull and little dental material available for *M. merriami*, there is considerable, mostly disarticulated postcranial material from several localities in the Virgin Valley and High Rock Canyon areas. In addition, specimens of *M. merriami* from the late Hemingfordian Massacre Lake local fauna represent the earliest known occurrence of this species and co-existed with *Zygodolophodon*, one of the earliest proboscideans found in North America. The Eastgate fauna (Monarch Mills Formation) and Stewart Springs local fauna also yield specimens that extend our knowledge of *M. merriami* in Nevada. The Eastgate chalicotherid includes some articulated material that allows improved understanding of the hindlimb. Information from other mammalian taxa in the Stewart Springs and Eastgate faunas, along with substantial paleobotanical evidence, helps to elucidate the environment in which *M. merriami* lived. *M. merriami* is also an approximately contemporary of some of the best known mid-Miocene European schizotheriine chalicotheres, such as *Metaschizotherium* from Germany, and thus improves our understanding of the worldwide distribution of schizotheriine chalicotheres during this time. Chalicotheres typically show size sexual dimorphism. There are actually three size groups among specimens referred to *M. merriami* from Virgin Valley and High Rock Canyon. While the medium and smaller sized specimens are the most numerous, about eight specimens are surprisingly big and represent some of the largest chalicotheres known.

Poster Session I (Wednesday)  
PRIMATE DIVERSITY IN THE UINTAN CASA BLANCA COMMUNITY,  
LAREDO FORMATION, TEXAS

COPE, Dana, College of Charleston, Charleston, SC, USA; WESTGATE, James, Lamar University, Beaumont, TX, USA; BEARD, K. Christopher, Carnegie Museum of Natural History, Pittsburgh, PA, USA; HUMPHREYS, Lauren, College of Charleston, Charleston, SC, USA

The Casa Blanca community is a diverse fossil assemblage including plants, invertebrates, fish, reptiles and mammals. These were recovered largely through screen washing over 15 tons of "shell hash" matrix from the locality. An abundance of evidence documents the environment as a coastal, tropical, mangrove forest. The mammalian sample includes over 1800 specimens attributed to at least 30 genera, including 50 teeth representing at least four primate genera. Three of these are new taxa endemic to the Laredo fauna. The lower cheek teeth provide the best samples for comparison. *Ourayia* is present, further extending its range in the Uintan. Genus A, first attributed to *Omomys*, differs from both latter genera in numerous characters. Diagnostic traits include a much straighter mesial crest on lower p4. The trigonid of m1-m2 is quite distinctive from other omomyines, in being completely enclosed by high, sharp crests. The talonid has very reduced cusps, surrounded by a sharp crest, indicating folivory. Metric analyses indicate it is smaller than *Ourayia* and larger than *Omomys*. Genus B is relatively much larger than other Laredo primates. One lower m1 or m2 is unique in having a very mesiodistally compressed trigonid with broad, bulbous cusps. Genus C has upper molars with a complex pattern of crests and accessory cusps. The Laredo primates significantly expand our knowledge of primate diversity, distribution and adaptation to a rarely sampled habitat during the Uintan NALMA.

Poster Session I (Wednesday)  
ABUNDANCE CHANGES AND TAPHONOMIC CONDITION OF  
OLIGOCENE TURTLES, NORTHWESTERN NEBRASKA

CORSINI, Joseph, Eastern Oregon University, La Grande, OR, USA; LEITE, Michael, Chadron State College, Chadron, NE, USA; SMITH, Toni, Eastern Oregon University, La Grande, OR, USA

The White River Group at Toadstool Park, NE, consists of the Chamberlain Pass, Chadron and Brule formations. The three members of the Brule (Orella, Whitney, and Sharps) contain large numbers of well-articulated turtle fossils. We discovered a number of turtle "pairs" in the upper Orella and lower Whitney, with each member of the pair at the same stratigraphic level within 5 meters of its partner turtle. This may indicate that at least some of these turtles died at the same time. Six of the Whitney pairs occurred at one narrow stratigraphic interval, suggesting a catastrophic death, perhaps a drought or prolonged cold spell. This apparent clustering of turtle remains could also be an indicator of preservation bias due to topography not recorded in the uniform lithology. We also document a decline in turtle abundance across the Orella/Whitney

contact. This analysis at 3m stratigraphic resolution shows that turtle abundance fell from a peak in the Orella to virtually no turtles in the lower parts of the Whitney, and then increased to another peak near the Lower Whitney Ash, in the middle of the Whitney member of the Brule. We also observed a similar turtle abundance decline across the Orella-Whitney contact in the White River exposures at Scotts Bluff National Monument, one hundred miles south of Toadstool Park, which, given tentative correlation, suggests that it was a regional event. In both localities, we also observed coincident declines in mammal fossils across the Orella-Whitney contact. These abundance changes coincide with an increase in 18O that occurs across the Orella/Whitney contact at Toadstool Park, raising the possibility that it was caused by the global cooling and/or drying events associated with the Eocene/Oligocene transition or perhaps cooling/drying episodes later in the early Oligocene.

Poster Session I (Wednesday)

PRIMATE DISTRIBUTIONS AND SAMPLE SIZE EFFECTS AT THREE EARLY MIOCENE SITES IN EAST AFRICA

COTE, Susanne, Harvard University, Cambridge, MA, USA

Differences in primate species composition and abundance between fossil assemblages are frequently attributed to habitat differences. Sampling biases can strongly affect fossil assemblages, and should be taken into consideration in any comparative or paleoecological analysis. Biases due to sample size are strongest with rare taxa, and consequently are particularly relevant to primate fossil assemblages. Here, I examine fossil catarrhines from the contemporaneous Early Miocene East African fossil sites of Songhor, Koro, and Napak. Despite their close temporal and spatial proximity, the catarrhine species found at these sites vary; some species are found at all three sites, while others are found at only one. Previous analyses of these sites have assumed that the observed pattern of catarrhine distribution is unusual, and must be due to habitat differences that existed between these sites in the Early Miocene. However, the effects of sampling bias have never previously been considered. Ten different catarrhine species are found at these three sites, with four restricted to a single site (*Rangwapithecus gordoni*, Cercopithecidae indet., *Limnopithecus evansi*, and *Lomorupithecus harrisoni*). A total of 1152 catarrhine fossils have been collected, of which 792 can be assigned to a specific species. A variety of statistical tests, including binomial probabilities and rarefaction, were applied to these data to assess the effects of sample size on these assemblages. Results show that *R. gordoni* and *L. evansi* likely were restricted to Songhor. In contrast, the very rare taxa *L. harrisoni* and the cercopithecoid may not be unique to Napak, and could have been present at Songhor or Koro as well. Relative abundances of the catarrhine taxa differ markedly between sites, as does the abundance of catarrhines as a proportion of the total mammalian fauna. The results of this study suggest that while many of the primate differences at these fossil sites may reflect real distributions, others do not. Analysis of other mammalian taxa from the sites may help to further elucidate the role that habitat difference may or may not have played in shaping these primate communities.

Student Poster Session (Thursday)

PALEOENVIRONMENTAL RECONSTRUCTION OF THE LATE CRETACEOUS WESTERN INTERIOR SEAWAY OF NORTH AMERICA USING OXYGEN ISOTOPES FROM MARINE VERTEBRATE FOSSILS

COULSON, Alan, University of South Carolina, Columbia, SC, USA

The Late Cretaceous Western Interior Seaway (WIS) affected the climate of North America and in principle controlled global oceanic circulation patterns by serving as a conduit between the boreal and Tethyan oceans. However, previous attempts to characterize WIS water parameters (e.g., temperature, isotopic composition, density, salinity) have yielded equivocal results due to difficulties in inferring these properties from the stable isotopic composition of calcareous invertebrate shells. This lack of reliable quantitative data impedes reconstruction of environments, circulation patterns, and water column stratification within the seaway and thus limits paleoclimate model accuracy. Analysis of oxygen isotopes from both bone phosphate and bone carbonate of marine vertebrate fossils provides a new approach that independently resolves water temperature and isotopic composition and also provides a means of identifying diagenetic alteration of the bone isotope signal. Employing this approach using turtle, fish, and shark fossils from the Niobrara Formation of Kansas improves paleoenvironmental reconstructions of the central portion of the WIS during the late Coniacian-early Campanian (ca. 87-82 Ma). These data also improve paleoclimate- and paleoceanic circulation models and our understanding of the global Cretaceous climate system.

Student Poster Session (Thursday)

MASS MORTALITY OF JUVENILE PLACODERMS (*BOTHRIOLEPIS* SP.) FROM THE CATSKILL FORMATION (UPPER DEVONIAN), TIOGA COUNTY, PENNSYLVANIA

CRISWELL, Katharine, Shippensburg University, Shippensburg, PA, USA; DOWNS, Jason, Academy of Natural Sciences, Philadelphia, PA, USA; DAESCHLER, Edward, Academy of Natural Sciences, Philadelphia, PA, USA

The antiarch placoderm *Bothriolepis* is commonly encountered in the Upper Devonian Catskill Formation in Pennsylvania. During road construction work in Tioga County in 2004 and 2005, we collected at least two hundred articulated, juvenile individuals of *Bothriolepis* sp. on several slabs of muddy siltstone. This large sample of juveniles from a single site provides an opportunity to improve our understanding of the early stages of ontogeny and life cycle ecology of this cosmopolitan taxon. Most of the juveniles have a combined head and trunk shield length between 30 and 35mm. Allometry in the dermal armor of *Bothriolepis canadensis* has been documented previously and the new material from Catskill Formation demonstrates characteristic juvenile features such as a relatively large orbital fenestra and a low width/length ratio in the dorsal thoracic shield. The juveniles of the Catskill sample also demonstrate a previously unreported feature: the lack of a median ventral element. In its place is a large opening in the ventral trunk shield bordered by the anterior and posterior ventral laterals. The new sample of juvenile specimens was recovered from discrete lenses with similarly sized, articulated individuals. Many of the specimens are closely packed, though not overlapping, on the bedding planes. This taphonomic context suggests that the individuals of a single horizon belong to the same hatching group. We interpret this as mass mortality in an ephemeral aquatic setting, perhaps the drying of a small floodplain pond. This depositional history would indicate that *Bothriolepis* sp. produced large numbers of offspring in low-energy environments that may have been seasonally restricted and with low predator stress.

Technical Session X, Friday 10:15

USING MESOWEAR TO TEST WHETHER HYPSONDONT NOTOUNGULATES WERE GRAZERS

CROFT, Darin, Case Western Reserve University, Cleveland, OH, USA; WEINSTEIN, Deborah, Case Western Reserve University, Cleveland, OH, USA

The great diversity of high-crowned (hypsondont) mammals - especially notoungulates - in Oligocene (Tinguirirican and Deseadan SALMA) faunas suggests the presence of open habitats (e.g., savannas) in South America 10-15 million years earlier than in other continents. The lack of extant notoungulates precludes directly examining the correlation between hypsodonty and diet/habitat in this clade, but methods such as microwear, mesowear, and isotopes provide a quasi-independent test of hypsodonty and, potentially, the presence of open habitats. This study is the first to apply the mesowear method to notoungulates. We studied mesowear in three very hypsondont tyotheriid notoungulates from the Deseadan fauna of Salla, Bolivia: the "archaeohyracid" *Archaeohyrax* (an unnamed new species; N=16), the mesotheriid *Trachytherus* (an unnamed new species; N=19), and an unnamed intertheriid (Salla New Taxon B; N=21). Following standard procedures, buccal cusps of M2 (N=50) or other molars (N=6) were scored for relief (high or low) and shape (sharp, rounded, or blunt). The percentages of individuals of each taxon displaying high, sharp, and blunt cusps were then used to infer diet using hierarchical cluster and discriminant function analyses based on comparative data from 66 modern ungulates of known diet. *Archaeohyrax* is classified as a grazer in all analyses. *Trachytherus* is classified as a grazer (compared to 27 "typical" ungulates) or a mixed feeder (compared to all ungulates). The intertheriid is classified as a mixed feeder (compared to 27 "typical" ungulates), but clusters with various small browsers/mixed feeders when compared to all 66 modern ungulates. The mesowear data imply at least some open habitat feeding in all of these notoungulates, paralleling interpretations based on tooth crown height alone. Combined with microwear and isotopic studies of Miocene and younger notoungulates, this analysis suggests that the "precocious" hypsodonty of notoungulates was correlated with the appearance of more open habitats in the Oligocene, but that later notoungulates facultatively changed their diets (and, possibly, their habitats) to take advantage of available resources.

Technical Session XV, Saturday 11:45

MOTOR CONTROL OF MASTICATORY MUSCLES IN PLACENTAL AND MARSUPIAL HERBIVORES

CROMPTON, Alfred, Cambridge University, Cambridge, MA, USA; OWERKOWICZ, Tomasz, Harvard University, Irvine, CA, USA; LIEBERMAN, Daniel, Harvard University, Cambridge, MA, USA

The derivation of the diverse molar patterns of mammalian herbivores from primitive tribosphenic molars is well documented. An important aspect of the changes in molar structure is the accompanying modification in the neural control of jaw movements. The masticatory motor pattern in "primitive" insectivorous marsupials and placentals consists of overlapping activity in two muscle groups each of which includes working and balancing side muscles. While the way in which a primitive motor pattern and



dentition was modified in placental herbivores to break down tough vegetation is well documented, the same is not true for marsupial herbivores. In order to address this deficit synchronous recordings of jaw movements and EMG activity in adductor muscles during normal feeding in six Australian diprotodont marsupials: common brush-tailed possum, long-nosed potoroo, tamar wallaby, red kangaroo, koala, and the southern hairy-nosed wombat were obtained at the University of Adelaide. It is shown that possums retain the "primitive" motor pattern, but other marsupial herbivores modified this pattern in unique ways. Koalas, having lost the inflected angle of the dentary, evolved a pattern similar to that of placental herbivores. The macropods (potoroo, wallaby and kangaroo) divide the power stroke into two distinct occlusal phases: orthal and transverse, by using an altered triplet of working- and balancing side adductors. In contrast, wombats control the single transverse power stroke solely with the working-side adductors. The profound difference in tooth and jaw structures of placental and Australian marsupial herbivores developed when the Australian continent was virtually isolated from other landmasses. The current fauna of Australia is but a remnant of an earlier rich and diverse fauna. Information on the control of mastication in living Australian mammals will help interpret the dentition and skull structure of members of this fauna, including among others, bizarre forms such as giant diprotodontids, marsupial lions, short faced kangaroos and omnivorous kangaroos.

#### THE ISOTOPIC HISTORY OF WESTERN NORTH AMERICAN GRASSLANDS: WHEN GLOBAL RESULTS CANNOT BE USED TO INTERPRET LOCAL CONDITIONS

CROWLEY, Brooke, University of California, Santa Cruz, Santa Cruz, CA, USA; KOCH, Paul, University of California, Santa Cruz, Santa Cruz, CA, USA

It has been claimed that C4 plants became globally abundant 6-8 Ma, when numerous studies record a large shift in carbon isotopes, indicating a large increase in the amount of C4 grasses from localities all around the world. Results from these studies have been used to infer a global shift from C3 to C4-dominated systems at this time. Unlike most of the United States, grasslands in modern California and Nevada are not dominated by C4-grasses. These states have a water regime similar to the Mediterranean, with hot and dry summers and most precipitation occurring during cool, winter months. Because C4-dominated environments in North America correlate most closely with growing season temperature, it is not surprising that these western states, which have a cool, winter growing season, do not support C4 plants. However, it is likely that this was not always the case. Although there are currently no native C4 species living in California or Nevada, climatic conditions may have supported some C4 in the past. Because the water and climate regimes were so different here compared to the rest of the US, conclusions about the C4-history of the Great Plains cannot be used to interpret the history of California and Nevada. Carbon stable isotopes can be used to determine whether C4 plants in the western US were abundant enough to show up in fossil ungulate diets in the Neogene. Using  $\delta_{13}C$  from ungulate enamel as a proxy, this study attempts to quantify C4 plant abundance in California and Nevada from ~18 Ma to the present.

#### Student Poster Session (Thursday)

##### MULTIVARIATE ECOMORPHOLOGICAL ANALYSIS OF FEEDING BEHAVIOR IN AFRICAN SUIDAE (ARTIODACTYLA, MAMMALIA)

CUDDAHEE, Rebecca, SUNY Buffalo, Buffalo, NY, USA; BOBE, Rene, University of Georgia, Athens, GA, USA

Reconstructing the dietary preferences of extinct species is central to an understanding of their paleobiology and evolution. This work examines the relationship between mandibular morphology, habitat and diet preference in extant African suid genera (*Hylochoerus*, *Phacochoerus* and *Potamochoerus*). African suids were classified into the following habitat and dietary groups: (1) closed/mixed-feeders (*Hylochoerus*), (2) open/grazers (*Phacochoerus*), and (3) intermediate/omnivores (*Potamochoerus*). The Southeast Asian *Sus barbatus* was used as an out-group in the analysis. Twenty-five measurements of the mandible were taken on a sample of N=160 to explore possible mandibular adaptations related to feeding behavior. Differences among groups were assessed using independent samples T-test, analysis of variance, and discriminant function analysis. Results of this study demonstrate: (1) significant differences between groups, and (2) correct reclassification of taxa. Compared to other studies on ungulate feeding behavior, results from this study reveal that the height of the mandibular corpus is not an accurate predictor of dietary preference. In addition, *Phacochoerus* and *Hylochoerus* share morphological characteristics to the exclusion of *Potamochoerus*. These results are used to predict feeding behavior in Plio-Pleistocene East African fossil suids, including *Nyanzachoerus*, *Notochoerus*, *Metridiochoerus*, and *Kolpochoerus*, which formed an important part of East African mammalian faunas.

#### Student Poster Session (Thursday)

##### A NEW ANOPLOTHERIINE ARTIODACTYL FROM THE MIDDLE EOCENE OF THE IBERIAN PENINSULA

CUESTA, Miguel Ángel, Instituto de Educación Secundaria/IES Victorio Macho, Palencia, Spain; BADIOLA, Ainara, University of Zaragoza, Zaragoza, Spain

Europe was an archipelago from the Middle Eocene to the earliest Oligocene when important changes in faunal and floral composition occurred as a result of global climate change, plate tectonics and several immigration waves. One of the intra-Eocene faunal turnovers involving immigration took place around the Middle-Late Eocene transition on the Central European Island. Some of the incoming taxa are anoplotheriine artiodactyls. The first recorded representative (*Robiatherium*) appeared earlier, in the late Middle Eocene (MP 16), whereas others (*Anoplotherium* and *Diplobune*) arrived later, in the Late Eocene (MP 18). We describe here a new genus of Anoplotheriinae from the late Middle Eocene (MP 15-16) of Mazaterón, a site in western Iberia, in Soria, Spain. This site, together with those of central and western Iberia, contains Middle and Late Eocene mammal fossil assemblages (mainly primates, rodents and perissodactyls) clearly different from those of the north-Pyrenean and Mediterranean regions and the rest of Europe. They are categorized as the Western Iberian Bioprovince. The change from a complex forest habitat to a more open environment observed in the Late Eocene in several regions of Europe seems to have started in the Middle Eocene in the Western Iberian Bioprovince, influencing its faunal composition. However, relatively little is still known about the Middle Eocene artiodactyl fossil assemblages from this bioprovince. The discovery of the new anoplotheriine at Mazaterón is crucial for comparing the Middle Eocene artiodactyl faunal composition in both areas of Iberia and for investigating the origin and dispersal directions of anoplotheriines, which are still unresolved.

#### Poster Session IV (Saturday)

##### UNUSUAL TRACKS OF SMALL JUMPING RODENTS FROM THE TERTIARY OF COLORADO

CULVER, Toni, University of Colorado Museum, Boulder, CO, USA; CHIN, Karen, UC Santa Barbara, Boulder, CO, USA; LOCKLEY, Martin, Birmingham Univ, Denver, CO, USA

Re-evaluation of enigmatic track-bearing slabs of gray sandstone donated to both the University of Colorado at Boulder and the University of Colorado at Denver collections reveal delicate tracks of arthropods (insects: cf. *Hexapodichnus*) and larger, symmetric tracks, with a bilobed "tulip" shape, that superficially resemble those of a small ungulate. Although original museum labels promulgated the ungulate interpretation, our research suggests that the trackmakers were hopping rodents. Museum records show that these slabs originated from eolian facies in the Brown's Park Formation (Miocene) of northwest Colorado. On close inspection some bilobed tracks are associated with elongate tail traces, and are divided into a double set of bilobed traces with the broad posterior and narrow posterior regions more or less differentiated. The tracks are therefore interpreted as the spoor of small jumping rodents with the large and small bilobed traces respectively representing paired manus and pes impressions. Prior to the initiation of this study no similar jumping rodent tracks had been reported from the Tertiary fossil record, and only one example (ichnogenus *Ameghinichnus*), with different morphology, was known from the Jurassic of Argentina. However, a preliminary report of "hopping rodent" tracks from the Miocene, near Enterprise, Utah was published. The Utah tracks occur in reworked volcanic ash dated at between 11.8 and 13.5 Ma (late Barstovian or possibly early Clarendonian). They compare favorably in size, morphology and quality of preservation with the tracks from Colorado. The association of small mammaloid and arthropod tracks (*Chelichnus-Octopodichnus* ichnofacies) in the Late Paleozoic and Mesozoic has been much discussed, but these are the first Tertiary records of such associations.

#### Technical Session I, Wednesday 10:00

##### PATTERNS OF DENTAL PATHOLOGY IN SYMPATRIC LIVING LEMURS (*LEMUR CATTALINA* AND *PROPTHECUS VERREAUXI*) INDICATE EVOLUTIONARY DISEQUILIBRIUM IN MADAGASCAR

CUOZZO, Frank, University of North Dakota, Grand Forks, ND, USA; SAUTHER, Michelle, University of Colorado, Boulder, CO, USA

The living and recently extinct lemurs of Madagascar formed a richer primate community than exists today. Extinction of large lemur forms (>10 kg) may have created new niches for the remaining lemur species, which has led to the Evolutionary Disequilibrium Hypothesis (EVDH). EVDH suggests that this extinction, along with the extinction of major large predators, allowed previously nocturnal forms to move into new cathemeral and diurnal niches for which they may not be behaviorally adapted. Our recent work indicates that there are anatomical indicators of such discordance. Here we assess patterns of dental pathology in two diurnal extant lemurs at the Beza Mahafaly Special Reserve (BMSR) as potential indicators of EVDH. Previous data on BMSR gallery forest ring-tailed lemurs indicate a mismatch between consumption of a key, fallback food (tamarind fruit) and dental morphology. Processing this large, hard fruit results in a high frequency of tooth loss (35% of all skeletal specimens [n = 27] at

BMSR). In contrast, folivorous Verreaux's sifaka exhibit 6% tooth loss in the skeletal sample (n = 69). However, 29% of this sifaka sample exhibit maxillary canine abscesses, with six of the 20 individuals having both canines abscessed. In at least two individuals, the infection became systemic, likely resulting in their deaths. Behavioral observations indicate that processing broad gallery forest leaves with their anterior dentition causes heavy canine wear, resulting in exposure of the pulp cavity and subsequent infection and abscesses in Verreaux's sifaka. Despite displaying significantly more tooth loss, sympatric ring-tailed lemurs display far fewer canine abscesses (15%). Given the recent extinction of five large (>10 kg) lemur species in the BMSR region over the past two millennia, data on patterns of dental pathology indicate that these two extant species regularly exploit resources for which they are not dentally adapted, thus suggesting evolutionary disequilibrium. These data illustrate the value of assessing patterns of dental pathology when interpreting primate paleobiology.

#### Poster Session II (Thursday)

##### A METHODOLOGY FOR REMOVING FOSSILS FROM THE KOANAKA HILLS DEPOSIT

CURETON, James, Sam Houston State University, Huntsville, TX, USA; LEWIS, Patrick, Sam Houston State University, Huntsville, TX, USA; THIES, Monte, Sam Houston State University, Huntsville, TX, USA

The excavation of cave deposits in the Koanaka Hills, western Ngamiland, Botswana has produced a large and varied fossil assemblage. These fossils have been dated to approximately 390,000 BP using thermoluminescence and are associated with a new species of fossil baboon. In order to better understand the paleoenvironment of the baboon, current research is attempting to identify the small animals present in the deposit and use them as proxy data for the past environment. These small fossils, however, are imbedded in a calcium carbonate matrix and difficult to remove without substantial damage. The goal of this research project is, therefore, to develop a methodology for extracting fossils from the matrix in a timely, inexpensive manner without damaging the fossils. Acetic acid is a weak acid used to break down calcium carbonate into calcium acetate, water, and carbon dioxide. Adding acetic acid water breaks down the matrix while minimally degrading the fossils. Variables such as an open/closed system, acetic acid concentration, matrix size, solution volume, and temperature are all being tested to determine an optimum methodology for breaking down the matrix from the Koanaka Hills deposit. Thus far, open samples treated with 5-6.5% acetic acid concentrations are most effective, dissolving the matrix in a relatively short period of time (1-3 days) while minimally degrading the fossils (1-2% loss of mass per specimen). Temperature does not have a predictable effect on dissolving the matrix; however, degradation rate is inversely correlated with matrix nodule size. New variables are still being tested and promise to provide an easy method for removing the fossils from the Koanaka Hills deposit while minimizing the risk of damaging embedded fossils.

#### Student Poster Session (Thursday)

##### CERVID ECOMORPHOLOGY AND HOMININ PALEOECOLOGY

CURRAN, Sabrina, University of Minnesota, Minneapolis, MN, USA

This study investigates the relationship of Cervidae hindlimb skeletal morphology and adaptations to specific habitats. Using extant cervids with known habitat preferences, a database of several aspects of joint and entheses morphology is constructed to which fossil cervid specimens can be compared. The goal is to use fossil cervids, often the dominant taxa in Eurasian paleoanthropological assemblages, as proxies in paleohabitat reconstruction. Ecomorphological studies have been conducted on Bovidae, but studies utilizing cervid ecomorphology are lacking. Cervids are generally thought of as woodland/forest browsers, however, cervid species are found in habitats ranging from tundra to tropical forests to open grasslands and occupy trophic niches as grazers, mixed-feeders, and browsers. While not as habitat-specific as bovids, cervids do demonstrate marked variation in skeletal morphology as it relates to locomoting in different habitats. This study quantifies variation in two units of analysis. First, joints are the points of contact between two bones and the morphology of joint surfaces limits how stable a joint is, and how much and what type of movement can occur between elements. This research quantifies the shape of several joint margins and surfaces and evaluates how they reflect the range and type of motion in cervid joints using outline-based geometric morphometrics (GM). Secondly, muscles provide the contractive forces that move bones in relation to one another. This study quantifies the size, shape, location, and rugosity of muscle scars, which indicate how a muscle was recruited in a cervid's locomotor behavior. The combined results from GM analyses of joint morphology and muscle scar analysis provide precise reconstructions of cervid ecomorphology. Principal components analyses and canonical variates analyses of several morphological characters are presented showing good separation between habitat types.

#### Technical Session XVII, Saturday 1:30

##### NEW DATA ON 'MALAGASY TAXON B,' A TITANOSAUR FROM THE LATE CRETACEOUS OF MADAGASCAR

CURRY ROGERS, Kristina, Science Museum of Minnesota, Saint Paul, MN, USA; IMKER, Melanie, University of St. Thomas, Saint Paul, MN, USA

The report of *Titanosaurus madagascariensis* in 1896 marked the first discovery of sauropods in the Upper Cretaceous of Madagascar. Since that time, additional material has been recovered that both clarifies and complicates the story of titanosaur anatomy, taxonomy, and evolution. At least two species of titanosaurs are present in the Maevarano Formation that can be readily distinguished on the basis of caudal vertebral morphology, even in the syntype of *T. madagascariensis*. *Rapetosaurus krausei* is known from a virtually complete record of juvenile and adult cranial and postcranial material. *Rapetosaurus* caudals are characterized by procoelous centra that retain a general 1:1 width to height ratio throughout the caudal series, and exhibit the anteriorly placed neural arches and high, laminar, posteriorly sweeping neural spines associated with other closely related titanosaur taxa. The second Malagasy titanosaur, 'Malagasy Taxon B' has remained more poorly understood with only a few isolated, but distinctive caudal vertebrae hinting at its presence. Here we report new data on 'Malagasy Taxon B' that clarify its anatomy in other regions of the caudal series, the forelimb, the pectoral girdle, and the skull. Extreme dorsoventral compression of caudal centra in 'Malagasy Taxon B' impart a subrectangular cross-sectional shape with a width to height ratio ranging from 2:1 to 3:1. Centra vary from extremely procoelous, to biconvex, to biconcave, and become increasingly elongated more posteriorly. Neural arches are generally anteriorly positioned, but are low and broad. A scapuloacoracoid confirms the presence of the infraglenoid lip, enlarged coracoid foramen, and quadrangular morphology of the coracoid, and provides the first look at the scapula. An articulated radius and ulna are more robust than known in *Rapetosaurus*, with more poorly defined interosseous crests and extremely broad proximal ends. Finally, a partial, newly discovered skull (occipital condyle, exoccipital-opisthotic, paroccipital processes, basicranium) exhibits significant departures from the known skulls of *Rapetosaurus*.

#### Technical Session IX, Friday 10:30

##### PLEUROKINESIS REVISITED, KINETIC LIMITATIONS OF CRANIAL JOINTS IN HADROSAURINE DINOSAURS

CUTHBERTSON, Robin, University of Calgary, Calgary, AB, Canada

Pleurokinesis, a complex cranial kinetic model, has been proposed for all ornithomimid dinosaurs. In hadrosaurids, this hypothesized chewing mechanism includes vertical adduction of the mandible with lateral displacement of the maxilla in combination with posterolateral movement of the quadrate. These primary actions drive a series of linked secondary motions (described below). However, based on the kinematic limitations imposed by joint structure, this collective series of motions cannot be recreated in *Brachylophosaurus canadensis* or *Edmontosaurus regalis*. Lateral movement of the maxilla is prevented by the structure of the joint between the anterior maxillary process and the premaxilla, and the articulation of the stationary lacrimal with the dorsolateral surface of the maxilla. Posterolateral rotation of the quadrate is also doubtful because this element forms a broad contact with the pterygoid, which in turn is rigidly linked to the palatine. Additional kinematic limitations render most of the imposed secondary movements unlikely. A scarf joint between the postorbital and jugal effectively prevents translocation, and there is no evidence that the quadratojugal was capable of disarticulating from the quadrate. The proposed cylindrical movement between the pterygoid process of the basisphenoid and the pterygoid seems possible if this joint is considered in isolation, but, as noted above, the movement of the pterygoid is limited by its articulation with the palatine and quadrate. Movements that seem most likely are associated with the mandible, but they are not motions hypothesized by the pleurokinetic model. The structure of the mandibular glenoid, in particular the relatively broad and shallow articular surface of the surangular, appears capable of accommodating minimal translational movements, as well as rotation of the mandible about the quadrate condyle. Accordingly, a simplified model based on a rigid maxilla and lower jaw exhibiting limited freedom at its mandibular glenoid cannot be rejected. Further comparison of cranial joint morphology is required to establish whether a simplified chewing mechanism was present in the remaining hadrosaur taxa.

#### Evolutionary History of Bats Symposium, Thursday 11:15

##### NEW BASAL NOCTILIONOID BATS FROM THE OLIGOCENE OF FLORIDA, USA

CZAPLEWSKI, Nicholas, Oklahoma Museum of Natural History, Norman, OK, USA; MORGAN, Gary, New Mexico Museum of Natural History, Albuquerque, NM, USA

A number of Oligocene and Miocene localities in Florida have produced abundant microvertebrate fossils including rare specimens of Chiroptera, a group with a sparse pre-Pleistocene record in North America. At two of the localities, I-75 and Brooksville 2, the bats include several specimens of a large and a small species, both belonging to an undescribed new genus, probably of a new family. The samples overlap in including an upper molar of each species; this tooth is identical in the large and small species

except for size. Only the large species is present in the Brooksville 2 fauna, where a better sample is available including an upper molar and all of the lower teeth except the incisors. The Brooksville 2 local fauna represents the late early Arikarean LMA (25–28 Ma; late Oligocene). Each of the two species is represented by a single tooth in the I-75 local fauna, which we interpret as being late Whitneyan LMA (about 30 Ma; late early Oligocene) in age. Parsimony analysis of available dental-osteological data suggests that the new bats are sister to a mystacinid-noctilionid-mormoopid clade, which in turn is sister to Phyllostomidae. The two species of the new family co-occur in the same localities with a new genus and species of mormoopid; together the three are the earliest known representatives of the Noctilionoidea. The age of these specimens more than doubles the known time depth of the noctilionoid lineage, previously known back to 12–13 Ma (Laventan LMA) in South America. Both of the Florida localities reflect deposition in paleokarstic situations and suggest a probable cave-dwelling habit for the bats. Several other families of bats also occur in various other late Oligocene and early Miocene sites in Florida (Emballonuridae, Mormoopidae, and Natalidae). Biogeographically, the occurrence of the new noctilionoids and these other families in what is now peninsular Florida, where these groups no longer exist, bolsters other faunal data suggesting a subtropical to tropical aspect to the Florida paleoenvironment in the middle Cenozoic, and a Neotropical influence or possible tropical North American origin for the Noctilionoidea.

#### Poster Session IV (Saturday)

##### THE FIRST DEFINITIVE TITANOSAUR (SAUROPODA) OSTEODERM FROM INDIA AND THE NATURE OF THE TITANOSAUR OSTEODERM RECORD

D'EMIC, Michael, University of Michigan, Ann Arbor, MI, USA; WILSON, Jeffrey, University of Michigan, Ann Arbor, MI, USA; CHATTERJEE, Sankar, Texas Tech University, Lubbock, TX, USA

Titanosaurs are the only sauropods that possessed osteoderms, although the phylogenetic distribution of this feature within the clade is not yet resolved. Whereas the majority of titanosaur osteoderms are from South America, several have been found in Cretaceous rocks in Africa, Madagascar, and Europe. Here we describe a titanosaur osteoderm from the Maastrichtian of India that extends the known geographic range of these “armored” sauropods. The element, originally found and ascribed to an ankylosaur by Barnum Brown in 1922, is one of the largest known osteoderms. It is elliptical and bears a convex external surface and a flat internal surface. The external surface is heavily ornamented and the internal surface bears a crosshatched texture similar to that seen in other archosaurs. Its edges are rugose and lack articular surfaces, suggesting that it did not have bony contact with other osteoderms. This appears to be a general pattern for titanosaur osteoderms. This Indian element is most similar in shape and size to osteoderms recovered from the Early Cretaceous of Mali and Malawi. The spatiotemporal distribution of titanosaur osteoderms is broader than the distribution of titanosaur osteoderms, which implies that (1) few titanosaur genera had osteoderms, (2) titanosaur osteoderms were not heavily armored, and/or (3) there are strong collection and taphonomic biases against these elements. More than 80 individual titanosaur osteoderms have been reported in the literature and can be assigned to ten of the 41 currently recognized titanosaur genera. Although they are not divisible into discrete size classes, titanosaur osteoderms are here shown to fall into four morphotypes: “ellipsoid,” “keeled,” “puck,” and “ossicle.” No morphotype is unique to any one taxonomic group, geographic area, or time period. Despite the relative scarcity of osteoderms, all known osteoderm-bearing titanosaur taxa are relatively diminutive in body size, with average femoral and humeral lengths that are 50% and 60% of the lengths of “unarmored” taxa, respectively.

#### Technical Session VII, Thursday 3:45

##### CLADISTIC ANALYSIS OF THE ENCHODONTOIDEI (TELEOSTEI: AULOPIFORMES)

DA SILVA, Hilda, Universidade do Estado do Rio de Janeiro, Instituto de Biologia, Departamento de Zoologia, Rio de Janeiro, Brazil; GALLO, Valéria, Universidade do Estado do Rio de Janeiro, Instituto de Biologia, Departamento de Zoologia, Rio de Janeiro, Brazil

Enchodontoidei are represented by extinct marine teleosts, generally with an elongate body, and long and narrow rod-like maxilla included in the mouth gape. They possess a long temporal range, extending from the Early Cretaceous to the Early Eocene, and a wide geographic distribution, being found in sedimentary deposits of South America (e.g., Bolivia and Brazil), Africa (e.g., Democratic Republic of Congo, Egypt, and Morocco), Europe (e.g., Belgium, England, Germany, Holland, Italy, and Sweden), Asia (e.g., Arabian Peninsula, India, Israel, Japan, and Lebanon), and North America (Canada, Mexico, and United States). Due to the lack of a comprehensive phylogenetic study for Enchodontoidei, we performed a parsimony analysis using a data matrix built with 87 characters, 31 terminal taxa for ingroup, and three taxa for outgroup. A heuristic algorithm of the computer program PAUP\* 4.0b10 was used. The analysis produced 52 equally parsimonious trees, with 435 steps, consistency index of 0.24, and retention index of 0.49. The strict consensus tree is represented by the following topology: (((new Brazilian Aulopiformes, (*Protostomias*, (*Yabrudichthys*, *Apateopholis*))),

(*Trachinocephalus*, (*Apateodus*), (*Ichthyotringa*), (*Apuliadercetus*), (*Caudadercetus*, (*Pelagorhynchus*, (*Nardodercetus*, (*Rhynchodercetus*, (*Hastichthys*, *Dercetoides*))))), (*Benthesikyme*), (*Cyranichthys*, *Robertichthys*), (*Dercetis*, *Ophidercetus*), (*Brazilodercetus*))), (*Serrilepis*, (*Cimolichthys*, (*Paranchodus*, (*Enchodus*, (*Palaeolycus*, (*Eurypholis*, *Saurorhamphus*))))), (*Halec*, *Phylactocephalus*), (*Prionolepis*), (*Hemisaurida*), (*Rharbichthys*), *Nardorex*). This analysis revealed that Enchodontoidei is not a monophyletic group, not allowing a new taxonomic classification for Enchodontoidei in the cladistic context. Also, the Apateopholidae is not a monophyletic group due to *Apateopholis* is sister-group of *Yabrudichthys*. The Dercetidae forms a clade supported by a single synapomorphy (very reduced neural spine) and shows a new arrangement. The Enchodontidae is monophyletic, but excluding *Rharbichthys* for its composition. Yet, the Halecidae possesses a new arrangement, with the exclusion of *Hemisaurida*. *Nardorex* and *Prionolepis* are Aulopiformes *incertae sedis*.

#### Technical Session VII, Thursday 2:00

##### NEW DATA ON *HYNERIA LINDAE* (SARCOPTERYGII; TRISTICHOPTERIDAE) FROM THE LATE DEVONIAN OF PENNSYLVANIA, USA

DAESCHLER, Edward, Academy of Natural Sciences, Philadelphia, PA, USA; SHUBIN, Neil, University of Chicago, Chicago, IL, USA

*Hyneria lindae* was the first taxon described from the Red Hill locality in Pennsylvania (Catskill Formation; Upper Devonian). A renewed collecting effort at the site beginning in 1993 has recovered a diverse flora and fauna including abundant new material of *H. lindae* that informs an amended diagnosis and phylogenetic treatment of the taxon. New material of *H. lindae* from Red Hill includes lower jaws, palate, snout, cheek, and skull roof as well as fin elements and abundant scales. Closely related tristichopterids from other Late Devonian sites around the world add paleobiogeographic context to the Pennsylvania discoveries. The monophyletic Tristichopteridae is characterized by cycloid scales with a median boss, vomers with a long caudal process, and the presence of a postspiracular bone. Features that *H. lindae* shares with other derived tristichopterids include contact between the lacrimal and posterior supraorbital that excludes the jugal and postorbital from the orbital margin, presence of a premaxillary fang, and lack of contact between the posterior supraorbital and intertemporal. Features unique to *Hyneria* include cycloid scales with a deeply folded margin along the trailing edge and wide vomers with a caudal process that extends at least 45% of the length of the parasphenoid. Preliminary cladistic analysis places *H. lindae* as the sister group to the large, derived, Famennian-age *Eusthenodon* spp. from Greenland, Russia, Belgium, Australia and South Africa. This cosmopolitan distribution suggests that intercontinental dispersal of these tristichopterids was possible during the Famennian Age when Euramerican and Gondwanan landmasses moved into closer proximity. Although *H. lindae* has only been recognized from the Red Hill site, re-diagnosis of the taxon allows identification of *Hyneria* sp. from at least two other Catskill Formation sites in Pennsylvania.

#### Technical Session IV, Wednesday 3:15

##### THE ROLE OF SOFT TISSUES IN SEDIMENT INFILLING AND PATTERNING: AN ACTUALISTIC STUDY WITH OSTRICH HEADS

DANIEL, Joseph, Ohio University, Athens, OH, USA; WITMER, Lawrence, Ohio University, Athens, OH, USA

Soft-tissue reconstruction in extinct animals is complicated by its rare and ambiguous preservation. A potentially new source of data may be found in the sediment that buries the body. Patterns within the sediment may be due to factors inherent in sediment infilling, biological activity, or some combination. Due to their complicated construction, fleshy heads and dried skulls may sort sediment, and this sorting may be influenced by soft tissue. If this hypothesis is corroborated, anatomical information may remain in the matrix even after the tissue degrades. CT scans have revealed density variations within several fossil skulls. The layered matrix in a *Hypacrosaurus* premaxilla may be explained solely by physical processes, but more difficult to explain is why matrix within the pneumatic sinuses of *Nanotyrannus* is lower in density compared to matrix elsewhere in the skull. To address this question, we are performing actualistic taphonomic studies using two flumes designed to emulate salient aspects of river deposition while controlling the aqueous depositional environment and sediment composition: one uses deep, slow-moving water, the other shallow, fast-flowing water. After burial in the flumes, ostrich heads were CT scanned and sediment patterns mapped. Sediment samples were taken from different parts of some sectioned heads for comparison with density measurements from the CT scans. Differences in sediment patterns were found in ostrich heads of various initial states (fresh, dried, partially decomposed, and clean skulls). For example, quick burial with wet sediment partially filled the oral and nasal cavities, but air remained in all sinuses. Fresh heads buried in the deep flume for over 14 hours retained air in the paratympic sinuses, but water and sediment filled the remaining sinuses and cavities. These data provide a baseline for interpretation of CT scans of matrix-filled fossils, possibly allowing us to extract more anatomical information. It may also allow us to identify optimal soft-tissue preservational environments, such that fieldwork can target promising rock units. Further work will be done on long-term burials of ostrich and pig heads.

Poster Session I (Wednesday)

NEW DATA ON SOFT-SHELLED TURTLES (TRIONYCHIDAE) FROM THE BISSEKTY FORMATION (LATE TURONIAN) OF DZHARAKUDUK, UZBEKISTAN

DANILOV, Igor, Zoological Institute of the Russian Academy of Sciences, St. Petersburg, Russia

Two forms of trionychids have been reported from the Bissekty Formation (Late Turonian) of Dzharakuduk, Uzbekistan: 1) *Khunnuchelys kizylkumensis* [Kh. k.] and 2) an undescribed "trionychid with slender jaws". A partial braincase of the 2nd form was found by URBAC team in 2006. Examination of this specimen and other available materials (jaw fragments), shows that the 2nd trionychid differs from *Kh. k.*, besides slender jaws, by the following characters: the skull is narrower and with a longer snout; the external narial opening is located less ventral to the orbits; the orbits face dorsolaterally; the internal nares are located more anteriorly and roofed by the maxilla; the palatine does not contribute to the triturating surface; the jugal is not excluded from the orbital margin; large parietal contribution to the processus trochlearis oticum; no ridge between incisura columellae auris and posterior wall of the cavum tympani; the basisphenoid is narrowed anteriorly; the basioccipital part of the skull is not shortened, the foramina posterius canalis carotici interni are located on the level of the basisphenoid/basioccipital suture; two pairs of the foramina nervi hypoglossi. The large parietal contribution to the processus trochlearis oticum suggests assignment of the 2nd trionychid to the Trionychini, whereas systematic position of *Kh. k.* remains unclear within the Trionychinae. The Trionychini from Dzharakuduk represent the oldest known record of this tribe. Study of abundant but fragmentary shell material of Dzharakuduk trionychids is needed to establish skull/shell associations and clarify their systematic position.

Preparators' Session, Thursday 8:45

PREPARING TO PREPARE YOUR FOSSIL VERTEBRATE: SET-UPS TO MAXIMIZE SPEED AND CONTROL

DAVIDSON, Amy, American Museum of Natural History, New York, NY, USA

Fossil preparation in lab conditions should not resemble erosion in the field, and yet an impatience to "just chisel it out" can result in similar deterioration and loss. If preparation is out of control it is most effective to stop and ask why. Perhaps the specimen needs to be more consolidated, bound more tightly or mounted more securely for handling. Or maybe you need to adjust your workspace to put yourself in a more comfortable and braced position, help you see better, or allow you to reach with ease for another tool or another adhesive to try. In the long run, taking the time to make these adjustments greatly increases efficiency and the quality of the end product. Set-ups for specimens can be anything from simple to complex, creative design projects. Examples are provided of consolidation and coating with Butvars B76, B98 and Acryloid/Paraloid B72. The filling of gaps and cracks with bonded sand is discussed. Also discussed are other materials useful for temporary facings, backings, bindings and supports. These include bonded paper, aluminum foil, plaster and plaster bandage, Duco cement and fiberglass, carbowax and cyclododecane. Workspace adjustment can also be as simple as adding a strategically placed sandbag, but sometimes a more time-consuming renovation is necessary. Adjustable equipment and quick adjustments are discussed, including table and seating height, microscope and lighting adjustments. Also illustrated are a collapsible, fragment-retrieving liner for an enclosed booth, the well-crafted sandbag, an air pedal and other ways to clear detritus, an Ethafoam holster and other systems for keeping tools and supplies stored but close to hand.

Poster Session II (Thursday)

SILICONE CAULK MOLDS: A 25 YEAR RETROSPECTIVE

DAVIES, Kyle, SNOMNH, Norman, OK, USA; RAINEY, Robert, Texas Memorial Museum, Austin, TX, USA

Pure silicone caulking compound, as used in the construction trade, has been used to make reasonably detailed, robust molds of fossil bones for at least a quarter of a century. Some of the oldest surviving molds of this style are still viable, showing a good lifespan under use and storage. The technique used can be rough on delicate specimens and attention must be paid to whether a specimen is sensitive to the minor amounts of acetic acid generated as part of the caulk's curing. This technique is best used for remolding existing casts or reconstruction models. Making such a mold requires coating the specimen with paste wax and buffing, followed by application of thin silicone caulk or regular caulk thinned with paint thinner to pick up detail. Allowing for curing between layers, the detail coat is followed by a thin layer and then a thick layer of regular caulk. Standard mother molds of plaster, resin, or fiberglass complete the process. Regular mold lay-ups can be used, provided the lay-up barriers are sealed and waxed, or a single, full-specimen caulk covering can be done that is then cut open with a "keying" knife or tool. The method is labor intensive. However, the long life and robustness of the molds makes them useful for items having sporadic but long-term demand.

Poster Session IV (Saturday)

MAMMALIAN FAUNA OF THE EAGLE FORMATION (LATE CRETACEOUS: UPPER SANTONIAN), NORTH CENTRAL MONTANA

DAVIS, Brian, University of Oklahoma, Norman, OK, USA

The Aquilan Land Mammal Age (late Santonian-early Campanian) was an important period in the evolution of early higher mammals. Recorded during this transition are first appearances of significant "alphadontid" and stagodontid marsupials, as well as an important diversification event for Late Cretaceous multituberculates. The Aquilan also marks the last known occurrences of triconodontid and symmetrodontan mammals. The only well represented mammalian faunas so far assigned to the Aquilan are from the Milk River Formation from southern Alberta (type fauna) and the Wahweap Formation from southern Utah. Vertebrate fossils were first discovered in the Eagle Formation, which crops out in north-central Montana, during the summer of 2004. Small samples were collected and processed by OMNH field parties during 2004 and 2005, yielding abundant and diverse mammalian remains. The Eagle Formation is laterally equivalent to the Milk River Formation, and many of the same mammals are present in both units. Represented in the fauna are at least 12 different taxa, including the spalacotheriid *Symmetrodontoides*, the "tribotheres" *Picopsis* and *Potamotelses*, the "alphadontids" *Varalphadon* and *Albertatherium*, the pedomioid *Aquiladelphs*, and at least four different multituberculates. The size of this mammalian fauna given the small rock sample collected underscores the importance of the Eagle Formation in adding to our understanding of mammalian evolution during the Late Cretaceous of North America.

Technical Session VI, Thursday 2:30

MULTIVARIATE ANALYSIS OF ASTRAGALI INDICATES LITTLE DIVERGENCE BETWEEN *ILINGOCEROS* AND *SPHENOPHALOS* IN THE THOUSAND CREEK FORMATION, NEVADA

DAVIS, Edward, University of Oregon, Eugene, OR, USA

The Hemphillian (~8Ma) Thousand Creek Fauna of northwestern Nevada contains three species of closely related antilocaprids in two genera, *Ilingoceros alexandrae*, *I. schizoceros*, and *Sphenophalos nevadanus*. These species were diagnosed on the basis of their distinct horn morphology, but little work has been done concerning their dental or postcranial differentiation. I test for morphological and body-size differentiation through a multivariate analysis of >200 astragali. I also test whether *I. schizoceros*, a smaller form, might be a female or juvenile form of *I. alexandrae*. While there is enough variation in the astragalar dimensions of antilocaprids from Thousand Creek, NV, to suspect that more than one species is present the distribution of astragalar dimensions does not contain any natural breaks. Seven of the eight sets of measurements of these astragali do not significantly deviate from normal distributions. When combined with the differences in the horn morphologies of the two genera, these data suggest that differences in reproductive behaviors and a slight difference in body size kept the two genera distinct while similarities in other aspects of their ecologies created a continuous distribution of astragalar dimensions. Taphonomic averaging may have contributed to the smoothness of the data. The lack of clear breaks between taxa suggests that *I. alexandrae* and *I. schizoceros* are actually only a single species.

Poster Session IV (Saturday)

*HYPOLAGUS* (MAMMALIA, LAGOMORPHA, LEPORIDAE) FROM THE PIPE CREEK SINKHOLE, LATE NEOGENE, GRANT COUNTY, INDIANA, USA

DAWSON, Mary, Carnegie Museum of Natural History, Pittsburgh, PA, USA; FARLOW, James, IPFW, Fort Wayne, IN, USA; ARGAST, Anne, IPFW, Fort Wayne, IN, USA

Quarrying in northeast Indiana (Pipe Creek Jr. Quarry, Swayzee, Grant County), uncovered fossiliferous, mostly unconsolidated sinkhole pond sediments buried beneath Pleistocene till. The paleobiota is abundant and diverse, and includes plants, invertebrates, and large and small vertebrates; the mammalian assemblage suggests a late Hemphillian age. Among the small mammals is a species of the leporid *Hypolagus*, represented by a partial left mandible, 14 isolated teeth, and a few fragments of the appendicular skeleton. The Pipe Creek Sinkhole (PCS) *Hypolagus* is characterized by having a p3 with a shallow anteroexternal reentrant and a long, straight walled, posteroexternal reentrant, the latter crossing about 69% of the tooth width. Upper cheek teeth have long (crossing 58% of tooth width on P3 or P4), renulinated to smooth hypostria. The PCS hare differs from previously named species of *Hypolagus* in size and/or dental characters, and so likely represents a new species. As such, it adds another new small mammal species to the PCS fauna, emphasizing the distinctiveness of this late Neogene assemblage from faunas in other parts of North America. Judging from fossils collected to date, the PCS *Hypolagus* was considerably less abundant than mice in the life assemblage, but possibly about as abundant as some of the ungulates. It could well have been prey of carnivorans and possibly some of the larger snakes in the PCS fauna.

Poster Session IV (Saturday)

MEASUREMENTS OF VASCULATURE IN *TYRANNOSAURUS REX* SHOW A RELATIONSHIP BETWEEN GROWTH RATE AND VASCULATURE ORIENTATION

DE BOEF, Maria, Redpath Museum, McGill University, Montreal, QB, Canada; LARSSON, Hans, Redpath Museum, McGill University, Montreal, QB, Canada; HORNER, John, Museum of the Rockies, Bozeman, MT, USA

By analyzing growth lines present in bone microstructure, several researchers have observed that tyrannosaurids tended to grow more quickly early in ontogeny and slow their growth as they matured. This group is well suited to such analyses due to the large number of samples collected and the willingness of their holders to section them. It has also been noted in both extinct and extant species that the orientation of bone vasculature varies predictably with growth rate. In this study sections from an ontogenetic series of *Tyrannosaurus rex* specimens were analyzed. Measurements of bone vascular orientation and osteocyte lacunae density were taken and compared to growth lines and predicted growth rates. It was found that when bone is being laid down more quickly, early in life, bone vascular orientation is more radially. However, as the animals aged and growth slowed bone orientation was found to become more laminar and later longitudinal. Finally, in the final stages of growth, bone becomes avascular. These relationships are similar to what has been found in other species and suggests a highly conserved pattern of development. A discussion of bone microstructure in extant species, particularly with respect to patterns in growth line formation will be included.

Technical Session I, Wednesday 11:45

ANIMAL PALEOCOMMUNITY VARIABILITY AND HABITAT SPECIFICITY OF *AUSTRALOPITHECUS ROBUSTUS* IN SOUTH AFRICA

DE RUITER, Darryl, Texas A&M University, College Station, TX, USA

The paleoenvironment associated with the Plio-Pleistocene hominin *Australopithecus robustus* has typically been reconstructed as an open, arid grassland. However, recent studies have suggested that *A. robustus* occupied a habitat mosaic, with some form of nearby woodland or forest in the vicinity of a permanent water source. Disentangling which aspect(s) of such a mosaic might have been occupied by the hominins presents a significant challenge. The aim of this study is to enhance our resolution of hominin paleocommunity structure in order to test which ecological conditions might have been favored/avoided by *A. robustus*. Faunal assemblage data were collected from the hominin-bearing deposits in the Sterkfontein Valley of South Africa. Conditions of isotaphonomy between deposits were assessed, and taphonomically biased assemblages were removed from consideration. A selection of environmentally sensitive taxa was assigned to a series of ecological categories based on isotopic, ecomorphological and taxonomic evidence. Correspondence analysis was used to assess changes in faunal composition between assemblages. Diversity indices and chord distance measures were employed to evaluate the significance of fluctuations in relative abundance of these categories. Results indicate that there is a weak, positive association of *A. robustus* with the more closed portion of the habitat mosaic, and a strong, negative association with the more open segment. Although *A. robustus* fossils are found in association with predominantly grassland-adapted faunas, these data indicate that the more grassland taxa there are in an assemblage, the fewer hominins there tend to be. This casts considerable doubt on any interpretation of *A. robustus* as an open, arid adapted taxon. Recent advances in the isotope ecology of *A. robustus* provide additional insight into our understanding of habitat preference/avoidance of this early hominin.

Student Poster Session (Thursday)

NEW LATE EOCENE FOSSIL PERISSODACTYLS FROM THOUSAND LAKE MOUNTAIN, CENTRAL UTAH

DEBLIEUX, Donald, Utah Geological Survey, Salt Lake City, UT, USA; KIRKLAND, James, Utah Geological Survey, Salt Lake City, UT, USA; BIEK, Robert, Utah Geological Survey, Salt Lake City, UT, USA; KUEHNE, Paul, Utah Geological Survey, Salt Lake City, UT, USA; WILLIS, Grant, Utah Geological Survey, Salt Lake City, UT, USA

In 2005, Utah Geological Survey (UGS) geologists were mapping a coarse clastic rock unit of unknown age on Thousand Lake Mountain in Sevier County, Utah. This unit is composed of unconsolidated sand and coarse gravel of presumed fluvial origin, and is unconformably underlain by Late Cretaceous rocks and capped by Oligocene volcanics. Previous workers hypothesized that these rocks correlate with the Paleocene Flagstaff Fm. During their investigation, the UGS geologists found a right dentary fragment of a perissodactyl preserving three molars. Based on the molar morphology, we identify this jaw as belonging to the basal rhinocerotid genus *Téletaceras*. Molar dimensions fall below the range of *T. radynskyi* from the Eocene Clarno Fm. of Oregon. At over 10,000 feet in elevation, this is the highest-altitude vertebrate fossil found in Utah, and the first report of this genus in Utah. During a subsequent visit to the area in 2006, we discovered a partial skull of a brontothere that preserves most of the anterior portion of the skull including the palate and a damaged, but complete, set of upper teeth. Based on the presence of two upper incisors and details of the molar morphology, we identify this specimen as *Duchesneodus uintensis*. Together, the two recently discovered fossils

indicate a Duchesnean Land Mammal Age (42-37 Ma) for these rocks. A Duchesnean age for these rocks shows that they are not related to the Paleocene Flagstaff Fm. Another specimen of *Duchesneodus* was reported from the Eocene Green River Fm. 100 kilometers north of this site in Sanpete County. The Green River Fm. in central Utah appears to be younger than it is in northeastern Utah and Wyoming where it lies below the Uinta and Duchesne River Fms. The rocks on Thousand Lake Mountain may be correlative with the upper Eocene Crazy Hollow Fm. that interfingers with the Green River Fm. in central Utah. The discovery of identifiable vertebrate fossils has provided important age data in addition to providing significant paleontological information.

Poster Session IV (Saturday)

TEMPOS AND MODES OF THEROPOD EVOLUTION.

DECECCHI, Thomas, McGill University, Montreal, QB, Canada; LARSSON, Hans, McGill University, Montreal, QB, Canada

Genomic clocks, a method for dating lineage divergences through the steady regular accumulations of sequence mutations, has become a standard tool in evolutionary biology yet is of limited use in paleontology. Genomic information is generally absent in fossils but a large amount of data is preserved in skeletal morphology. We present a novel method that estimate a "morphological clock" to examine divergence times within Theropoda. Origination times for major clades of theropods are calculated using a recent large and broad-ranging data set from "The Dinosauria" and grounded with known geological times for specimens. This method has also been extended to predict the origin of theropods and can, when combined with traditional "relative" rate measurements, allow for comparisons between different evolutionary trajectories within Theropoda. The results presented give the first insight into absolute evolutionary rates within theropod evolution. They provide data for the evaluation of modular evolutionary rates across the skeleton and transformational evolutionary modes across the lineage. Using this method we have determined the origin of Theropoda at during the Late Anisian, 5-7 million years before the Ischigualasto fauna, a date consistent with other estimates of theropod origins. Our data shows that at Eumaniraptora (Deinonychosaurians + Aves) there is a noted increase in the rate of character evolution coincident with the origin of flight, especially in the pectoral region. Beginning at the node Eumaniraptora a separate morphological clock using a different calibration points is proposed to estimate early avian divergence times, since this increase in character rate evolution during this transition is not adequately modeled by the general theropod trend.

Preparators' Session, Thursday 11:00

ESPECIALLY DURABLE PROTOTYPES OF FOSSIL SPECIMENS AND REPLICAS FOR USE IN PUBLIC PROGRAMMING

DECK, Linda, Idaho Museum of Natural History, Pocatello, ID, USA; SCHLADER, Robert, Idaho Virtualization Laboratory, Pocatello, ID, USA; CLEMENT, Nicholas, Idaho Virtualization Laboratory, Pocatello, ID, USA; GIBBS, William, College of Technology, Pocatello, ID, USA;

CHAPMAN, Ralph, Idaho Virtualization Laboratory, Pocatello, ID, USA

One of the major problems with presenting the ideas and specimens that define the science of paleontology to the general public, both in the classroom and through permanent or traveling exhibitions, is that many of the materials cannot withstand the inexperienced handling that results. The rougher treatment that would inevitably accompany significant manipulation by the general public would certainly harm if not destroy fossils. Yet it is imperative to make specimens available to students and the general public for first-person exploration enabling deeper understanding and long-term support of the science. This has traditionally meant providing some sort of physical replica, such as a cast or sculpture. Yet this presents other problems: some materials are too fragile even for traditional molding and casting; a sculpture of a specimen is not nearly as satisfying as a cast of the real specimen; and casts made from traditional media degrade as well. In preparing a traveling exhibit that includes a section on horse evolution, duplicates of old, fragile exhibition replicas were needed that could withstand the rigors of travel. The solution was to use detailed laser scanning of the surface morphology of the models and their subsequent high-resolution reproduction in aluminum on a Haas Automation CNC machine. The resulting highly durable models were painted to resemble the originals. This process can work well for original fossil materials also, providing a very stable, durable and high-quality copy of the original specimen. This approach is especially well suited for making casts that are intended for outdoor use. Examples using dinosaur and fossil mammal material are provided.

Poster Session III (Friday)

STABLE ISOTOPE RATIOS OF VERTEBRATE MICROFOSSILS OF THE MESAVERDE FORMATION, WYOMING; EVIDENCE FOR PALEOECOLOGICAL RECONSTRUCTIONS

DEMAR, David, University of Wyoming Geological Museum, Laramie, WY, USA; CLEMENTZ, Mark, University of Wyoming, Laramie, WY, USA; BREITHAUPT, Brent, University of Wyoming Geological Museum, Laramie, WY, USA

Carbon ( $\delta^{13}\text{C}$ ) and oxygen ( $\delta^{18}\text{O}$ ) stable isotope values have been obtained from vertebrate microfossil enamel and enameloid of several taxa from the Upper Cretaceous (Campanian) Mesaverde Formation, Wyoming. These analyses were conducted to determine if expected patterns in carbon and oxygen isotope compositions could be preserved in tooth enamel from a variety of Mesozoic carnivorous and herbivorous terrestrial and aquatic vertebrates (i.e., Hybodontidae, Dasyatidae, Lepisosteidae, Amiidae, Crocodylidae, Hadrosauridae, Ceratopsidae, and Tyrannosauridae). The extent of diagenetic alteration of specimens was assessed by 1) defining the mineral composition of specimens via X-ray diffraction analysis; 2) comparing the isotope composition of diagenetically resistant tooth enamel with other less resistant materials (i.e., tooth dentine); and 3) comparing the isotope composition from hadrosaur teeth of varying enamel thicknesses. For terrestrial vertebrates, tooth enamel  $\delta^{13}\text{C}$  values are controlled by the carbon isotope composition from diet, whereas  $\delta^{18}\text{O}$  values are controlled by environmental water and physiology. Given the known flora of this time period, we expect consumers to have  $\delta^{13}\text{C}$  values consistent with C3 environments and  $\delta^{18}\text{O}$  to track local surface waters. For aquatic vertebrates, enamel and enameloid  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  values are often most strongly influenced by the chemistry of ambient waters. We expect  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  values for aquatic taxa to show high values for primarily marine taxa (e.g., hybodonts), intermediate values for brackish water taxa (e.g., lepisosteids), and low values for freshwater taxa (e.g., amiids). We used  $\delta^{13}\text{C}$  values as evidence of dietary preferences to discriminate taxa into dietary guilds. Results from this study, in addition to previous faunal and statistical analyses from this same locality (Barwin Quarry/ Fales Rocks), are giving further insight into the paleoecology of the Campanian coastal facies of Wyoming.

Technical Session XII, Friday 2:00

FOSSIL TAPIRS AS INDICATORS OF FORESTED ENVIRONMENTS: EVIDENCE FROM EVOLUTIONARY MORPHOLOGY AND STABLE ISOTOPES  
DESANTIS, Larisa, University of Florida/FLMNH, Gainesville, FL, USA; MACFADDEN, Bruce, Florida Museum of Natural History, Gainesville, FL, USA

Plant macrofossils and pollen are usually analyzed to determine the distribution of ancient forested environments. However, fossils of mammalian herbivores may provide another line of evidence typically unavailable to paleobotanists. Because fossil tapirids can be demonstrated to be highly conservative in morphology over time and maintain a browsing diet, they may serve as indicator taxa of forested environments. In order to use tapirs this way, we first document their conservative morphology through time and compare them to the closely related horses (Equidae), a family with a considerably different evolutionary and adaptive history. Secondly, we compare stable isotope values of tapirid tooth enamel through time to confirm their occupation as forest dwelling browsers. Lastly, we use the Paleobiology Database to map tapirid distributions through time, therefore, reconstructing forest distributions in Deep Time. Our morphologic, isotopic, and biogeographic analyses indicates that tapirids are excellent indicators of forested environments, and adds to our knowledge of these ancient habitat types based on other fossil evidence, e.g., as derived from paleobotany. Specifically, we conclude that after a relatively widespread distribution of tapirids during the Eocene of ~58° latitude, declines in tapirid latitudinal ranges during the Oligocene are consistent with paleobotanical evidence for contracting mesothermal and megathermal vegetation. Subsequently, tapirs and their associated forested environments increased their latitudinal ranges from the Miocene through the Pleistocene, and recently retreated to occupy only southern distributions below 21° N within the last ~10,000 years. Tapirs may not be a good group to investigate evolution "in the fast lane," but they are model taxa for paleoecological reconstructions. As additional localities are discovered and analyzed in the future, we are bound to find more evidence of herbivore-plant interactions such as those exemplified by extinct forest-dwelling tapirs.

Poster Session III (Friday)

THE TAXONOMIC STABILITY OF LARGE MAMMALS IN THE WHITE RIVER CHRONOFAUNA MASKED THEIR CHANGING DIETARY ECOLOGY  
DEWAR, Eric, Suffolk University, Boston, MA, USA

The White River chrono fauna was a remarkable case of taxonomic stability that persisted despite significant climatic and vegetational change during the Eocene-Oligocene transition (EOT) in North America. This taxonomic stability has come to imply ecological stasis due to the relatively matched levels of species originations and extinctions during this time interval. The biogeography and biostratigraphy of this transition is well understood, but we know much more about the species turnovers than the community structure changes through the EOT. In order to inform hypotheses of community structure during the EOT, I observed the tooth wear of ungulates, creodonts, car-

nivorans, and other clades from the rich Chadronian, Orellan, and Whitnean collections from the Great Plains, using data from stereoscopic (35x) microwear to feed into ordinations of community structure. I limited my microwear analyses to relatively large species in order to take advantage of the existing database of enamel scars associated with many herbivorous and carnivorous diets. My primary collections were from the White River, Chadron, and Brule Formations of Wyoming, Nebraska, and South Dakota, as well as Northern Colorado and North Dakota, spanning from 37-30 Mya. Some general dietary trends in microwear were found: (1) there was noticeable overlap of wear fabric among ungulates; (2) most ungulate families trended from a browsing mode toward a more grazing mode through the section; (3) most carnivorous species showed evidence of bone-chewing, so few were meat specialists; and (4) overall most species and lineages were plastic in their dental wear if not morphology throughout the section, probably tracking environmental changes. I also compared contemporaneous faunas from different paleobiogeographic zones by comparing middle Chadronian localities in Montana with those from the Great Plains. Here, I found (1) noticeable differences among families that occurred in both areas; (2) ungulate families endemic to Montana showed more evidence of browsing, indicating a more closed habitat; but (3) roughly comparable diets among carnivorans.

Technical Session II, Wednesday 8:15

THE PHYLOGENETIC POSITION OF *SANGAIA LAVINAI* AND STATUS OF THE RHYTIDOSTEIDAE (STEREOSPONDYLII: TREMATOSAURIA)

DIAS DA SILVA, Sérgio, Universidade Federal do Pampa, São Gabriel, Brazil; MAR-SICANO, Claudia, Universidade de Buenos Aires, Buenos Aires, Argentina

Until recently, rhytidosteids were unknown from South America, a remarkable circumstance as members of this group of temnospondyls are well known from the Lower Triassic of Gondwana and Laurasia. The new rhytidosteid taxon, *Sangaia lavinae*, was exhumed from Lower Triassic levels of southern Brazil. As part of a comprehensive re-evaluation of rhytidosteids a new phylogenetic analysis of known representatives of this group and related taxa was performed. The only previous analysis of the group resulted in a monophyletic Rhytidosteidae even though the internal relationships of most included taxa remained unresolved. In the new analysis a data-matrix of 95 characters and 24 terminal taxa was evaluated and four most parsimonious trees (MPTs) were found. As a result, the monophyly of Rhytidosteidae was reassessed and this clade appears as the sister-group of (Brachyopidae + *Laidleria*). The sister-group relationship between rhytidosteids and brachyopoids has been previously suggested in other stereospondyl phylogenies. Nevertheless, the position of the South African *Laidleria* as the sister-taxon of brachyopoids is unexpected; it has been previously related to a more basal position as the sister-taxon of (Rhytidosteidae + Brachyopidae). The Australian *Nanolania* results as the most basal rhytidosteid. Regarding *Sangaia*, its original description claimed that it was a basal taxon close related to *Indobrachyops* than to any other rhytidosteid due to the presence, in both taxa, of a prominent lachrymal bone, a feature lost in more advanced rhytidosteids. Nevertheless in the new analysis, *Sangaia* is allied with *Mahavisaurus* from Madagascar and they are the sister-group of a clade including all Australian rhytidosteids plus *Indobrachyops*. These results suggest a closer relationship among the eastern Gondwanan rhytidosteids (Australian and Indian taxa) than to the western Gondwanan taxa (South America and Madagascar), which resulted as sister-taxa.

The Dissorophioidea - Early Amphibian Radiation Symposium, Friday 9:45

NEW DATA ON THE VERTEBRAE AND OSTEODERMS OF *CACOPS ASPIDE-PHORUS* AND *DISSOROPHUS MULTICINCTUS* (TEMNOSPONDYLII: DISSOROPHIDAE)

DILKES, David, University of Wisconsin Oshkosh, Oshkosh, WI, USA

Dissorophids are a clade of temnospondyl tetrapods from the Late Pennsylvanian to Late Permian characterized by dermal ossifications along the dorsal side of the presacral vertebrae or neural spines with prominent dermal sculpturing. Recent work on the anatomy and functional mechanics of the vertebrae and osteoderms of *Cacops aspidephorus* and *Dissorophus multicinctus* has revealed many new anatomical details that bear directly upon the biomechanics of the vertebral column. A specimen of *Cacops* from the University of Michigan Museum of Paleontology shows that the orientation of the zygapophyses of those vertebrae with osteoderms changes little for those posterior presacrals that lack osteoderms. The neural spines of those vertebrae without an osteoderm are shorter and retain the transverse expansion present on those vertebrae with an osteoderm. Zygapophyses of *Dissorophus* are closer to the midline than in *Cacops*. Their transverse axis is at an angle of approximately 45° and the parasagittal axis is approximately 25° throughout the presacrals. Coupling between lateral flexion and axial rotation was evidently greater in *Dissorophus* than in *Cacops*. Insertion of a flange from an internal osteoderm of *Dissorophus* in to a deep notch along the anterior, dorsal, and posterior sides of the neural spine is confirmed for the four vertebrae immediately posterior to the enlarged first osteoderm. This flange has a greatly thickened middle section that fits into a portion of the notch along the dorsal edge of the neural spine and much thinner extensions that insert in to the portions of the notch along the anterior and posterior sides of the neural spine. This flange would largely preclude any significant lateral and vertical flexion of this segment of the vertebral column. Insertion of

the flanges of the more posterior internal osteoderms of *Dissorophus* between the neural spines is also confirmed. A pronounced anterior inclination of these posterior flanges and close proximity of neighboring internal osteoderms suggests contact between a flange and the next anterior internal osteoderm.

Technical Session III, Wednesday 2:45

ENAMEL MICROSTRUCTURE AND THE TIMING OF PLATE FORMATION IN *ELEPHAS (PALAEOLOXODON) CYPRIOTES*

DIRKS, Wendy, Newcastle University, Newcastle upon Tyne, United Kingdom; BRO-MAGE, Timothy, New York University College of Dentistry, New York, NY, USA

Fossil elephantids are often aged using "African Elephant Years," a system in which the tooth in wear at death provides a relative age for the specimen based on tooth eruption and wear in extant African elephants. This is problematic when the fossil taxon is either much larger than an African elephant, as in some mammoth species, or much smaller, as in dwarfed island forms. Previous studies of elephantid enamel microstructure have focused on "schmelzmuster" rather than the timing of plate growth. In this study, we introduce a new method for determining the actual time a tooth plate takes to form in the "pygmy" elephant of Cyprus, *Elephas (Palaeoloxodon) cypristes*. We utilize the growth increments visible in a histological ground section from two adjacent plates of a third molar (the last molar in the tooth series). These include daily increments, or cross-striations, long-period increments, the striae of Retzius, and accentuated increments forming during periods of physiological stress. Daily enamel secretion rate (DSR) is similar to that in other mammals. At the enamel dentine junction, the DSR is between 2-3µm, then gradually rises to around 4µm in the middle of the plate and falls back to around 3µm near the interface with the cementum. The enamel extension rate, or the rate at which plate height grows, is 34µm per day for the first 4-5 months of plate formation, then falls to 31µm a day after a year, and 29µm a day after two years. Thus, plate height is achieved by rapid recruitment of large cohorts of enamel forming cells, each of which secretes enamel at a relatively slow rate. The total time to form the plate is estimated to be 4.75 years. This represents the minimum time for tooth formation, as the pattern of accentuated increments indicates extensive overlap in the formation of adjacent plates.

Poster Session I (Wednesday)

APPLICATION OF TRACE ELEMENTS (Ba, Sr, Zn) TO PALEOECOLOGICAL RECONSTRUCTION OF MIDDLE MIOCENE HERBIVORES AT SOMOSAGUAS SITE (MADRID, SPAIN)

DOMINGO, Laura, Universidad Complutense, Madrid, Spain; LÓPEZ-MARTÍNEZ, Nieves, Universidad Complutense, Madrid, Spain; GRIMES, Stephen T., School of Earth, Ocean and Environmental Sciences, University of Plymouth, Plymouth, United Kingdom

Somosaguas is a Middle Miocene (ca. 14 Ma) vertebrate paleontological site situated in the grounds of the Complutense University at Pozuelo de Alarcón (Madrid, Spain). Two different localities situated 60 m apart have been systematically excavated since 1998: North Somosaguas (represented mainly by macro-mammal remains) and South Somosaguas (represented by micro-mammal remains). Four fossil-bearing levels have been identified. In chronological order they are T1, a sandy clay (South Somosaguas), and T3-1, T3-2 and T3-3, all arkosic sands (North Somosaguas). Mammals (23 species: mastodont, rhino, horse, ruminants, pig, carnivores, rodents, etc.), reptiles (turtles, lizards, snakes) and rare birds have been identified. Geochemical analyses have been performed on herbivore tooth enamel (*Gomphotherium angustidens*, *Prosantorhinus douvillei*, *Anchitherium* cf. *A. cursor*, *Conohyus simorensis* and ruminants) from three of the four levels (T3-1, T3-2 and T3-3) with the aim of detecting palaeoecological patterns. Previously, analyses of Rare Earth Elements (REEs) were performed to check the degree of diagenetic alteration of tooth enamel. A flat REE pattern has been obtained on all samples, which is indicative of a low degree of diagenetic alteration. Ba/Ca, Sr/Ca and Sr/Zn ratios allow particular dietary patterns in modern and fossil herbivores to be determined due to the different trace element content in plants. In our results, higher Ba/Ca, Sr/Ca and Sr/Zn ratios in the horse *Anchitherium* cf. *A. cursor* tooth enamel suggest it occupied a more grazing habit, compared to the browsing mastodont *Gomphotherium angustidens*. More enriched Ba/Ca and Sr/Ca ratios in the ruminants, when compared with the rest of the taxa, suggest a distinction among the Somosaguas herbivores as a result of different gastrointestinal tracts, with the ruminants having foregut microbial fermentation. Finally, a high variability in the trace elements ratios shown by the suid *Conohyus simorensis* could be connected to some degree to omnivorous behaviour.

Poster Session III (Friday)

MIOCENE PREY AND PREDATORS: DIVERSITY OF THE MOSCHIDAE (RUMINANTIA; PECORA) FROM THE CARNIVORE-TRAP SITE OF BATALLONES-1 (LATE VALLESIAN; MN 10; MADRID BASIN; SPAIN) AND EVIDENCE OF CARNIVORE TROPHIC ACTIVITY ON MOSCHIDS.

DOMINGO, M. Soledad, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; SÁNCHEZ, Israel, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; MORALES, Jorge, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; ALBERDI, M. Teresa, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain

The Moschidae comprises small hornless pecoran ruminants whose only extant representative is the genus *Moschus*. The moschids *Micromeryx* and *Hispanomeryx* were a typical and widespread component of the European Miocene mammalian faunas from MN 5 to MN 11. Recent studies have proved the existence of a high specific diversity of the group, at least in the Iberian Peninsula. It has been recorded the simultaneous occurrence of two or more species of moschids in the same fossil site, and this is the case of Batallones-1, an exceptional carnivore-trap site where two species of *Micromeryx* (a medium sized form with very advanced lower teeth, and a large sized form with primitive dentition) and one of *Hispanomeryx* (probably a smaller morphotype of the early Vallesian *H. duriensis*) are found together. We did realize that fossils belonging to these three taxa showed a state of preservation clearly different from the more than 3300 specimens from Batallones-1 (the vast majority corresponding to other mammalian taxa) that we have examined until now. We conclude that moschid bones were digested by carnivore mammals since they show the features described as typical of this process: glossy aspect of the bone, clear rounding of both the natural edges of the bone and the broken ends, and intrusive digestion with heavy tissue loss. These bones constitute the first described evidence of carnivore trophic activity in Batallones-1, a scarce and valuable evidence, since no coprolites have been currently found and only 21 specimens out of 3300 shows direct gnaw marks. All these data lead us to the role of moschids as prey in Miocene ecosystems. The carnivore fauna discovered at Batallones-1 give us an excellent picture of the likely predators of the Late Vallesian Moschidae. The small sized moschids were probably a preferred prey item for a varied array of mammalian predators, excluding the saber-toothed felids due to their particular adaptations for taking down large prey, and including amphicyonids, the lynx-sized feline felids, the ailurid *Simocyon batalleri* and the primitive hyenid *Protictitherium crassum*, which also could feed on moschid carcasses, breaking and ingesting the bones.

Poster Session I (Wednesday)

NEW DETAILS ON A LATE DEVONIAN TOP PREDATOR: *LACCOGNATHUS* SP. (SARCOPTERYGII, POROLEPIFORMES) FROM ELLESMERE ISLAND, NUNAVUT, CANADA

DOWNS, Jason, Academy of Natural Sciences, Philadelphia, PA, USA; DAESCHLER, Edward, Academy of Natural Sciences, Philadelphia, PA, USA; SHUBIN, Neil, University of Chicago, Chicago, IL, USA; JENKINS, JR., Farish, Harvard University and Museum of Comparative Zoology, Cambridge, MA, USA

In addition to *Tiktaalik roseae*, the diverse vertebrate fauna from the Upper Devonian (Frasnian Stage) Fram Formation on Ellesmere Island, Nunavut, Canada, includes the first Western Hemisphere occurrence of the porolepiform *Laccognathus* sp. Two species, *L. panderi* and *L. grossi*, have been previously described, both from the Middle Devonian (Givetian) of Latvia. An occurrence of *Laccognathus* sp. has also been reported from the Upper Devonian (Frasnian) of Central Russia. *Tiktaalik roseae* and the Fram Formation *Laccognathus* sp. belong to a fossil assemblage that additionally includes heterostracans, placoderms, and other sarcopterygians. Similarities between the taxonomic composition of this assemblage and others, including those that bear the other species of *Laccognathus*, have been used to highlight the biogeographic affinities among field sites in Arctic Canada, Latvia, Scotland, and, to a lesser degree, Quebec and Nevada. The Fram Formation material has been designated *Laccognathus* sp. according to the presence of three elongate pits on the labial side of the lower jaw. This, the only discrete character among those listed in the original diagnosis for *Laccognathus*, suggests affinity with *L. panderi* and *L. grossi*. The Fram material additionally shows features distinct from those of the other species (e.g., the lack of a toothed dorsal margin on the precoronoid and intercoronoid). At present, the diagnoses of *L. panderi* and *L. grossi* are primarily based on morphometric features that may be dispelled with improved understanding of intraspecific variation and allometry in *Laccognathus*. The well-preserved Fram Formation *Laccognathus* sp., represented by at least twenty individuals including six partial to complete articulated skulls, enables a thorough morphological description with the potential to inform this understanding.

Technical Session VIII, Thursday 2:45  
EXPERIMENTAL TAPHONOMY AND MICROANALYSIS OF CROCODYLIAN  
BITE MARKS

DRUMHELLER, Stephanie, The University of Iowa, Iowa City, IA, USA

While the presence of reptilian bite marks has been cited from the fossil record throughout the literature, they have not enjoyed the same level of actualistic and experimental study as their mammalian counterparts. Since crocodylians are both important top predators in their own right and popular proxies for a wide variety of extinct organisms in biomechanical, paleoecological, and paleobehavioral research, this clade is a perfect starting point for studies of bone modifying behaviors and the types of traces that reptilian actors create. A survey of bite marks from twenty of the twenty-three currently recognized species of extant crocodylians was collected under controlled conditions. Age, sex, weight, and a variety of length measurements were recorded for each animal in order to address additional variables and biases in any patterns of the bite marks' morphology. Visually, the samples exhibited the expected types of marks including hook scores and bisected pits and scores, which have previously been assigned to members of *Crocodylus niloticus* and *cf. Rimasuchus lloidi*. However, other marks were identified under microanalysis, including a variety of bisected structures that were not visible in hand samples and a new feature, which is characterized by three parallel sub-scores. These results help support the assumption that the creation of hook scores and bisected bite marks is a clade-wide phenomenon, and adds quadrisectioned scores to the list of features that can be used to diagnose similar structures in modern samples and the fossil record. Future correlation with morphological features of the jaw, such as bite radius and tooth shape, might be able to further refine identification to specific clades or suites of characters related to niche partitioning. When used in a phylogenetic context, the features of these modern bite marks can also be used to make informed predictions about the types of bone modifications that extinct members of Crocodylia might have caused, a tool that might help identify not only the marks themselves, but also presage the presence of these animals in preserved ecosystems.

Technical Session VIII, Thursday 1:45  
ONTOGENY AND PHYLOGENY OF THE TYMPANIC PNEUMATIC SYSTEM  
OF CROCODYLIIFORM ARCHOSAURS

DUFEAU, David, Ohio University, Athens, OH, USA; WITMER, Lawrence, Ohio University, Athens, OH, USA

Both groups of extant archosaurs (birds and crocodylians) possess a highly elaborated configuration of pneumatic diverticula derived from the pharyngotympanic air space. It is not clear whether this characteristic is homologous or if it represents two independent trajectories of diverticular development. In fact, among archosaurs, tympanic pneumaticity is not at all well understood with regard to its ontogeny, morphological variability, and phylogenetic distribution. Moreover, the relationship of true tympanic pneumaticity to other pneumatic systems in the braincase (e.g., the median pharyngeal system) has been completely unexplored. We present here a survey of the development of these diverticular systems both as an ontogenetic trajectory in Alligator mississippiensis and as a phylogenetic pattern within Crocodyliformes. We also present criteria for the identification and discrimination of individual diverticula, allowing tests of hypotheses of homology—both within crocodyliforms as well as archosaurs generally. Methods include computed X-ray tomography (CT), microCT, and 3D visualization of the CT data, which together provide a detailed characterization of the pneumatic recesses relative to the skeleton, otic labyrinth, and brain cavity. To shed light on the highly derived condition of adult crocodylians, the ontogeny of pneumatic sinuses is traced via microCT in a growth series of American alligator. Morphological similarities between sampled fossils and extant taxa are examined in a phylogenetic context, allowing tests of hypotheses of homology. Focal fossil taxa include the protosuchian *Eopneumatosuchus*, the thalattosuchian *Pelagosaurus*, the goniopholidid *Eutretauranosuchus*, and the sebecid *Hamadasuchus*. Three groups of paratympanic diverticula are identified: the pharyngotympanic sinus, the intertympanic sinus, and the median pharyngeal sinus. Some sinuses show relative expansion during ontogeny (intertympanic diverticulum), while others become relatively reduced (laterosphenoid and quadrate diverticula) or even lost in the adult (pterygoid diverticulum). This same pattern of reductions and expansions are observed across the phylogeny of crocodyliforms.

Evolutionary History of Bats Symposium, Thursday 8:00  
FLIGHT AND THE EVOLUTION OF FEEDING IN BATS  
DUMONT, Elizabeth, UMass Amherst, Amherst, MA, USA

Roughly a quarter of all mammal species are bats and they occupy all but the coldest and most remote habitats on earth. Flight was certainly a key innovation behind their success and adaptations for aerial locomotion are clear in the postcranial skeleton, where the form and composition of skeletal elements are uniquely modified to enhance aerodynamic function. Has flight had an equal impact on the structure of the skull and, if so, how might it have affected the evolution of feeding? Here I present data on the density and scaling of skull bones in bats, passerine birds, rodents, and "insectivorans" (i.e., erinaceomorphs, soricomorphs, and afrosericids). Skull bone volume and

mass scale with isometry in all groups, illustrating that skull bone density is constant across these disparate vertebrate taxa. Surprising patterns emerge when skull mass is regressed on brain mass. Both bats and birds exhibit low skull mass relative to brain mass but they accomplish this in very different ways. Skull mass scales with strong positive allometry in birds, rodents and insectivorans; birds simply have much less bone. Bats, on the other hand, are unique in that skull mass and brain mass scale with only very slight positive allometry. Thus, although the skulls of bats aren't as lightweight as those of birds, they clearly bear the mark of selection for weight minimization. With respect to feeding, the skulls of bats are more likely to be tuned to the mechanical demands of feeding and less likely to be "overbuilt" than the skulls of other mammals. Links between skull structure and the loads encountered during feeding are explored using finite element models of New World leaf-nosed bats (Phyllostomidae) that exhibit very different skull shapes and feeding behaviors.

Student Poster Session (Thursday)  
RESULTS FROM A PRELIMINARY STUDY OF THE BONE HISTOLOGY  
OF THE EARLY CRETACEOUS ALLOSAURID *ACROCANTHOSAURUS*  
*ATOKENSIS*

EDDY, Drew, North Carolina State University, Raleigh, NC, USA

The bone microstructure of many large theropods has been described, and the presence of lines of arrested growth (LAG's) has been used to estimate the relative age and maturity of these animals, as these features are deposited annually in closely related extant taxa. The results of microstructural analyses of a rib and tibia of one of the largest and most complete specimens of *Acrocantnosaurus atokensis* from the North Carolina Museum of Natural Sciences are reported here. Although LAG's are not well preserved in either the tibia or rib, extensive remodeling in both of these load- and non-load bearing bones suggests NCSM 14345 was a mature, full-sized individual. Intense remodeling in the rib's mid-shaft is supported by the presence of dense, multi-generation Haversian bone, although a region of primary fibro-lamellar bone lies along the dorsal margin. The shaft of the tibia is also heavily reconstructed, as evidenced by a trabecular marrow cavity surrounded by dense Haversian bone. The periosteal surface of the cortex shows a layer of primary fibro-lamellar bone with longitudinal canals transitioning to plexiform bone with circular and radial canals. Near the periosteal surface, approximately seven closely spaced lamellae and a decline in the vasculature suggest the presence of an External Fundamental System (EFS), marking a cessation of growth that usually accompanies sexual maturity. This further supports the hypothesis that NCSM 14345 was a full-grown individual. By comparison, long bones from many large *Allosaurus* specimens show animals that were still growing, as their thin sections preserve LAG lines surrounded by primary bone, highly vascularized cortices, and an absence of the EFS. Therefore, NCSM 14345 may be one of the few fully mature allosaurid specimens, or, alternatively, indicate the potential for *Allosaurus* and *Acrocantnosaurus* to have undergone different growth patterns. Mid-shaft histological samples of load-bearing elements from NCSM 14345 and other *Acrocantnosaurus* specimens will help resolve this problem.

Student Poster Session (Thursday)  
PALEOBIOLOGY OF AN EXCEPTIONALLY WELL PRESERVED FOSSIL OF  
THE MODERN WHITE SHARK (*CARCHARODON CARCHARIAS*) FROM  
THE PISCO FORMATION (NEOGENE) OF PERU

EHRET, Dana, University of Florida, Gainesville, FL, USA; HUBBELL, Gordon, Jaws International, Gainesville, FL, USA; MACFADDEN, Bruce, Florida Museum of Natural History, Gainesville, FL, USA

Due to the lack of a calcified skeleton, the fossil record for cartilaginous sharks is based almost exclusively on unassociated teeth. In rare instances, however, vertebral centra and small pieces of cartilage can be preserved. In extremely rare circumstances, sets of associated shark teeth can be found in conjunction with vertebral centra and other cartilage fragments. Here we report on an exceptionally well-preserved specimen of the white shark, *Carcharodon carcharias* (Lamnidae) from the Pisco Formation near Sacaco, Peru. The Pisco Formation is exposed along the southern coast of Peru. It is composed of a terrestrial and marine sequence that spans the Miocene and Pliocene (14.0-2.0 million years ago). The Sacaco region is well known for its abundance of shark and marine mammal fossils. The material from this specimen includes: a complete associated dentition still within the fossilized jaws, portions of the endocranium, and approximately 25 to 30 vertebral centra. Such a complete specimen provides a unique opportunity to study size and growth, as well as a more detailed look at an early example of the modern *Carcharodon carcharias*. Based on tooth morphology and the growth curve of the extant white shark, this specimen was approximately 5.2 meters long, which is at the upper range of living examples. Growth annuli found within the vertebral centra were also analyzed using x-ray photography and isotopic signatures. In addition, samples of fossilized cartilage from the endocranium were found to contain preserved organics. This important specimen allows us to look at the paleobiology of the white shark in ways that have never been accomplished before.



Evolutionary History of Bats Symposium, Thursday 8:45  
REGIONAL AND GLOBAL PERSPECTIVES ON THE QUALITY OF THE  
FOSSIL RECORD OF BATS

EITING, Thomas, University of Michigan, Ann Arbor, MI, USA; GUNNELL, Gregg, University of Michigan, Ann Arbor, MI, USA

The idea that bats have a poor fossil record is a pervasive one. Much recent work investigating the evolutionary history of bats has focused principally on molecular and morphological analyses of extant forms, with utilization of the fossil record only to provide calibration points in phylogenetic analyses. Though rarely attempted, studies of completeness and of the quality of the fossil record of bats have important consequences for our understanding of evolutionary rates, patterns, and relationships among chiropterans. We compiled a database of Cenozoic fossil bat genera at the finest known stratigraphic level (usually sub-epoch or stage) and coarse geographic provinces. We tabulated each genus as a separate record if its known age differed across its geographic range. This resulted in approximately 350 unique genus-locality occurrences and 240 distinct genera. Of the approximately 180 extant genera, 72 (40%) occur as fossils. At least 13 genera of modern bats have fossil representatives from a geographical province different from their modern distribution. There are at least 55 bat genera known only from fossils. In this analysis we applied phylogeny-independent methods to analyze completeness of the bat fossil record. We also used genus-level phylogenies, to which we applied consistency- and gap-based metrics, to analyze the quality of the bat fossil record. Initial results suggest that the quality of the bat fossil record may not be as poor as previously thought, at least for some groups and some geographic regions. Vespertilionidae has one of the best fossil records, in part because two of the best-sampled regions, Europe and North America, contain many of the genera with good records. At the subepoch-level (and without dissecting genera according to the method outlined above), the preservation probability of a bat genus may be as high as 67%, with a corresponding completeness of 82%. Though likely an upper limit, this value at least provides a first approximation of the genus-level completeness of the bat fossil record. It suggests that bat fossils—especially of extinct genera—may provide crucial insight into the phylogenetic relationships of this group.

Poster Session IV (Saturday)  
THE BONY LABYRINTH OF *KULBECKIA* (MAMMALIA,  
ZALAMBDALESTIDAE)

EKDALE, Eric, The University of Texas at Austin, Austin, TX, USA

Petrous bones assigned to *Kulbeckia kulbecke* (Zalambdalestidae) were recovered from Cretaceous deposits in Uzbekistan. The external surface of the petrosal of *K. kulbecke* was described previously, but little information was revealed about the internal morphology, which forms the bony labyrinth of the inner ear. High resolution X-ray computed tomography (CT) provides a nondestructive method for observing the morphology of the bony labyrinth. I constructed digital endocasts of the inner ear of several *K. kulbecke* specimens using CT data, and I quantified various aspects of the bony labyrinth. The measurements include volumes of the various inner ear components (such as the cochlea and semicircular canals), size and shape of the semicircular canals, and the number of turns completed by the cochlea. The structure of the bony labyrinth of *K. kulbecke* was compared to that of other eutherians, including its closest zalambdalestid relatives. Zalambdalestidae, which also contains the genera *Alymlestes*, *Barunlestes*, and *Zalambdalestes*, is known from dental, cranial, and postcranial material recovered from Late Cretaceous deposits in Asia. At least one natural endocast of the cochlea of *Zalambdalestes* was described in the 1980's. The morphology of the cochlea of *K. kulbecke* is similar to *Zalambdalestes*, although the cochlea of *K. kulbecke* coils to a greater degree. The gross anatomy of the bony labyrinth of *K. kulbecke* is comparable in structure to that of other Cretaceous Eutheria. One example is the degree of coiling (around a single coil) of the cochlea. This is likely the ancestral condition for eutherians, and this state separates several extinct taxa from crown eutherians, or the placental mammals.

Student Poster Session (Thursday)  
A COCHLIODONT LOWER JAW (CHONDRICHTHYES, HOLOCEPHALI)  
WITH ARTICULATED TOOTH PLATES FROM THE CARBONIFEROUS  
BIRD SPRING FORMATION OF NEVADA

ELLIOTT, David, Northern Arizona University, Flagstaff, AZ, USA; ROWLAND, Stephen, University of Nevada, Las Vegas, NV, USA

We report the discovery of a large lower jaw with articulated dentition of a cochlodont fish from the basal part of the Bird Spring Formation of southern Nevada, of latest Mississippian or early Pennsylvanian age. Cochlodonts are holocephalians, a group of chondrichthyans with dentition comprising teeth or tooth plates, which are shed infrequently or retained and enlarged throughout life. The dentition always indicates durophagy and is often heterodont. Systematics of the Holocephali are poorly understood as the fossil record is sparse and fragmentary but it is generally accepted that the modern chimaerids developed from the Paleozoic cochlodonts. This order of late Paleozoic fishes consisted almost entirely of tooth-based taxa until the recent description of complete individuals from the Mississippian of Montana. Although entire spec-

imens are key in understanding the taxonomy and morphology of cochlodonts they are rare and refinement of tooth-based taxa can still be effected when articulated dentitions are found. The new specimen consists of a large lower jaw with complete articulated dentition from a cochlodont provisionally identified as *Deltodus sublaevis* (Agassiz), a taxon otherwise known only from Ireland and the Naco Formation of Arizona. The specimen shows one posterior pair of robust, tightly coiled plates followed anteriorly by a second pair of more narrow coiled plates, with a third pair of coiled but more triangular plates occupying the symphysis. The only other articulated cochlodont dentition, from *C. contortus*, does not include the anterior tooth plates. Wear facets on the tooth plates indicate an upper dentition that was broadly similar in morphology, contrary to the proposed arrangement for *C. contortus* in which the upper jaw had a posterior pair of large oblong plates succeeded anteriorly by two pairs of whorls of *Helodus*-like teeth. This specimen will help resolve long-standing taxonomic and morphological questions within this group of fishes.

Poster Session III (Friday)  
REPEATED HORIZONS OF DINOSAURIAN MASS TURBATION IN THE  
LOWER JURASSIC GLEN CANYON GROUP, DINOSAUR NATIONAL  
MONUMENT, AND THEIR PALEOENVIRONMENTAL IMPLICATION  
ENGELMANN, George, University of Nebraska, Omaha, NE, USA; CHURE,  
Daniel, Dinosaur National Monument, Jensen, UT, USA

The Lower Jurassic Glen Canyon Group (GCG) and its equivalents have yielded rare body fossils of vertebrates, and a more abundant & diverse ichnofauna. Although the GCG represents the deposits of a great sand sea, conditions at times must have been suitable for vertebrate habitation. Other workers have shown that pluvial episodes are recorded within the Navajo Fm., indicating times of greater availability of water and utilization of resulting wetland habitats by terrestrial invertebrates and vertebrates. Most of the evidence for these conditions has come from the southern extent of the formation, in southern Utah. Dinosaur tracks have been observed in the GCG in the vicinity of Dinosaur National Monument (DNM) in northern Utah. The ichnofauna is biased in favor of prosauropods plus large and small theropods; ornithopods and non-dinosaurian tracks are lacking. During recent fieldwork we re-examined Lockley's sites and newly discovered track sites within the GCG. Dinosaur turbated horizons are less than 2m thick. Well-formed tracks, with claw impressions, can be observed on bedding plane exposures of intervals of essentially horizontally bedded layers between the massive eolian sands that make up the bulk of the formation. No skin impressions have been observed but pad depressions, sometimes distorted, are not uncommon. These intervals frequently have abundant bedding plane depressions that represent degraded tracks, undertracks, or are the result of more intense bioturbation. In cross section, these intervals exhibit disturbed bedding with concave upward features that are may also reflect biological activity. Rarely, carbonate horizons less than 1m thick are present and represent longer-lived bodies of water. These carbonates and the track bearing intervals suggest wetter conditions alternating with more arid times of active dune migration. The recurrence of the tracks horizons throughout the section may be related to the climatic episodes interpreted for this unit farther south.

Technical Session XVII, Saturday 2:00  
GROWTH PATTERNS IN BROODING DINOSAURS REVEALS THE TIMING  
OF SEXUAL MATURATION IN NON-AVIAN DINOSAURS AND GENESIS OF  
THE AVIAN CONDITION

ERICKSON, Gregory, Florida State University, Tallahassee, FL, USA; CURRY ROGERS, Kristina, Science Museum of Minnesota, St. Paul, MN, USA; VARRICCHIO, David, Montana State University, Bozeman, MT, USA; NORELL, Mark, American Museum of Natural History, New York, NY, USA; XU, Xing, Chinese Academy of Sciences, Beijing, China

The timing of sexual maturation in non-avian dinosaurs is not known. In extant squamates and crocodylians it occurs in conjunction with the initial slowing of growth rates as adult size is approached. In birds (living dinosaurs) on the other hand, reproductive activity begins well after somatic maturity. Here we used growth line counts and spacing in all of the known brooding non-avian dinosaurs to determine the stages of development when they perished. From this it was revealed that sexual maturation occurred well before full adult size was reached—the primitive reptilian condition. In this sense, the life history and physiology of non-avian dinosaurs was not like that of modern birds. Paleobiological ramifications of these findings include the potential to deduce reproductive lifespan, fecundity, and reproductive population sizes in non-avian dinosaur species. Furthermore we can use maturity information to better identify secondary sexual characteristics that are integral for understanding reproductive behavior and characterizing species variability.

Poster Session III (Friday)

TERRESTRIAL MAMMAL REMAINS FROM THE MIOCENE CHESAPEAKE GROUP OF CALVERT CLIFFS, MARYLAND, AND COMPARISONS WITH MIOCENE TERRESTRIAL MAMMAL FAUNAS OF THE MID-ATLANTIC COAST

ESHELMAN, Ralph, Lusby, MD, USA; BEATTY, Brian, New York College of Osteopathic Medicine, Old Westbury, NY, USA; DOMNING, Daryl, Howard University, Washington, DC, USA

In over one hundred and sixty years of collecting, hundreds of specimens of terrestrial mammals have been recovered from the marine deposits of the Chesapeake Group on the mid-Atlantic coast, USA. Most of these specimens were recovered as "float" from Maryland and Virginia beaches along the western shore of the Chesapeake Bay, where deposits largely represent the Calvert Formation. Presented is a summary of the terrestrial mammalian remains from the Chesapeake Group of Maryland, with a comparison to other equivalent-age deposits of the mid-Atlantic coast. A surprisingly diverse and in some instances unusual fauna is represented from the float of the Calvert Cliffs, including protoceratids, amphyconids, and a possible red panda. Since the 1970s, hundreds more specimens have been recovered from the spoils of the Aurora Phosphate Mine in eastern North Carolina, largely from the younger Yorktown Formation. Scores of specimens have been recovered from the Calvert Formation of Delaware. The significance of these Delaware fossils is that micro-mammal remains such as bat, shrew and rodent have been recovered as well as the more typical macro remains of horses and proboscideans. Fewer, but nevertheless significant, land mammal remains have also been recovered from the correlative Kirkwood Formation of New Jersey. Ultimately, by comparing these different faunas we get a more complete picture of the distribution of various Miocene ecosystems along the mid-Atlantic coast.

Poster Session III (Friday)

THE STRATIGRAPHIC DISTRIBUTION OF FOSSIL SITES IN THE BRULE FORMATION IN BADLANDS NATIONAL PARK, SOUTH DAKOTA

EVANOFF, Emmett, University of Northern Colorado, Greeley, CO, USA

The lower Oligocene Brule Formation of the White River Group is one of the most fossiliferous terrestrial sequences in North America. The density of fossil sites in the Brule Formation in Badlands National Park approaches that found in marine sequences. The formation is divided into the lower, fluvial-deposited Scenic Member, and the upper, aeolian (loess) deposited Poleslide Member. The Scenic Member is composed primarily of widespread, fossiliferous mudstone beds and less fossiliferous sandstone sheets. Fossil sites in the Scenic are typically isolated, laterally discontinuous bone-beds that contain very abundant fossil vertebrates. They occur in mudstone units at several distinct stratigraphic positions. The lowest, and most famous, fossiliferous interval is the "lower nodule beds," a widespread blanket of thick clayey mudstone beds that draped over an erosional topography developed on the underlying upper Eocene Chadron Formation. Fossil sites also occur in mudstone beds directly below widespread clayey mudstone marker beds that represent stacked paleosol complexes. Though fossil sites occur in all mudstone beds from the base to the top of the Scenic Member, they are separated by thick intervals of poorly fossiliferous sandstone and clayey mudstone beds. The Poleslide Member of the upper Brule Formation is characterized by thick siltstone beds interbedded with muddy sandstone sheets and rare mudstone beds. Unlike the Scenic, fossil sites occur in all stratigraphic levels of the Poleslide Member. Siltstone beds contain the greatest number of fossil sites in the Poleslide, with isolated bone accumulations occurring throughout the individual siltstone units. Certain horizons within the siltstone units contain a large number of *in-situ* fossil sites, indicating discrete stratigraphic horizons of bone accumulation. Sandstone sheets and the widespread mudstone units in the Poleslide contain fewer fossil sites. A greater understanding of the stratigraphic distribution of Brule Formation fossil sites will result in a high-resolution biostratigraphy of vertebrate taxonomy and a greater understanding of the Orellan-Whitneyan transition.

Technical Session XVI, Saturday 2:30

HOW DOES TOOTH WEAR AFFECT DENTAL COMPLEXITY? IMPLICATIONS FOR TOOTH FUNCTION AND DIETARY RECONSTRUCTION

EVANS, Alistair, University of Helsinki, University of Helsinki, Finland; FORTELIUS, Mikael, University of Helsinki, University of Helsinki, Finland; JERNVALL, Jukka, University of Helsinki, University of Helsinki, Finland

Recent work has established that there is a relationship between tooth complexity and gross diet. Dental complexity tends to increase when there is an increasing requirement of mechanical processing of food, from hypercarnivores through omnivores to herbivores. The method holds great promise for reconstructing diets of extinct species based on their dental complexity. It also has great functional implications for the animal, as any change in this feature will affect the overall functional effectiveness of the tooth. Tooth wear can have a profound effect on tooth shape, and therefore possibly dental complexity. The initial investigations into dental complexity were largely based on individuals at a similar wear stage. For instance, as enamel is breached at the early stages of wear, dentine basins form, and this is likely to increase the rugosity of the tooth sur-

face. The usefulness of dental complexity of fossil teeth to reconstruct the diet of the species will depend on whether the dietary complexity signal is maintained throughout tooth wear. Here, we examined several rodent species, where there are enamel-free areas on the tooth at the time of eruption, and we found that dental complexity was relatively constant for much of the tooth wear that occurred. Only in the last stages of wear did it substantially decrease. For rodent species with overall dissimilar tooth shapes, differences in complexity were maintained between species until the very end of the wear process, indicating that for the majority of the height of the tooth, function and dietary signal should be maintained. A similar result was obtained for primate species with primary occlusal morphology: tooth wear does not greatly change dental complexity. This indicates the maintenance of tooth shape with wear in many species, which is a very important characteristic in retaining an effective tooth form despite substantial wear. It also indicates that dietary reconstruction from both unworn and worn teeth has promise.

Technical Session IX, Friday 11:00

PHYLOGENY OF LAMBEOSAURINE DINOSAURS USING PARSIMONY AND BAYESIAN LIKELIHOOD APPROACHES

EVANS, David, Royal Ontario Museum, Toronto, ON, Canada

Lambeosaurinae is a clade of hadrosaurid dinosaurs characterized by hypertrophied nasal passages housed within distinctive cranial crests. Large sample sizes, taxonomic diversity, and increasing control on their chronostratigraphic and paleoecological contexts make Lambeosaurinae a suitable model clade with which to test hypotheses regarding modes and mechanisms of Late Cretaceous dinosaur evolution and historical biogeography. Determination of the lower-level phylogenetic relationships within Lambeosaurinae is required for evaluation of these evolutionary hypotheses. To construct a hypothesis of the species-level relationships of lambeosaurines, phylogenetic analyses were conducted based on a data matrix of 89 cranial and postcranial characters, 17 ingroup taxa, and four outgroup taxa. Cranial characters, including dentition and lower jaws, form 69% of the characters in the data matrix. The primary parsimony analysis resulted in a single most parsimonious tree with resolved relationships within both major lambeosaurine clades. This analysis corroborates monophyly of the genera *Lambeosaurus*, *Hypacrosaurus*, and *Parasaurolophus*. *Hypacrosaurus* is more closely related to *Corythosaurus* than to *Lambeosaurus*. Time-calibration of the cladogram and the distribution of autapomorphies allows for first order assessment of hypotheses relating to evolutionary mode and ancestor-descendant relationships in the clade. Previous hypotheses of anagenetic ancestor-descendant relationships can be rejected or considered untenable in light of the available data, although the possibility that the biostratigraphic successions of *Corythosaurus* and *Lambeosaurus* species within the well-sampled Dinosaur Park Formation represent phyletic evolution within two independent, co-occurring dinosaur lineages can not be ruled out. A Bayesian analysis of the morphological data matrix was also conducted using the Mk likelihood model. The results of the Bayesian analysis correspond closely with the parsimony result, suggesting a strong signal in the current data that is robust to different methods of phylogenetic inference.

Poster Session I (Wednesday)

THE UPLOADING CHALLENGE: STRATEGIES FOR EDITING AND UPLOADING DIGITAL 3D SHAPE DATA TO AN ONLINE DATABASE

EVANS, Gudrun, University of Helsinki, University of Helsinki, Finland; EVANS, Alistair, University of Helsinki, University of Helsinki, Finland; FORTELIUS, Mikael, University of Helsinki, University of Helsinki, Finland; JERNVALL, Jukka, University of Helsinki, University of Helsinki, Finland

One of the key components of scientific databases is the ability for researchers to submit or upload their data, a prime example being GenBank where individual researchers submit new gene sequences. This not only enables comparisons of a user's data to that in the database, but also increases the store of information in the database for future research. In contrast to gene sequence databases, there are not yet established procedures for handling or uploading 3D scans of morphology, including fossils, to databases. Protocols for this would enable workers to communicate in an effective manner. We demonstrate some methods for doing this using the MorphoBrowser database. The MorphoBrowser is an online database that contains a diverse range of 3D mammalian tooth morphologies. The user can browse through and view the three-dimensional shape of the teeth from any direction by rotating and scaling the tooth. There are two principal approaches for ensuring a standard format is adhered to: either the 3D data is standardized before it is uploaded or it is manipulated as part of the upload process. The former method is used in the current work, with a view to developing methods for the latter. We have developed strategies for standardizing file format, scan resolution and tooth orientation. Here, we show a stepwise protocol to process 3D tooth scans locally that can then be uploaded to the MorphoBrowser through the PHP web interface. Resolving these issues is important to enable collaborative efforts between individual researchers collecting 3D shape scans using different technologies and databases with diverse research objectives, in much the same way as has already been achieved in genomics research.

Technical Session V, Wednesday 1:30

A GIANT HYPEROSSIFIED FROG WITH SOUTH AMERICAN AFFINITIES  
IN THE LATE CRETACEOUS OF MADAGASCAR

EVANS, Susan, University College London, London, United Kingdom; JONES, Marc, University College London, London, United Kingdom; KRAUSE, David, Stony Brook University, New York, NY, USA

The extant anuran fauna of Madagascar is exceptionally diverse, with a preponderance of endemic taxa (99% of species) that reflect its long isolation from other major landmasses. Unfortunately, the Mesozoic and Cenozoic history of this fauna is virtually unknown and has to be inferred from molecular phylogenetic analyses of living taxa. According to these analyses, the radiation of extant lineages may have been relatively recent, prompting suggestions that parts of the original, and potentially rather different, frog fauna became extinct at the end of the Cretaceous. Frog remains from the Upper Cretaceous Maevarano Formation of Madagascar provide a rare glimpse into the evolutionary history of the island's anuran fauna. Initial discoveries in the early-mid 1990s documented the presence of a hyperossified frog that differed strikingly from extant Malagasy taxa in its very large size, heavy cranial exostosis and robusticity. Its phylogenetic position, however, remained uncertain. The recovery of many additional isolated specimens since the mid 1990s has permitted a reconstruction of much of the skull and parts of the postcranial skeleton, revealing a new genus and species exhibiting a unique combination of characters shared with extant and extinct (Late Cretaceous *Baurubatrachus* and Miocene *Wawelia*) South American frogs of the family Ceratophryidae. This apparently incongruous finding is consistent with work on other elements of the Maevarano assemblage, most notably the crocodiles, theropod and sauropod dinosaurs, turtles, and mammals. It thus provides added support for paleobiogeographical models that posit physical and biotic links among Madagascar, the Indian subcontinent, and South America that persisted late into the Late Cretaceous.

Poster Session I (Wednesday)

STONE CITY REVISITED: A DIVERSE FISH OTOLITH FAUNA FROM THE  
MIDDLE EOCENE CROCKETT FORMATION, BURLESON COUNTY,  
TEXAS

EVERETT, Ashley, Texas A&M University, College Station, TX, USA; STIDHAM, Thomas, Texas A&M University, College Station, TX, USA

Otoliths have proven to be excellent indicators of fish biodiversity, and therefore also are useful in the reconstruction of past environments. We studied a single storm bed present in the main glauconite unit in the Stone City Member of the Crockett Formation on the banks of the Brazos River in Burleson County, Texas. Bulk sediment samples from that storm bed were screen-washed and sorted for their vertebrate component. The Stone City member has produced fossils of marine (sharks, rays, and bony fish) and terrestrial (turtle and lizard) vertebrates. Previous work documented a very diverse otolith fauna from the Stone City Member with over 17 taxa described. Our research on the hundreds of otoliths collected from the storm bed has documented all families of fish previously known in the member (Ophidiidae-Brotulidae, Congridae, Sciaenidae, Serranidae, Berycoidea, and Soleidae), as well as one new family not previously reported from the formation (Carapidae). The overall small absolute size of the otoliths suggests that the assemblage is composed of ontogenetically young individuals. We have identified two species (*Eosolea claibornensis* and *Preophidion stintoni*) previously not known from the member. These specimens increase the known stratigraphic range of those taxa in East Texas. The vast majority of the otoliths identified belong to the family Ophidiidae (cusk-eels). Thirty-five indeterminate otolith specimens were placed into 14 different groups, potentially representing 14 species new to the member. The presence of these additional unidentified otoliths suggests that the environment at this site during the Middle Eocene was much more diverse than previously thought. The high percentage of burrowing cusk-eels (Ophidiidae) suggests that the Gulf of Mexico at that time was temperate to tropical. The otolith fauna also suggests that the depositional setting of this storm bed was closer to the coastline than has been argued recently.

Technical Session XII, Friday 3:15

THE PLEISTOCENE/HOLOCENE TRANSITION IN CENTRAL EUROPE - A  
CLEAR CUT OR SLOW PROCESS? NEW INSIGHTS INTO THE MECHANISMS  
INFLUENCING MAMMALIAN FAUNAS

FAHLKE, Julia, Universität Bonn, Bonn, Germany

The end of the Last Glacial was a time of overall climatic warming but is characterised by smaller-scale oscillations (stadials and interstadials). The beginning of the Holocene is marked by a sudden temperature rise. Though the climate at the Pleistocene/Holocene transition, the youngest mass extinction event, has been exhaustively analyzed, the reaction of the biosphere has not yet been resolved in detail. The dynamics of mammal communities play an important role in the reconstruction of Pleistocene/early Holocene climates. Mammal faunas not only respond to shifting temperatures, but also to oceanic/continental influence. Mammal populations expand from permanent to temporary distribution areas under favorable climate, but go locally extinct when conditions worsen. As a temporary distribution area Central Europe is of

great interest. The faunal dynamics are most evident in the well-stratified mammal sequence of the Zigeunerfels abri site near Sigmaringen (Southern Germany), a locality that also yielded mollusc faunas and artefacts. Based on this record, information on 450 Central European and South Scandinavian mammal sites from 15,000 to 8,000 <sup>14</sup>C BP has been collected and correlated. New <sup>14</sup>C dates have been acquired. While some mammals went totally extinct at the end of the Last Glacial, many others survived. For climate reconstruction, the recent distribution areas of the latter have been taken into account. Geographical differences in the effects of climatic changes become obvious by comparing the percentages of typically glacial, interglacial/Holocene and climatically indifferent mammal taxa on a regional scale. It is shown that stadials and interstadials did not affect Central Europe as a whole. Characteristically Holocene faunas first appeared in the continentally influenced southern parts, and the extinction of cold-adapted steppe elements was also delayed in the north. For some mammals, the first appearance in the northeast even coincides with the local extinction in the southwest. Thus, the final warming at the Pleistocene/Holocene boundary, though rapid, affected Central Europe asynchronously and with significant regional differences.

Poster Session III (Friday)

FINITE ELEMENT ANALYSIS OF DINOSAUR TRACKS

FALKINGHAM, Peter, University of Manchester, Manchester, United Kingdom; MANNING, Phillip, University of Manchester, Manchester, United Kingdom; MARGETTS, Lee, University of Manchester, Manchester, United Kingdom

Historically, dinosaur tracks have been predominantly interpreted as two dimensional surface features, geometrically resembling the track maker's foot. Previous work has shown that this is not necessarily the case, and has highlighted the importance of recognizing and interpreting transmitted tracks. Such transmitted tracks are formed when sedimentary layers are deformed beneath the surface on which a track maker crawled, walked, hopped or ran. The mechanical properties of the sediment, foot morphology, and limb kinematics all affect the translation of pressures within a 3-dimensional soil volume. Depending on which layer within the soil volume is exposed, the visible track may be a transmitted track or over-track, and thus vary considerably from the 'true' surface track. Interpretation is dependant upon track geometry and morphology. If a feature is incorrectly interpreted as a surface feature, subsequent analysis (speed, population dynamics, producer etc) will be flawed. Finite element analysis (FEA) is a tool familiar to many palaeontologists as a method for investigating properties of materials (such as bone) under stress. Here, FEA is proposed to be a valid method for understanding how sediment properties can affect track morphology throughout a three dimensional volume. Initial results provide quantitative analysis of the pressure transmission of a virtual dinosaur foot within a 3D soil volume. This provides insight into surface and transmitted 3-D track geometry. The use of an FE track simulator will provide a robust tool to undertake repeated and quantifiable track studies.

Poster Session IV (Saturday)

AN UNUSUAL TRACKWAY OF A MEDIUM-SIZED DINOSAUR FROM THE  
GLEN ROSE FORMATION (LOWER CRETACEOUS, COMAL COUNTY,  
TEXAS)

FARLOW, James, IPFW, Fort Wayne, IN, USA; DESCHNER, E., Heritage Museum of the Texas Hill Country, Canyon Lake, TX, USA; SOLIS, Richard, Heritage Museum of the Texas Hill Country, Canyon Lake, TX, USA; WARD, William, Heritage Museum of the Texas Hill Country, Canyon Lake, TX, USA

Trackways of bipedal dinosaurs are common in the Glen Rose Formation, but the trail of a medium-sized dinosaur from Comal County shows a combination of unusual features. The tracksite occurs in the bed of Deep Creek near its confluence with the Guadalupe River, in a laminated dolowackestone near the very top of the Upper Glen Rose Formation. The trackmaker headed in a northerly direction. Although few of the footprints are well preserved, the trackway begins with nine reasonably distinct prints, some of which are clearly tridactyl (with no indication of a hallux impression), about 25-40 cm long, and up to 12 cm deep. The pace length in this part of the trackway ranges 76-95 cm, and the stride length 160-177 cm; the pace angulation ranges 139-169 degrees. Footprints angle outward with respect to the trackmaker's direction of travel. Two possible (but questionable) manus impressions occur in association with a right pes print in this part of the trail. One is to the right of, and slightly behind, the right pes print. The second is in front of the right pes impression, somewhat to the left of a line connecting the right pes print with the following left pes print. Both of the possible manus prints are featureless circular or elliptical depressions. However, because there are indications of footprints of other dinosaurs at the tracksite, it is possible that the putative manus prints are poorly preserved prints of other trackmakers. The trackway continues with 20 or more poorly defined prints, many of which are recognized as prints only because they occur in trackway sequence. Some of the footprints in this trackway are merely elongate depressions like the (in)famous "man tracks" of the Lower Glen Rose Formation exposed in the bed of the Paluxy River (Somervell County). Many of the footprints are very deep, but nonetheless show poorly defined or no toe marks, suggesting a very soft substrate at the time of emplacement.

Ernie Lundelius Symposium (Faunal Dynamics and Extinction), Wednesday 8:30  
PLEISTOCENE MAMMALS OF MEXICO: A CRITICAL REVIEW OF  
REGIONAL CHRONOFAUNAS, BIOGEOGRAPHIC PROVINCIALITY AND  
CLIMATE CHANGE RESPONSE

FERRUSQUIA-VILLAFRANCA, Ismael, Universidad Nacional Autonoma de Mexico, Mexico City, Mexico; ARROYO-CABRALES, Joaquin, Instituto Nacional de Antropologia e Historia, Mexico City, Mexico; MARTINEZ HERNANDEZ, Enrique, Instituto de Geologia, Mexico City, Mexico; GAMA-CASTRO, Jorge, Universidad Nacional Autonoma de Mexico, Mexico City, Mexico

Mexico's Pleistocene mammal record includes 15 orders [Didelphimorphia, Xenarthra, Lipotyphila, Carnivora, Primates, Chiroptera, Rodentia, Lagomorpha, Artiodactyla, Cetacea, Perissodactyla, Sirenia, Notoungulata, ?Litopterna and Proboscidea], 44 families, 149 genera and ~300 species, collected from ~800 localities across the country; the extant mammal record consists of 12 orders [the latter three are extinct], 42 families, 164 genera and 453 species. So, the Pleistocene record is a sound basis for paleobiologic studies such as this. However, caution is needed given that: a) Most localities lack stratigraphic data and independent age control, since their find was not through geologic/paleontologic studies; b) Less than half of the material was collected by professional paleontologists; c) The geographic distribution is biased toward the Trans-Mexican Volcanic Belt (= TMVB, ~45% of the localities) and the Central Plateau (~9%); d) Based on critical biochronologic evidence, C<sup>14</sup> and K-Ar dates, most of the record belongs to the Rancholabrean, and only a small portion to the Irvingtonian. Nonetheless, some general patterns can be discerned: Comparison of the Rancholabrean and extant mammal records show a marked impoverishment of the latter in "large" species (> 10 Kg), so that micromammals far outnumber "large" ones. The causes are still poorly understood, but might involve the final outcome of the climate changes (both in temperature and humidity) recorded in Late Pleistocene fluvio-lacustrine strata, palynofloras and paleosols from sites within and north of the TMVB, some of which are linked to changes in Rancholabrean faunal makeup or distribution. The Irvingtonian faunas [El Golfo, Son.; El Cedazo *partim*, Ags. and La Goleta *partim*, Mich.] and to a greater extent the chief Rancholabrean ones [San Josecito Cave, N. L.; El Cedazo *partim*, Ags.; El Cedral, SLP.; Tequixquiac and Tlapacoya, E. Mex.; Chapala *partim*, Jal., Valsequillo, Pue.; Loltum Cave, Yuc. and Villa Flores, Chis.] show a latitudinal differentiation, roughly corresponding to the Recent biogeographic Nearctic, Transitional and Neotropical regions, indicating that such were already present in the Pleistocene.

Poster Session I (Wednesday)

RECORDS OF ICHTHYODECTIFORM FISHES FROM THE UPPER CRETACEOUS (CAMPANIAN) OF ARKANSAS

FIELITZ, Christopher, Emory & Henry College, Emory, VA, USA; IRWIN, Kelly, Arkansas Game and Fish Commission, Benton, AR, USA

Ichthyodectiform fishes have previously been reported from Upper Cretaceous deposits of the Atlantic and Gulf Coastal Plains (New Jersey to Mississippi) and the Western Interior Seaway (Texas to Manitoba). We provide the first reported descriptions of both historic and recently collected specimens of ichthyodectiform fishes recovered from Campanian deposits in southwestern Arkansas. A recent specimen of the saurodontid, *Saurocephalus lanciformis*, from the middle Campanian, upper Ozan Formation of Hempstead County, is the first record of this taxon from Arkansas, and fills a gap in geographic distribution records between Alabama and Texas. This specimen affords a detailed description of palatal bones, including ectopterygoid teeth. Although collected over 65 years ago, we describe for the first time remains of two specimens of the ichthyodectid, *Xiphactinus audax*, from the lower Brownstown Marl, lower Campanian, Sevier County. We also describe material from three recently collected specimens of *X. audax* recovered from the same locality. These specimens fill the hiatus in geographic distribution between records from the Gulf Coast, of Mississippi and Alabama with those from the Western Interior Seaway of north central Texas. These records also confirm the presence of *Xiphactinus audax* in the lower Campanian in the Mississippi Embayment and not the congeneric *Xiphactinus vetus*.

Poster Session III (Friday)

MISSISSIPPIAN TETRAPOD FOOTPRINTS FROM THE MAUCH CHUNK FORMATION IN EASTERN PENNSYLVANIA, USA

FILLMORE, David, Bethlehem, PA, USA; LUCAS, Spencer, New Mexico Museum of Natural History & Science, Albuquerque, NM, USA; SIMPSON, Ed, Kutztown University, Kutztown, PA, USA

In the vicinity of the town of Pottsville in Schuylkill County, eastern Pennsylvania, the Upper Mississippian Mauch Chunk Formation of siliciclastic red beds is approximately 110 meters thick. The rock units consist of interbedded red sandstones and shales, which are interpreted as fluvial and overbank deposits. Ichnotracas preserved in the rocks are typically, but by no means exclusively, found in mud drapes covering sandstones. The middle member of the Mauch Chunk Formation yields an extensive tetrapod footprint assemblage originally discovered in 1849. We have worked at 8 different collection sites in the Pottsville vicinity and have collected more than 250 ichnofossil

specimens, mostly variants of tetrapod footprints. This collection has considerably augmented the diversity of the tetrapod footprint assemblage, which now includes the ichnogenera *Batrachichnus* (= *Nanopus*), *Cincosaurus*, *Hylopus*, *Matthewichnus*, *Notolacerta* and *Palaeosauropus*. The Mauch Chunk tetrapod footprint assemblage is one of the oldest examples of the *Batrachichnus* tetrapod ichnofacies. An extensive collection of tracks and trackways of *Palaeosauropus* indicate that it is the track of a temnospondyl (which has a tetradactyl manus), with a gleno-acetabular length of up to 400 mm, which is much larger than any Mississippian temnospondyl now known from body fossils. The morphology of trackways of the temnospondyls (*Batrachichnus*, *Palaeosauropus*) and amniotes (*Hylopus*, *Notolacerta*) that dominate the Mauch Chunk track assemblage does not differ significantly in character from some younger Pennsylvanian and Early Permian track assemblages. This suggests that the diversity of terrestrial tetrapod locomotion strategies characteristic of Paleozoic tetrapod tracksites was achieved by the Late Mississippian. The Mauch Chunk tetrapod footprints are associated with invertebrate ichnotaxa characteristic of the *Scoyenia* ichnofacies, including *Cruziana*, *Diplichnites*, *Diplopodichnus*, cf. *Kouphichnium*, *Planolites*, *Rusophycus* and *Taenidium*.

Romer Prize Session, Thursday 8:30

EVOLUTIONARY DYNAMICS OF BODY SIZE EVOLUTION IN TERRESTRIAL CANIFORMIA (CARNIVORA, MAMMALIA)

FINARELLI, John, University of Chicago, Chicago, IL, USA

Body size has been described as the fundamental organismal character, correlated with numerous physiological and life history variables of interest to paleobiology. In this study, increases and decreases in body mass were tallied for proxy ancestor-descendant (AD) pairs for 519 terrestrial caniform species in 198 genera. To account for uncertainty in the actual phylogeny, a bootstrapping routine shuffled hypothesized AD pairs. Median proportions of increased descendant body mass for 1000 iterations were computed and binned by ancestral body mass. A suite of candidate models related the proportion of AD increases to ancestral body mass using either flat binomial probabilities or weighted, logistic regression to account for size-dependant change in proportions. Model likelihoods were evaluated with the Akaike Information Criterion (AIC). AIC recovered support for three models, all of which propose AD increases for small caniform taxa and decreases for large taxa. While the models differ in the specific treatment of taxa at intermediate size ranges, these results do demonstrate that caniform body sizes are bounded at large and small body size, constraining caniform taxa to intermediate body masses. This stands in sharp contrast to a broader mammalian pattern, where stable equilibria have been hypothesized at large and small body size, with an unstable equilibrium at medium body size, causing overall divergence away from intermediate body masses. Body size dynamics for individual caniform subclades within the intermediate size classes demonstrate that although many clades do not differ significantly from unbiased change, several clades display proportions that are significantly higher than 0.5. Each of these belongs to the families Amphicyonidae, Canidae or Ursidae; three clades that have previously been cited as examples of Cope's Rule. Several clades, including Mephitidae (skunks) and Vulpini (foxes), show proportions of increase that are significantly lower than 0.5, and therefore exhibit biased decrease in size. These results indicate that Cope's Rule is a common but clade-specific pattern in the Caniformia.

Technical Session III, Wednesday 2:00

LIFE HISTORY AND UNILATERAL LOSS OF MOLAR FUNCTION IN THE COHOES MASTODON: A CASE STUDY IN NUTRITIONAL STRESS?

FISHER, Daniel, University of Michigan, Ann Arbor, MI, USA; FOX, David, University of Minnesota, Minneapolis, MN, USA

The Cohoes mastodon was excavated in 1866 near Albany, New York, and was studied by several luminaries of nineteenth century North American geology and paleontology. It is an almost fully-grown, adult male and shows a puncture wound in its temporal fossa (left side) indicative of death in a musth battle. It also shows an anomalous lower right cheek dentition consisting of only an m1, rotated into a recumbent position with the normal occlusal surface facing anteriorly. We trace this condition to an earlier (probably tusk-inflicted) injury to the right dentary posterior to its functional tooth row. We suspect that infection following this injury caused regression of the developing right m2 and developmental failure of the right m3. Anterior progression of m1 was inhibited in response to this injury, but occlusion with the normally developing upper dentition, still translating anteriorly in a cranial reference frame, drove the rotation of m1. Analysis of dentin increments in the left tusk and lower molars allows these events to be placed within the context of a complete life history. The original injury occurred at about age 11. Progressive loss of dental function on the right side compromised nutritional condition, delaying attainment of sexual maturity by 2-3 years relative to contemporary male mastodons of the Great Lakes region and resulting in slower than normal tusk growth. Additional dental anomalies (probably reflecting transient protein stress) began to appear by age 25 and recurred seasonally until death (in spring) at age 32. Despite these problems, this individual matured normally and engaged in normal musth behavior (including fasting and high energy output during musth battles). In its last years of life, able to chew effectively only on its left side,  $\delta^{15}N$  (AIR) values from

its dentin collagen ranged from 3.0 to 4.3‰ (mean=3.5‰), indicating very little long-term nutritional stress. The relative normalcy of this male's life, despite deteriorating dental function and the physiological costs of male life history, suggests that neither forage quality nor quantity were severe stressors for late Pleistocene mastodons in the Great Lakes region.

Poster Session II (Thursday)

REPRODUCTIVE HEALTH AND SAFETY FOR FEMALE EMPLOYEES WORKING IN VERTEBRATE PALEONTOLOGY LABORATORIES

FITZGERALD, Vicki, Yale Peabody Museum of Natural History, New Haven, CT, USA; MILAM, Mason, Cincinnati Museum Center, Cincinnati, OH, USA

There are more women working in preparation laboratories than ever before, most of them of reproductive age. These employees must routinely use chemicals in preparation, molding, and casting that may not be encountered in other professions. Some of these chemicals are or may be hazardous to reproductive health, including certain adhesives, consolidants, casting resins, and the solvents used with them that are so commonplace in the laboratory that their safety is often taken for granted. Some of these chemicals pose developmental risks to human embryos even before a woman is aware of the pregnancy. This poster will outline certain chemicals and their associated risks as well as less toxic alternatives. A general guideline of preventative lab practices will be included.

Technical Session I, Wednesday 10:30

COMPARING PRIMATE CRANIA: THE VALUE OF FOSSILS

FLEAGLE, John, Stony Brook University, Stony Brook, NY, USA; GILBERT, Christopher, Stony Brook University, Stony Brook, NY, USA; BADEN, Andrea, Stony Brook University, Stony Brook, NY, USA

Although there have been numerous studies of many aspects of cranial form and function in many different groups of living and fossil primates, broader comparisons of overall cranial shape throughout the Order Primates are remarkably absent. In this presentation, we offer the initial results of a project aimed at providing a multivariate comparison of the major patterns of cranial shape change during primate evolution. We also provide quantitative assessments of cranial diversity among different clades, and evaluate the importance of fossil taxa in our understanding of the evolution of primate cranial evolution. We digitized a set of 18 landmarks designed to capture overall cranial shape differences on male crania of over 65 genera of extant primates as well as a smaller number of fossil taxa for which nearly complete crania were available. The landmark data were aligned using a Generalized Procrustes Analysis and then subjected to a Principle Components Analysis to identify major axes of cranial variation. Cranial diversity among clades was compared using multivariate measurements of variance. Separate analyses were performed on the extant primates alone, and the combined extant and fossil taxa. The first two components account for over 60 percent of the total variance. The first principle component reflects differences in cranial flexion, relative nasal length, and aspects of orbit size and orientation. It separates strepsirrhines and haplorhines. The second principle component reflects differences in relative snout length and neurocranial height. Hominoids show the highest variance among extant clades and haplorhines and anthropoids have higher variance than strepsirrhines. The multivariate distance between humans and chimpanzees is much greater than between any other pair of extant sister taxa. Addition of fossil taxa does not change the overall pattern of the major axes of cranial shape. However, the subfossil lemurs of Madagascar greatly expand the diversity of strepsirrhine crania. Fossil hominid crania fill the large morphological gap between chimpanzees and modern humans in a nearly linear temporal sequence.

Carnivora: Phylogeny, Form and Function Symposium, Saturday 8:30

PHYLOGENY OF THE CARNIVORA AND CARNIVORAMORPHA, AND THE USE OF THE FOSSIL RECORD TO ENHANCE UNDERSTANDING OF EVOLUTIONARY TRANSFORMATIONS

FLYNN, John, American Museum of Natural History, New York, NY, USA; FINARELLI, John, University of Chicago, Chicago, IL, USA; SPAULDING, Michelle, Columbia University, New York, NY, USA

Recent morphological, molecular, and combined analyses yield a well-resolved and stable higher-level phylogeny of Carnivoramorpha; current studies will soon permit similar refinements at lower levels. Morphological analyses indicate that "Creodonts" are the nearest relatives of Carnivoramorpha, while molecular results suggest that Pholidota are the nearest living relatives of Carnivora. There is strong support for monophyletic Carnivoramorpha, Carnivora, Caniformia, Feliformia, Arctoidea, Pinnipedia, Musteloidea, Feloidea, Herpessioidea, and all traditional modern families (except Viverridae and Mustelidae); many subclades also are well resolved. Early Cenozoic carnivoramorphan (a monophyletic Viverridae plus a paraphyletic series of stem "miacids") form basal outgroups to crown Carnivora. Fossils, placed within a robust phylogeny, are crucial to interpretations of many evolutionary transformations. Studies of Recent taxa alone indicate a large ancestral body size for Arctoidea, whereas including fossils documents small-bodied ancestors for Caniformia and Arctoidea, and a

moderate-sized ancestral musteloid with size reduction in some mustelids. Brain volumes can be accurately estimated for fossil carnivoran taxa using 3 simple external cranial measures, allowing the number of fossil caniform endocranial volume estimates to be increased by ~700%. Body size and brain volume estimates for fossil caniforms suggest their encephalization was at or below the modern median from the Oligocene-late Miocene and that modern encephalization levels were achieved independently in caniform "familial" clades. Canidae encephalization appears to follow a simple phase shift of increased brain volume restricted to the crown radiation, coinciding with both taxonomic diversification and neocortex anatomy reorganization. Prior studies of "miacid" postcranial anatomy generally used exemplars. Detailed analyses of more (and more varied) taxa document mosaic distributions of features, with greater disparity in anatomy and inferred habitus (terrestrial, scansorial, arboreal). These results indicate that reliable ancestral locomotor reconstructions will require enhanced taxon sampling.

Technical Session XVI, Saturday 1:15

EVOLUTION AT THE BASE OF CROWN GROUP MUROIDEA

FLYNN, Lawrence, Harvard University, Cambridge, MA, USA

In parallel with the growing body of molecular data bearing on the relationships of muroids, particularly subterranean lineages, the relevant fossil record has improved to the point that its data constrain scenarios of evolution about both the timing and mode of evolution of burrowing muroids: bamboo rats, blind mole rats, and zokors. Morphologists have considered these as distinct, but the three lineages appear to be related as a monophyletic Family Spalacidae, sister taxon to all other living muroids, based on both nuclear and mitochondrial genes. Although living genera are fully subterranean, the fossil record shows that the three groups evolved burrowing characteristics independently. Bamboo rats have the longest fossil record, extending into the Late Oligocene, but do not show fossorial traits until the late Miocene. Blind mole rats (Spalacinae) have a fossil record nearly that long, and its early members also lack burrowing traits. Zokors (Myospalacinae) show more characteristics considered as derived than do the other groups, and have a shorter fossil record. The fossil record of the Tribe Rhizomyini extends to about 10 million years ago, with early species distinct at the generic level from living *Rhizomys*. The oldest well-known species assignable to the extant genus is *Rhizomys (Brachyrhizomys) shansius* from the early Pliocene of Yushe Basin, China, north of the geographic range of modern *Rhizomys*. A hypothesis of close relationship of bamboo rats, blind mole rats and zokors leads to a re-evaluation of affinities of certain Asian fossil taxa and re-evaluation of polarity of some features, but molecular data are not yet robust enough to pose testable inter-relationships of the groups.

Technical Session V, Wednesday 3:00

EVOLUTION OF THE AMPHIBIANS AND SQUAMATES OF THE CONTINENTAL CRETACEOUS-PALEOGENE TRANSITION IN EUROPE

FOLIE, Annelise, Royal Belgian Institute of Natural Sciences, Brussels, Belgium

The Maastrichtian herpetofaunas of the Hateg Basin (Romania) and those from the Middle Paleocene of the Mons Basin (Belgium) have been analysed to evaluate the influence of the Cretaceous / Paleogene crisis on amphibians, lizards and snakes of Europe and to understand their biogeographic origins. This study was based on 303 specimens from three Romanian sites and 1054 specimens from the Belgian borehole of Hainin. The herpetofaunas from the Hateg Basin are composed of at least one albanerpetontid allocaudate of the genus *Albanerpeton*, two discoglossid anurans, two paramacellodid lacertilians, the first true teiid lacertilian in Europe, and a madtsoiid snake. In the herpetofaunas from the Mons Basin, caudates are represented by three new salamandrid species, and anurans by a new genus of discoglossids and a new species of palaeobatrachids. Lacertilians are represented by two new genera of scincoids and six other undetermined scincomorphs, by a new genus of amphisbaenians and probably also by a limbless anguid. Snakes are represented by the oldest boid of Europe and by the oldest known scoleophidian. These paleontological data, combined with lithological data of the two areas, indicate the following conclusions. (1) The climate was warm, temperate, and humid with stagnant water areas. (2) The Cretaceous / Paleogene crisis did not tragically influence the European herpetofaunas. Actually, only the albanerpetontid allocaudates, the polyglyphanodontine lacertilians and the madtsoiid snakes disappeared after the crisis in Europe. (3) The Maastrichtian herpetofaunas of Europe underwent a North-American influence during the Upper Cretaceous. A second migration probably occurred during the Upper Paleocene. A third migration wave, coinciding with the arrival of the modern mammal orders, occurred at the beginning of the Eocene. The latter migration would be responsible of the arrival of numerous modern families of lacertilians in Europe as the agamids, geckkonids, varanids, helodermatids and lacertids.

Technical Session I, Wednesday 11:00

HISTORICAL BIOGEOGRAPHY OF PAPIONIN MONKEYS AND CORRELATED PATTERNS IN PLIO-PLEISTOCENE VERTEBRATES

FOLINSBEE, Kaila, University of Toronto at Mississauga, Mississauga, ON, Canada

The papionin clade contains some of the most widely spread and abundant species of non-human primates, for example, the living macaques and *Papio* baboons, a trend which appears to have extended throughout its evolutionary history. Phylogeny reconstruction of ten ingroup taxa, including both extinct and extant members of the papionin clade, reveals interesting paleobiogeographic range shifts. For example, during the Plio-Pleistocene, species of *Theropithecus* (the sister taxon to *Papio*) were widespread across Africa and extended into Eurasia, while currently all have become extinct except *Theropithecus gelada*, which is restricted to Ethiopia. The large, extinct South African genera *Gorgopithecus* and *Dinopithecus* are members of the extant *Mandrillus-Cercocebus* clade, which is now restricted to Central Africa. Mapping geographic ranges onto the phylogeny reveals patterns of dispersal between areas. A new method in historical biogeography, PACT (Phylogenetic Analysis for Comparing Trees), tests whether these patterns are specific to cercopithecoids, or whether they belong to a more general series of paleogeographic events that affected multiple clades. PACT identifies correlated biogeographic patterns by combining multiple phylogenies of different clades from the crowns downward to create a general area cladogram that contains the biogeographic and phylogenetic information from all input phylogenies. General nodes indicate multiple independent speciation events in different clades due to vicariance (range contraction) or biotic expansion (range increase). For a dataset of five clades, PACT analysis reveals general biotic expansion and vicariance events between and within Africa and Eurasia over the last 5 Ma. This supports the hypothesis that large-scale geological and/or climatic changes caused correlated changes to the distribution and evolutionary history of vertebrate taxa within the Old World over the last 5 Ma. In particular, it appears that many taxa with ancient widespread distributions have more recently become restricted to the equatorial region. PACT analysis also revealed clade-specific range changes that may indicate peripheral isolates speciation.

Technical Session VI, Thursday 1:30

A FUNCTIONAL EXPLANATION FOR THE JUGAL FLANGES AND MANDIBULAR TUBERCLES ON THE ENTELODONT SKULL (MAMMALIA, ENTELODONTIDAE)

FOSS, Scott, Bureau of Land Management, Salt Lake City, UT, USA

The Entelodontidae is characterized by lateroventrally oriented flanges derived from the jugal bone and by one, but usually two, pairs of knob-like tubercles on the ventral surface of the mandible. Many different explanations have been offered to explain these unusual features, but to date, an in depth study of the anatomy and functional morphology of the flanges and tubercles in entelodonts has not been offered. For this study, over 200 entelodont skulls and jaws were examined. The results show that entelodonts supported wide gape in a similar, though inverse, way to that in hippos. Hippos have a laterally oriented dependent angle of the jaw, whereas entelodonts have a ventrolaterally oriented jugal flange on the skull. Each system accomplishes the same thing, supporting laterally oriented masseter musculature that has both longer muscle fibers and offers optimal stability over the full range of motion in order facilitate wide gape. Similarly, the jaws of both entelodonts and hippos have analogous tubercles and muscle scars that support the insertion of a derived sternum-to-mental muscle system. Additionally, entelodont flanges and tubercles grew significantly during the later stages of ontogeny and continued to grow well into adulthood. Large jugal flanges and mandibular tubercles correlate with increased age and high tooth wear, suggesting continued growth or late-stage terminal growth in these features. These results not only inform functional explanations for the entelodont skull, but also affect taxonomic assignments in the family that have historically been based on flange and tubercle size and shape.

Poster Session IV (Saturday)

RECENTLY REDISCOVERED BARYONYCHINE TEETH (DINOSAURIA: THEROPODA): NEW MORPHOLOGIC DATA, RANGE EXTENSION & SIMILARITY TO CERATOSAURUS

FOWLER, Denver, Museum of the Rockies, Bozeman, MT, USA

Newly identified baryonychine teeth from the UK Wealden illustrate the morphologic variability and stratigraphic range of this taxon. Whilst common in the formations in which they occur, their distinctive fluted and finely serrated teeth are often misidentified as crocodylian, which are superficially similar in appearance. Fourteen teeth from mainland Weald collections of the British Museum of Natural History (some collected over 150 years ago, all stored with goniopholid specimens) demonstrate the presence of baryonychines in the Hauterivian and possibly Valanginian stages of the Early Cretaceous: the oldest record of this group. An unusual laterally compressed, posteriorly recurved, and fluted tooth from the Purbeck Limestone (Late Jurassic - earliest Cretaceous) may extend the range of baryonychines even further. Some specimens from the Barremian Wessex Fm (Isle of Wight, UK) and older mainland deposits show both lingual and labial fluting, previously seen only in teeth from Spain. Spanish specimens

can no longer be considered phylogenetically distinct based on this character. The fluted premaxillary and anterior dentary teeth of *Ceratosauros* (and to a lesser extent, some other ceratosaurs e.g. *Masiakasaurus*) bear remarkable similarity to the fluted teeth of baryonychines. Whether this represents convergence or a real phylogenetic signal requires further analysis. However, isolated teeth identified as *Ceratosauros* sp. from the Late Jurassic of Tendaguru, Tanzania, can no longer be assigned with confidence to this taxon and should be reassessed, especially as ceratosaur lateral teeth are unknown from these strata. The observed phylogenetic trend towards reduced denticle size in baryonychines through to spinosaurines suggests that the hypothetical ancestral condition possessed larger denticles, similar to typical theropods and what is seen in the Tendaguru teeth. A ceratosaur origin for baryonychines has been previously suggested and subsequently rejected by recent workers. However, this relationship should be critically reassessed considering the similarity between these taxa, and recent phylogenetic analyses placing *Ceratosauros* closer to the Tetanurae.

Technical Session XII, Friday 3:30

HABITAT PATCHINESS DURING THE TRANSITION TO THE MODERN GRASSLAND ECOSYSTEM IN THE GREAT PLAINS

FOX, David, University of Minnesota, Minneapolis, MN, USA; PASSEY, Ben, University of Utah, Salt Lake City, UT, USA; CERLING, Thure, University of Utah, Salt Lake City, UT, USA; MARTIN, Robert, Murray State University, Murray, KY, USA

Carbon isotope compositions ( $\delta^{13}\text{C}$ ) of paleosol carbonates in southwestern Kansas indicate the modern, C4-dominated grassland in the Great Plains developed in two stages: an initial increase from the late Miocene (ca. 20% C4 biomass, as in other Miocene sections in the region) to the early Pliocene (ca. 40% C4), and a subsequent increase during the late Pliocene-early Pleistocene to modern levels (>60% C4). Lateral sampling of single calcareous horizons in early Pliocene outcrops containing Blancan small mammal faunas indicates the abundance of C4 biomass varied from 20-75% on small spatial scales (<2 km), although mean C4 abundance is identical to other early Pliocene measured sections in the area. High landscape-scale heterogeneity in C4 abundance is consistent with discrete patches of C3- and C4-dominated habitat that migrated laterally on time scales short relative to the duration of sediment accumulation. We tested this interpretation using  $\delta^{13}\text{C}$  values of tooth enamel sampled by laser ablation to reconstruct time-integrated diets of most species of small herbivorous mammals from two Blancan faunas (Fox Canyon and Rexroad Loc. 3). Home ranges of small mammals are relatively small, so small mammal diets should be sensitive to local heterogeneity in C4 abundance. If early Pliocene habitats in Kansas had discrete C3 and C4 patches, then small herbivore species in faunas and individuals in small herbivore species should have  $\delta^{13}\text{C}$  values that range between end-member C3 and C4 diets. Rodent  $\delta^{13}\text{C}$  values (n=81, 14 species) range from -14.4 to -1.0‰, indicating diets that range from 100% C3 to >75% C4. Lagomorphs (n=7, 3 species) range from -10.7 to -7.6‰, suggesting greater reliance on C3 biomass. Two well-sampled species (*Spermophilus rexroadensis*, *Geomys adamsi*, n=15 each) have values that range from -14.4 to -6.2 and -13.2 to -7.1‰, respectively, indicating variable diets within species. Our results are consistent with habitat patchiness during the early Pliocene.

Preparators' Session, Thursday 10:45

THE PREPARATION, MOLDING, CASTING, AND DISARTICULATION OF *POPOSAURUS GRACILIS*, YPM 58100

FOX, Marilyn, Yale Peabody Museum of Natural History, New Haven, CT, USA; FITZGERALD, Vicki, Yale Peabody Museum of Natural History, New Haven, CT, USA

In 2003, Yale Peabody Museum field crews excavated, in six separate field jackets, the almost complete, fully articulated skeleton of the little known Triassic archosaur *Poposaurus gracilis* from BLM administered lands in Grand Staircase/Escalante National Monument, Utah. The skeleton was prepared as found, in articulation, photographed, and molded before disarticulation. The primary preparation of soft bone in matrix that ranged from weathered mudstone to sandstone was complicated by the inclusion of numerous hard calcium carbonate nodules in the matrix. Five-layer silicone molds, backed by FGR Hydrocal and fiberglass jackets were made of each of the six field jackets. The bones were fractured extensively. This necessitated filling gaps, before molding, with a variety of materials, including Carbowax, cyclododecane, Aquazol 200 with marble dust, and sulfur-free clay. The first or master cast was retained as a permanent record of the specimen in articulation. Molding and casting was followed by complete disarticulation of the skeleton, and re-adhesion of the numerous breaks to allow for research of the individual elements. This paper describes some of the tools, materials and techniques involved and rationale for decisions made in the process of preparation, molding, casting, and disarticulation of the specimen.

Technical Session III, Wednesday 1:30  
MEGAFAUNAL CARNIVORE SPECIES INTERACTIONS AND DIETS IN  
LATE PLEISTOCENE ALASKA

FOX-DOBBS, Kena, University of California Santa Cruz, Santa Cruz, CA, USA;  
KOCH, Paul, University of California Santa Cruz, Santa Cruz, CA, USA

Late Pleistocene eastern Beringia is a model paleo-ecosystem for the study of potential and realized species interactions within a diverse mammalian carnivore guild. Beringian paleontological records store a wealth of information that can be used to investigate how predator-prey and competitive interactions shifted in response to past episodes of environmental change. Two such recent periods of rapid climate change are the Last Glacial Maximum (LGM) and the end of glacial conditions at the beginning of the Holocene. Here we assemble carbon and nitrogen stable isotope, and AMS 14C data collected from bone collagen of late Pleistocene carnivores and megafaunal prey species from the interior of eastern Beringia (Alaska), and reconstruct the diets of ancient Alaskan carnivores. The patterns of carnivore species presence/absence and dietary overlap show that not all carnivores were present simultaneously, and suggest that some species may have been interacting competitively. Our ecological interpretations are done in the context of known landscape-scale changes in climate and vegetation before, during, and after the LGM. The network of Beringian carnivore interaction was complex and dynamic; we found that some species (wolves) persisted for long periods of time, while others were only present during specific timeframes (large felids). There was limited evidence for large differences in prey selection among carnivores during most of the late Pleistocene. Throughout this time the primary prey of all analyzed carnivore species were yak, horse, bison, and caribou. Mammoth and muskox only appeared in carnivore diets during specific times in the late Pleistocene. The variances in the isotope values of carnivore species were not constant through time, with significant differences between pre- and post-glacial carnivores. Individual-level feeding preferences of carnivores may have broadened or narrowed in response to changing prey abundances associated with late Pleistocene environmental shifts.

Student Poster Session (Thursday)

TOOTH MORPHOLOGY AND PLACEMENT OF A NEW SPECIES OF  
*MYLEDAPHUS* FROM THE MILK RIVER VALLEY, FOREMOST FORMA-  
TION (CAMPANIAN), ALBERTA, CANADA, WITH COMPARISON TO  
*MYLEDAPHUS BIPARTITUS*

FRAMPTON, Emily, University of Calgary, Calgary, AB, Canada

Approximately 4000 *Myledaphus* teeth were recovered from the Pinhorn Ranch North Site (PHRN), a Late Cretaceous faunal assemblage in the Foremost Formation, with all teeth appearing to belong to a single species. Analysis of the teeth resulted in the identification of 6 tooth forms: Irregular Elongate, Indistinct Rhombic, Transitional, Hexagonal, Distinct Rhombic and Oval. The teeth within these groups have a reduced to absent labially arched transverse ridge on the occlusal surface, smooth enamel on the dorsal, labial and lingual surfaces of the crown and a bifurcated root of hololacurhizous condition. Comparison of the teeth from the PHRN site and those from an articulated specimen of *Myledaphus bipartitus*, (RTMP 1998.62.01) revealed a consistent variation in morphology and indicates a new species. This new species differs from *Myledaphus bipartitus* in its lack of a distinct transverse ridge on the occlusal surface and raised enameloid folds on the occlusal and lateral facets of the tooth crown. The two species are similar in that the teeth from *Myledaphus bipartitus* can be grouped into the same 6 tooth forms that were identified from teeth in the PHRN site. On the articulated specimen of *Myledaphus bipartitus*, these 6 tooth forms occur in different positions on the dental apparatus, indicating that tooth form and position are directly related. Based on the articulated specimen, Irregular Elongate teeth are found at the proximal end of the symphysis on the upper tooth pavement. Indistinct Rhombic teeth occur on either side of the symphysis below the Irregular Elongate teeth. Moving laterally from the symphysis, Indistinct Rhombic teeth grade through Transitional teeth to Hexagonal teeth, which have a medial position on both sides of the upper tooth pavement. The lower tooth pavement is dominated by Distinct Rhombic teeth, with Oval teeth occupying a lateral position on both the upper and lower tooth pavements. Based on this arrangement, the tooth pavements of the new species of *Myledaphus* were reconstructed.

ASSEMBLING MODERN ACANTHOMORPH DIVERSITY: EXAMPLES  
FROM TWO APOMORPHIC CLADES

FRIEDMAN, Matt, University of Chicago, Chicago, IL, USA

Extant acanthomorph teleosts include taxa with some of the most divergent bodyplans found among vertebrates, ranging from massive ocean sunfishes to delicate pipefishes. Much of this diversity appears to have been generated in explosive fashion during the Late Cretaceous and early Paleogene; most living families with a fossil record appear before the close of the Eocene. The interrelationships of extant acanthomorphs remain an area of considerable uncertainty. Many apomorphic acanthomorph groups are readily identified by the large suites of morphological specializations that characterize them, but these same derived features often obscure primitive conditions for these clades, making their placement within a phylogenetic framework difficult. Here I explore the

role that paleontological data can serve in establishing primitive conditions by examining the fossil record of two highly apomorphic acanthomorph clades: Lampridiformes (moonfishes and ribbonfishes) and Pleuronectiformes (flatfishes). Lampridiformes are the probable sister group of all other acanthomorphs, but most living forms are extremely specialized. This radiation includes two major divisions, the deep-bodied bathysomes, which define a grade, and the long-bodied taeniosomes, which form a clade. A diversity of deep-bodied lampridiforms is known from the fossil record, and renewed examination of these taxa reveals that they are broadly spread across lampridiform phylogeny: some are stem-group lampridiforms, others are stem-group lampridids, while many occupy a surprising position along the taeniosome stem. Pleuronectiforms are of uncertain placement among percomorph acanthomorphs, and are characterized by profound cranial asymmetry related to their benthic ecology. The developmental origins of flatfish asymmetry are well documented, but the evolution of this peculiar bodyplan remains obscure; all fossil flatfishes show apparent cranial asymmetry, and no members of the pleuronectiform stem-group have yet been identified. Investigation of possible fossil relatives of flatfishes provides hints to the origins of this distinctive group.

Carnivora: Phylogeny, Form and Function Symposium, Saturday 9:30  
MUSTELIDAE: A MODEL FAMILY IN A MODEL ORDER

FRISCIA, Anthony, University of California - Los Angeles, Los Angeles, CA, USA;  
KOEPLI, Klaus-Peter, University of California - Los Angeles, Los Angeles, CA, USA

A recent, comprehensive, molecular-based phylogeny of the Mustelidae, allows us to map the ecological patterns in the family within an evolutionary framework. The mustelids are a diverse group of mammalian carnivores, dentally, post-cranially, and ecologically including semi-fossorial omnivores (badgers), arboreal carnivores (martens), terrestrial hyper-carnivores/scavengers (wolverines) and aquatic hard-object feeders (otters). No mustelid is strictly insectivorous, which seems to be true throughout their evolutionary history, and distinguishes them from other small carnivore groups, such as herpestids (mongooses), viverrids (civets), and procyonids (raccoons). Dental morphology was studied using simple dental measures, and mustelids were found to be unique among mammalian carnivores in having disproportionately strong jaws. A preliminary study of post-crania correlated morphology with the primary locomotor mode of the taxa, but showed some interesting phylogenetic effects. For example, *Enhydra* (the sea otter) is the most distinctive mustelid, with relatively long limbs, although it does group with other otters (Lutrinae). Both species of *Martes* used in this study (the fisher and the pine marten) do not group with other arboreal taxa, nor with their closest relatives, but with the similarly elongate *Mustela* (weasels). The evolution of morphology throughout the group is complex and driven both by phylogeny and ecology, and also demonstrates an interesting biogeographical history. Contrary to the typical evolutionary radiation patterns seen in other wide-spread carnivoran groups, such as canids (dogs), particular mustelid ecological types seemed to originate once, then migrate to different continents. This is especially true for the New World, which received numerous emigrants from the Old World.

Technical Session II, Wednesday 11:30

GLOBAL TAXONOMIC DIVERSITY OF ANOMODONTS (THERAPSIDA)  
ACROSS THE PERMIAN-TRIASSIC BOUNDARY

FRÖBISCH, Jörg, University of Toronto, Mississauga, ON, Canada; REISZ, Robert, University of Toronto, Mississauga, ON, Canada

The diversity of anomodonts through time is of particular interest, since their largest subclade, the Dicynodontia, are said to have suffered the most of all terrestrial tetrapods at the end-Permian extinction. Two prerequisites for a global taxonomic diversity assessment are a solid faunal correlation and a robust alpha taxonomy. In both areas much work has been done recently for Permian and Triassic anomodonts, and the current study presents for the first time a detailed, up to date correlation of anomodont-bearing tetrapod faunas with the focus on a well-resolved stratigraphic and taxonomic documentation. Furthermore, the taxonomic diversity of this clade is assessed on the genus and species level. Taxonomic diversity is analyzed within the framework of the established land-vertebrate faunachrons (LVF) as well as in a real-time scale with intervals of 1 Ma. In this study, a total of 69 genera and 120 species of anomodonts is accepted as valid, stretching across twelve LVF from the Middle Permian Kapteinskraalian LVF (Wordian) to the Late Triassic Revueltian LVF (Norian). Anomodont diversity climbs from initially five genera and species to twelve genera and thirteen species in the early Gamkan LVF (Capitanian). It drops slightly in the late Gamkan LVF, but thereafter increases continuously until it reaches its maximum of 20 genera and 40 species in the latest Permian Platbergian LVF (Changhsingian). As a result of the end-Permian extinction global anomodont diversity collapses down to only two genera (90% extinction) and seven species (82.5% extinction) in the earliest Triassic Lootsbergian LVF (Induan & early Olenekian). Recovery of the global anomodont diversity after the Permian-Triassic boundary lasted several Ma, but diversity increased continuously to reach a second peak of twelve genera and 22 species in the Perovkan LVF (late Anisian). Thereafter, anomodont diversity rapidly collapsed for a second time at the Anisian-Ladian boundary and remained low, not exceeding two genera and three species until the extinction of the clade at the end of the Triassic.

The Dissorophoidea - Early Amphibian Radiation Symposium, Friday 11:00  
A NEW LOWER PERMIAN AMPHIBAMID (DISSOROPHOIDEA, TEM-  
NOSPONDYLI) FROM THE FISSURE FILL DEPOSITS NEAR RICHARDS  
SPUR, OKLAHOMA

FRÖBISCH, Nadia, McGill University, Montreal, QB, Canada; REISZ, Robert,  
University of Toronto at Mississauga, Mississauga, ON, Canada

The Lower Permian deposits of Richards Spur (Fort Sill), Oklahoma, have produced over the last seven decades a wealth of disarticulated skeletal elements and occasional articulated skeletons of terrestrial vertebrates. Recent excavations at the Dolese quarry have yielded an unusually large number of skulls and partial skeletons of lower tetrapods. A new dissorophoid amphibian is represented by a small, exquisitely preserved, complete skull revealing detailed features of the skull roof, palate, braincase and mandible. The skull is relatively elongate with large tabular and postparietal. The teeth are monocuspid and show no sign of pedicel. The denticle field of the parasphenoid is greatly expanded and continues along the length of the cultriform process. The large interpterygoid vacuities are covered by a mosaic of small dermal plates that each carry more than a dozen strongly recurved teeth. Incorporation of this new taxon into a phylogenetic analysis of Dissorophoidea results in two most parsimonious trees with the new taxon in a monophyletic Amphibamidae as the sister taxon to the Lower Triassic *Micropholis* from South Africa. The analysis supports for the first time a basal split of Amphibamidae into two distinct clades. One subclade contains the new taxon, *Micropholis*, and *Tersomius*. The second subclade comprises *Amphibamus*, *Doleserpeton*, *Eoscopus*, and *Platyrhinops*. The exclusion of postcranial characters from the analysis results in one most parsimonious tree with the topology for Amphibamidae identical to the analysis including postcranial characters. The Amphibamidae have been implicated in the highly controversial origins of modern amphibians from among Paleozoic tetrapod taxa. Most authors favor the Amphibamidae as the closest relatives of modern anurans and urodeles. Despite this, the taxonomy, diversity and phylogenetic relationships of amphibamids are poorly understood, and the new taxon provides important new insights into both amphibamid cranial morphology and evolutionary history.

Poster Session III (Friday)

EXPANSION OF GRASSLAND IN THE EARLY LATE MIOCENE IN NORTH-  
ERN THAILAND

FUKUCHI, Akira, Kagoshima University, Kagoshima, Japan; RATANASTHIEN,  
Benjavun, Chiang Mai University, Chiang Mai, Thailand; SONGTHAM, Wickanet,  
Department of Mineral Resources, Bangkok, Thailand; NAKAYA, Hideo, Kagoshima  
University, Kagoshima, Japan; SUZUKI, Shigeyuki, Okayama University, Okayama,  
Japan

Several mammalian fossil localities have been reported in the rift basins in the northern Thailand. Based on the mammalian fossil assemblages and magnetostratigraphic analysis, the Chiang Muan and the Sop Mae Tham mammalian fossil localities are estimated to be the late Middle to early Late Miocene and early Late Miocene in age, respectively. We report the paleoenvironments of both fossil localities. The Chiang Muan locality has yielded plenty of vertebrate fossils, including the earliest large-bodied Miocene hominoid in Southeast Asia. The Chiang Muan mammalian fauna is characterized by relatively abundant suoid species and the absence of *Hipparion*. On the other hand, the occurrence of *Hipparion* is a characteristic of the Sop Mae Tham mammalian fauna. These features imply that the Sop Mae Tham locality was more open environment than the Chiang Muan. The supporting evidence for the open environment in the Late Miocene in northern Thailand was obtained by the study of deposits of both localities. Fossil vertisols are recognized in the upper Middle Miocene members of the Chiang Muan Formation in the Chiang Muan locality. However, paleosols of the lower Upper Miocene member of the Chiang Muan Formation can be classified into mollisols. The impermeable calcrete layer was formed in the Upper Miocene paleosols in the Chiang Muan locality. Concentrations of fish fossils in the calcrete layers are characteristics of the deposits in the Sop Mae Tham locality. The burrows are commonly found below the calcrete layers in the Sop Mae Tham. These features strongly suggest a seasonality of climate in the early Late Miocene in northern Thailand. The timing of changes from woodland soil to grassland soil in the Chiang Muan locality corresponds to the timing of uplifting of Himalayas and Tibetan Plateau around 11 Ma inferred from the boreholes in the northern Indian Ocean and South China Sea. Expansion of grasslands in the early Late Miocene in northern Thailand could be caused by the monsoonal climate.

Poster Session I (Wednesday)

A THEORY OF LATER HOLOCENE MEGAFUNAL EXTINCTION

GALBREATH, Gary, Northwestern University, Evanston, IL, USA

It has been debated whether transitional (between 13,000 and 7,000 B.P.) Pleistocene/Holocene extinctions of American and Eurasian megafauna were caused mainly by anthropogenic hunting, climate change, disease, or some combination of such factors. As an alternate theory, I propose that, at least in Eurasia, most or all of

these large vertebrates may actually have become extinct within the last 7,000 years, with the majority becoming extinct within historical times (roughly, the last 5,000 years). Holocene environmental changes may have confined previously widespread megafaunal species to smaller geographic enclaves containing appropriate habitat, as is known to have been the case for the woolly mammoth *Mammuthus primigenius* and the giant deer *Megaloceros giganteus*. I suggest that remnant populations were destroyed (sometimes indirectly, as in the case of carnivores that lost their prey) by dense, settled human populations supported by horticulture, agriculture, and/or efficient use of maritime resources. The primary modes of extinction would have been hunting and habitat destruction. This is intrinsically more plausible than megafaunal extermination by small bands of hunter-gatherers in earlier times. In this model, most of the extinct megafauna lack a fossil record from recent times due to geographic rarity prior to anthropogenic extinction; 'absence of evidence is not evidence of absence'. Nonetheless, documented survival well into historical times of the woolly mammoth in Siberia and the giant tamaraw buffalo *Bubalus mephistopheles* in China suggests that we may eventually locate evidence of other survivals. The theory can also be tested via the Eemian fossil record. It predicts that during the warmest parts of that Interglacial, relevant megafaunal lineages were similarly geographically restricted, and that most of them should be temporarily absent from the fossil record. The Eurasian record may be sufficiently dense to test this prediction. Application of this model to the Americas requires the megafaunal extinctions there to have occurred largely after 3,500 B.P.

Poster Session I (Wednesday)

THE LAST MOSASAURS

GALLAGHER, William, New Jersey State Museum, Trenton, NJ, USA; MCKEE, Joseph, Society of Vertebrate Paleontology, Palmerston North, New Zealand; MULDER, Eric, Museum Natura Docent, Denekamp, Netherlands; SCHULP, Anne, Natuurhistorisch Museum Maastricht, Maastricht, Netherlands

An oft-quoted explanation for the extinction of Late Cretaceous marine vertebrates invokes the widespread regression of epicontinental seas during the Maastrichtian Stage, and the concomitant shrinking of marine habitats. One possible way to test this hypothesis is to look at the Late Maastrichtian fossil record of mosasaurs, large squamates that were apical predators in Late Cretaceous marine ecosystems. Late Maastrichtian marine deposits yield mosasaur remains in the stratotype area of Maastricht in the Netherlands, and in adjacent Belgium; in the Wisla Valley of central Poland; in New Jersey and Missouri where they occur in the highest (youngest) North American ammonite zones; in the Western Interior upper Fox Hills Formation; and in the latest Cretaceous beds in New Zealand. In addition, some of the California mosasaur material may questionably be Late Maastrichtian in age. Late Maastrichtian mosasaurs were widespread, diverse, and not particularly rare if compared to other older mosasaur faunas. Close relationships between mosasaur populations across the Atlantic and into the Western Interior suggest wide ranges for these large predators, a characteristic of modern large marine animals. Even though marine habitats shrank as sea level fell during the Maastrichtian, mosasaurs could simply retreat into deeper waters and remain in those areas still covered by the sea. The disappearance of the mosasaurs is more probably linked to collapse of the Latest Cretaceous marine food webs as plankton populations crashed at the K/P Boundary.

Poster Session I (Wednesday)

PRESENCE OF AN UNPAIRED VOMER IN JUVENILE AND ADULT INDIVIDUALS OF *LEPIDOTES PIAUHYENSIS* (NEOPTERYGII, SEMIONOTIDAE) AND A REAPPRAISAL OF THIS BONE IN SEMIONOTID FISHES

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The adults of the semionotid *Lepidotes piauhyensis* are represented by hump-backed fishes reaching about 500 mm standard length. They exhibit, among other characters, dermal bones of the skull roof and circumorbital series densely ornamented with tubercles, suborbitals disposed in a single row, moderately developed crushing dentition, a complete dorsal scale row, and smooth ganoid scales of lepisosteoid type. The analysis of well-preserved juvenile and adult specimens allowed the description of anatomical structures previously unknown for *L. piauhyensis*, particularly of the vomer. It is a small and wide median structure, which fits in the parasphenoid through a complex suture. Although being toothed, the teeth are badly preserved in all examined specimens. In the 1980's literature, there is a statement that juvenile individuals of *L. decanensis* have two vomers and this is the condition found in this ontogenetic stage of the genus *Lepidotes*. This assertion was not confirmed in *L. piauhyensis*, but specimens of *L. decanensis* examined in the Natural History Museum (e.g., BMNH P. 12138 and 12139) show, in fact, a paired vomer. On the other hand, within all species of *Lepidotes* other than *L. decanensis*, both juvenile and adult individuals are considered to bear unpaired vomers. The presence of a paired vomer is verified in several primitive fishes. The other semionotids (e.g., *Paralepidotes ornatus*, *Semionotus elegans*, *Semionotus* sp. from the Parana Basin, and *Plidetes nigeriensis*) possess a pair of toothed vomer. According to some authors, only the presence of a single median vomer is diagnostic to separate



*Lepidotes* from other semionotids. Even so, such feature should not be considered a synapomorphy of *Lepidotes*, since the hypsomatic genera *Dapedium* and *Tetragonolepis* also bear a median vomer.

Technical Session IX, Friday 10:45  
TAPHOMY AND PALEOECOLOGY OF A REMARKABLY RICH UPPER  
CRETACEOUS HIGH LATITUDE BONEBED FROM THE PRINCE CREEK  
FORMATION, NORTH SLOPE ALASKA

GANGLOFF, Roland, Museum of Paleontology, Berkeley, CA, USA; FIORILLO,  
Anthony, Museum of Nature and Science, Dallas, TX, USA

The Liscomb bonebed, the richest source of dinosaur remains in either polar region, is assigned to the upper part the Prince Creek Formation and is uppermost Campanian to lowermost Maastrichtian in age. The bonebed, which is laterally continuous for 176 m and varies from 0.4 to 0.9 m in thickness along its mid-section, is in an argillaceous siltstone, rich in comminuted plant remains and palynomorphs with a TOC of 6.8-10.55. The bonebed although multitaxic, is primarily a low-diversity, monodominant assemblage. Four theropods are almost exclusively represented by shed teeth. The assemblage is dominated by hadrosaurs, which represent late juveniles, very rare subadults and a few early juveniles. Some 3,416 curated skeletal specimens, an NISP of 3,135 elements, of which 3,072 are assigned to the dominant taxon, mark the bonebed. This dataset represents 20 1m x 1m quarry-squares set along the mid 2/3 of the bonebed. An MNI of 41, the presence of all three Voorhies Groups and an under representation of teeth and skulls further characterizes the Liscomb. A high degree of fragmentation, but low weathering and abrasion indices are present. Bite-marks are rare (1% of elements) and signify scavenging. The bonebed is moderately well graded, with the largest bones at the bottom of the bonebed. These lowermost bones are found in concentrations with density ranges from 195-407/m<sup>3</sup> and 27-88/m<sup>2</sup>/10cm interval. The Liscomb is the result of frequent seasonal floods that were part of a complex fluvial system. Floods breached levees forming splays that often resulted in ephemeral ponds and marshy wet soils bearing lush vegetation. Evidence derived from this extensive study of the Liscomb bonebed adds further support to the hypothesis that hadrosaurids were gregarious and developed some types of social groups. In addition, added support is given to the hypothesis that Arctic dinosaurs most probably did not engage in long distance migrations because of the presence of abundant juveniles and winter food sources.

Poster Session IV (Saturday)

LONGEVITY AND GROWTH PATTERNS IN THE DROMAEOSAURID  
*VELOCIPTOR MONGOLIENSIS* INFERRED FROM LONG BONE  
HISTOLOGY

GARCIA, Bonnie, Florida State University, Tallahassee, FL, USA; ERICKSON,  
Gregory, Florida State University, Tallahassee, FL, USA; CURRY ROGERS, Kristina,  
Science Museum of Minnesota, St. Paul, MN, USA; NORELL, Mark, American  
Museum of Natural History, New York, NY, USA

The extremely rapid growth rates of living birds (*Aves/Neornithes*) are unusual among extant vertebrates. Do these rates find their origin in non-avian dinosaurs or are they a unique avian innovation? We conducted a histological analysis using the long bones of *Velociptor mongoliensis*, a member of the Deinonychosauria (sister taxon to Avialae), with the intention of helping characterize non-avian dinosaur growth patterns preceding the genesis of birds. Six specimens, juvenile through adult, from the Late Cretaceous, Djadokhta Formation of Mongolia were studied. Several elements from each individual were sampled including: fibulae, femora, tibiae, ribs, and gastralia. Growth line counts and tissue type characterizations were then made. Longevity estimates range from 1 to 15 years. The primary cortices from large long bones in younger individuals are composed of fibro-lamellar tissue with plexiform (and occasionally radial) vascularization. In larger individuals, parallel-fibered bone predominates and vascularization is longitudinal. Dense haversian reconstruction is prevalent in ribs and gastralia. We constructed a growth curve from these data using Developmental Mass Extrapolation. Maximum exponential stage growth rates are estimated at 13.5 g/day. Plotted with respect to body mass, this value is comparable with other non-avian dinosaurs of similar size—animals that grew considerably slower than extant precocial birds. This supports contentions that rapid avian growth rates evolved no earlier than the cladogenesis of *Archaeopteryx*.

Poster Session I (Wednesday)

*TRANODIS CASTRENSIS* FROM THE MISSISSIPPIAN (CHESTERIAN) OF  
KENTUCKY AND ITS RELEVANCE TO MISSISSIPPIAN VERTEBRATE PALEO-  
BIOGEOGRAPHY

GARCIA, William, University of North Carolina Charlotte, Charlotte, NC, USA

The Hancock County locality preserves a diverse fish and tetrapod fauna consisting of xenacanthids, palaeoniscids, rhizodonts, acanthodians, dipnoans, whatecherids and colosteids. The most numerous taxon is the dipnoan *Tranodis castrensis* which is represented by numerous articulated specimens, as well as isolated teeth and bones. *Tranodis* is known from three other Illinois Basin localities (Goreville, Illinois; Delta, Iowa; and

Chester, Illinois) and one locality in the Appalachian Basin (Greer, West Virginia). This regional distribution contrasts with other well-known Mississippian dipnoans. The well-known Mississippian dipnoans *Ctenodus* and *Sagenodus* are known from multiple localities in both Europe and North America. The restricted distribution of *Tranodis* may reflect true differences in the range of this taxon compared to contemporaneous dipnoans and hence be an indication of vertebrate provinciality during the Mississippian. Numerous studies suggest provinciality among fish during the Devonian. Similar results during the Mississippian are less common, although provinciality may be present among Mississippian tetrapods. The most likely explanation is that *Tranodis* was limited in distribution to North America during the Mississippian. The restricted occurrence of *Tranodis* compared to other Mississippian dipnoans could result from different environmental tolerances, although all three genera are known from both marine-influenced and freshwater deposits.

Poster Session III (Friday)

PALEOECOLOGY OF A *CHASMOSAURUS MARISCALENSIS* BONEBED,  
LATE CRETACEOUS (LATE CAMPANIAN), BIG BEND NATIONAL PARK,  
TEXAS

GASAWAY, Stephen, California State University, Stanislaus, Turlock, CA, USA;  
SANKEY, Julia, California State University, Stanislaus, Turlock, CA, USA; ORTIZ,  
Nicole, California State University, Stanislaus, Turlock, CA, USA; MEREDITH,  
Vanessa, California State University, Stanislaus, Turlock, CA, USA

The most complete skull of the ceratopsian dinosaur, *Chasmosaurus mariscalensis*, was collected in 1989 from the upper Aguja Formation (Late Cretaceous: late Campanian), Rattlesnake Mt., Big Bend National Park, Texas by a team from the Universities of Chicago and Texas. The skull provided more detailed anatomical information about this dinosaur, which is unique to the southern biogeographical province. The site was re-located with field photographs in January 2007, and it was discovered that it occurred within the same bonebed that Sankey and student teams have been collecting during the past seven years. This surface collecting (and some screening) has yielded hundreds of fossils from ~ 35 vertebrate taxa. Fossils include abundant small fragments of plants, snails, coprolites, dinosaur eggshell fragments, and bones and/or teeth from fish (gar), salamander, lizard, turtle, crocodylian, dinosaur (hadrosaur, ceratopsian, ankylosaur, tyrannosaurid, cf. *Saurornitholestes*, ornithomimid, and other theropods), bird, and mammal. Turtles include: Baenidae, cf. *Hoplochelys*, *Adocus*, *Basilemys*, trionychids, and cf. *Helopanopia*. During the January, 2007 expedition, specimens of a pterosaur and a horn core from a juvenile *Chasmosaurus* were collected. The abundant dinosaur eggshell fragments and the small teeth from hatchlings or juveniles of hadrosaurs, ceratopsians, and theropods demonstrate that nesting sites may have been a source of the bonebed. Fossils are from a silty mudstone to fine sandstone with abundant small plant fragments. The depositional environment may have been a crevasse splay into a marshy area of a coastal floodplain. These fossils provide more detailed information about the paleoenvironments and paleoecology for this important dinosaur site, and flesh out the paleoecology of this unique southern dinosaur province.

Romer Prize Session, Thursday 8:15

EVOLUTION OF NORTH AMERICAN HADROSAURID DINOSAURS  
(ORNITHISCHIA: ORNITHOPODA)

GATES, Terry, University of Utah, Salt Lake City, UT, USA

Hadrosaurid dinosaurs were the most abundant large-bodied herbivores in the majority of North American Late Cretaceous terrestrial ecosystems. The Campanian-Maastrichtian North American Western Interior Basin (WIB) provides the greatest diversity and tightest geographic and stratigraphic control of hadrosaurid dinosaurs in the world, due in large part to recent advances in hadrosaurid collections and dating/correlation across fossiliferous WIB formations. Therefore, review of the 22 currently recognized WIB hadrosaurid taxa within a joint geographic, stratigraphic, and phylogenetic framework reveals numerous previously unrecognized patterns. First, at least during the best-sampled time interval (76-74 Ma), hadrosaur diversity was remarkably high, with up to eight contemporaneous taxa living within the WIB near 75 Ma. Second, hadrosaurid species appear to have occupied remarkably diminutive geographic ranges, limited to narrow latitudinal spans. This highly consistent pattern indicates that most taxa did not engage in long distance migrations. Third, a time-calibrated phylogeny posits faunal turnover in two separate clades of late Campanian hadrosaurine (non-crested) hadrosaurids, the (*Gryposaurus*+*Brachylophosaurus*) clade and the (*Prosaurolophus*+*Edmontosaurus*) clade. Within the former, examination of the large variation in cranial morphology between the three members of the *Brachylophosaurus* clade compared to the minimal changes observed in four species of *Gryposaurus* demonstrates two differing evolutionary/ecological patterns within pencontemporaneous WIB hadrosaurid groups. Finally, biostratigraphic evidence regarding the first occurrence of derived hadrosaurids across Laurasia indicates that hadrosaurid dinosaurs likely did not disperse across the northern landbridge until the early Maastrichtian. Additionally, contrary to prevailing hypotheses, the direction of

hadrosaur dispersal appears to have been from North America to Asia as evidenced by the persistence of primitive Asian hadrosaurids throughout the late Campanian and the occurrence of derived hadrosaurs in North America at minimally 80 Ma.

Technical Session XVII, Saturday 2:15  
EXPLORING FOOTPRINT MORPHOSPACE BY 3-D COMPUTER-ANIMATED TRACK SIMULATION

GATESY, Stephen, Brown University, Providence, RI, USA; MIDDLETON, Kevin, Cal. State San Bernardino, San Bernardino, CA, USA

Late Triassic tracks from East Greenland attributable to theropod dinosaurs exhibit a continuum of morphologies based primarily on depth. Plantar anatomy is most accurately preserved in shallow tracks, whereas deeper impressions record more evidence of foot movement. However, significant variation is present among the hundreds of documented deep tracks. The metatarsal impression, entry slit of digit I, and exit crater of all four digits differ in their geometric relationships to the entry slits of digits II and IV. Such variation might result from disparate feet undergoing distinct movements, but could have been created by a single type of foot using slight alterations of a basic kinematic pattern. Using a 3-D digital model of a foot skeleton based on *Coelophysis*, we simulated track contours in the animation program, Maya. Sediment dynamics were not calculated; the foot's path was simply recorded using particles to mark its intersection with a surface plane. Simulations were done first for the hallux alone, then the entire foot. Starting with a reference animation, we generated track profiles by altering penetration angle and track depth in different combinations. The resulting footprint morphospace contains geometries that are quite similar to those found in Greenlandic deep tracks. Although not proving that our animated sequences are correct, these kinematic patterns serve as hypotheses that can be further tested by measuring penetration angle and depth in actual tracks to see if they match simulation predictions. Supported by NSF and Autodesk.

Poster Session IV (Saturday)

A PROTOSIRENID (PROTOSIRENIDAE, SIRENIA) INNOMINATE FROM THE CROSS MEMBER OF THE TUPELO BAY FORMATIO (BARTONIAN, LATE MIDDLE EOCENE) OF SOUTH CAROLINA

GEISLER, Jonathan, Georgia Southern University, Statesboro, GA, USA; BEATTY, Brian, New York College of Osteopathic Medicine, Old Westbury, NY, USA

A partial right innominate of a sirenian, mostly consisting of the ischium, was recently recovered from the late middle Eocene (Bartonian) Cross Member of the Tupelo Bay Formation in Orangeburg County, South Carolina. It most closely resembles the innominate of *Protosiren sattaensis* from the late Lutetian (44-43 Ma) of Pakistan, though due to its fragmentary nature and the present lack of knowledge of variation within the genus, it is best assigned to *Protosiren* sp. This specimen was collected from the same horizon as the holotype of *Carolinacetus gingerichi*, representing an unusual case of protosirenid and protocetid co-occurrence. Previous reports of Sirenia from South Carolina have consisted of indeterminate rib fragments except for a skullcap that has subsequently gone missing. Earlier (Lutetian) *Protosiren* material is known from the Castle Hayne Formation of North Carolina, and this specimen confirms the presence of *Protosiren* in the Carolinas into the Bartonian when they are otherwise only known from Florida and the Eastern Hemisphere.

Poster Session III (Friday)

THE DIVERSITY OF BUNODONT UNGULATES DURING THE EARLY EOCENE IN CENTRAL-WESTERN PATAGONIA, ARGENTINA

GELFO, Javier, Museo de La Plata, La Plata, Argentina; TEJEDOR, Marcelo, American Museum of Natural History, New York, NY, USA

An outstanding diversity of mammals, including South American ungulates, marsupials, bats, and xenarthrans has been revealed from the localities of Laguna Fria and La Barda, the westernmost Paleogene mammal-bearing sites in Patagonia, Argentina. Located in northwestern Chubut Province, near the town of Paso del Sapo, these outcrops have <sup>40</sup>Ar/<sup>39</sup>Ar dates taken from volcanic deposits underlying and overlying the mammal-bearing levels. Both faunas are late-early Eocene (Ypresian-Lutetian boundary), with an age ranging from 49.51 ± 0.32 Ma to 47.89 ± 1.21 Ma. The diversity and peculiarity of the mammalian fauna from this area is biochronologically important and pertinent to a better understanding of the South American Land Mammal Ages (SALMAs). During the Paleogene, bunodont South American ungulates were limited to the scarce diversity of the Protolipternidae litopterns, the "condylarths" Mioclaenidae, and the endemic Didolodontidae. The bunodont ungulates from Paso del Sapo are small in body size. They include at least two new didolodontids and the most abundant record of *Asmithwoodwardia subtrigona* (?Protolipternidae). One new genus is represented by a left mandibular fragment with m3 (LIEB-PV 1611). Unlike in other didolodontids, the entoconid presents a low cristid reaching the hypoconid distally. The second new genus is based on a right mandible with part of the talonid of m2 and complete m3 (LIEB-PV 1612). The major diagnostic character is the presence of a huge entoconid larger than the hypoconid, almost closing the talonid basin. In contrast to *Asmithwoodwardia scotti* from the Itaboraian SALMA (late Paleocene-early

Eocene), *A. subtrigona* from Paso del Sapo is larger and has postparaconular and premetaconular cristae; the M3 is not so transversally elongated, and the postcingulum lingually ends in a small hypocone. The inferred subtropical, moderately seasonal climate of these mammalian assemblages toward the end of the Early Eocene Climatic Optimum in some ways is transitional between the mammalian records of previous and later SALMAs.

Technical Session XV, Saturday 10:15

AN EXPLICIT EXAMINATION OF SHREW IDENTIFICATION AND THE POTENTIAL FOR PALEOECOLOGY WITHOUT SPECIES-LEVEL IDENTIFICATIONS

GEORGE, Christian, University of Texas at Austin, Austin, TX, USA

It is a standard premise of paleoecologic interpretations that species identifications are necessary to make accurate and meaningful paleoclimatic reconstructions. This has driven paleoecologists to facilitate identification by making temporal and geographic assumptions about the taxa they are studying. Many paleoecologic analyses rely on indicator taxa that today have a specific range of tolerances to environmental conditions such as temperature, moisture, and salinity. When these taxa are found in the fossil record past climate is interpreted to be similar to the conditions where they are found today. Species of shrews are frequently used as indicator taxa in Quaternary paleoclimate reconstructions. However, many workers use modern geographic distributions to restrict the pool of species with which they make comparison, and thereby enhance the frequency of species-level identification. I gathered cranial and dental characters from dichotomous keys and other published descriptions of shrew species and coded them as phylogenetic characters. My goals were to identify apomorphic characters and determine their power for taxonomic resolution, and to explicitly describe how fossil shrews can be identified. My results show that species-level identifications are not possible without complete specimens (which are rarely preserved in the fossil record) or geographic assumptions. Generic identifications are supported by a number of unambiguous apomorphies. Past studies that used shrews to make paleoecologic interpretations have been functionally operating at the generic level, but have published taxa with species names. This provides an example where paleoecologic interpretations are commonly made at a level above species. Unfortunately applying a species name by using geographic assumptions can cause problems. For example, the genus *Cryptotis* is easily recognizable and when found as a Quaternary fossil in the United States the species epithet parva is automatically applied because that is the only species found there today. This eliminates the potential discovery that any other species of *Cryptotis* lived in the United States in the past.

Poster Session III (Friday)

ANATOMY OF LEPOSPONDYLS AND ORIGIN OF LISSAMPHIBIANS

GERMAIN, Damien, UMR 7179 Squelette des Vertébrés, Paris, France

Lissamphibians are one of the last clade of extant tetrapod whose origin in the fossil record is still currently very debated. Three main hypotheses are discussed: a monophyletic origin within dissorophoid temnospondyls, a monophyletic origin within lepospondyls and a polyphyletic origin with urodeles and anurans evolving from two clades of dissorophoid temnospondyls and caecilians from microsauro lepospondyls. The anatomy of two lepospondyls have been studied. The Late Permian diplocaulids from Morocco are redescribed and the systematics of nectrideans is discussed. Moreover, they are the last lepospondyls known in the fossil record. An aistopod from the Upper Carboniferous of France is also described. It exhibits some anatomical features that were previously known only among Lissamphibians and some dissorophoids. This study reveals that some synapomorphies used to unit Lissamphibians and temnospondyls are homoplastic. A developmental study of ossification sequences of urodeles reveals that these developmental sequences are highly variable and should be used very carefully to solve the problem of lissamphibian origin. Finally, a phylogenetic analysis of a large scale of Paleozoic tetrapods is performed and shows that each hypothesis concerning the origin of Lissamphibians is weakly supported. The main causes of these incongruences are various. An extensive homoplasy reigns among Paleozoic tetrapods. The lack of "transitional" fossils provides huge morphological gaps between crown-lissamphibians and their putative sister-taxa and temporal gaps in the beginning the Carboniferous (the Romer's gap) where all groups of Paleozoic tetrapods diversified, with a very poor fossil record, and in the Permo-Triassic boundary, after which the first Lissamphibians appeared whereas all their putative sister-groups had disappeared well before. Some new axes of research are thus proposed in order to solve the origin of Lissamphibians despite the lack of fossils that could exhibit enough features to anchor Lissamphibians in one (or more) Paleozoic group.

Technical Session XV, Saturday 8:45

NEW CRETACEOUS EUTHERIAN FROM THE GOBI DESERT

GIALLOMBARDO, Andres, American Museum of Natural History, New York, NY, USA

One of the most debated issues in mammalian phylogeny is the origination time of extant placental groups. Three models of placental mammal evolution have been proposed (long fuse, short fuse and explosive radiation), and the acceptance of any model depends on whether or not the living orders and supraordinal groups were already differentiated before the K-T boundary. Cretaceous eutherian specimens are rare and often fragmentary, so any addition to the knowledge of this critical time period in mammalian evolution is extremely important. Here I present a new eutherian mammal species from the Khugenslavkant sandstone facies (Dorngobi Aimag, Eastern Gobi, Mongolia). Although the age of the Khugenslavkant beds is poorly constrained, an Albian-Aptian age (upper part of the Early Cretaceous) has been proposed. The new taxon is represented by a single specimen: a fragmentary skull with associated jaws, preserving the last three upper premolars and molars, and m1-3. P5 is molarized, with a strong parastyle and metastyle; the protocone is somewhat compressed and it has pre- and postcingulum. M1 has a narrow styler shelf with a well-developed parastyle, but the metastyle is undifferentiated from the postmetacrista. The paracone and metacone are somewhat connate and the conules are well developed. The protocone is slightly displaced anteriorly, and the post cingulum is better developed than the precingulum. M2 is similar to M1, but it has an ectoflexus, its protocone is more compressed and the precingulum is narrower. M3 has a well-developed parastylar lobe that extends labially from the paracone, but has no metastylar lobe; the metacone is displaced lingually, and the protocone is more compressed and anterior than in the other molars. There is no precingulum. On the lower molars, the protoconid is as tall as the metaconid, and the paraconid is low and located antero-labially respect to the metaconid. The new taxon seems to be related to taxa of the paraphyletic "Zhelestidae", which has been proposed to form a clade with the ungulates, but some of its features also resemble the Asioryctitheria, making its phylogenetic position less certain at this time.

Technical Session XIV, Saturday 9:15

THE EFFECT OF TOOTH MORPHOLOGY ON INDENTATION FORCE IN NON-AVIAN THEROPOD DINOSAURS

GIGNAC, Paul, Florida State University, Tallahassee, FL, USA; MAKOVICKY, Peter, The Field Museum, Chicago, IL, USA; ERICKSON, Gregory, Florida State University, Tallahassee, FL, USA; WALSH, Robert, Florida State University, Tallahassee, FL, USA

A recent analysis of *Deinonychus antirrhopus* bite-force generation using tooth indentation simulations indicates that tooth shape has considerably more influence on puncture force than was previously realized. The distal crowns of *Deinonychus* lateral teeth are recurved and laterally compressed whereas proximally all faces are parallel to one another suggesting that they were not as well suited to sustaining bone impacts as some of other dinosaurs (e.g. tyrannosaurs). However, numerous *Deinonychus* bite marks were discovered on a specimen of the iguanodontian dinosaur *Tenontosaurus tilletti* from the Cloverly Formation of Wyoming. To quantify puncture force, bite marks were simulated by indenting a nickel alloy cast of an adult *D. antirrhopus* tooth into bovine long bones using a mechanical loading frame. The results revealed a force of approximately 3000 N. A similar study had been previously performed on *Tyrannosaurus rex*, in which the loading patterns indicated that increasing puncture depth required increasing values of force. In contrast *Deinonychus* tooth indentation force was found to be independent of cortical depth. We attribute this finding to the ensiform shape of *Deinonychus* teeth whereby indentation forces increase substantially only at the distal crown where the tooth broadens distal-proximally. Once reached, the constant size and shape of the tooth neck requires little addition of force to continue penetration. These results suggest that for any ensiform tooth (e.g. in *Allosaurus* and *Carcharodontosaurus*) force will not be dependent on the thickness of the indented medium itself. To test this hypothesis we used a mechanical loading frame to indent an assortment of conical, laterally compressed, and ensiform teeth into polyurethane foam. This foam was used as a standard indentation medium because it is homogenous and uniformly compliant. This study allowed us to quantify the absolute and relative differences in indentation loading patterns and total puncture force. Findings indicate repeatable, consistent patterns of loading and include showing that the indentation force of a *T. rex* tooth is approximately 30 times that of one for *D. antirrhopus*.

Technical Session I, Wednesday 11:15

A NEW GENUS OF PAPIONIN MONKEY FROM THE PLIO-PLEISTOCENE OF SOUTH AFRICA AND THE BIOGEOGRAPHY OF THE *CERCOCEBUS/MANDRILLUS* CLADE.

GILBERT, Christopher, Stony Brook University, Stony Brook, NY, USA

An number of craniomandibular characters have now been documented that support the molecular phylogenetic groupings of the African papionin monkeys. Given a set of potentially informative characters to use in the assessment of fossil taxa, the phylogenetic position of at least some of the ambiguous Plio-Pleistocene fossil papionins can be elucidated. In an analysis of craniomandibular characters within the fossil genus

*Parapapio*, it is determined here that the taxon previously referred to as *Parapapio antiquus* is significantly different from other *Parapapio* taxa and, in fact, this species is instead a member of the *Cercocebus/Mandrillus* clade. Therefore, this species is assigned into a new genus to more accurately reflect its evolutionary history. A phylogenetic analysis of over 130 craniomandibular characters supports the position of this new genus as a member of the *Cercocebus/Mandrillus* clade. Although the new taxon appears most similar in overall body size and morphology to extant *Cercocebus torquatus*, some phylogenetic analyses suggest that this new genus may be the sister taxon of *Mandrillus*. Paleocological reconstructions at Taung indicate that, similar to extant *Cercocebus*, a predator-prey relationship with African crowned eagles existed during the Plio-Pleistocene. Notably, the new genus lacks the full set of hard object feeding adaptations that is characteristic of extant *Cercocebus* and *Mandrillus* taxa, suggesting that this taxon was moving into the hard-object niche but had not yet reached the level of specialization seen in *Cercocebus* or *Mandrillus*. Currently, this new genus of fossil papionin is documented only at the South African site of Taung. The occurrence of a *Cercocebus/Mandrillus* relative in South Africa suggests a much larger range than the extant clade currently occupies. In addition, this distribution suggests a different scenario than previous reconstructions of *Cercocebus* and *Mandrillus* evolutionary biogeography have posited.

Technical Session XVIII, Saturday 2:15

KHASHM EL-RAQABA: A NEW LOCALITY YIELDING MIDDLE EOCENE WHALES AND SEA COWS FROM WADI TARFA IN THE EASTERN DESERT OF EGYPT

GINGERICH, Philip, University of Michigan, Ann Arbor, MI, USA; ATTIA, Youssry, Egyptian Geological Museum, Cairo, Egypt; AL-BEDAWI, Ferial, Mansoura University, Mansoura, Egypt; SAMEEH, Salah, Egyptian Mineral Resources Authority, Cairo, Egypt

Skeletons of three new archaeocete whales and sea cows have been discovered in recent years in Italy and Portugal in slabs of nummulitic limestone imported commercially as blocks from Egypt. The only information available from dealers was that the blocks came from Sheikh Fadl, a small city in the Nile Valley north of Minya. Prof. Hamza I. Lotfy of Minya University suggested that these limestones were being quarried in Wadi Tarfa east of Sheikh Fadl, and in 2006 we organized an expedition to investigate the source of the specimens. Recovery of marine mammals as skeletons rather than isolated bones is important for understanding the nature and degree of their adaptation to life in water. We located a complex of large quarries extracting a hard white limestone of the Gebel Hof Formation, north and east of Khashm el-Raqaba on the northern flank of Wadi Tarfa (28.451° N, 31.834° E). The Gebel Hof Formation is limestone, marblized limestone, and dolomitic limestone rich in *Nummulites gizehensis* and *N. lyelli*. It is early Bartonian in age, equivalent to the Sath el-Hadi and Guishi formations elsewhere in Egypt. At Khashm el-Raqaba the limestone is removed in 10-12 cubic-meter blocks, and then trucked through Sheikh Fadl and Cairo to Alexandria for export to Europe and Asia. This is undoubtedly the source of the archaeocete and sirenian specimens recovered in Europe. However, specimens are rare in the field, and it will be difficult to locate new ones. The best chance for recovery of new specimens in the future will be through cooperation with professional stone cutters in Egypt and wherever Gebel Hof blocks are slabbled. Specimens recovered to date do not include hands, feet, or tails, indicating that burial may have been slow, and the environment of deposition may have included scavengers that removed these before burial. The Khashm el-Raqaba limestones are extensively fissured, and the karst fissures are filled with red clay. These clays include numerous fossil mammal bones, principally of bats, which could reflect subaerial exposure as early as the late Eocene or Oligocene, with entrapment of mammals of Eocene or later age.

Technical Session XIII, Friday 2:00

DEVELOPMENTAL PATTERN OF WRIST ELEMENTS IN PALAEOGNATHS AND ITS BEARING ON THE EVOLUTION OF THEROPOD CARPALS

GISHLICK, Alan, Gustavus Adolphus College, Saint Peter, MN, USA

The identities of the carpal elements of non-avian theropods have always been unclear due to the vagaries of preservation. Carpal identity with respect to extant theropods (Aves) is complicated by the unclear developmental and morphological homologies of the carpal elements and their associated digits. Given the phylogenetic position of birds within theropod dinosaurs, the highly modified and fused carpal elements of extant avians should be presaged by the less fused elements present in the wrists of extinct dinosaurs, and this pattern should be consistent with extant theropod wrist development. To determine theropod carpal identity, I compared fossil carpal patterns to the developmental patterns of extant palaeognaths, as they represent the most basal lineage of extant theropods with both volant and secondarily flightless members. I examined cleared and stained developmental series, housed in the Yale Peabody Museum, of the tinamou, *Eudromia elegans*, and the ostrich *Struthio camelus*, and compared them to a developmental series of the chicken, *Gallus gallus*, and individual embryos of the emu, *Dromaius*, and the kiwi, *Apteryx*. Throughout development the largest carpal elements are a semilunate element and a radial carpal. A distinct semilunate was unfused to other elements for most of development and is present in the earliest embryos. The

semilunate appears to be distal carpal 2, with a small amount of distal carpal 1, and fuses to MC II before fusing to MC I and III later in development. For most of development, the wrist of *Struthio camelus* is nearly identical to that of non-avian maniraptors. This suggests that the non-avian theropod carpal pattern is consistent with the developmental pattern of extant theropods, and gives possible identities of the adult elements: The semilunate carpal is principally distal carpals 2 and 1, while distal carpal 3 fuses to metacarpal III before fusing to DC 1+2 and the rest of the metacarpus. Finally, the late developing "cuneiform," or ulnar-most carpal, is probably a sesamoid, which would explain its complex shape and late development, as well as its apparent non-preservation or absence in many fossil theropods.

Poster Session I (Wednesday)

PRELIMINARY REPORT ON A PLESIOSAUR FROM THE EARLY CRETACEOUS OF CENTRAL QUEENSLAND, AUSTRALIA.

GLEN, Christopher, University of Queensland, Brisbane, Australia; MCHENRY, Colin, School of Environmental and Life Sciences (Geology), Newcastle, Australia

Plesiosaurian specimen QMF 12719 includes cranial, girdle and rib fragments plus most of the vertebrae of the torso, and was found in 1983 on the Dunraven Station North West of Hughenden, and prepared and housed in the Queensland Museum. Good three-dimensional preservation is exhibited, typical of large vertebrate remains from the nodular limestones of the Early Cretaceous of the region, however the skull and mandible were exposed to weathering and fragmentation. This made it difficult to classify the specimen at that time, though similarities of the vertebrae suggested it was possibly related to local 'polycotylids'. Recent re-examination of the cranial material, with some further acid preparation, has allowed reassembly of the fragments clarifying their orientation and anatomical identity. Erosion of the lateral, dorsal, ventral and rostral surfaces of the snout and dental symphysis has exposed many of the dental alveoli, though tooth size and arrangement can still be determined, suggesting a high degree of anisodonty. The snout was short, as was the 'spatulate' dental symphysis. The premaxilla bears 4 teeth, the diameter of the 3 anterior-most were at least 2 to 3 times that of the smaller 4th tooth positioned just rostral of the suture with maxilla. The first 2 to 3 teeth of the maxillae were of equally small diameter, however the tooth that followed had the largest diameter in the series with successively smaller teeth following it. An abrupt reduction in tooth size and diameter is also observed in the mandibular tooth series following the first 4 robust teeth in the symphyseal region. The palate, 'internal nares' and part of the nasal passages are preserved. The unique tooth pattern suggests this specimen represents a new taxon and similarities cranial and postcranial skeleton to those of the earlier *Leptocleidus* and later elasmosaurs and polycotylids are discussed.

Poster Session IV (Saturday)

BURROW CONSTRUCTION BY JUVENILE *RATTUS NORVEGICUS*: EVOLUTIONARY IMPLICATIONS OF "PUP DENS" AND ADAPTIVE DIGGING BEHAVIOR FOR THE FOSSIL RECORD

GOBETZ, Katrina, James Madison University, Harrisonburg, VA, USA; HANNUM, Aubrey, James Madison University, Harrisonburg, VA, USA

Burrows are valuable in determining the presence of mammals in the fossil record where skeletal remains may be absent. Extinct diggers with unusual morphology, such as mylagaulid rodents (*Umbogaulus*, *Ceratogaulus*), may be better understood in the context of their trace fossils. To aid studies of ecology and burrows of extinct mammalian diggers, laboratory rats (*Rattus norvegicus*) were observed and filmed in a plexiglass-sided, soil-filled box. Young adult males (c. 200g) excavated short tunnels without incentive. Unexpectedly, however, parent rats did not excavate burrows for pups. Instead, three separate litters of nursing pups about 10 days old (23-35g) created burrows and dens immediately after their eyes opened, without help from the parents. The pups used a primarily mouth-digging strategy in humid soil and mainly fore/hind limb scratch-digging in fine sand. Burrowing was most pronounced in 14-day old pups (60g). Nursing and weaned pups excavated three types of burrows: U-shaped (often the first attempt), simple ramp, and ramp with secondary underground passage. Soil removed during excavation was piled into distinctively cross-stratified slopes that can be used to recognize mammalian bioturbation of fossil strata, along with filled burrows and scratch-marks from fore- and hind claws. The rat pups' behavior suggests that burrowing is entirely instinctive, not learned, and is immediately employed in a species that is otherwise not highly adapted for digging. Slightly longer foreclaws and shorter forearms compared to the manus in pups compared to adults may correlate with digging ability. The habitual, adaptive digging of nursing pups indicates that this ontogenetic stage may have an important role in the selection of adaptive traits under various environmental conditions. Some individuals moved soil by head-shoveling, a behavior that may have led to the evolution of horns in fossil mylagaulids. We will test the conditions that instigate head-shoveling, as well as spiral-digging and other evolutionarily significant behavior in digging mammals.

Technical Session III, Wednesday 2:30

PALEODIETARY AND ENVIRONMENTAL IMPLICATIONS OF CARBON AND NITROGEN ISOTOPIC VARIATION IN LATE PLEISTOCENE AND HOLOCENE TUSKS OF *MAMMUTHUS PRIMIGENIUS* FROM NORTHERN EURASIA

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Causes of the late Pleistocene extinction of large-bodied mammals have long been debated. We use carbon ( $\delta^{13}\text{C}$ ) and nitrogen ( $\delta^{15}\text{N}$ ) isotope ratios of collagen and structural carbonate in apatite in serial samples of late Pleistocene and Holocene tusks to examine the role of diet and habitat change in the extinction of *M. primigenius* in northern Eurasia. Tusk  $\delta^{13}\text{C}$  values reflect multiple environmental and physiological factors. Collagen  $\delta^{13}\text{C}$  values reflect dietary protein and carbonate values reflect bulk diet. Eurasian mammoths would have had pure C3 diets and variation in  $\delta^{13}\text{C}$  values within and between tusks probably results from differences in aridity and fat metabolism. Collagen  $\delta^{15}\text{N}$  values reflect diet composition with a 3‰ trophic level increase. Water and nutrient stress both increase  $\delta^{15}\text{N}$  values. We currently have data from six tusks from the Taimyr Peninsula (ages from 43 to 20 ka), two from Chukotka (49 and 43 ka), and five from Wrangel Island (6.6 to 4.4 ka). Mean collagen  $\delta^{13}\text{C}$  values for 12 tusks vary from -22.1 to -20.8‰ and intra-tusk variation ranges from 0.8 to 1.8‰, indicating little regional variation. Carbonate  $\delta^{13}\text{C}$  values are more variable within regions and tusks. Means for 11 tusks range from -12.9 to -5.8‰ and ranges within tusks are 2-4‰. Carbonate values range from typical C3 dietary compositions to surprisingly high values requiring considerable aridity and/or fat formation. However,  $\delta^{13}\text{C}$  values do not vary systematically between regions or through time. Variation in mean collagen  $\delta^{15}\text{N}$  values is like that for collagen  $\delta^{13}\text{C}$  values, but intra-tusk  $\delta^{15}\text{N}$  variability is higher. Taimyr tusks have mean  $\delta^{15}\text{N}$  values that range from 8.0 to 10.3‰ and intra-tusk ranges of 1.7 to 3.3‰. Chukotka and Wrangel tusks have similar mean  $\delta^{15}\text{N}$  values that range from 9.1 to 9.8‰ and consistent variability within each region (ca. 3‰ and 1.4‰). High  $\delta^{15}\text{N}$  values within tusks are not consistently seasonal or close to time of death. Our data suggest high spatial and temporal variability in environmental conditions across Siberia and within regions. Additional data may be needed to rule out strong secular trends, but none are evident in these samples.

Student Poster Session (Thursday)

TURONIAN SHARKS FROM THE MATANUSKA FORMATION SOUTH-CENTRAL ALASKA

GONZALEZ-BARBA, Gerardo, Universidad Autonoma de Baja California Sur, La Paz, Baja California Sur, Mexico; PASCH, Anne, University of Alaska, Anchorage, AK, USA; MAY, Kevin, University of Alaska, Anchorage, AK, USA; WHITE, Tim, US Geological Survey, Anchorage, AK, USA

Shark and fish teeth have been reported from the Middle Turonian in age Matanuska Formation in association with dinosaur bones of an hadrosaur excavated in the "Lizzie" quarry on the Glenn Highway. They report "mako-type" shark teeth and fish teeth, jaw fragments and scales of fish. Subsequent analysis indicates the teleost fish teeth in jaw fragment specimen (AK-524-V-54) as the lower teeth of the pigmy seven-gill hexanchid shark: *Notorynchus* sp. The commonly reported hexanchid is *Hexanchus microdon*, an index fossil for the Upper Cretaceous/Lower Eocene. But some referred *Hexanchus* could belong to *Notorynchus*, according to some authors. A second specimen from a nearby outcrop along the Glenn Highway (AKMNH 2004.3.1) can be assigned to the same genus. *Notorynchus* sp. has also been recorded from the English Chalk. *Notorynchus* appeared during the early Cretaceous as a single species *Notorynchus aptiensis*. The specimen AK-524-V-72 can be assigned to an upper anterior of the extinct goblin shark *Scapanorhynchus* sp. cf. *S. raphiodon*. This cosmopolitan genus has a range from Aptian to Maastrichtian of Europe, the former U.S.S.R., North and South America, North and West Africa, Near East, and Far East. And the specimen (AK-524-V-61) corresponds to a lower anterior tooth of the extinct thresher shark *Paranomotodon angustidens* with a worldwide distribution during late Cretaceous. Five additional specimens are small crowns lacking roots that can only be assigned to this taxon. The assemblage indicates temperate to cold, deepwater affinities.

Poster Session IV (Saturday)

ODONTOMETRIC PATTERNS IN THE RADIATION OF NORTH AMERICAN GROUND-DWELLING SQUIRRELS, TRIBE MARMOTINI

GOODWIN, H., Andrews University, Berrien Springs, MI, USA

A large database of cheek tooth morphology has been assembled for the tribe Marmotini (extant genera *Ammospermophilus*, *Spermophilus*, *Cynomys*, and *Marmota* along with several extinct genera), including most extant and many extinct North American species. Preliminary morphometric analyses, superimposed on published phylogenetic scenarios based on mitochondrial cytochrome-*b* sequences, suggest that

marmotines were primitively small to moderately large ground squirrels with relatively narrow, low-crowned teeth, small P3 and M3, and short m3. During the subsequent marmotine radiation, many taxa (notably *Amnospermophilus* and the classically recognized subgenera *Callospermophilus* and *Otospermophilus*) basically retained this character complex, but others greatly expanded the total region of morphospace occupied by Marmotini. *Marmota* generally retained the suite of primitive shape attributes but achieved much larger body size; the extinct *Parapaemarmota* and *Paemarmota* attained even larger body size. At least 2 and probably 3 marmotine clades (Barstovian *Cynomys* known only from lower dentition, extant subgenus *Spermophilus* and genus *Cynomys*) independently evolved relatively wider, higher-crowned teeth, larger P3 and M3, and longer m3, although one derived species (*Spermophilus parryi*) sharply reversed this trend. Other classical ground squirrel subgenera (*Xerospermophilus*, *Poliocitellus*, and *Ictidomys*), allied with *Cynomys* on molecular evidence, exhibit intermediate values on these shape attributes. Thus, across marmotine taxa, tooth shape variables (relative crown height, tooth width, size of P3 and M3, and length of m3) show strong correlation with each other (but not with body size). This indicates strong genetic or (more likely) functional linkages among traits, which can no longer be viewed as independent characters in taxonomic analyses.

Poster Session IV (Saturday)

#### NEW EUTHERIAN MAMMALS FROM THE KAIPAROWITS FORMATION (JUDITHIAN), UTAH

GORDON, Cynthia, University of Oklahoma, Norman, OK, USA; CIFELLI, Richard, Oklahoma Museum of Natural History, Norman, OK, USA; EATON, Jeffrey, Weber State University, Ogden, UT, USA

The Kaiparowits Formation is a thick (ca. 850 m) terrigenous unit that achieves wide exposure in Garfield and Kane counties, southern Utah. Since the early 1980s, studies have resulted in recognition of a diverse vertebrate fauna (some 90-100 taxa, mainly microvertebrates), together with geochronologic calibration, for the unit. Collectively, fossiliferous horizons span an interval of about 1 million years, about 76-75 mya. Previous studies permitted formal description of only one eutherian species from the Kaiparowits Formation, the ungulatormorph *Avitotherium utahensis*. Newly collected fossils allow recognition of a new genus and species of Cimolestidae, representing the geologically oldest occurrence of that group. Our study supports the hypothesis that two species of *Paranyctoides* are present in the Kaiparowits Formation. We now recognize one of these as new, *Gypsonictops*, which makes its first appearance in the Judithian, is represented by a new species; *G. lewisi* and an unidentified species are also present. The presence of an unidentified yet highly distinctive ?ungulatormorph is indicated by a single deciduous tooth. Of the four eutherians identifiable to species level, three are endemic to the Kaiparowits Formation. Despite poor fossil representation, the eutherian assemblage is surprisingly diverse for a Judithian fauna, including eight taxa recognized to date. This diversity contrasts with the general observation that eutherian mammals did not achieve significant diversity until the Lancian in North America.

#### Carnivora: Phylogeny, Form and Function Symposium, Saturday 8:45 PHYLOGENETIC SIGNALS IN CARNIVORAN CRANIAL MODULES AND IMPLICATIONS FOR PHYLOGENETIC ANALYSES

GOSWAMI, Anjali, University of Cambridge, Cambridge, United Kingdom

Character independence is a major assumption in many phylogenetic analyses using morphological data, despite the presence of strong correlations among some traits. Morphological integration and modularity summarize patterns of trait correlations, providing practical tools for estimating the consequences of correlations on phylogenetic analyses. While phylogenetic signals have been identified in studies of morphological integration, there has been little study of phylogenetic signals within modules, semi-autonomous subsets of highly correlated traits. It has been demonstrated that the carnivoran skull is composed of six modules, which reflect functional and developmental relationships among cranial traits. Here, I extend these studies and assess: 1) Do individual modules differ in the relationship between shape disparity and phylogenetic distance? 2) Do individual modules differ in the relationship between pattern of integration and phylogenetic distance? and 3) Do biases towards a few modules in phylogenetic analyses influence resulting hypotheses of relationships? 51 3-D landmarks were digitized from 36 species of extant and fossil carnivorans for analysis of shape and morphological integration. To quantify shape disparity, partial Procrustes distance was calculated for each pair of species for each of the six cranial modules. Matrix correlation analysis was used to compare Procrustes distances to a patristic distance matrix from recent molecular phylogenies of Carnivora, with Mantel's test for significance. The cranial base shows the strongest phylogenetic signals in both shape and integration of the modules across all carnivorans and in individual analyses of caniforms and feliforms. Five modules show significant phylogenetic signal in shape in Caniformia, while four do in Feliformia. Only the cranial base and zygomatic-pterygoid show phylogenetic signals in their integration in any analysis. While morphological phylogenies often rely on cranial base and molar characters, there is no evidence that nodes supported by characters within only one module are less consistent with molecular phylogenies than those supported by multiple modules.

Poster Session I (Wednesday)

#### A NEW FOSSIL RECORD FOR THE AFRICAN LUNGFISH *PROTOPTERUS* FROM THE PALEOGENE OF TANZANIA

GOTTFRIED, Michael, Michigan State University, East Lansing, MI, USA; STEVENS, Nancy, Ohio University, Athens, OH, USA; O'CONNOR, Patrick, Ohio University, Athens, OH, USA; ROBERTS, Eric, University of the Witwatersrand, Johannesburg, South Africa; NGASALA, Sifa, Michigan State University, East Lansing, MI, USA

Several field seasons of exploring Red Sandstone Group exposures in the Rukwa Rift Basin (RRB) of southwestern Tanzania have resulted in a growing list of Cretaceous and Paleogene (likely Oligocene) discoveries, which are helping to fill in critical geographic and temporal gaps in our knowledge of African vertebrate history. The Paleogene RRB fauna accumulated in a freshwater fluvial setting and includes mammals (phiomorph rodents, macroscelideans, and a primate), abundant frogs (among them semi-articulated specimens), and bony fishes. The Paleogene fish diversity is not extensive, but does include two recently recovered specimens of the still-extant African lungfish genus *Protopterus*. The specimens are well-preserved tooth plates and are diagnostic for the genus. The first consists of most of an isolated lower (prearticular) tooth plate, and the second (and more complete) specimen is an upper (pterygoid) tooth plate that preserves two blade-like ridges and is still attached to a nearly complete pterygoid. These each compare very closely with the distinctive tooth plate morphology of extant *Protopterus*, and the prearticular tooth plate in particular is virtually indistinguishable from that of the extant species *P. dolloi*, found today in the Congo River basin of Central Africa. Assuming that fossil *Protopterus* shared their extant relative's ability to aestivate during periods of desiccation, the identification of *Protopterus* in the Paleogene of the RRB may reflect a warm and seasonally dry Oligocene environment in this part of the East African Rift, consistent with our interpretations based on sedimentology and other aspects of the fauna. The fossils also add a new temporal occurrence and paleogeographic datum to our rather poor knowledge of the ancient distribution of this genus, which is today represented by four extant African species and is the most diverse of the three surviving lungfish genera.

Technical Session VII, Thursday 1:45

#### LUNGS IN PLACODERMS, A PERSISTENT MYTH RELATED TO ENVIRONMENTAL PRECONCEIVED INTERPRETATION

GOUJET, Daniel, Muséum National d'Histoire Naturelle, Paris, France

In many textbooks of comparative anatomy and even primary literature dealing with the respiratory system or breathing functions, placoderms are cited as the first fish with lungs. This is based on the interpretation of a single feature observed in a unique specimen of *Bothriolepis canadensis*, in which the hypothesized lungs were placed in a space corresponding to the front of the pericardium area. Since then, the arguments developed to support such interpretation appear spurious. They are presently outdated by the accumulated knowledge of the group gathered during the last 66 years. The so-called "lungs" do not fit with our present views of the placoderm relationships with the other gnathostomes. The hypothesized relationship between the presence of lungs with an environmental interpretation of the Escuminac Formation has been refuted by recent studies. Moreover, no other placoderm has ever been found with anatomical evidences or traces of what could be interpreted as "lungs". Is the conjectural interpretation of a supposed organ interpreted as lungs in a single species sufficient to prove what is claimed in textbooks? When properly analysed, "lungs" in placoderms appear as a myth with no demonstrable evidence.

Poster Session IV (Saturday)

#### ZERO, ONE, TWO, THREE... OR MORE: HOW MANY CARPAL ELEMENTS IN SAUROPODOMORPHS? NEW EVIDENCES ON CARPUS EVOLUTION AMONG SAUROPODOMORPHA

GOUSSARD, Florent, Muséum National d'Histoire Naturelle, 75005, France; LÄNG, Emilie, Muséum National d'Histoire Naturelle, Paris, France; ALLAIN, Ronan, Muséum National d'Histoire Naturelle, Paris, France; WILSON, Jeffrey, Museum of Paleontology - The University of Michigan, Ann Arbor, MI, USA

Except some rare exceptions, the arrangement and evolution of the carpus remain poorly understood among sauropodomorphs, mainly because of a bad preservation in the fossil record. If preserved, the other problem is the difficulty to identify the carpal elements, rarely found in articulation. Whereas the carpus of Prosauropoda is relatively well-known in regard of the remains of *Massospondylus* and *Plateosaurus*, the structure of the Sauropoda carpus is still unknown and was subject of many interpretations so far. The redescription of the wrist of « *Bothriospondylus* » *madagascariensis*, a Middle Jurassic sauropod from the Majunga Basin in Madagascar previously described by Lavocat in 1955, is the occasion to propose different hypotheses on the evolution of the carpus in sauropodomorphs. The wrist of « *Bothriospondylus* » *madagascariensis* thus consists in five carpal elements, an unusual feature among sauropods which preserved most of the time three or few carpal bones while among prosauropods, *Massospondylus* and *Plateosaurus* preserved respectively seven and five carpal elements. So, the study of some taxa such as Crocodylia, *Herrerasaurus* and prosauropods leads us to test different

homological hypotheses in the carpus of « *Bothriospondylus* », in order to propose a reinterpretation of the carpal bones preserved in other sauropods. These results are finally replaced in a phylogenetic context, in order to propose a preliminary hypothesis on evolution of the carpus within Sauropodomorpha.

Ernie Lundelius Symposium (Faunal Dynamics and Extinction), Wednesday 12:00  
THE ROLE OF NON-ANALOG BIOTAS IN THE TERMINAL PLEISTOCENE EXTINCTION

GRAHAM, Russell, EMS Museum, University Park, PA, USA

Non-analog biotas contain species that do not occur together today. These biotas represent habitats that no longer exist and habitat destruction is clearly a significant factor in the extinction process. Non-analog biotas are characteristic of the entire Pleistocene in North America, although their composition varies through time, although claims have been made that they are rare or insignificant. Re-analysis of the FAUNMAP database demonstrates their ubiquity. Furthermore, those of the late Pleistocene are quite different from those in the early and middle Pleistocene. Non-analog faunas of the early Pleistocene appear to persist throughout glacial and interglacial times. This suggests that climate changes in the late Pleistocene were more severe than those in earlier times. Finally, non-analog biotas are quite rare in the Holocene. Consequently, these changes suggest that the natural habitat destruction at the end of the Pleistocene may have been unique.

Poster Session IV (Saturday)

MARSUPIALS OF THE RODENT HILL LOCALITY, CYPRESS HILLS FORMATION, SOUTHWEST SASKATCHEWAN.

GRAHAM, Terri, University of Saskatchewan, Saskatoon, SK, Canada; BRYANT, Harold, Royal Saskatchewan Museum, Regina, SK, Canada

Marsupial dental remains are preserved at the Rodent Hill Locality in the Cypress Hills Formation in Saskatchewan. Dental remains consist of over 150 isolated teeth that were recovered through dry screening of large amounts of unconsolidated matrix. Previous studies of the rodent and equid assemblages had determined that the site was representative of Whitneyan North American Land Mammal Age (NALMA). The purpose of this study was to identify and describe the species present within the marsupial assemblage and to determine if the aforementioned assemblage corresponds to the Whitneyan NALMA. Two families of marsupials, the Didelphidae and Peradectidae, are present at the Rodent Hill Locality. The family Dielphidae experienced a short-lived diversification and is represented by two genera, *Herpetotherium* and *Copedelphys*. *Herpetotherium* is represented by 3 species, *H. fugax*, *H. merriami*, and *H. youngi*, while the genus *Copedelphys* is represented by a single species, *C. stevensoni*. The *Herpetotherium* species are the most abundant while *C. stevensoni* is the rarest. The family Peradectidae follows the general trend for marsupials during the Tertiary of a reduction in diversity and is represented by one species, *Nanodelphys hunti*. This study produced several interesting results. First, the co-occurrence of marsupial species at the Rodent Hill Locality that were previously known from older (Orellan) or younger (Arikarean) deposits supports the results of earlier studies that suggested that the site is Whitneyan in age. As a result the temporal ranges of the above mentioned species are extended to include the Whitneyan. In addition, the specimens of *C. stevensoni* blur the lines of distinction between this species and *Copedelphys titanelix*, suggesting the synonymy of the two species. This study increases our knowledge about small mammal diversity at the Rodent Hill Locality and marsupial evolution during the Whitneyan.

Technical Session XVI, Saturday 2:45

INTER-TOOTH VARIATION OF MICROWEAR FEATURES IN THE DENTINE OF EXTANT XENARTHANS AND ITS IMPORTANCE IN RECONSTRUCTING PALEODIET

GREEN, Jeremy, North Carolina State University, Raleigh, NC, USA

Recent dental microwear research reveals a correlation between scar features in dentine and primary diet in xenarthans, confirming dentine microwear analysis as a tool for paleodietary reconstruction in fossil taxa. However, previous studies applied this method to the same tooth across different extant xenarthans to define variations in ecomorphospaces. While standardized tooth comparison is preferable when inferring paleodiet in extinct forms, how microwear in dentine varies across the tooth row and how this affects dietary inferences is currently unknown. Identifying large samples of the same tooth from different fossil xenarthran taxa is difficult due to their homodont dentition, and maxillae with teeth *in situ* are relatively rare. This study addresses the question of whether a standard xenarthran tooth must be used for paleodietary inference by testing the hypothesis that dentine scar features are consistent between teeth in individuals within a dietary group. A representative species (N=5 individuals/species) from each of the 4 extant xenarthran dietary groups ((Carnivore-Omnivore (CO)=*Euphractus sexcinctus*, Folivore (F)=*Bradyptes variegatus*, Frugivore-Folivore (FF)=*Choloepus didactylus*, Insectivore (I)=*Dasyptes novemcinctus*) was analyzed for inter-tooth variation in microwear features. To control for both gender differences and geographic/temporal variation in diet, individuals from each species were the same gender and were collected from the same locality. Number of scratches (S) is the most diagnos-

tic variable for quantifying diet in xenarthans. S was quantified at 35X in a 0.4mm counting square on mesial and distal wear facets of left teeth (M2-5/m3-6 for CO, M/m2-5 for I, 16 data points/specimen; M2-4/m1-3 for F and FF, 12 data points/specimen) for each individual. Mean S values both between teeth in each group and between groups were tested for significant differences via ANOVA and Fisher's LSD, among other statistical tests. How microwear varies per dietary group and how different diets affect inter-tooth variation in microwear is discussed. Microwear in *Nothrotheriops shastensis* (N=10) is also analyzed for paleodietary inferences using these results.

Preparators' Session, Thursday 9:00

DIGITAL PREPARATION FOR THE ANALOG PREPARATOR

GROENKE, Joseph, Stony Brook University, Stony Brook, NY, USA; FARKE, Andrew, Stony Brook University, Stony Brook, NY, USA; GEORGI, Justin, Stony Brook University, Stony Brook, NY, USA

Computed tomography (CT) scanning and subsequent coarse digital preparation of jacketed material from the Cretaceous and Paleogene of Madagascar conducted at Stony Brook University has greatly augmented mechanical preparation objectives. Pre-preparation scanning allows prioritization of preparation projects while generating archival datasets of specimen condition and taphonomy. Datasets allow us to gauge the research value of jacketed specimens prior to opening, to mine data that could potentially be compromised in subsequent mechanical preparation, and to obtain three-dimensional maps from which the safest and most efficient preparation strategies can be charted. While the generation of image files and rendering of high-quality digital preparations is sometimes expensive and can be time consuming, readily-available free-ware programs allow any preparator with access to CT datasets to view stacked data in three planes (ImageJ, e.g.) and to build rough three-dimensional models of specimens within jackets and matrix (3D Slicer, e.g.). In some cases, such as when density contrast is good between fossil bone and matrix but fossil bone is extremely fragile and matrix extremely hard, digital preparation may, in fact, be the safest and most economical method available to preparators and researchers. Generating datasets is not always possible, however. Scanning facilities may not be able to accommodate overly large or heavy jackets. Thick or particularly dense matrices may inhibit scanning effectiveness, and bone/matrix contrast may be too poor to render useful information from a preliminary scan.

Technical Session I, Wednesday 10:45

LOW MAGNIFICATION DENTAL MICROWEAR OF EARLY AND MIDDLE MIOCENE CATARRHINES FROM AFRICA: IMPLICATIONS FOR DIETARY DIVERSITY

GROSSMAN, Ari, Stony Brook University, Stony Brook, NY, USA; SEMPREBON, Gina, Bay Path College, Longmeadow, MA, USA

Modern catarrhine primates employ a wide range of diets focusing on various food objects ranging from primarily leaf-eating to primarily fruit eating and graminivorous taxa. Early and Middle Miocene catarrhine primates from Africa are a speciose and morphologically diverse group representing the ancestors of living catarrhines. Here we employ low-magnification stereomicroscopy to quantify the range of microwear patterns observed in Early and Middle Miocene catarrhines to our extant sample. Secondly, we use our data to make some inferences about dietary preferences of the Miocene catarrhine taxa. A sample of second molars of 23 fossil taxa was compared with an extantive modern sample. All molars were first cleaned and then molded using a quick hardening silicone mold. Then, casts were produced using a clear epoxy resin. Next, pits and scratches in two 0.4 mm<sup>2</sup> squares on the same cusp were obtained using a stereomicroscope under oblique light and the results averaged. Application of a principal components analysis of all taxa and a discriminant function analysis of dietary groups produced the following results: a) modern catarrhine primates have a wider range of microwear signatures than the fossils examined; b) Early and Middle Miocene taxa used in this sample exhibit microwear patterns consistent with a frugivorous diet. Furthermore, none of the fossil taxa in this study are consistent with a primarily folivorous diet.

Poster Session III (Friday)

MAXIMIZING UTILITY OF LARGE ISOLATED HADROSAURID POSTCRANIAL ELEMENTS FOR GENERIC DIVERSITY AND POPULATION VARIABILITY

GUENTHER, Merrilee, University of Pennsylvania, Philadelphia, PA, USA

The abundant collections of hadrosaurids from the northwestern United States and Canada have provided a wealth of data, with the taxonomy of these specimens benefiting from well preserved skulls and cranial material. Some of the more southern localities however, such as those in New Mexico, include hadrosaurids, but lack some of the more complete and well-preserved specimens of their northern counterparts. What these southern localities do include are tantalizing isolated elements, some of which are among the largest found. Localities in the Kirtland Formation in New Mexico, among others, have generated humeri with lengths exceeding 90 cm and scapulae with lengths

exceeding 130 cm. It is important to maximize the utility of these specimens so that we may gain a proper understanding of the hadrosaurid diversity in these more southern faunas where postcranial elements may be found in abundance with little associated cranial material. Qualitatively, the morphology of the forelimb elements appears hadrosaurine. The large humeri have the more slender construction of hadrosaurines, including a deltopectoral crest that extends far less than twice the width of the shaft. The large scapulae have the thick-necked blades characteristic of hadrosaurines. This hadrosaurine identification is confirmed using geometric morphometric methods that remove the impact of size on the morphology. Application of such methods suggests that the humeri and scapulae belong to *Cryposaurus*-like and *Edmontosaurus*-like taxa. The large hadrosaurid specimens also exhibit unique bone textures. The forelimb elements, particularly the scapulae, exhibit a deeply pitted and globular bone texture on the articular surfaces that appears pathological rather than taphonomic in nature. The scapulae also exhibit a more reduced pitted bone texture on the lateral surface of the scapular blades. These textures may be the result of the advanced age of the individuals. Recognition of larger and older individuals through such isolated specimens will help to balance what we know of earlier ontogenetic stages and can contribute to our understanding of the age structure of hadrosaurid populations.

Evolutionary History of Bats Symposium, Thursday 9:30

BACK TO THE FUTURE - AFRICAN VESPERTILIONOIDEA (CHIROPTERA) AND THE ANTIQUITY OF MYOTINAE

GUNNELL, Gregg, University of Michigan, Ann Arbor, MI, USA; EITING, Thomas, University of Michigan, Ann Arbor, MI, USA; SIMONS, Elwyn, Duke University Primate Center, Durham, NC, USA; SEIFFERT, Erik, Oxford University, Oxford, United Kingdom

Vespertilionidae is the most diverse extant bat family with 34+ genera and 260+ species. Controversies surround the interrelationships of vespertilionids but a traditional subdivision based on molar tooth morphology (nyctalodonty vs. myotodonty) is useful for grouping most major subclades. Nyctalodont (postcristid connects hypoconid and hypoconulid) forms include murinines, pipistrellinins, lasiurins, and some plecotins while myotodont (postcristid connects hypoconid and entoconid, isolating hypoconulid) forms include myotines, antrozoinins, kerivoulines, and the majority of vespertilionins and plecotins. Nyctalodonty has been viewed as primitive for vespertilionoids with taxa such as Late Eocene/Early Oligocene *Stehlinia* exhibiting that pattern. Myotodont vespertilionids previously have not been recorded prior to the Early Oligocene (MP 21) when *Myotis*-like forms began to appear in Europe. Recent fieldwork in Fayum, Egypt has led to discovery of a new myotodont vespertilionid from late Eocene sediments at Quarry L-41 (34 Ma). This bat resembles extant myotines but differs in having relatively larger and more robust c1 and p2-3, p3 double-rooted, and molars relatively shorter and broader; differs from *Stehlinia* in having p2 larger than p3, p3 much smaller than p4, p3-4 not homodont, p4 relatively more elongate, and myotodont molars; differs from Early Oligocene *Quinetia* in having an elongate and more robust p4, and myotodont molars with excavated talonid basins and lacking lingual cingulids. An extinct group of myotodont bats, the Philisidae, also is represented from Fayum, including three (possibly four) species ranging in age from 37 to 30 Ma. Philisids (Early Eocene to Early Miocene) traditionally have been viewed as a sister group (and possibly ancestral) to vespertilionids. However, philisids are more derived than the L-41 myotin in lacking p3. This suggests that a philisid-vespertilionid split must predate 37 Ma, that myotodonty may be primitive for both of these clades (or the combined clade if they are sister taxa), and that it may be prudent to look to Africa as a possible source area for the origination of myotodont vespertilionids.

Poster Session I (Wednesday)

AGE STRUCTURE OF THE DIRE WOLF AT RANCHO LA BREA

GUST, Sherri, Cogstone, Santa Ana, CA, USA

Age structure of dire wolves from Rancho La Brea (RLB) were analyzed using 345 innominates. Morphological criteria on bone fusion were used to define six age categories. These were juvenile based on unfused acetabulum, young subadult based on fusion of the acetabulum, old subadult based on additional fusion of the ischial tuberosity, young adult based on additional fusion of the iliac crest, middle adult based on additional fusion of the pubic symphysis and old adult based on additional fusion of the sacroiliac joint. Veterinary literature reveals that in dogs the acetabulum fuses by six months and progression to the young adult stage occurs by 2 years. The literature ends at this point when dogs are considered adult so the remaining stages cannot currently be converted into years of age. The RLB sample consists of 2% juveniles, 5% young subadults, 26% old subadults, 25% young adults, 24% middle adults and 18% old adults. The striking lack of pups indicates that dire wolves were not denning at RLB but were carrying food back to young as modern wolves do. The large number of adults also reflects known wolf behavior wherein dominant pack members feed first followed by subordinate members. Just as large herbivore behavior explains the preponderance of subadult bison and horses at RLB, wolf behavior patterns explain the large number of adults. Taphonomic interpretations that do not take animal behavior into account are incomplete. The age stages defined here can be applied elsewhere.

Student Poster Session (Thursday)

LATE OLIGOCENE MAMMALS FROM NORTHERN KENYA

GUTIERREZ, Mercedes, Washington University in St. Louis, Saint Louis, MO, USA; RASMUSSEN, David, Washington University in St. Louis, Saint Louis, MO, USA

Lothidok and Benson's Site are two vertebrate localities located in northern Kenya, west of Lake Turkana. Teams associated with the Kenya National Museums have collected fossils in the area for several decades, but only in recent years was it determined that Lothidok was Late Oligocene in age. The only mammal from Lothidok that has been previously discussed in light of the age determinations (~24-27 Ma) is a catarrhine primate, *Kamoyapithecus*. We introduce here the rest of the mammals known from these sites, a fauna consisting of at least 15 species in eight orders. Lothidok and Benson's Site share several unique species, indicating that biostratigraphically they are about the same age. The taxonomic composition of both sites is distinctively Oligocene, including African Early Tertiary groups such as hyracoids, arsinotheres, primitive proboscideans, thryonomyoid rodents, proviverrine and pterodontine creodonts, catarrhine primates, and anthracotheres. There are no new immigrants from the northern continents except for a small fissiped carnivore, the earliest fossil record of Carnivora in Africa. The new fauna is transitional between earlier Oligocene faunas of Africa (known from Ethiopia, Egypt, and several other countries) and the Early Miocene faunas of East Africa. Several taxa are morphological intermediates, and potential phylogenetic links, between early Tertiary forms and Miocene taxa. Others represent the earliest record for African groups otherwise known in the Miocene. Still others represent the latest occurrence of taxa previously known from the Early Tertiary. The new discoveries highlight the fact that the faunal transition between archaic endemic mammals of the Early Tertiary and the more modern Neogene faunas occurred during a very short time interval at or near the Oligocene-Miocene boundary, what we call the African Mid-Tertiary Event (AMTE).

Evolutionary History of Bats Symposium, Thursday 11:45

SHOULDER JOINTS AND INNER EARS OF *TACHYPTERON FRANZENI*, AN EMBALLONURID BAT FROM THE MIDDLE EOCENE OF MESSEL

HABERSETZER, Jörg, Forsch. Inst. Senckenberg, Frankfurt, Germany; STORCH, Gerhard, Forsch. Inst. Senckenberg, Frankfurt, Germany; SCHLOSSER-STURM, Evelyn, Forsch. Inst. Senckenberg, Frankfurt, Germany; SIGÉ, Bernard, UMR 5125 PEPS CNRS France, Villeurbanne cedex, France

*Tachypteran franzeni* is the only one of seven bat species known from Grube Messel (near Darmstadt, Germany) which can be assigned to an extant family. This extraordinarily well-preserved fossil shows trabecular microstructures of the elongated tuberculum majus of the humerus and also internal microscopic details of the cochlea, which compare well to emballonurid species (e.g. *Taphozous melanopogon*, *T. kachhensis*) and also to other extant bats with similar morphological specializations (e.g. *Molossus molossus*). These details are made visible by  $\mu$ CT and high resolution radiographs and - additionally to other morphological characters - strongly support the view of a rapid and constant flight style for *Tachypteran franzeni* in combination with an echolocation system adapted for hunting in the open air above the forest canopy. Thus, this type of ecological adaptation extends the known spectrum of foraging strategies in the Messel bat community to the extreme of high altitude flight foraging, which obviously also existed during Middle Eocene of Messel. A couple of different radiographic and tomographic methods (like  $\mu$ CT,  $\mu$ CT-laminography,  $\mu$ CT-tomosynthesis, and limited angle  $\mu$ CT) were applied and compared in this study to meet the demands of very small regions of interest, and proved invaluable even though the specimen is preserved on a very much larger fossil plate.

Poster Session III (Friday)

PREDICTING WING SHAPE AND FLIGHT DYNAMICS FROM OSTEOLOGICAL STRUCTURES IN BIRDS AND PTEROSAURS

HABIB, Michael, Johns Hopkins School of Medicine, Baltimore, MD, USA

Wing shape encompasses a wide range of parameters important to flight dynamics. It is tightly linked to flight pattern in flying animals, and any given flight kinematic will select for specific characteristics of wing morphology. Accurate estimates of wing shape and flight kinematics for fossil species are important for reconstructing the paleoecology of extinct flying organisms, but such estimates are challenging in the absence of preserved soft tissue features. Fossils of volant vertebrates rarely preserve soft tissue from the wings, leaving only osteological information as a guide to flight mechanics. Thus, there is great utility in identifying (and quantifying) the relationships between wing shape, flight dynamics, and bony architecture. Here I present the first phases of an ongoing project that seeks to understand the correlations between structural mechanics and flight dynamics in volant archosaurs. Several osteological parameters have been found to relate to wing shape and flight kinematics. Despite the anatomical differences between birds and pterosaurs, some trends in structural adaptation extend to both groups (due to the constraints imposed by aerial locomotion). Average bending strength in proximal appendicular elements strongly relates to wing shape and flight mode in birds, and may show similar relationships in pterosaurs. Relatively short humeri with high torsional strength are associated with highly maneuvered flight.

Humeral diaphyseal shape is related to wing chord and launch dynamic, and can serve as a guide for reconstructing aspect ratios. The location and direction of internal braces in thin-walled bones, common to many large-bodied birds and pterosaurs, can yield vital information about wing shape and launch dynamics. For example, both the internal bracing and diaphyseal shape of the humerus of the azhdarchoid pterosaur *Bennettazhia oregonensis* indicate a forelimb-dominated launch cycle and narrow-chord wing. I hypothesize that other azhdarchoids had similar structural characteristics and flight dynamics. A thorough investigation of internal structure will be required to confirm this hypothesis.

Student Poster Session (Thursday)

#### COMPARATIVE ONTOGENETIC ANALYSIS OF TELEOCERAS AND EXTANT RHINOS

HAGGE, Mark, Louisiana State University, Baton Rouge, LA, USA

Ontogenetic comparisons can provide insight into developmental patterns, phylogenetic affinities, and morphological adaptations in rhinos. The skull ontogenies of the extant rhinos *Ceratotherium simum* (white rhino), *Diceros bicornis* (black rhino), *Rhinoceros unicornis* (Indian rhino), and *Dicerorhinus sumatrensis* (Sumatran rhino) were obtained and compared with the extinct North American rhino *Teleoceras major* from the Miocene Ashfall Fossil Beds. Eighteen developmental age classes were distinguished using posterior mandibular dental eruption and wear patterns. Wear and eruption patterns up to maturity (eruption of lower third molar) were consistent across all taxa studied. Skull conformations of the extant rhinos in infant and adult stages support the geographic phylogenetic hypothesis. The African rhinos (*Ceratotherium* and *Diceros*) and the Asian rhinos (*Rhinoceros* and *Dicerorhinus*) are morphologically more similar to each other than to members of the other group. *Teleoceras* shares more morphologic similarities to the extant rhinos as adults than as infants. In adult stages, *Teleoceras* has a combination of morphological attributes seen in extant species, such as a strong mandibular angle (*Diceros*, *Rhinoceros*), a long facial crest (*Ceratotherium*), a high zygomatic arch (*Rhinoceros*), and an intermediate parietal slope (*Dicerorhinus*). In infant stages, *Teleoceras* shows these adult attributes, but they are not present in the extant rhino infants. The extant rhinos appear to undergo more pronounced developmental changes when compared to *Teleoceras*, with prominent changes in size and shape of the occipital crest, mandibular angle, and zygomatic arch. Furthermore, *Teleoceras* has an intriguing mix of characteristics in adult morphology not present in the extant rhinos, for example, a small temporal fossa and large masseteric fossa. Results suggest *Teleoceras* as a mixed feeder because of the combination of extant rhino adult morphologies.

Poster Session I (Wednesday)

#### FUNCTIONAL IMPLICATIONS OF ONTOGENETIC CHANGES IN JAW MORPHOLOGY ASSOCIATED WITH DUROPHAGY IN *VARANUS NILOTICUS* AND INFERRED DUROPHAGY IN THE MOSASAUR *GLOBIDENS ALABAMAENSIS*

HALL, Justin, Stony Brook University, Stony Brook, NY, USA; POLCYN, Mike, Southern Methodist University, Dallas, TX, USA

Durophagy has been observed in several species of *Varanus*, such as *V. niloticus*, and inferred in some mosasaurs based on similarities in dentition and jaw morphology. Dental and cranial morphology of *V. niloticus* undergoes a dramatic change during ontogeny, correlated with a dietary switch from generalized carnivory to specialized durophagy. The juvenile dentition is laterally compressed, recurved and sharply pointed. It changes to a rounded, bulbous, molariform dentition in adults. The bones of the lower jaw, especially the dentary and angular, thicken dorso-ventrally. Similar changes also occur through ontogeny in the mosasaur *Globidens alabamaensis*. The ontogenetic changes in *V. niloticus* and *G. alabamaensis* were compared using two-dimensional finite element modeling and geometric morphometrics. The results of these analyses suggest that the changes in morphology correspond with markedly higher resistance to strain throughout the lower jaw, consistent with the hypothesis that these morphological changes facilitate a durophagous diet in both species as adults.

Poster Session III (Friday)

#### A PRELIMINARY ANALYSIS OF DINOSAUR TEETH FROM THE MUGHER MUDSTONE OF ETHIOPIA

HALL, Lee, Bozeman, MT, USA; GOODWIN, Mark, University of California Berkeley, Berkeley, CA, USA

This study presents an initial examination of dinosaur teeth from the Late Jurassic Mughher Mudstone exposed in the valley of the Jema River, northwestern plateau, Ethiopia. Fourteen teeth were found in the washed and picked sediment from a small geological hand sample (< 10 lbs) collected from this microvertebrate locality (UCMP V98113). This site also yielded abundant teeth of chondrichthyans (*Hypodus*), osteichthyans (*Lepidotes* and *Pycnodus*), and the dipnoan *Asiatoceratodus*. The presence of tetrapods is documented by fragmentary skeletal remains of turtles and crocodylians. The dinosaur teeth range from one to seven millimeters in length and do not have intact roots. There are three general morphotypes: ornithischian premaxillary, ornithis-

chian maxillary, and theropod. Ornithischian premaxillary teeth are 'leaf' shaped, conical or triangular, and recurved with subtle or no carina along margins. Ornithischian maxillary teeth bear prominent triangular carina on both margins and have a single median ridge on the medial and lateral surfaces. The lone theropod tooth is laterally compressed and blade-like with a well-worn crown tip, exhibits small, rounded serrations on the mesial margin and large, rectangular serrations angled toward the tip of the crown on the distal margin. Ethiopia's first dinosaur specimens were confirmed from collections made earlier between 1993 and 1998. Two theropods (cf. *Acrocanthosaurus*; genus and sp. indet.) and two hypsilophodontid teeth were discovered at nearby sites in the Mughher Mudstone. Fieldwork is continuing in the Mughher Mudstone at V98113, in the Jema River Valley and nearby tributaries, and in Late Triassic exposures in the northern province of Tigray. Further analysis and identification of these Ethiopian fossils will serve to strengthen our understanding of Gondwanan dinosaur diversity and biogeography by comparison with known vertebrate faunas from Niger, Tanzania, Egypt, Malawi and Cameroon.

Evolutionary History of Bats Symposium, Thursday 9:00

#### AUSTRALIAN AND NEW ZEALAND BATS: THE ORIGIN, EVOLUTION, AND EXTINCTION OF BAT LINEAGES IN AUSTRALASIA

HAND, Suzanne, School of Biological, Earth and Environmental Sciences, Sydney, Australia; BECK, Robin, School of Biological, Earth and Environmental Sciences, Sydney, Australia; WORTHY, Trevor, School of Earth and Environmental Sciences, Adelaide, Australia; ARCHER, Michael, School of Biological, Earth and Environmental Sciences, Sydney, Australia; SIGÉ, Bernard, UMR 5125 PEPS CNRS, France, Lyon, France

Australian Paleogene and Neogene bats, and New Zealand's first pre-Pleistocene bats, enable study of community structure, resource partitioning, foraging behaviour, faunal turnover and patterns of extinction in Australasian bat communities throughout the Cenozoic. They also provide opportunities for testing molecular phylogenies and competing biogeographic hypotheses concerning the origins and evolution of the Australasian bat fauna. The Australian fossil record documents the pre-Pleistocene presence of all extant Australian bat families, with the notable exception of Pteropodidae and Rhinolophidae. Archaeonycteridids, a radiation of mystacinids, and bats yet to be assigned to family are also represented. Data from Australia's Riversleigh World Heritage Area is used to quantify change in diversity and abundance of bat lineages and communities during three greenhouse/icehouse cycles in the Cenozoic, providing a tool to help anticipate the response of bat communities to current and future climate change and to inform development of effective conservation strategies. New Zealand's Early Miocene fossils include bats referable to three modern families as well as taxa that appear to have no close living relatives. While yet limited, the NZ fauna has affinities with Eocene (55 Ma) and Oligo-Miocene (25-12 Ma) Australian faunas, as well as Eurasian and South American bat faunas. Like Australia's Neogene bat communities, NZ's Miocene bats appear to have been derived from more than one geographic source. The fossils enable testing of the "out of Asia" versus "out of South America" biogeographic hypotheses (based on analysis of both molecular and morphological data) for several extinct and extant Australasian bat lineages. Palaeoecological hypotheses about the evolution of terrestriality in NZ bats are also tested. Chiropteran fossils indicate that there have been substantial changes to the Australasian bat fauna since the Miocene, with trans-Tasman dispersal and a cooling climate contributing to this turnover. They add further weight to calculations of extinction risk and phylogenetic diversity loss for several lineages, including *Mystacina*.

Poster Session II (Thursday)

#### MEGA MOVERS: ENORMOUS FIELD JACKETS

HANKS, Harold, Marmarth Research Foundation, Marmarth, ND, USA; HOGANSON, John, North Dakota Geological Survey, Bismarck, ND, USA; WOODWARD, Brett, North Dakota Geological Survey, Bismarck, ND, USA

We report two previously unreported techniques of removing large specimens from the field. In July of 2005, the Marmarth Research Foundation (MRF) began the recovery of an articulated hadrosaur specimen from the Hell Creek Formation, during which skin impressions were discovered. The specimen was split along a natural fracture line into two separate blocks, the largest of which (10 ft by 6 ft rectangle and 5 ft thick) was jacketed with a total of 1800 lbs of plaster. The delicate nature of the skin impressions along with the sheer size of the jacketed blocks necessitated that traditional recovery methods be abandoned and other techniques be implemented for its recovery. The plaster-capped blocks were undercut and holes were drilled to allow a steel frame to be assembled and welded in place underneath the blocks. The supporting pillars were removed and replaced with plaster soaked burlap leaving the blocks resting entirely on the steel frame which allowed a front-end loader to easily scoop up the blocks and successfully transport them to the lab with no damage to the specimen. In August of 2006, the MRF along with the North Dakota Geological Survey (NDGS) recovered a large, partially complete mosasaur from the Pierre Formation. The specimen was broken into two large jackets (8 1/2 ft by 4 ft rectangle and the other a 3 1/2 ft diameter circle). The very friable nature of the shale matrix and the long length and width of the blocks required the jackets to be flipped in the field instead of building a frame under-



neath, which would likely result in the middle of the jacket falling out. The jackets were capped with plaster and reinforced by plastering into the jacket two 3 inch solid steel roundstock rods along its length and stacked 2 x 4's along its width to act as skids. Holes were drilled at approximately 10 inch intervals underneath the jackets, and 3/4 inch concrete reinforcing rebar rods were inserted and incorporated into the jackets allowing the jackets to be flipped without the very friable matrix falling out from the middle of the jacket. The rods were cut off, the excess matrix was removed, and the bottom of the block was jacketed prior to its removal from the field.

#### Poster Session IV (Saturday)

##### NEW PTEROSAUR TRACKSITES IN THE WESTERN USA: IMPLICATIONS FOR GLOBAL PTEROSAUR ICENOLOGY

HARRIS, Jerald, Dixie State College, St. George, UT, USA; LOCKLEY, Martin, University of Colorado at Denver, Denver, CO, USA; BREITHAUPT, Brent, University of Wyoming, Laramie, WY, USA; MITCHELL, Laura, University of Wyoming, Madison, WI, USA

New *Pteraichnus* sites from Utah and Wyoming bring the total of known Late Jurassic localities in western North America to at least 17. All are dominated by small tracks (pes length ~2-10 cm) attributed to the two ichnospecies, *P. saltwashensis* and *P. stokesi*, based on trackway segments, not isolated tracks. French and Polish Late Jurassic track sites also yield small tracks (pes ~3-5 cm); much larger, unnamed tracks (pes ~18 cm) are known from Asturias, Spain. Because diagnostic impressions of "rhamphorhynchoid" pedal digit V are rarely clearly impressed, it is unknown if *Pteraichnus* track makers were pterodactyls, non-pterodactyls, or both. At least 25 pterosaur track sites are known from Cretaceous localities in North and South America, Europe, East Asia, and possibly North Africa. Footprints and trackways from these sites have been assigned to nine ichnospecies. Small (pes ~1-5 cm), primarily isolated, basal Cretaceous (Berriasian) *Pteraichnus* from ~12 sites in Soria, Spain have been assigned to six ichnospecies, some of which, for technical and preservational reasons, may be *nomina dubia*. Although *Pteraichnus* sp. and *P. indet.* also occur sporadically in the post-Berriasian, most other ichnogenera - *Purbeckoptus* (pes ~19-22 cm) from England, *Haenamichnus* (pes ~30 cm) from Korea, and possibly *Agadirichnus* (~12 cm) from Morocco - are larger and disparate in morphology, partly due to poor preservation. The multiple assemblages from the western USA and Soria appear to represent important *Pteraichnus*-dominated ichnofacies, best understood in stratigraphic context. Other occurrences are more scattered and not representative of defined ichnofacies zones. Globally, 11 ichnospecies in four ichnogenera are currently known from 47+ Late Jurassic-Late Cretaceous sites and are the subject of over 100 citations. Both Jurassic and Cretaceous assemblages often contain very high track densities and a range of track sizes associated with invertebrate traces, suggesting that diverse pterosaur flocks may have congregated to feed. Some assemblages reveal swim tracks that suggest pterosaurs floated in shallow water touching the submerged substrate with their hind feet.

#### Ernie Lundelius Symposium (Faunal Dynamics and Extinction), Wednesday 11:15 LATE PLEISTOCENE ENVIRONMENT AT RANCHO LA BREA

HARRIS, John, George C. Page Museum, Los Angeles, CA, USA; WARD, Joy, University of Kansas, Lawrence, KS, USA

The size and diversity of the vertebrate assemblages from Rancho La Brea are well known but the type locality of the Rancholabrean Land Mammal Age has also yielded a series of *Juniperus californica* wood samples that span the interval 7.7 to 55 kyr B.P. The information these provide about late Pleistocene environmental changes in southern California has ramifications for elsewhere in North America. The late Pleistocene encompassed a series of glacial/interglacial cycles in which the glacial intervals were characterized by both low temperature and reduced concentration of atmospheric CO<sub>2</sub> ([CO<sub>2</sub>]). During the last glacial interval, [CO<sub>2</sub>] values fell to one of the lowest concentrations encountered during the evolution of higher land plants. The abundant presence of juniper leaves and seeds at Rancho La Brea suggests a cooler climate than that supporting the modern oak woodland and scrub flora. The δ<sup>18</sup>O of the fossil juniper wood cellulose indicates that late Pleistocene humidity at Rancho La Brea was about 10% higher than that of today. Both lower temperatures and higher humidity are confirmed by other elements of the fossil biota. Recovered plant fossils and isotopic analysis of Rancho La Brea herbivores indicate a pure C3 flora. Modern C3 plants respond to low levels of [CO<sub>2</sub>] by significant reductions in photosynthesis (50-75%) and growth (52-90%) and may fail to reproduce. The δ<sup>13</sup>C analyses suggest that stomatal regulation of the late Pleistocene juniper leaves was similar to that of modern juniper and hence the fossil trees were severely carbon stressed. The effect of low [CO<sub>2</sub>] on photosynthesis and plant productivity would have deleteriously affected resources available to large herbivores and stressed the whole ecosystem. As usual, the arrival of humans only made things worse.

#### Technical Session II, Wednesday 8:30

##### MOLECULAR EVOLUTION AND CORRELATION OF *HOXA-11* AND *HOXA-13* GENES TO SKELETAL EVOLUTION AND GENE EXPRESSION CHANGES ACROSS THE FIN TO LIMB TRANSITION

HARRISON, Luke, McGill University, Montreal, QB, Canada; LARSSON, Hans, McGill University, Montreal, QB, Canada

*Hoxa-11* and *Hoxa-13* are important genes in autopodial development. There is also evidence to suggest the segregating expression of these genes at the level of Tetrapoda is critical for the evolution of the autopodium in that clade. We examine the molecular evolution of these genes and correlate to morphological and developmental changes. Changes in nucleotide and amino acid sequences were examined across selected vertebrate species chosen to best resolve this evolutionary transition. Morphological evolution is assessed with fossil and extant skeletal data. The coding sequences of *Hoxa-11* and *Hoxa-13* across the fin to limb transition were examined for evidence of changes related to gene expression pattern shifts. Rates of molecular evolution were found to vary considerably among branches and at some levels appear to correlate with periods of significant morphological change. Actinopterygian sequences, in particular, show a great deal of coding sequence change for both *Hoxa-11* and *Hoxa-13* that is correlated with periods of morphological change and gene duplication events within teleosts. Tests were also applied for the type of selection across branches. A number of branches were shown to be under positive selection, while most others indicate purifying selection. There does not appear to be large-scale change in the coding sequences of *Hoxa-11* and *Hoxa-13* associated with the morphological and gene expression changes across the fin to limb transition. This suggests coding sequence changes in these genes are not responsible for this evolutionary transformation.

#### Poster Session III (Friday)

##### RE-EVALUATING WING SHAPE IN *ARCHAEOPTERYX*: INFORMATION FROM THE THERMOPOLIS SPECIMEN

HARTMAN, Scott, Wyoming Dinosaur Center, Thermopolis, WY, USA

Previous specimens of *Archaeopteryx* have failed to preserve evidence of tertial remiges emerging from the humeri. This has traditionally been assumed to be due to preservational artifact; most aerodynamic reconstructions have therefore restored tertial remiges via analogy with extant volant avians. The Thermopolis Specimen of *Archaeopteryx* exhibits complete soft-tissue impressions near the humerus; the specimen lacks true tertials, as the remiges decrease rapidly in size progressing proximally from the elbow. The series of remiges terminates less than half way along the humerus. The sequential decrease in size and fur-like feather impressions evident along this transition are consistent with the preservation of actual wing morphology, rather than preservational artifact. The resulting reduction in wing area affects previous estimates of wing loading, and lift and drag coefficients, resulting in a degraded estimate of flight ability. Combined with recent studies establishing that *Archaeopteryx* lacked an ossified sternum and retained a non-derived state of ligamental stabilization at the shoulder, this data calls into question the degree of volancy achieved by the urvogel.

#### Technical Session VIII, Thursday 3:30

##### NEW SHORT-SNOUDED DYROSAURID (CROCODYLOMORPHA) FROM THE PALEOCENE OF NORTHERN COLOMBIA

HASTINGS, Alexander, University of Florida, Gainesville, FL, USA; BLOCH, Jonathan, Florida Museum of Natural History, Gainesville, FL, USA

The fossil record of crocodyliforms in tropical South America prior to the Oligocene has not been well sampled and has been mostly limited to fragmentary postcranial and mandibular remains. In this study we describe a nearly complete skull and associated mandible from the Paleocene Cerrejón Formation of northeastern Colombia. The skull has elongated supratemporal fenestrae, anterolateral postorbital processes, and well-developed occipital tuberosities, all characteristics of Dyrosauridae. The previous record of Dyrosauridae in South America was limited to three localities, two from the Late Cretaceous/Early Paleocene of non-paleotropical Bolivia, and the third of the same age from Brazil in an area that may have been tropical. This material is fairly limited, and only the Brazilian specimen, *Hyposaurus derbianus*, has been diagnosed to species. Otherwise, *Hyposaurus* is best known from North America with some fragmentary remains also known from the Paleogene of Africa. Unlike all previously described species, the snout of this new taxon is only 59% of the length of the skull, making it the shortest of any known dyrosaurid. A phylogenetic analysis using 87 cranial and mandibular characters was conducted for all species of Dyrosauridae known from cranial material. A branch and bound search resulted in 8 most parsimonious trees. A strict consensus unambiguously supported a clade with the new South American taxon as sister to *Hyposaurus rogersii*. This species is mostly known from Cretaceous and Paleocene deposits in New Jersey, but isolated elements have also been found as far south as Alabama. Given the established record of *Hyposaurus* in the Cretaceous of North America, we suggest a Late Cretaceous dispersal of *Hyposaurus* to South America and possibly to Africa during the Early Paleocene. Due to the new taxon's affinity to

the long-snouted Hyposaurus and more distant relation to the other short-snouted dyrosaurid, *Chenanisuchus lateroculi*, from the Paleocene of Morocco, the short-snouted condition appears to have evolved independently at least twice within Dyrosauridae.

Poster Session III (Friday)

DIFFERENT GROWTH PATTERNS BETWEEN THE BODY SKELETON AND OSTEODERMS OF *STEGOSAURUS* (ORNITHISCHIA: THYREOPHORA)

HAYASHI, Shoji, Hokkaido University, Sapporo, Japan; CARPENTER, Kenneth, Denver Museum of Nature & Science, Denver, CO, USA

*Stegosaurus* is characterized by having unique plate- and spike-shaped osteoderms. Previous studies have focused on *Stegosaurus* osteoderms to discuss their functions; however, the timing of maturity of these osteoderms with respect to its body growth is little known. In this study, we assessed bone growth of both body skeletons (rib, tibia and fibula) and osteoderms (plate and spike), using thin sections from a juvenile, a sub-adult and three adult individuals. In a juvenile stage, the bone histology shows a fibro-lamellar tissue with a reticular vascular network both a body element (fibula) and osteoderm (plate). In a sub-adult stage, the cortex with longitudinal column system was formed in body skeleton (fibula and rib), while the osteoderms (plates and a spike) display no histological changes but have only cancellous bone with extensive vascular network system. In adult stage, both body elements (tibiae and fibula) and osteoderms (plates and spikes) show a fibro-lamellar tissue and the lines of arrested growth (LAGs). Only the body skeletons of adults have external fundamental systems (EFS) in its periphery. The both plates and spikes in the adult stage have a thicker cortical bone than the juvenile and sub-adult stages but are still absent in EFS. The four histological changes are observed in body skeleton from this growth series of *Stegosaurus* sections: a fibro-lamellar tissue with a reticular vascular network, with longitudinal column system, LAGs, and ESF. Osteoderms, however, preserve two histological changes (a fibro-lamellar tissue with a reticular vascular network and LAGs), where the lack of a fibro-lamellar tissue with longitudinal column system probably is preservation. This indicates that the timing of the histological changes in osteoderms might have been delayed from the changes of the body skeleton and that osteoderms maintained faster growth rates than the body elements after the maturity of the body skeleton.

Technical Session V, Wednesday 3:30

MORPHOLOGY, MOLECULES AND TIME: EFFECTS OF COMPETING PHYLOGENETIC HYPOTHESES ON ECOMORPHOLOGICAL HISTORIES IN SNAKES

HEAD, Jason, University of Toronto at Mississauga, Mississauga, ON, Canada

Phylogenetic hypotheses of the interrelationships of snakes based on morphology are generally congruent in topologies among extant taxa, including monophyly of Alethinophidia, Macrostomata, and Caenophidia regardless of outgroup selection and character ordering, but the placement of fossils including *Dinilysia*, Pachyophiidae, and Madtsoiidae are highly divergent, resulting in competing hypotheses of origin ecologies and ecomorphological character correlation. Molecular hypotheses find little consensus aside from robust support for monophyly of Alethinophidia and Caenophidia, but indicate a basal position of wide-gape macrostomatan feeding in contrast to a derived position in morphological studies. Neither dataset has been compared to the stratigraphic record to determine the temporal distribution of ecomorphological innovation, however. To examine the fit of phylogenetic sequences of character evolution to the temporal record of snakes, I optimized both recent molecular topologies and a revised morphological topology against the snake stratigraphic record. The morphological topology was derived from reanalysis of osteological characters using *Varanus* and *Heloderma* as outgroups. Results included novel positions for fossils and paraphyly of anilioid taxa. Molecular hypotheses in which wide-gape feeding is basal are most stratigraphically congruent based on the early occurrence of macrostomy in pachyophiids and a young record of definitive crown-group anilioids. Molecular hypotheses additionally suggest the narrow-gape feeding morphology and perceived plesiomorphies of the otic capsule in anilioids, *Xenopeltis*, and fossil taxa are derived feature correlated with fossoriality. Limitations to resolving the sequence of character evolution in snakes continue to be poor resolution of their placement within Squamata, and a long stratigraphic history of phylogenetically and ecologically ambiguous taxa represented by isolated vertebrae.

Poster Session II (Thursday)

A MULTI-MEDIA SOLUTION TO COMPLEX MOLDING AND CASTING OF INTERNAL AND EXTERNAL SURFACES OF A FOSSIL *HOMO ERECTUS* CRANIUM FROM JAVA

HEARD, Amber, Michigan State University, East Lansing, MI, USA; GRAF, John, University of Michigan, Ann Arbor, MI, USA; SANDERS, William, University of Michigan, Ann Arbor, MI, USA

Replication of complex fossil surfaces is a difficult process that is usually accomplished by proper choice of molding material, construction of multi-piece molds and mother-molds, and insertion of plugs into recesses and undercuts. Molding and casting the outer and inner surfaces of a cranium present even greater challenges. This problem

was resolved using a combination of molding and mother-mold media, which protected the specimen and permitted multiple copies of the specimen to be cast without damage to the mold. The replicated specimen is a *Homo erectus* cranium from Sangiran Dome, Java, missing its mid-lower face, and most of the basicranial region. It essentially forms a bowl in shape. It was first molded using a single-piece solid silicone pour technique, which was cut open to extract the original cranium. One solid replicate was cast in this mold, using urethane casting compound; in the process, the mold was destroyed. We received this cast for production of additional copies. Obstacles to making the mold included the depth of the neural cavity, and extensive overhangs partially blocking the cavity. These were addressed by making a highly flexible mold from thin latex, reinforced with gauze. The mold of the internal cranium was done in a single piece; the external cranium was molded in two pieces. The parting lines of the mold followed the seams on the urethane cast. Mother-mold supports were built in polyester resin and fiberglass. Internally, the mother-mold was shaped as a column; the space between this and the latex mold was filled by thickened silicone rubber. The silicone insert was then quartered and labeled to register the individual pieces to the mother mold. Removal of the mold, inserts, and mother-mold pieces preserved the integrity of the original cast. Multiple casts showing fine detail were made in pigmented and talced polyester resin and fiberglass, and finished with an acrylic paint wash. It is likely that this method would also have succeeded in molding the original fossil cranium without causing damage to the specimen.

Poster Session III (Friday)

BARSTOVIAN ANURANS FROM THE MADISON VALLEY FORMATION NEAR ANCENEY, MONTANA

HENRICI, Amy, Carnegie Museum of Natural History, Pittsburgh, PA, USA

A large, mainly unsorted collection of herp bones was discovered recently in the collections of the Section of Vertebrate Paleontology, Carnegie Museum of Natural History. They were presumably collected during the 1970's using screen wash techniques from the Anceney locality, Montana. This locality lies in a road cut west of Bozeman near the town of Anceney, Gallatin County, and is in the early Barstovian (Miocene) Madison Valley Formation. Over 400 anuran bones were sorted and cataloged from this collection; salamander bones and hundreds of lizard jaws are present as well. The Anceney anurans are the first to be described from the Miocene of the northern Rocky Mountain region and provide information about anuran distribution and diversification during the Miocene. The majority of North American Miocene anuran faunas are known from the Great Plains region and Florida. Preliminary study reveals that three anuran families are represented. Pelobatid remains are the most numerous anurans in the collection. Only one taxon, which may be a new species, appears to be present. It is represented by frontoparietals, squamosals, maxillae, scapulae, clavicles, coracoids, ilia, vertebrae, fused sacral vertebrae-urostyles, tibialia, fibularia, and spades. On the basis of the morphology of the frontoparietal, squamosal, maxilla, coracoid, fused sacral vertebra-urostyle, and spade, it compares most closely with *Spea*. The frontoparietal, however, differs from known *Spea* in bearing sculpture and the presence of a broad ridge along the lateral edge. Several taxa of Hylidae appear to be represented, on the basis of nine ilia, but these require further analysis. About seven ilia of *Bufo* (Bufonidae) have been recovered. They possess a long, low dorsal prominence, which occurs in only a few extinct and extant Bufo, such as the extant *B. marinus*, *B. valentinensis* from the late Barstovian Valentine Formation of Nebraska, and *B. suspectus* from the Blancan (Pliocene) Rexroad Formation of Kansas. Of these, the Anceney Bufo compares most closely with *B. suspectus*.

Student Poster Session (Thursday)

HYPOXIA, BUT NOT HYPEROXIA, CONSTRAINS EMBRYONIC GROWTH OF THE AMERICAN ALLIGATOR

HICKS, James, UC Irvine, Irvine, CA, USA

Adequate oxygen supply to the embryo is necessary for normal growth and development, and chronic hypoxia (oxygen < 21% of air) is known to constrain embryonic growth in many amniotes. Embryos of ectotherms can remain viable and hatch successfully at lower oxygen levels than embryos of endotherms. Little is known about the effects of chronic hyperoxia (oxygen > 21% air) on embryonic development. However, ancestors of modern amniotes are known to have endured and survived large-scale fluctuations in oxygen levels, including a dramatic drop from 30%, in late Permian down to 12% in mid-Triassic. To investigate the influence of such an atmospheric change on reptilian embryonic development, we incubated eggs of the American alligator under different laboratory conditions: hypoxia (12-13%), normoxia (20-21%) or hyperoxia (29-30%). All embryos were incubated at 30°C and were litter-matched. Hatchlings incubated under normoxia and hyperoxia did not differ significantly in their morphology. In contrast, hypoxic hatchlings showed a 42% smaller yolk-free body mass and a 167% greater unutilized yolk mass. Absolute wet heart mass was 26% smaller in hypoxic hatchlings; but in mass-specific terms, wet heart mass of hypoxic hatchlings was 30% greater than that of normoxic/hyperoxic hatchlings. Hypoxic hatchlings also showed reduced skeletal growth, in terms of head (-12%), femoral (-15%), snout-vent (-13%) and total (-15%) lengths. Interestingly, total incubation time and hatching success rate were not affected by atmospheric oxygen levels. We suggest that changes in

atmospheric oxygen levels may have had a profound influence on metabolism and growth of ectothermic amniotes in their evolutionary history (e.g., acting as a constraint on growth rates in some Triassic taxa). Attempts to infer growth rates of extinct taxa from their fossil bone microstructure should consider contemporary oxygen levels when offering alternative explanations.

Technical Session VIII, Thursday 1:30

SKINNING DINOSAURS: BONY CORRELATES AND PATTERNS OF CEPHALIC SKIN EVOLUTION IN ARCHOSAURIA

HIERONYMUS, Tobin, Ohio University, Athens, OH, USA; WITMER, Lawrence, Ohio University, Athens, OH, USA

Extant archosaurs bear a number of striking skin features on their heads, ranging from the elaborate display structures seen in many birds to highly sensitive feeding structures such as the bill tip organ of woodcocks and the dome pressure receptors of crocodilians. Several bony features of extinct archosaur skulls have been advanced as bearing similar skin structures, but in the absence of exceptionally preserved examples, many of these morphological hypotheses have been difficult to resolve. This study examined skin-to-bone relationships in extant sauropsids as a source of robust osteological correlates of skin structure. We tested (1) existing concepts of homology in facial skin, with the inclusion of underlying dermal structures, and (2) ahistorical relationships between similar skin morphologies and their associated osteological correlates in extant taxa. We were able to identify consistent bony correlates for some specific skin types, such as hardened scales and the heavily keratinized plates associated with beaks and horn sheaths. Bony correlates for scales suggest the presence of similar scale patterns in such distantly related groups of dinosaurs as abelisaurids, tyrannosaurids, and neoceratopsians. In addition, there are consistent associations of morphologically distinguishable regions of skin with the extent of medial ophthalmic (CN V<sub>1</sub>), lateral ophthalmic (CN V<sub>2</sub>), and nasopalatine (CN V<sub>3</sub>) nerve supply. The bony foramina and canals that conduct these nerves through the facial skeleton are highly conserved among sauropsids, and thus the approximate boundaries of skin regions on the maxillary rostrum in fossil specimens can be visualized by identifying the corresponding bony correlates for major neurovascular bundles. The distinction between medial ophthalmic- and nasopalatine-innervated skin regions around the oral margin provides a more detailed framework for testing hypotheses of beak evolution, especially among the six parallel occurrences of beaks in maniraptoran theropods.

Romer Prize Session, Thursday 10:45

AQUATIC LOCOMOTION IN BASAL ORNITHURAE AND THEIR TRANSITION FROM AQUATIC TO TERRESTRIAL HABITATS

HINIC-FRLOG, Sanja, University of California, Davis, Davis, CA, USA

Transitions of secondarily aquatic organisms to terrestrial habitats are not common; yet, birds represent a noted exception. Basal ornithurans that ultimately gave rise to all living birds were most likely aquatic. However, their aquatic adaptations remain to be quantitatively corroborated. This study is an investigation of locomotor strategies of basal members of Ornithurae to test whether these birds were truly aquatic and if there were any adaptive reasons why the unlikely transitions from aquatic to terrestrial habitats occurred. To understand aquatic affinities of extinct groups, I quantified swimming adaptations in bird skeletons through a framework of statistical analyses and mechanical models. I sampled 247 species of extant birds (n=1112) for 28 osteological characters. Discriminant analysis (DA) suggests that 90% of the avian taxa are placed in correct locomotor categories implying that we can safely correlate osteology with locomotion. My study strongly suggests that basal ornithuran birds were aquatic, supporting the view that all living birds had a common aquatic ancestor in the Cretaceous. DA and principal component analyses predict ecological preferences of these birds: basal Hesperornithiformes explored underwater habitats in at least two different ways, while *Gansus yumenensis* was not an underwater diver. Morphologically, hesperornithiforms had a reduced range of motion around the knee and a poor alignment of the hip with the center of mass. *Gansus yumenensis* was not as constrained by water: foot and wing shapes indicate surface swimming or at least skimming behavior. Surface swimmers and skimmers exhibit a very small degree of skeletal adaptations relative to terrestrial birds whereas diving birds are clearly distinguished from both. According to recent avian phylogenies, it is likely that the birds with locomotion restricted to the water surface historically gave rise to terrestrial descendants.

Poster Session I (Wednesday)

CRANIAL MORPHOLOGY OF *MESODERMOCHELYS* (CHELONIOIDEA; TESTUDINES) FROM THE LATE CRETACEOUS OF JAPAN

HIRAYAMA, Ren, Waseda University, SILS, Shinjuku-ku, Tokyo, Japan

*Mesodermochelys undulatus* is a chelonoid sea turtle dominated in the Late Cretaceous (Campanian and Maastrichtian) of Japan (Hokkaido, Hyogo, and Kagawa Prefectures). *Mesodermochelys* has been classified as a primitive Dermochelyidae, largely based on postcranial morphology such as an elongate lateral process of the humerus. An isolated skull presumed as *Mesodermochelys* was found from the calcareous concretion of the Late Cretaceous (Santonian) Yezo Group of Tomamae-cho, Hokkaido Prefecture,

northern Japan by Mr. Yoshiyuki Hattori in October of 2005. A large portion of the dermal roofing elements, including prefrontal, frontal and squamosal, and premaxilla were missing due to weathering from this specimen, which is donated in the Historical Museum of Hokkaido, Sapporo as HMH 151807. Nonetheless, this is the first known well-preserved skull of this genus, though more fragmentary skull and lower jaws were unearthed from the Maastrichtian type locality (Hobetsu of Mukawa-cho, Hokkaido Prefecture). HMH 151807 was carefully prepared by using formic acid, revealing the following distinct characters: 1) palatines medially meeting, 2) foramen posterius canalis carotici interni incompletely covered by bones on ventral surface of pterygoids as in *Plesiochelys*, 3) basisphenoid has a V-shaped crest on its ventral surface, deeply emarginated from the posterior. One tree was obtained through PAUP analysis (Version 4.0) by using 142 characters of 36 taxa (4 outgroups and 32 chelonoids). Tree length is 356, with a consistency index of 0.4888. *Mesodermochelys* is here shown as a sister taxon of the Protostegidae, an extinct member of chelonoids once flourishing during the Cretaceous. Thus, *Mesodermochelys* is a chelonoid closely related with protostegids, or basal member of the latter, though dermochelyid-like limb morphology was independently acquired in this genus.

Poster Session IV (Saturday)

A REVIEW OF THE *PANTHERA ONCA* (MAMMALIA; CARNIVORA; FELIDAE) FROM THE CURTIS RANCH LOCAL FAUNA (BLANCAN), SOUTHEASTERN ARIZONA

HODNETT, John-Paul, Northern Arizona University, Flagstaff, AZ, USA

The fossil materials from the Curtis Ranch local fauna referring to jaguar (*Panthera onca*) has been cited as the oldest occurrence of *P. onca* in North America. These fossils include a left partial p4, a right calcaneum, and an upper third metatarsal fragment. This material was originally attributed as "*Felis*, near *F. atrox*" by Gazin was then later placed in *Panthera onca* by others. Reexamination of these fossil materials now suggests that *Panthera* did not occur within the Curtis Ranch local fauna and instead these fossils represent two separate taxa. In comparison of the lower p4 in *Panthera* the principle cusp is usually broad and low, has a concavity on the medial margin of the crown when viewed in occlusal, and lacks the presence of a cingulum on the posterior margin of the tooth. The lower p4 from Curtis Ranch has a broad and tall principle cusp, is ovate when viewed in occlusal, and has the presence of a pronounced cingulum on the posterior margin of the tooth. These characters suggest an affinity not with *Panthera* but rather the hyaenid *Chasmaporthetes ossifragus*. Bi-variant analysis of the length and width of lower p4s of *Panthera* and *Chasmaporthetes* shows the Curtis Ranch p4 to be placed in the *Chasmaporthetes* cluster. This p4 represents the first record of *Chasmaporthetes ossifragus* from the Curtis Ranch local fauna. The characters in the calcaneum of *Panthera* vary between species, with *Panthera onca* having a shorter peroneal tubercle relative to other *Panthera* species. In the Curtis Ranch calcaneum the peroneal tubercle is proportionately longer than that seen in *P. onca* and a navicular is present, a character that is typically absent in pantherid felids. The long peroneal tubercle, the presence of a navicular facet, and a long shaft for the Achilles tendon attachment are characters seen in the large felid *Miracinonyx inexpectatus*. This specimen was found in association with the metatarsal fragment that also shows characters to a very large *M. inexpectatus*. This reevaluation of the Curtis Ranch material supports *Panthera onca* migrating into North America during the middle Irvingtonian and not before the Pleistocene.

Poster Session III (Friday)

PITCH, YAW AND, ROLL - HADROSAURIAN LOCOMOTION KINETICS INVESTIGATED WITH CAE

HOHLOCH, Alexander, Eberhard-Karls-Universität, Tuebingen, Germany

In this study digitized bones of *Brachylophosaurus*, a non-crested hadrosaur, are employed to generate biomechanical 3D computer models. These are used in a CAE (Computer Aided Engineering) software to investigate the different postures and gaits of hadrosaurs. The purpose is to achieve a better definition of their locomotion capabilities with special regards to interspecific interaction. The front limbs of hadrosaurs show significant adaptations for locomotion, such as elongation of the forearm and the hoof-shaped unguals. Additionally, hadrosaurs exhibit the most rigid axial skeleton among dinosaurs due to the trellis-like pattern of well-ossified longitudinal tendons on the spinal processes. Kinetic/dynamic computer modeling of *Brachylophosaurus* for slow speeds shows differing duty factors in the fore- and hind limbs, caused by the unequal limb lengths and the position of the center of gravity, which rests almost directly above the toes. This means that hadrosaurs used a 'normal walk with emphasis on the hind legs'. This effect increases with greater step lengths (i.e. higher speeds). The fact that weight carrying on the front limbs appears not to play a significant role begs the question why hadrosaurs use the fore limbs at all when walking. Potentially, lateral instabilities ('yawing' motions) induced by the transfer of rotational inertia along the body axis are countered. Most other animals can employ lateral bending of the vertebral column to this purpose, but hadrosaurs lack the required body mobility. Also, vertical 'pitching' motions are induced by rapid locomotion; again, the rigidity of the hadrosaur backbone does not allow the conventional counter of dorsoventral flexion. Furthermore, faster turn rates and higher speeds during turns may be achieved with only limited

energy input through use of the front limbs, as they offer a long lever arm. This has implications for predator/prey interactions, as the main predatory threat for hadrosaurs stems from agile bipeds, e.g. tyrannosaurids.

Poster Session I (Wednesday)

FIRST 3-D FESS (FINITE-ELEMENT STRUCTURE SYNTHESIS) OF THE SHOULDER GIRDLE OF A RECENT ARCHOSAUR UNDER CONSIDERATION OF ARCHOSAUR MUSCULATURE AND LOCOMOTION.

HOHN, Bianca, Ruhr-University Bochum, Bochum, Germany; PREUSCHOF, Holger, Ruhr-University Bochum, Bochum, Germany; WITZEL, Ulrich, Ruhr-University Bochum, Bochum, Germany; DISTLER, Claudia, Ruhr-University Bochum, Bochum, Germany

3-D FESS has formerly been applied for vertebrate skulls, especially of primates and sauropod dinosaurs. Now we present a virtual structure synthesis of a tetrapod shoulder-girdle skeleton. Unlike the most inductive studies using Finite-Elements our deductive approach is focusing on the relationship between form and function according to Wolff's law. The 3-D model is constructed with *Ansys 10.0*, choosing 10-nodes tetrahedral finite-elements, with a Young's modulus of cortical bone. Initial conditions consist of four homogeneous solids (the "Bauraum") roughly shaped as trunk, including neck and head, scapulo-coracoid and the forearm bones. These parts are completely independent from each other, held together and kept in balance by forces simulating the necessary muscles. Their values and positions were calculated from muscle dimensions obtained by dissecting an *Alligator mississippiensis*. These assumptions, however, are tested by the mechanical stability and balance of the model. The stress flows of each investigated load step were summarized by "physiological superposition". Stress free areas in the model were eliminated to reduce "the Bauraum" to the most exact shape regarding to the archosaur anatomy in iterative steps. Since bony material is only deposited where compression stresses occur, the stress-bearing regions indicate the elements forming the shoulder girdle. So our method allows the simulation of developing processes and shows the muscles and tendons responsible for the bony structures and their influence on skeletal shape. FESS is an appropriate technique to point out the direct relationship between function and form. Since we are able to construct a 3-D model of the postcranial parts of a skeleton it will be possible to investigate any fossil skeletal structure by using FESS.

Student Poster Session (Thursday)

RHINOCEROTOID AFFINITIES OF DEPERETELLIDAE (MAMMALIA, PERISSODACTYLA) BASED ON ENAMEL MICROSTRUCTURE

HOLBROOK, Luke, Rowan University, Glassboro, NJ, USA

Deperetellids are a family of perissodactyls endemic to the Eocene of Asia. Like the contemporary lophialetids, deperetellids have generally been classified as tapiroids or else as a ceratomorph family of uncertain relationships. Although some authors have alluded to a possible relationship between endemic Asian "tapiroids" and rhinocerotoids, no previous study has explicitly allied deperetellids and rhinocerotoids. Rhinocerotoids share an unusual feature of their enamel microstructure, namely vertical decussation of the enamel prisms. Vertical enamel decussation is a rare feature in mammals, and rhinocerotoids are unique among perissodactyls in possessing it. Thus, vertical enamel decussation is likely a synapomorphy of rhinocerotoids. Although it is a feature of the enamel microstructure, vertical decussation can be detected under low magnification from the characteristic ridges visible on the occlusal edge of the enamel of cheek teeth. Specimens of deperetellids from the Lagrelius Collection of the Museum of Paleontology at the University of Uppsala and from the Central Asiatic Expeditions of the American Museum of Natural History possess these ridges indicative of vertical enamel decussation. The presence of vertical enamel decussation in deperetellids supports a close relationship between deperetellids and rhinocerotoids. A preliminary phylogenetic analysis places Deperetellidae as the sister-taxon of Rhinocerotidae, and Tapiroidea and Lophialetidae are successive sister-groups to this clade.

Technical Session VIII, Thursday 2:00

THE EPIPTERYGOID OF CROCODYLIFORMS AND ITS SIGNIFICANCE IN THE EVOLUTION OF THE ORBITOTEMPORAL REGION OF EUSUCHIANS

HOLLIDAY, Casey, Marshall University, Huntington, WV, USA; WITMER, Lawrence, Ohio University, Athens, OH, USA

The orbitotemporal region of crocodyliforms is highly apomorphic and poorly understood and may represent a reservoir of informative features. A broad survey of fossil and extant crocodyliform archosaurs was conducted to explore the evolutionary and morphological patterns of the region. Observational and radiological data were gathered on the topological similarity and evolutionary congruence of features of the epipterygoid, laterosphenoid, and temporal region as a whole including relevant osteological correlates and inferred soft tissues such as the trigeminal nerves and jaw musculature. Despite the complete suturing of the palatocranial junction, the epipterygoid remained a consistent cranial element throughout crocodyliform evolution, only to be

replaced by the topologically analogous, but developmentally neomorphic laterosphenoid lateral bridge during the early evolution of neo- and eusuchians. These changes led to a unique morphology of the exit of the trigeminal nerve and surrounding region in the crown clade. Mesoeucrocodylian taxa exhibit a diversity of epipterygoid morphologies including waisted (e.g., *Araripesuchus*), overlapping (e.g., *Sarcosuchus*) and isolated (e.g., *Goniopholis* and *Leidyosuchus*) forms. The isolated form represents a key transition to the extant condition in which the epipterygoid uncoupled from the pterygoid and failed to cover the cavum epiptericum laterally. The distribution of these characters in current phylogenies indicates the epipterygoid was convergently eliminated several times within Neosuchia and also Crocodylia suggesting it and related features may bear systematic importance. These changes in braincase and palatal construction are potentially linked to the apomorphic migration of *M. pseudotemporalis* superficialis to a position rostroventral to the dorsotemporal fossa and topological change in the intermuscular path of the maxillary nerve-both are apomorphies of extant taxa. These data suggest a diverse spectrum of orbitotemporal morphologies among mesoeucrocodylians and eusuchians were present and warrant further developmental and functional investigations as well as their inclusion in phylogenetic analyses.

Carnivora: Phylogeny, Form and Function Symposium, Saturday 9:00

EVOLUTION OF HYPERCARNIVORY: CONVERGENCE AND CHARACTER STATE BIAS IN CARNIVORA

HOLLIDAY, Jill, Spring Hill College, Mobile, AL, USA

Carnivores are well known for their tendency to independently evolve similar phenotypes in similar environments (ecomorphs). Once such phenotype is the hypercarnivore, or meat-specialist, which is recognized morphologically on the basis of a specific suite of features that includes elongation of the carnassial blade, reduction or loss of the post-carnassial molars, and shortening of the rostrum. A previous study of the evolution and effects of specialization to the hypercarnivore morphotype compared levels of morphological diversity between hypercarnivores and their sister groups, and showed that hypercarnivores not only occupy relatively less morphospace than their sister groups, but also exhibit fewer character state changes overall. Here, I use detailed character mapping in conjunction with sister and outgroup comparisons in order to evaluate the underlying processes that might lead to a reduction in morphological state changes. Outgroup comparisons provide a "baseline," or expected rate of morphological change, while sister group comparisons allow comparison of rates since a shared ancestor. Use of multiple sister group comparisons (= replicated sister-group comparisons) facilitates consideration of patterns that are applicable to hypercarnivory in a broad sense. Topological and branch length information from recent phylogenetic analyses also allows me to perform more sophisticated tests of bias than have been previously feasible, significantly improving confidence in the results.

Technical Session VI, Thursday 1:45

NEW DATA ON ANTHRACOTHERIIDAE (ARTIODACTYLA) FROM THE PALEOGENE OF EGYPT

HOLROYD, Patricia, University of California, Berkeley, CA, USA; GUNNELL, Gregg, University of Michigan, Ann Arbor, MI, USA

Anthracotheiid artiodactyls are fairly abundant in the successive late Eocene to early Oligocene terrestrial faunal assemblages of the Qasr el Sagha and Jebel Qatrani Formations, Fayum Province, Egypt. They have received little attention until recently, partly because previous systematic work has been conducted on specimens of unclear provenance. Here we use the stratigraphically constrained collections resulting from expeditions by the AMNH, UCMP, and YPM to establish the stratigraphic ranges of Fayum anthracotheriids. Compilation of historical data and maps help us to establish the provenance of most specimens and place these in a chronostratigraphic framework. Anthracotheres are only represented by postcrania from the uppermost part of late Eocene Qasr el Sagha Formation, dated to approx. 35 Ma. Based on size, two taxa appear to be present, and these represent the oldest occurrences of the family in Africa. In the overlying Jebel Qatrani Formation, dental and gnathic specimens are common in the three successive faunal horizons assessed. Four distinct species of *Bothriogenys*, a single species of the rare genus *Qatraniodon*, and a small form of unclear taxonomic status are recognized. Of these *B. gorringei* and *Q. parvus* are the only taxa recognized in the early Oligocene lower sequence of the Jebel Qatrani Formation, occurring in two distinctive horizons dated to approx. 33.6 and 33 Ma. *B. fraasi* and *B. rugulosus* co-occur in the upper sequence of the Jebel Qatrani Formation from quarries approx. 30.2-29.5 Ma in age. No additional specimens clearly assignable to *B. andrewsi* were found in our survey of collections. Based on analysis of metric and morphological data, the two most common species *Bothriogenys gorringei* and *B. fraasi* are sister taxa and may form a single time-successive lineage. Relationships among the remainder of the *Bothriogenys* species are less clear, in large part due to the rarity and incompleteness of specimens. *Qatraniodon* is the sister taxon to all *Bothriogenys* species, and together these two genera appear to form a distinctive Paleogene African anthracotheriid clade.

Technical Session XVII, Saturday 3:45  
DINOSAURS OUT OF THIN AIR: PHYLOGENETIC PERSPECTIVES ON  
WARD'S ATMOSPHERE/EVOLUTION HYPOTHESES

HOLTZ, Thomas, University of Maryland, College Park, MD, USA

In recent publications a set of hypotheses linking changes in atmospheric composition (primarily the partial pressure of oxygen) and Phanerozoic macroevolutionary patterns have been presented. Some of these hypotheses address specific morphological and physiological attributes in particular groups, while others represent broader trends in the history of Life. Predictions relevant to the evolution of Dinosauria are here addressed in relation to a composite stratigraphically scaled phylogeny of Mesozoic dinosaurs. Several of these hypotheses are consistent with the observed patterns of dinosaur evolution. For example, a parasagittal stance appeared multiple times within Archosauria (including the ancestors of dinosaurs) during a period of low oxygen levels, when overcoming Carrier's Constraint would have been particularly useful. However, other predictions are more problematic. When controlled for phylogenetic signal (especially ghost lineages), the general pattern of overall dinosaur diversity and speciation rates are strongly influenced by the intermittent nature of dinosaur-bearing strata (and especially lagerstätten). Thus, while it is possible that the increasing levels of dinosaurian diversity over the Mesozoic tracks changes in atmospheric oxygen levels, support for this currently tenuous. Additionally, predictions of earlier workers about the evolution of the avian respiratory system show some match to the oxygen curve. However, examination of the particular distribution of postcranial pneumaticity within various saurischian subclades (especially sauropodomorphs, ceratosaurs, carnosaurs, tyrannosauroids, and maniraptorans) shows that osteological records of the air sac system are variable. This variability is influenced by size and/or ontogenetic status of the various fossils, which may mask the presence of this system in small individuals. Finally, earlier hypotheses were made in the context of one particular estimate of changes in Phanerozoic atmospheric composition (GEOCARBSULF). Other models (such as COPSE) exist, which have very different predictions for later Mesozoic oxygen levels.

Technical Session VI, Thursday 3:30  
LAMBDOOTHERIID PERISSODACTYLS: EVIDENCE OF AN ORIGIN AND  
MODEST RADIATION IN ASIA

HOOKE, Jerry, Natural History Museum, London, United Kingdom;  
DASHZEVEG, Demberel, Mongolian Academy of Sciences, Ulaanbaatar, Mongolia;  
POLLY, P. David, Indiana University, Bloomington, IN, USA

Family Lambdotheriidae containing the North American genus *Lambdotherium* and the Chinese genus *Danjiangia* is recorded from the later part of the Early Eocene. We here recognize two other Asian species of perissodactyl, which have been placed in the Equoidea, as lambdotheriids. *Propalaeotherium sinense* was described from the Guangzhuan Formation, Shandong Province, China, where it occurs with typical early Middle Eocene mammals. Unlike the palaeotheres *Propalaeotherium* and *Eurohippus* (originally placed in *Propalaeotherium*), *P. sinense* upper molars have a short, relatively transverse metaloph which fails to reach the metacone, a mesially bowed preprotocrista, large parastyle and relatively short postmetacrista, in common with *Lambdotherium*. *P. sinense* lower molars are strongly crested, have a relatively lingually situated hypoconulid on m1-2 and an oblique hypolophid and short hypoconulid lobe on m3, also unlike *Propalaeotherium* but like *Lambdotherium*. *Gobhippus menneri*, based on a lower jaw with three molars from the Kholboldzhi Formation of the Valley of the Lakes, Mongolia, was originally considered to be an equid. Recent collecting has additionally yielded a p4. *Gobhippus* bears a close overall resemblance to *P. sinense* and *Lambdotherium*, but differs in having a more central m1-2 hypoconulid and m3 with an autapomorphic greatly expanded hypoconulid lobe and incomplete hypolophid. A number of the key characters of *Lambdotherium*, *Danjiangia*, *P. sinense*, and *Gobhippus*, which differentiate them from equoids, are shared with the phenacodontid *Ectocion* and are primitive for Perissodactyla. This raises the possibility that Lambdotheriidae are paraphyletic and represent an initial radiation of perissodactyls in Asia, with minor dispersal to North America.

Technical Session IV, Wednesday 3:00  
EVOLUTION OF BURROWING IN SMALL MAMMALS AND THE IMPORTANCE OF FOSSIL DATA IN CHARACTER RECONSTRUCTION  
HOPKINS, Samantha, University of Oregon, Eugene, OR, USA

Burrowing behavior has evolved repeatedly in mammalian lineages throughout the Cenozoic. Diverse groups of mammals, both living and extinct, have evolved adaptations to excavating burrows and living underground. Because these adaptations are frequently expressed in the morphology of mammalian skeletons, this character provides an ideal case for looking at patterns of convergent evolution in living and extinct organisms. The evolution of these features is best studied in a phylogenetic context, using our understanding of the evolutionary relationships among the members of these mammalian clades. Unfortunately, for most mammalian groups, and for small mammals in particular, the species-level phylogenies needed to study the evolution of an ecological feature like this one are frequently available only for extant species. I have used the available phylogenies, combined with morphological and ecological data, to

reconstruct the patterns of evolution of adaptations to life underground. Precise reconstruction of the course of evolution of burrowing is only possible in some extant clades. In many lineages, some of the stages in the evolution of burrowing are only represented by extinct species, leaving substantial gaps in our understanding of the course of evolution. Much better results are obtained for clades where complete phylogenies including extinct species are available. This improvement in the quality of evolutionary ecological reconstruction emphasizes the importance of developing phylogenies for extinct and extant mammals together, in spite of the difficulty of this task in incompletely preserved small mammal taxa. It is apparent that fossorial (burrowing) life habits have evolved by a similar pattern in a number of lineages, and that burrowing exerts an "evolutionary ratchet" on lineages that specialize on an underground life habit. This ratchet is hypothesized to be generated by the selective "push" of predation pressure on animals with extreme locomotor specializations for digging.

Evolutionary History of Bats Symposium, Thursday 10:30  
DEVELOPMENTAL DYNAMICS OF CHIROPTERAN MOLARS:  
ON VARIATION AND CONSTRAINTS

HORACEK, Ivan, Department of Zoology, Charles University, Praha, Czech Republic

The enamel architecture of adult molars (SEM), its embryonic development, pre- and perieruptional changes in teeth shape and dynamics of enamel maturation in selected model taxa (mostly vespertilionid bats) revealed that the tribosphenic molars of bats are composed of several, more or less independent, structural modules: the crests of (a) paracone, (b) metacone, and (c) protocone, (d) parastyle and (e) palatal cingulum, in the upper molars, (f) the trigonid crest, (g) hypoconid crest (cristid oblique partim, postcristid), (h) entoconid and (i) labial cingulum, in the lower molars. The variation in basic design of these components and their positional relations are largely constrained within the insectivorous bats whereas there is a large variation in the structures interconnecting the basic modules and/or extending the essential tribosphenic design (e.g. mesostyle, profossa, para- and metaloph, hypocone and talon, hypoconid fossids, mesial cristid obliqua, distal postcristid, entoconid crest). The design of these structures is often clade specific. As the enamel must be completely hardened prior to tooth eruption, all of these characters have to be attained during tooth development via the specific heterochronies. These heterochronies and the way the particular structural modules are integrated into the tooth phenotype are thus the essential characteristics of particular clades. Nevertheless, some phylogenetic morphoclines may appear in common: e.g. disappearance of some intermodular elements due to a prolonged developmental autonomy of individual modules (comp. e.g. myotodonty in lower molars) or a scaling of variation and role of some structures with prey and body sizes. With larger prey the original crown design (spacious profossa, well developed para- and metalophs and mesostyle) is often effected by increase in height of the dentition, and decrease in the role of protocone-talonid occlusion compared to that at the intermolar-trigonid complex where the respective structures go underdeveloped compared to the prolonged lateral elements of the plagiocrista (common in e.g. megadermatids, hipposiderids or among vespertilionids such as murines or Paleogene Phylisinae).

Poster Session IV (Saturday)  
PRESENCE AND ABUNDANCE PATTERNS OF MIDDLE MIOCENE PIKAS  
FROM NORTH CENTRAL SPAIN

HORDIJK, Kees, Utrecht University, Utrecht, Netherlands; VAN DER MEULEN, Albert, Utrecht University, Utrecht, Netherlands

The high resolution, magnetostratigraphically dated, succession from the Daroca-Villafeliche area, consists of more than 100 localities covering the time interval between 17 and 10 Ma. Pikas (Ochotonidae, Lagomorpha, Mammalia) are relatively common in the record, having an average abundance of almost 20% in the category of small-mammal primary consumers. The pikas represent the folivorous guild, while the rodents are generally more granivorous or omnivorous. The ranges of the four observed pika lineages show distinct similarities with those observed in the rodents, for which regularities in the community structure and turnover have been demonstrated. The studied time interval is marked by distinct changes in global climate, of which the most prominent is the Middle Miocene Climate Transition (~14.2-13.7 Ma). This cooling phase is reflected in the rodent record by a major turnover event. The pika record reveals a specific pattern in the relative abundance distribution during this phase, which is also marked by the immigration of a fourth lineage and, ultimately, the disappearance of another. The four pika lineages show different presence and abundance distributions through time, which are assumed to indicate differences in paleoecology and hence diverse habitat preferences. Three lineages represent so-called residents, having long residence times, and are considered core-species in the community over time. The presence/abundance patterns reveal two types of residents, which are the rare persistent and common persistent types, respectively. The latter pattern is shown by two lineages of which one is associated with the Early-Middle Aragonian community and the other with the Late Aragonian community. The rare persistent lineage is associated with both communities, but is frequently absent during the turnover phase. One lineage is a transient community member, which is characterized by short residence times. Its presence/abundance pattern can be characterized as rare occasional.

Poster Session I (Wednesday)

THE TARKIO VALLEY GROUND SLOTH EXCAVATIONS: AN ADULT JEFFERSON'S GIANT GROUND SLOTH (*MEGALONYX JEFFERSONII*) IN ASSOCIATION WITH TWO JUVENILES FROM THE LATE PLEISTOCENE OF SOUTHWESTERN IOWA

HORGEN, Sarah, The University of Iowa, Iowa City, IA, USA; BRENZEL, David, The University of Iowa, Iowa City, IA, USA; SEMKEN, Holmes, The University of Iowa, Iowa City, IA, USA;

Excavation of an adult *Megalonyx* in the West Tarkio Valley of Iowa has revealed the second most complete skeleton of the species recovered to date. Even more remarkable, this individual lies in situ and partially intermingled with the remains of two juvenile specimens of *Megalonyx*. In 2002, remains of an adult *Megalonyx jeffersonii* were brought in to the Department of Geoscience, University of Iowa, by landowners who had discovered the specimen in the bed of the West Tarkio. Investigation of the site revealed that part of the sloth was under a 24 foot cut bank, part was in the creek bed, all of it is below the water table—and the site includes two properties. Both property owners agreed to permit excavation and donate the specimen to the University of Iowa for research and exhibition. Excavation of this logistical nightmare in Page County began in 2003 by the UI Department of Geoscience and Museum of Natural History with the help of volunteers and contractors from around the Midwest. To date, the project has produced the second-most complete, as well as the second largest, adult specimen of this species with more than 90 elements recovered. In the spring of 2006, the remains of a juvenile *Megalonyx jeffersonii* were discovered juxtaposed with the adult and the remains of a second juvenile were discovered that fall. This represents the first time two juveniles of *Megalonyx* have been found in direct association with an adult. Questions as to why and precisely when the animals perished together remain unanswered but preliminary pollen analysis suggests a post-glacial environment. A proposal is currently in preparation to fund analysis of stable isotope, DNA, pollen, plant macrofossil, stratigraphic and sedimentological parameters of the specimen and associated deposits. This site opens the door to research that has not been possible with earlier low density sites and should provide insight into sloth behavior, habitat, resource partition, family associations, and paleoenvironments during the Pleistocene/Holocene transition. Twenty University units are involved in the ongoing research.

Technical Session IX, Friday 11:15

SYNONYMY CONSEQUENCES OF DINOSAUR CRANIAL ONTOGENY

HORNER, John, Montana State University, Museum of the Rockies, Bozeman, MT, USA; GOODWIN, Mark, University of California, Berkeley, Museum of Paleontology, Berkeley, CA, USA; WOODWARD, Holly, Montana State University, Museum of the Rockies, Bozeman, MT, USA

The effect of cranial allometry during the growth of dinosaurs cannot be overlooked in distinguishing taxonomic differences from individual, ontogenetic, or sexual variation. This ontogenetic problem was recognized in tyrannosaurids from the Nemegt Formation of Mongolia by Rozhdestvensky in 1965, and quantitatively resolved in lambeosaurine hadrosaurs by Dodson in 1975. Subsequently, additional discoveries of various ontogenetic series, such as the recently described cranial series of *Triceratops*, confirm Dodson's findings that dinosaur juvenile morphology was retained for an extended period, until the skulls attained nearly adult proportions (based on average adult cranial dimensions). Several groups of dinosaurs hatched from their eggs, grew to approximately 3/4 adult size while retaining many juvenile cranial morphologies, and then underwent rapid cranial development of adult characteristics (hypothesized as display features). The severity of this cranial allometric transformation is well illustrated in our hypothesized ontogenetic stages of *Pachycephalosaurus*. Comparative cranial morphology supplemented by computerized tomography and osteohistology of the taxa *Dracorex*, *Stygmoloch* and *Pachycephalosaurus*, all from the Upper Cretaceous Hell Creek Formation of Montana, and adjacent states, support an alternative interpretation that these taxa form an ontogenetic series of the single taxon *Pachycephalosaurus*. Extreme ontogenies such as this have important consequences for many current phylogenetic, ecological, and evolutionary hypotheses relating to dinosaurs.

Poster Session I (Wednesday)

SEDIMENTOLOGICAL AND PALEOGEOGRAPHICAL CONTEXT OF THE MOJOKERTO HOMININ SITE, EAST JAVA

HUFFMAN, Frank, Univ Texas, Austin, TX, USA; BUFFLER, Richard, Univ Texas, Austin, TX, USA; KAPPELMAN, John, Univ Texas, Austin, TX, USA; RUEZ, Dennis, Auburn Univ, Auburn, AL, USA; ZEIM, Yadhi, Institut Teknologi Bandung, Bandung 40132, Indonesia

Although the Mojokerto hominin calvaria is one of the best preserved juvenile specimens of *Homo erectus*, uncertainties about the exact location of its discovery site and the circumstances surrounding its recovery in 1936 have served to limit its place in discussions of human evolution. In 2001 and 2002 we undertook a field relocation using archival photographs, original field maps, and other documentation, and determined that the discovery site lies above marine Mollusk Member II and within a fossiliferous pebbly sandstone in the upper Pucangan Formation. The sandstone is a fluvial deposit

with a broad channelized base, prominent cross-bed sets, and other bedding indications of mid-channel river bars, including preserved dune surfaces (mega-ripples) on the bars, and is conformably overlain by a 4-5 m paleosol developed on a mudstone. This bed is, in turn unconformably overlain by sandstones and mudstones containing burrows and marine mollusks representing the basal beds of Mollusk Member III. These lithofacies represent a variety of depositional environments ranging from flood plain to delta slope, and together preserve evidence for the localized progradation of a delta lobe into a shallow water marine embayment. Since present-day deltas in this region of Java can experience very rapid progradation rates, the Perning lobe may have been deposited in < 10<sup>4</sup> years and is not necessarily linked to a glacio-eustatic sea-level lowstand. Given that the Mojokerto hominin specimen appears to have experienced minimal transport, we conclude that *Homo erectus* inhabited seacoast environments. This paleoenvironmental reconstruction is in strong contrast to the more typical savanna-woodland settings of this species in Africa, and suggests that *Homo erectus* had a broad adaptive niche.

Poster Session III (Friday)

CURRENT STUDIES ON KOREAN DINOSAURS AND VERTEBRATE FOOTPRINTS

HUH, Min, Gwangju, Korea, South; PAIK, In Sung, Dept. of Environmental Science, Pukyong National University, Pusan, Korea, South; LOCKLEY, Martin, University of Colorado at Denver, Denver, CO, USA; KIM, Jeong-Yul, Korea National University of Education, Cheongwon, Korea, South; LIM, Jeong Deock, National Research Institute of Cultural Heritage, Daejeon, Korea, South

Abundant dinosaur fossils have been found from the Cretaceous non-marine deposits of South Korea. Over 27 dinosaur localities in Korea have been discovered in several basins. The track sites (dinosaur, pterosaur, bird) comprise the majority of fossil localities in Korea. Especially, the unique and distinctive dinosaur tracksites are known as one of the world's most important dinosaur track localities. Ornithopod tracks are the most common at most sites. The variety of morphotypes and sizes of the footprints and the calculated body sizes indicate that different dinosaurs with various gaits inhabited in these areas during the Cretaceous. The fossil sites also show diverse gaits with unusual walking patterns and postures in some tracks. Recent studies have revealed the presence of a small theropod tracks. Abundant dinosaur eggs and clutches occur in seven dinosaur egg localities. Mostly the eggs are top-broken and filled with surrounding sediments, while some eggs show geoid-fill. Four structural egg types are identified from the Korean dinosaur eggs. A new sauropod, *Pukyongosaurus milleniumi* excavated from Hasandong Formation, is also described. Very well preserved dinosaur bones excavated from Boseong dinosaur egg sites are assigned to a new hypsilophodontid dinosaur. The pterosaur tracks are the largest in the world. The longest pterosaur trackway yet known from any track site suggests that pterosaurs were competent terrestrial locomotors. The Uhangri pterosaur tracks assigned to a new ichnospecies, *Faenamichnus uhangriensis*. More bird track ichnogenera are also well known from Korea. We have 6 named bird ichnospecies. The Cretaceous bird track record is very significant, especially because it is dominated by the tracks of shorebird-like species not represented in the body fossil record. In the dinosaur localities of Korea, the other fossils including turtles, crocodiles, fishes, fossil woods, plants, trace fossils and microfossils have also been discovered. The occurrences of Korean dinosaurs provide an opportunity to study the palaeoecologic and palaeoenvironmental conditions of the sites of the Late Cretaceous dinosaurs.

Poster Session IV (Saturday)

AN ARTICULATED PES OF THE LATE TRIASSIC AETOSAUR *TYPOTHORAX* FROM NEW MEXICO AND THE TRACKMAKER OF *BRACHYCHIROTHERIUM*

HUNT, Adrian, New Mexico Museum of Natural History, Albuquerque, NM, USA; LUCAS, Spencer, New Mexico Museum of Natural History, Albuquerque, NM, USA; RINEHART, Larry, New Mexico Museum of Natural History, Albuquerque, NM, USA; HECKERT, Andrew, Department of Geology, Boone, NC, USA; SPIELMANN, Justin, New Mexico Museum of Natural History, Albuquerque, NM, USA

Upper Triassic aetosaurs are well known from osteoderms, but fossils of the manus and pes are rare, and articulated feet are very rare. A recently collected skeleton of the aetosaur *Typhorax coccinarum* from the early Revueltian interval of the Bull Canyon Formation (Chinle Group) in Quay County, New Mexico, includes the nearly complete right and left pes preserved in articulation. The pes of *T. coccinarum* is very similar to that of *Euparkeria* in overall proportions, metatarsal shape (note the large trapezoidal metatarsal and very small phalanges on digit V) and in having slender digits I-IV and all distal phalanges that are curved, laterally compressed claws. Digit lengths (in mm) and phalangeal formulas are: V = 100, 3; IV = 115, 4; III = 160, 4; II = 158, 3; I = 130, 2. Total pes length (including the ankle) = 215 mm, and total width across the distal digits = 180 mm. Total divarication of digits = 110 degrees, with interdigital divarications (in degrees) of V-IV = 40, IV-III = 20, III-II = 20 and II-I = 30. The manus is not preserved, but the width of the distal tibia and fibula is about double that of the distal radius and ulna (100 mm versus 56 mm), so we infer that the manus was approximately half the size of the pes. *Brachychirotherium* is a common Late Triassic ichnotaxon that has sometimes been inferred to be the track of an aetosaur. Many fea-

tures of the *Typothorax* pes are comparable to *Brachychirotherium*, including: (1) digit lengths III>II>IV>I>V (although IV appears longer than II in some tracks); (2) short digits with small claws; (3) digits I-IV approximately as wide as long; (4) digit V pad impression (imprint of proximal metatarsal) posterior or slightly lateral to digit IV; (5) manus about half the size of pes; and (6) size of *Typothorax* pes within range of *Brachychirotherium* tracks in general, and upper Chinle tracks in particular. In addition, *Brachychirotherium* tracks are restricted to the Late Triassic, which corresponds to the distribution of aetosaurs, and the tracks are abundant in many Late Triassic ichnofaunas, which suggests that they pertain to a herbivore. We conclude that *Brachychirotherium* tracks were made by aetosaurs.

Evolutionary History of Bats Symposium, Thursday 10:45  
EVOLUTIONARY TRENDS IN THE CHIROPTERAN BRAIN: A COMPARATIVE ANALYSIS OF BAT SENSORY ECOLOGY  
HUTCHEON, James, Georgia Southern University, Statesboro, GA, USA

Recent debates in bat systematics surrounding the precise placement of the Pteropodidae with respect to other bat families have given rise to new questions regarding patterns in the evolution of echolocation, and to a lesser extent, other bat sensory capabilities. The implications of the recently proposed groups Pteropodiformes and Vespertilioniformes are that the ability to echolocate was either lost in the Pteropodidae or was convergently evolved in the Rhinolophoidea and the Vespertilioniformes. To address this question I analyzed volumes of the inferior and superior colliculi, the hippocampus, the olfactory bulbs, and the auditory nuclei of 139 bat species using the PDAP set of programs. I conducted these analyses using both the molecular framework (Vespertilioniformes & Pteropodiformes) and the traditional framework (Megachiroptera and Microchiroptera). In both cases results very strongly suggest that echolocation is an ancient trait of the chiroptera and thus forms another line of evidence that the Pteropodidae might have lost this ability. The results for other capabilities (olfaction, vision, spatial memory) suggest these characteristics are more highly labile and might be subject to selection, rather than phylogenetic constraint.

Technical Session XIII, Friday 1:30  
A COMPARISON AND TEST OF THE VALIDITY OF RANGE-OF-MOTION STUDIES ON FOSSIL ARCHOSAUR FORELIMBS USING WHOLE AND SKELETONIZED EXTANT ARCHOSAURS  
HUTSON, Joel, Northern Illinois University, Mundelein, IL, USA

Recent functional studies have presented degree-of-motion data for dinosaur forelimbs based on manipulations of articulated fossil limb elements. Using these data, researchers have inferred limb orientations, postures, gaits, ecological functions, and even phylogenetic trends within archosaur clades. Some of these studies have defended their conclusions with extant phylogenetic bracket evidence, but have failed to address the main source of concern surrounding these studies: how does the range of motion of a limb change after soft tissue is lost? This important point has been difficult to test because of an obvious lack of living nonavian dinosaurs, but this does not prevent it from being indirectly tested on extant archosaurs. Here this question was investigated by obtaining range-of-motion data from fresh *Struthio camelus* and *Alligator mississippiensis* forelimbs with intact soft tissue. These specimens were subsequently dissected and examined for soft tissue effects on joint mobility, then skeletonized so that their ranges of motion with bone could be compared to those with soft tissue. The data obtained resulted in the *Struthio* having close matches for four out of five joint measurements, while the *Alligator* only matched two out of five. The overall similarity of joint mobility to previously published data from fossil taxa gave credibility to undertaking range-of-motion studies and for using these taxa as the extant phylogenetic bracket in functional research. The hypothesis that the articular surfaces of bone alone provide a general approximation of mobility was supported in all cases, but these results did not support the hypothesis that articular cartilage markedly adds to or restricts range of motion. It was also discovered that the empirical methods in previous studies lacked the clarity and details necessary for them to be repeated precisely. Consequently improvements will be suggested to standardize and simplify the methodology of these studies.

Technical Session II, Wednesday 11:15  
NEW HISTOLOGICAL INVESTIGATIONS OF HYPERELONGATE NEURAL SPINES IN EUPELYCOSAURS (AMNIOTA: SYNAPSIDA) AND THE AFFINITIES OF *LUPEOSAURUS KAYI*  
HUTTENLOCKER, Adam, California State University, San Bernardino, San Bernardino, CA, USA; REGA, Elizabeth, Western University of Health Sciences, Pomona, CA, USA; SUMIDA, Stuart, California State University, San Bernardino, San Bernardino, CA, USA

Edaphosauridae and Sphenacodontidae comprise two lineages of early pelycosaurian-grade synapsids that are believed to have independently acquired hyperelongate neural spines supporting a dorsal sail. Although the function of the dorsal sail in these taxa has been the subject of much speculation, recent analyses of neural spine histology in the sphenacodontid genus *Dimetrodon* have helped to elucidate further aspects of its

growth, mechanics, and responses to injury. New observations from additional specimens of *Dimetrodon*, *Sphenacodon*, and *Edaphosaurus* present familial and genus-level distinctions between these taxa with respect to neural spine growth and mechanics. Comparisons with microanatomical features of short-spined relatives also provide a means for distinguishing between sail-backed and sail-less species because their histological organization dictates precisely where the spine emanates above the dorsal extent of the epaxial musculature. The new findings also contrast with earlier interpretations of the internal structure of the spines of *Edaphosaurus* (with particular reference to the extent of the central "canal" and its hypothesized function). New data from the enigmatic eupelycosaur *Lupeosaurus kayi* also show striking similarities to the genus *Edaphosaurus*. Sections of neural spines referred to the family Edaphosauridae demonstrate a lack of a double-cylinder cross-sectional morphology in distal portions of spines (in contrast to most species of *Dimetrodon*), a thickened cortex with few peripheral vascular channels, and the presence of a central cavity, all of which appear to be shared in *Lupeosaurus*. A preliminary cladistic analysis, the first to incorporate the genus *Lupeosaurus* based on postcranial characters, supports a placement of *Lupeosaurus* within Edaphosauridae (corroborating the osteohistological features discussed above and tentative assignments by previous authors). In addition to providing evidence for soft-tissue attachments, growth dynamics and mechanics, neural spine characters at gross and microanatomical scales can provide useful information for resolving the phylogenetic relationships of these early amniotes at familial and sub-familial levels, even in the absence of large amounts of skeletal material.

Poster Session III (Friday)  
OCCURRENCE OF A HADROSAURID CRANIAL MATEIAL FROM THE UPPER CRETACEOUS MIFUNE GROUP IN KYUSHU, JAPAN  
IKEGAMI, Naoki, Kyushu University / Mifune Dinosaur Museum, Kamimashiki-gun, Kumamoto Prefecture, Japan; TOMIDA, Yukimitsu, National Museum of Nature and Science, Shinjuku, Tokyo, Japan

A partial skull with braincase elements of a hadrosaurid ornithomorph was discovered from the "Upper formation" of the Mifune Group (Coniacian-Santonian). This is the first discovery of a hadrosaurid braincase from Japan, and this discovery provides us with a better understanding of poorly known early Late Cretaceous hadrosaurids. These braincase, as well as some postcranial elements, were found from the coarse sandstone bed, which is overlain by a reddish mudstone of floodplain deposits. These are considered to be fluvial complex deposits. Several hadrosaurid teeth and a fragment of maxilla also have been found from other localities of the Mifune Group. The fission-track age of 83.6 +/- 3.1Ma was obtained recently from the zircon crystals extracted from a tuff bed in the "Upper formation" of the Mifune Group. The newly discovered cranial material consists of the supraoccipital, exoccipital, basioccipital, prootic, basisphenoid, parasphenoid, laterosphenoid, squamosal, parietal, and postorbital. Although the parietal is incomplete, it is not elongated and is estimated to have a low ratio of its total length and minimal width (< 2) as in lambeosaurines. The squamosal has an elevated lateral wall above the cotylus, and shows an affinity with derived lambeosaurines from the Campanian-Maastrichtian of North America and Asia. This specimen also displays a short caudal ramus of the postorbital and a mediolaterally wide basioccipital, characters also observed in *Jaxartosaurus aralensis*, a basal lambeosaurine from the Santonian of Kazakhstan. The only lambeosaurine from Japan is known from the Maastrichtian Kita-Ama Formation of Hyogo Prefecture. Therefore, this occurrence indicates the possible maximum temporal range of the existence of lambeosaurines in Japan from Coniacian to early Maastrichtian, also suggests the possibility of an early appearance of a lambeosaurine hadrosaurid in the Far East of Asia.

Student Poster Session (Thursday)  
ONTOGENETIC AND INTRACOLUMNAR VARIATION IN COMPLEXITY OF THE NEUROCENTRAL SUTURE IN DWARF AND LARGE CROCODYLIAN SPECIES  
IKEJIRI, Takehito, The University of Michigan, Ann Arbor, MI, USA

Fusion of vertebral elements is an important ontogenetic event in reptiles that is often used as an indicator of relative maturity. However, without understanding of the factors that influence fusion timing, the utility of this criterion is diminished. I examined fusion timing and suture complexity in the extant crocodiles *Paleosuchus palpebrosus* and *Alligator mississippiensis* that differ in body size (smallest vs. very large species), habitats (forested freshwater rivers vs. open marshes/swamps in freshwater and saline water), and evolutionary history (diverged in the Jurassic or Cretaceous). Qualitative comparisons of these species show differences in suture morphology that may be attributed intracolumnar, ontogenetic and/or phylogenetic factors. A Length Ratio method (ratio of actual-to-straight distance) was used to quantify suture complexity. Suture complexity in the presacral vertebrae increases through ontogeny in both species. Fully-grown individuals of both species commonly show low complexity in the sacral and caudal vertebrae, but high complexity in the presacral vertebrae, especially anterior dorsal vertebrae. In adults, *A. mississippiensis* has an interdigitated articulation (finely zig-zagged suture); in contrast, *P. palpebrosus* exhibits an interlocking articulation (a smooth line with a strong dorsoventral curvature). The results suggest that fusion seems to occur first in vertebrae that have lower complexity, but sutures rarely disappear com-

pletely in the presacral vertebrae that have higher complexity. Comparisons of intracolumnar and ontogenetic variation using this method are potentially useful for various groups of extinct and extant tetrapods, which may provide additional information for understanding their growth and evolution.

Technical Session IV, Wednesday 2:15

FORMATION OF MARINE BONEBEDS: INSIGHTS FROM THE MIDDLE MIOCENE SHARKTOOTH HILL BONEBED OF CALIFORNIA

IRMIS, Randall, University of California, Berkeley, CA, USA; PYENSON, Nicholas, University of California, Berkeley, CA, USA; LIPPS, Jere, University of California, Berkeley, CA, USA

Marine bonebeds commonly concentrate high abundances of marine vertebrate specimens in thin stratigraphic sequences. Despite many studies of these accumulations, comparatively few data are available to infer origin and mode of accumulation. Most bonebeds are formed from disarticulated remains that are laterally restricted in extent; these examples are generally thought to represent environmentally condensed and transported assemblages. In contrast, the Middle Miocene (Barstovian) Sharktooth Hill (STH) bonebed, northeast of Bakersfield, California, has a geographic extent of at least 100 km<sup>2</sup>, and comprises millions of vertebrate specimens. Until now, no studies have investigated how such atypically large bonebeds form. The STH bonebed ranges in thickness from 10-50 cm, and contains the disarticulated remains of elasmobranchs, osteichthyans, turtles, birds, land mammals, pinnipeds, and diverse cetaceans preserved in a matrix of silt to very fine sand. The bonebed directly overlies similar non-fossiliferous sediment in some areas and a highly bioturbated clay layer in other areas. Overlying non-biogenic sediments are identical to those in the bonebed, and they often preserve associated and/or articulated vertebrate remains. Vertebrate specimens from the bonebed are often lightly abraded and/or broken, though much of this breakage is probably post-burial. Ferro-manganese encrustations and nodules are also common. Compositionally, the bonebed is dominated by elasmobranch teeth and cetacean ribs and vertebrae. Evidence of predation and/or scavenging is extremely rare. We suggest that after a depositional hiatus, the STH bonebed accumulated over thousands of years on a sea-floor surface with little or no net sedimentation. Most bones were probably not transported far, though rare land mammal specimens imply some longer transport. The presence of occasional, but articulated vertebrates above the bonebed suggests that sedimentation rates gradually increased, ceasing bonebed formation. These data suggest that condensation beds may be a common mode of bonebed accumulation, regardless of spatial scale.

Poster Session IV (Saturday)

FOOTPRINT EVIDENCE OF EXTREME OUTWARD ROTATION OF THE MANUS OF SAUROPOD DINOSAUR FROM MIDDLE JURASSIC OF WESTERN MOROCCO

ISHIGAKI, Shinobu, Hayashibara Museum of Natural Sciences, Okayama, Japan

Six sauropod trackways indicating an extraordinary gait with extreme outward rotation of manus prints were discovered from two Middle Jurassic tracksites near the village of Imin-Tanoute, Western Morocco. Though the site was briefly described and figured, we carefully reinvestigated the data, and present a new interpretation of the posture of trackmakers here. Footprints are exposed on road-cut cliffs. At Site 1, the exposed, footprint-bearing bedding surface is 4 to 5 m high and 46 m wide, and is red or gray-white fine sandstone 15 cm in thickness. At Site 2 the exposed bedding plane is only 5 m high and 1.5 m wide, and is gray-white fine sandstone 50 cm in thickness. Both Sites are interbedded between red, massive siltstone. At Site 1, more than 500 footprints are observed. Most of them are round, oval or half moon shaped, and 20 to 70 cm in length. Five trackways are recognized among them. At Site 2, 8 footprints forming one trackway are observed. The characteristics of the footprints and trackways indicate that the trackmakers of those prints were sauropod dinosaurs. The characteristics of those 6 trackways are as follows. Pes print: Oval shape with some digit end impressions rotated slightly outward; 50 - 70 cm in length; the gauge is rather narrow, with the pace angulation of the narrowest gauge trackway 143 degrees. Manus print: Half moon shape with some digit end impressions, rotated strongly outward; in the most extreme case, the average rotation angle from the trackway axis is 101 degrees. The average values of the outward rotation angle of the manus are less than 10 degrees in Glen Rose, and 20 to 30 degrees in most sauropod tracksites. The manus of *Opisthocoelicaudia skarzynskii* was reconstructed with an outward rotation of almost 90 degrees. This Moroccan discovery is new evidence that the sauropod with greater outward rotation once existed.

Student Poster Session (Thursday)

PETALODONT CHONDRICHTHYANS FROM THE PENNSYLVANIAN-PERMIAN OF SOUTHERN NEW MEXICO

IVANOV, Alexander, St. Petersburg University, St. Petersburg, Russia; LUCAS, Spencer, New Mexico Museum of Natural History, Albuquerque, NM, USA; RINEHART, Larry, New Mexico Museum of Natural History, Albuquerque, NM, USA; SPIELMANN, Justin, New Mexico Museum of Natural History, Albuquerque, NM, USA

Petalodontiform chondrichthyans are very common in the marine Carboniferous and Lower Permian deposits of many regions, especially the USA. They are known mainly from isolated teeth, except for *Janassa*, *Belantsea*, *Netsepoye* and *Siksika*. Two teeth of *Petalodus* have been recovered in the Upper Pennsylvanian (Missourian: NMMNH locality 6939) and Lower Permian (Wolfcampian: NMMNH locality 6938) strata of the Horquilla Formation in the Big Hatchet Mountains, Hidalgo County, southwestern New Mexico. The complete tooth from locality 6939 has a slightly asymmetrical crown and base. The base is considerably curved labially and thickened in the distal part. The Permian tooth of *Petalodus* is symmetrical, with a very well-preserved crown and an incomplete, flattened base. Both teeth are assigned to a group of species that includes *P. ohioensis* Safford and *P. acuminatus*. The teeth of *P. acuminatus* differ from those of *P. ohioensis* in the wide, lingually-ridged band and in smaller tooth size and equally short crown and base. However, the lingual band of *P. ohioensis* teeth described by various authors from different localities displays a large variation in width. Such differences could be explained by the position of the teeth in the heterodontous dentition of one *Petalodus* species. Probably, a detailed redescription of Safford and Agassiz's type collections will allow recognition of or synonymy of those species. The crown preservation of the Permian tooth from the Big Hatchet Mountains allows us to suggest a new reconstruction of the *Petalodus* dentition. According to some reconstructions, the teeth in the *Petalodus* jaws were arranged in a checkerboard pattern and have the contacts on the lateral edges of the crowns. The crown top in that case could be not used in the cutting of prey. But, the well-preserved crown of the Permian tooth bears a larger trace of abrasion on the top than traces on the lateral edges. Probably, the *Petalodus* dentition shows tooth occlusion in which the crown of the tooth from one jaw overlaps the tooth crown from the opposite jaw.

Technical Session XVII, Saturday 2:30

UNCOVERING SAURISCHIAN EGGS: POTENTIAL RATES OF WATER VAPOR CONDUCTANCE IN SAUROPOD AND THEROPOD EGGS

JACKSON, Frankie, Montana State University, Bozeman, MT, USA; VARRICCHIO, David, Montana State University, Bozeman, MT, USA; JACKSON, Robert, Montana State University, Barcelona, MT, Spain; VILA, Bernat, Consorci Ruta Minera, Barcelona, Spain

The incubation environment of modern eggs is closely linked to eggshell water vapor conductance rates ( $G_{H_2O}$ ). Reptiles incubate eggs in high humidity/ low oxygen substrates and the eggs exhibit high  $G_{H_2O}$ . Avian eggs, incubated in open nests have greater risk of desiccation and display low  $G_{H_2O}$ . Studies of European *Megaloolithus* eggs typically report less than 15 eggs per clutch, and a high eggshell  $G_{H_2O}$  that suggests egg burial. Based on  $G_{H_2O}$  and embryonic oxygen requirements (modeled on extant reptile eggs), workers proposed a 13-egg limit for buried sauropod clutches. In contrast, titanosaur clutches (*Megaloolithus patagonicus*) from the Auca Mahuevo locality in Argentina are larger (20 to 40 eggs), and sedimentological data indicate the eggs were not buried. The eggs, therefore, should show significantly lower  $G_{H_2O}$  than those of a buried clutch. To test this hypothesis, we calculated  $G_{H_2O}$  on the first egg identified by titanosaur embryonic remains (note that  $G_{H_2O}$  represents a "potential" value, due to many unknown variables); we then compared this value to *M. siruguei*, a European egg type often assigned to titanosaurs. The 14 cm Auca Mahuevo egg has a thinner eggshell but 47 times fewer pores than the 22 cm *M. siruguei* egg. The  $G_{H_2O}$  values of *M. siruguei* and the titanosaur egg are 3979 and 371 mg<sub>H<sub>2</sub>O</sub>/(dayTorr) respectively; these rates are 10 and 2 times greater than avian eggs of comparable size. The European egg  $G_{H_2O}$  exceeds that of the Argentine egg by an order of magnitude, thereby supporting egg burial in *M. siruguei*. The Argentine titanosaur egg closely approximates the  $G_{H_2O}$  of *Troodon* and oviraptorid eggs, previously calculated as equal to or two times greater than avian eggs of similar size, respectively. Higher embryonic growth rates (compared to modern reptiles) and large clutch mass may have required incubation in a more open environment, where water conservation represented a more critical factor than in a buried clutch. Contrary to recent studies, site taphonomy and  $G_{H_2O}$  rates of the three saurischian eggs indicate that not all dinosaurs completely buried eggs in a substrate.



Poster Session II (Thursday)

A DISSOLVABLE SUPPORT JACKET FOR PREPARATION OF THIN ARTHRODIRE AND SHARK SPECIMENS FROM THE UPPER DEVONIAN CLEVELAND AND BEDFORD SHALES UTILIZING CARBOWAX 4000

JACKSON, Gary, C, USA

Complete preparation of large arthrodire and shark specimens that are thin and delicate, and entirely embedded in a hard, or mineralized matrix can be difficult; particularly so if your lab is not set up for acid prep, or the specimen is not compatible to acid reduction, thus requiring mechanical preparation. This is where Carbowax 4000 can be a great aid. The use of Carbowax to support fossils for preparation is not a new idea; work having been done on microvertebrates. The techniques employed here are somewhat similar, but on a larger scale. One side of the specimen is completely prepared, leaving a backing of matrix. The prepared surface should then be treated with thin glue as a sealant, and fillers applied, as the situation dictates. A pseudo mold set up is constructed around the specimen, and Carbowax 4000 applied directly to the prepared and sealed surface. The size and thickness of the jacket will vary depending on the fossil. After the wax cures, the specimen can be flipped and the remaining matrix removed. An added advantage of a Carbowax 4000 jacket is that after preparation is completed, the wax can be reclaimed by dissolution in a warm water bath and subsequent dehydration. Setting up the support jacket is time consuming, but if properly constructed, the rewards are worth it. It will allow you to work with confidence, with little fear that the fossil will fracture. If fracturing does occur, the jacket should hold the pieces securely until glue can be applied. A Carbowax 4000 dissolvable jacket should permit complete or near complete preparation of most thin fossil specimens. Detailed anatomy can be revealed that would otherwise be impossible to expose via mechanical preparation alone.

Technical Session II, Wednesday 11:45

ELUCIDATION OF DICYNODONT CRANIAL FUNCTION USING FINITE ELEMENT ANALYSIS

JASINOSKI, Sandra, University of Bristol, Bristol, United Kingdom; RAYFIELD, Emily, University of Bristol, Bristol, United Kingdom; CHINSAMY, Anusuya, University of Cape Town, Cape Town, South Africa

Differences in cranial morphology across Dicynodontia have been correlated with changes in masticatory function, and hence, dietary preference. Although the derived masticatory apparatus of dicynodonts allowed propaliny, it has been previously hypothesized that *Lystrosaurus* utilised powerful orthal jaw movements to process fibrous vegetation. Cranial specialisations of *Lystrosaurus*, such as an anteroposteriorly shortened skull and a patent premaxilla-nasal suture, have been hypothesized to have increased the efficiency of its masticatory system compared with generalised Permian dicynodonts. This study examines the biomechanical significance of cranial form of *Lystrosaurus* and also *Oudenodon*, a generalised dicynodont, using Finite Element Analysis (FEA). Two types of bite were modeled using FEA: 1) a shearing beam bite along the maxillary rim, and 2) a propalinal grinding bite along the palate. Bite forces were estimated using the dry skull method, and the averaged bite force was applied to both taxa allowing direct comparison of strain magnitude and distribution. During a beam bite, higher compressive and tensile strains occur globally throughout the *Oudenodon* skull, whereas the strain magnitude and distribution is smaller in *Lystrosaurus*. This suggests that the *Lystrosaurus* skull could have tolerated a higher shearing bite force that is necessary to masticate fibrous plants. Similarly, less strain accumulated within the *Lystrosaurus* skull during a propalinal bite. Whether the patent premaxilla-nasal suture of *Lystrosaurus* acted as a shock absorber to further decrease strain in the snout will be tested using a new FE model with a sutural break in that region.

Poster Session IV (Saturday)

ARVICOLINE RODENTS AND CHRONOLOGIC COMPLEXITY AT SMITH CREEK CAVE, NEVADA

JASS, Christopher, University of Texas at Austin, Austin, TX, USA

Examination of arvicoline rodent fossils from Smith Creek Cave, Nevada, resulted in the identification of two previously unreported taxa including *Microtus meadensis* and *M. paroperarius*. Also identified were 4-triangle morphotypes of *Lemmiscus curtatus*. Smith Creek Cave is only the seventh known locality to preserve a 4-triangle morphotype of *L. curtatus*. The presence of *M. meadensis* and *M. paroperarius* is particularly significant given the currently known chronologic distribution of these taxa. Age estimates based strictly on known chronologic distributions would place one of the lowest sedimentary horizons in Smith Creek Cave (the Reddish/Pink Silt Zone) somewhere between 820 Ka and 252 ± 30 Ka. This is in stark contrast to a previously published radiocarbon age for the same horizon (28,650 ± 760 <sup>14</sup>C yr BP). In either case, the taxonomic character of the arvicoline rodent fauna from Smith Creek Cave suggests a more complicated history for the site than previously recognized. The chronologic quandary between age estimates serves to re-emphasize the complex nature of paleontological and/or archaeological accumulations in cave deposits.

Poster Session I (Wednesday)

MARINE REPTILE HORIZONS IN THE ANISIAN (MIDDLE TRIASSIC) OF GUIZHOU, CHINA AND THEIR IMPLICATION TO MARINE REPTILE EVOLUTION AFTER END-PERMIAN EXTINCTION

JIANG, Da-yong, Peking University, Beijing, China; MOTANI, Ryosuke, University of California, Davis, Davis, CA, USA; HAO, Wei-cheng, Peking University, Beijing, China; TINTORI, Andrea, Università degli Studi di Milano, Milan, Italy; RIEPPEL, Olivier, Field Museum of Natural History, Chicago, IL, USA

Early Pelsonian (Anisian, Middle Triassic) beds of Xinmin District, Panxian County, Guizhou Province, China have yielded many new marine reptile species since 1999. However, the exact horizons of some of these marine reptiles remained ambiguous. Through new fieldwork during the summer of 2006, we established a detailed, small-scale correlation among four major fossil quarries in the area. Three different marine reptile horizons are identified therein, namely Lower, Middle and Upper Reptile Horizons (LRH, MRH, and URH, respectively). The only marine reptile species that are found throughout these reptile horizons is the ichthyosaur *Mixosaurus panxianensis*, whereas the only species that is known from outside of these horizons is *Dinocephalosaurus*; all others are known only from one of the three horizons. URH is well laminated and yields shallow water species that are not very large (less than 1 meter in total length, *M. panxianensis* being the largest). The largest species in the area, including *Qianosuchus*, are known from MRH. LRH is characterized by the occurrence of three species that are interpreted as shell-crushers. Also, LRH is the only horizon in the area where shelled invertebrates (specifically bivalves) co-occur with reptile skeletons. A global comparison shows that shell-crushers were abundant among marine reptiles in the Middle Triassic but became extinct before the Jurassic. The rise and demise of marine reptiles after the end-Permian extinction is correlated with not only the recovery of fishes and prey invertebrates, but also the transgression/regression cycles. Panxian fauna shows strong western Tethyan paleobiogeographic affiliation in Middle Triassic. Located about 100 km northwest from Nanpanjiang Basin, it may indicate that the ocean was open toward this direction into the East Tethys. This is in contrast to what is suggested by another famous Triassic marine reptile fossil site in Guanling, representing the early Carnian. By this time, the ocean in southwestern China opened toward southeast, through the Nanpanjiang Basin to Panthalassa, with the South China Block being sutured to the North China Block.

Poster Session I (Wednesday)

A PRELIMINARY REPORT ON A NEW PLEISTOCENE FAUNAL SITE FROM NORTHEASTERN OAXACA, SOUTHERN MEXICO

JIMENEZ-HIDALGO, Eduardo, Inst. Recursos, Universidad del Mar, Campus Puerto Escondido, Puerto Escondido, Mexico; GUERRERO-ARENAS, Rosalia, Instituto de Recursos, Universidad del Mar, Campus Puerto Escondido, Puerto Escondido, Mexico; SANTIAGO-ROMERO, Hector, Inst. Recursos, Universidad del Mar, Campus Puerto Escondido, Puerto Escondido, Mexico; CEBALLOS-GUTIERREZ, Lorena, Inst. Recursos, Universidad del Mar, Campus Puerto Escondido, Puerto Escondido, Mexico

Well-studied Pleistocene terrestrial vertebrate faunas from Mexico include El Golfo, Rancho La Brisa and Terapa in Sonora; Chapala in Jalisco, El Cedazo in Aguascalientes; San Josecito Cave in Nuevo León, those from the Valley of Mexico and the Valley of Puebla-Tlaxcala. Regarding Oaxaca, reported Pleistocene localities represent 2.58 % of the total from Mexico. Since the 1960's several localities with Pleistocene mammals have been reported in the Mixteca oaxaqueña, but at present none of them have been systematically studied. Invited by a resident of a village in the Coixtlahuaca District, we visited the brook where he discovered pelvic fragments of *Mammuthus* sp. During this visit we discovered additional fossil material in the surroundings, such as freshwater gastropods, a *Mammuthus* sp. upper molar, a distal fragment of a right scapula of cf. *Mammuthus* sp., an articulated pelvis of cf. *Cuvieronius* sp., a *Camelops* sp. lower molar, which is the first record of a Pleistocene camelid in southern Mexico, and a *Bison* sp. horn core, which indicates a Rancholabrean mammal age for the associated fauna. The fossil material was recovered from a 1.7 m width basal bed of sand and gravel. Screenwashing of the sediments contained in the jackets allowed us to recover additional freshwater mollusks, rodent teeth fragments and unran vertebral fragments. This Mixteca site is rich in Pleistocene vertebrates, whose further study will allow a better understanding of the species richness and structure of the Pleistocene communities in southern North America, specially south of the Transmexican Volcanic Belt; it also will allow us to establish the habitat (grassland, savanna, forest) where these mammals lived, and to infer the paleoclimate of this area during the Late Pleistocene.

Student Poster Session (Thursday)

MESONYCHIDS FROM THE EARLY PALEOGENE OF ERLIAN BASIN, CHINA

JIN, Xun, Beijing, China

Fieldwork during the last a few years in the Erlian Basin, Inner Mongolia, China, has clarified several stratigraphic problems and collected numerous fossil mammals, including eighteen specimens of mesonychids from major fossil levels in the Nomogen,

Arshanto and Irdin Manha Formations. Seven specimens were collected from both the Nomogen and Arshanto Formations, respectively, and four were recovered from the Irdin Manha Formation. Those fossils from two faunas of the Nomogen Formation (Cashatan and Bumbanian) were identified as *Dissacus*. One exception from the Bumbanian fauna is an astragalus that, based on its relatively larger size, could belong to a mesonychid. Of the seven specimens from the Arshanto Formation, two are *Dissacus* and the rest belongs to *Mesonyx* and/or *Harpagolestes*. The Irdin Manha mesonychids are relatively larger species, such as *Mongolonyx* or *Mongolestes*, but lack species of *Dissacus*. Specimens of *Dissacus* and *Harpagolestes* account for two thirds of the total eighteen specimens and co-exist only in the Arshanto Formation. One Arshanto specimen may represent a new, smallest species of *Harpagolestes*. The specimen is a fragmentary lower jaw with p4 and m1, and the teeth are smaller and relatively more slender and labiolingually compressed than those of other species of *Harpagolestes*, including *H. orientalis*. The dentary is uniquely deep, about twice the height of the tooth crown. Another isolated specimen of a left P2 exhibits roots with an inflated distal end, which may be a pathological condition of the tooth. Mesonychids, as predators of these herbivore-dominant faunas, are expected to be sensitive to environmental changes during the Paleocene-Eocene transition. New specimens of mesonychids were mainly found from the Nomogen and Arshanto Formations, which suggested a diverse mesonychid group during the Paleocene-Eocene transition, but a decline in the group while persisting to the Irdin Manhan Formation.

Technical Session XVII, Saturday 3:30

THE FIRST <sup>40</sup>AR/<sup>39</sup>AR AGE DATE FROM THE WAHWEAP FORMATION (LATE CRETACEOUS OF UTAH): IMPLICATIONS FOR FAUNAL CORRELATIONS

JINNAH, Zubair, University of the Witwatersrand, Johannesburg, South Africa; DEINO, Alan, Berkeley Geochronology Center, Berkeley, CA, USA; GATES, Terry, Utah Museum of Natural History, Salt Lake City, UT, USA; ROBERTS, Eric, University of the Witwatersrand, Johannesburg, South Africa

The Upper Cretaceous Wahweap Formation (Fm) of southern Utah consists of a series of fossil bearing, fluvial and floodplain sandstones and mudstones that were deposited within a low-relief coastal- to alluvial-plain setting in the central Western Interior Basin (WIB). The formation has recently produced a range of new dinosaurs and other vertebrate taxa; however, it is best known as an important locality for preserving otherwise rare, pre-Judithian (North American Land Mammal Age [NALMA]) mammals. In order to place better temporal constraints on this fauna, the first radiometric dating of the Wahweap Fm was performed via laser-fusion, single crystal <sup>40</sup>Ar/<sup>39</sup>Ar dating of sanidine phenocrysts from a bentonite located 54 m above the base of the ~400 m-thick formation. The analysis yields an age of 80.1 ± 0.3 Ma, which, when combined with a previously dated ash bed (~75.9 Ma) from the base of the overlying Kaiparowits Fm, permits calculation of undecomposed sediment accumulation rates. A rate of ~8.2 cm/ka was determined, indicating that the Wahweap Fm accumulated between ~80.8 and 76.1 Ma. Wahweap mammals have traditionally been correlated with the mammalian fauna of the type-Aquilan NALMA in the Milk River Fm of southern Alberta. However, this study demonstrates that the Wahweap Fm is considerably younger than the Milk River Fm (84.5-83.5 Ma), and hence, younger than the Aquilan NALMA. Further, this study indicates that the Wahweap Fm more appropriately correlates with well-constrained Judith River Fm localities (Montana), strongly suggesting that Wahweap faunas are Judithian in age rather than Aquilan, despite the apparent faunal similarities with the latter. The Wahweap Fm also correlates to other important Judithian sequences including portions of the Two Medicine Fm in Montana, as well as the Foremost and Oldman formations of Alberta. In addition to having implications for land mammal ages, radiometric age dates from the Wahweap Fm, will also play an important role in correlation of the newly discovered dinosaur taxa within coeval formations across the WIB.

Poster Session I (Wednesday)

ROLAND SPRINGS RANCH LOCALITY 1 — A PLEISTOCENE LOCALITY ON THE SOUTHERN PLAINS OF TEXAS

JOHNSON, Eileen, Texas Tech University, Lubbock, TX, USA; ARROYO-CABRALES, Joaquin, Inah, Mexico City, D.F., Mexico; WHYNOTT, Amy, Museum of Texas Tech University, Lubbock, TX, USA; MORETTI, John, Museum of Texas Tech University, Lubbock, TX, USA

Roland Springs Ranch (RSR) Locality 1 is situated on Turtle Creek that is an ephemeral tributary to the Clear Fork of the Brazos River. Located on the Roland Springs Ranch, east of Snyder (Texas), the locality is Pleistocene in age and has yielded a sizeable collection representing both large and very small animals from all classes. The modern drainage has cut through over 1.9m (6.2ft) of loamy sand deposit to expose the bone-bearing unit. A fluctuating water table is indicated at some time after the bones were deposited. Field explorations, started in 2005, are ongoing. After mechanical removal of overburden, a block of 9 1x1m units are being hand-excavated by trowel in 10cm levels within a defined stratigraphic unit, with all materials found in place mapped, photographed, and recorded. All sediments from each 10cm level in 2.5cm increments are water-processed through 1/16" mesh screens on site for recovery of

microvertebrates and other biological materials. Results to date are at least 44 known taxa. Preliminary taphonomic observations note that some of the remains may have gone through a predator's digestive system. Spatial analysis has yet to be addressed. Identifications are preliminary, based on comparison with type and other identified fossils and modern species, preliminary measurements, and literature descriptions. Most notable are the remains of *Geochelone* (giant land tortoise), *Nannipus peninsulatus* (gazelle-horse), *Paramylodon* (ground sloth), *Buissnictis* (small skunk), *Canis lepophagus* (Johnston's coyote), *Miracinonyx trumani* (American cheetah), *Capromeryx cf. arizonensis* (Skinner's pronghorn), and a specimen of *Neotoma* (woodrat) with an S-pattern m3. This *Neotoma* is neither the modern *Hodomys allenii* nor the mid-Irvingtonian *N. fyl-lanensis*. Taken together, these animals indicate a potential transitional Blancan to Irvingtonian fauna of probable early Pleistocene age.

Poster Session I (Wednesday)

RAPID MINERALIZATION OF COPROLITES

JOHNSON, Elizabeth, Montana State University, Eagle, ID, USA; VARRICCHIO, David, Montana State University, Bozeman, MT, USA

Rapid mineralization is a key process involved in soft tissue fossilization. Coprolites are typically found in phosphate rich horizons and are commonly phosphatized. The recent discovery of a coprolite with undigested muscle proteins suggests that mineralization must occur rapidly to preserve these structures. Other workers have undertaken unrelated experiments involving the mineralization of shrimp have shown that soft tissues can mineralize within weeks under specific conditions. A six-week experiment involved placing wolf feces in salt and fresh water environments of varying phosphate, carbonate, bacteria and oxygen concentrations. Dissolved oxygen, salinity, conductivity, total dissolved solids, pH, water clarity, presence and/or absence of bio-films, and visual approximation of feces consolidation were measured during the experiment. At the termination of the experiment, wolf feces resembled the average coprolite morphology with a hard, pitted matrix. Analytical techniques suggest that limited mineralization occurred on connective tissues of elongate bone fragments. There is a substantial preservation bias towards preservation of bone-bearing feces. Bone fragments could be a source of added phosphate causing a bias towards coprolite phosphatization in the fossil record.

Poster Session III (Friday)

PALEOCLIMATE RECONSTRUCTION THROUGH STABLE ISOTOPE ANALYSIS OF SOIL CARBONATE NODULES FROM THE SOUTHWESTERN WYOMING WASHAKIE BASIN

JOHNSON, Michael, University of Wyoming, Laramie, WY, USA; CLEMENTZ, Mark, University of Wyoming, Laramie, WY, USA

The Eocene began with a peak in global temperature 55 Ma with temperatures remaining high until 50 Ma. This Initial Eocene Thermal Maximum was then followed by a gradual cooling trend. The temperature spike resulted in warm humid climates across North America in the early Eocene, and ecosystems of dense forests populated by both arboreal and large terrestrial mammals. As a result, terrestrial ecosystems in the early Eocene have received a great deal of attention, while climate changes in the middle Eocene are not as well understood, nor their effects on terrestrial animals. These changes can be quantified by stable carbon and oxygen isotopes preserved in pedogenic carbonate nodules. Isotopic composition of these nodules is related to ambient conditions. Higher  $\delta^{18}\text{O}$  values imply warmer temperatures, while low  $\delta^{13}\text{C}$  values correspond to high humidity and the presence of C3 plants. Thirty paleosol horizons of the middle Eocene Washakie Formation in the Washakie Basin of southwestern Wyoming bear carbonate nodules, and from these we can determine local paleoclimatic changes. Five nodules were collected from each of these horizons at a depth of 1-3 ft below the top of the horizon. Each nodule was cut in half, and replicate carbonate samples were drilled from micritic calcite at the center of the nodule. Isotopes were measured at the University of Wyoming Light Stable Isotope Facility. These same nodule-bearing sediments in the Washakie Formation have also produced a wide range of vertebrate material including turtles, uinathares, and primates. By determining local climate changes we can reconstruct the environment in which these animals lived, and pressures they may have experienced in the middle Eocene. Preliminary data suggests a climate that was overall cooler and drier than the early Eocene, but experienced a trend towards warmer and more humid conditions.

Poster Session I (Wednesday)

THE GOPHER TORTOISES OF SOUTHERN CALIFORNIA

JONES, Cory, San Diego State University, San Diego, CA, USA

*Gopherus* is a clade of tortoises that has been restricted to North America throughout its history. Fossil gopher tortoises have been found in southern California spanning over forty million years. A majority of these discovered species remain undescribed. The only described species aside from the extant *Gopherus agassizii* is the Miocene, *G. mohavetus*, which is known from Barstovian and Clarendonian sediments. The taxonomy and phylogenetic position of this species has been highly contested because of its lack of cranial and appendicular material. An undescribed *Gopherus* from middle

Eocene sediments of San Diego County possibly represents the earliest diverging species of *Gopherus*. This species is very similar in morphology to *Hadrianus majusculus*, the earliest known testudinid. A few characteristics of the shell and the cranial material distinguish the early diverging *Gopherus* from *H. majusculus*. Early diverging members of the Eocene San Diego *Gopherus* may have given rise to the more derived *G. utahensis*, which is possibly the ancestor of all other gopher tortoises. A new Oligocene gopher tortoise, similar in morphology to *G. mohavetus* has been found in the Eastlake local fauna from the Otay Formation, an early Arikarean locality of San Diego County. This is the only known record of *Gopherus* from this time outside of the Great Plains. The geographical range of the extant *G. berlandieri* has also been extended with the confirmation of fossils from Pleistocene sediments of the Sonoran Desert. This drastically expands its prehistoric range to the west, resulting in large range overlap with their suspected sister taxon *G. agassizii*. The description of these tortoises has added important details to understanding the evolution of the only group of tortoises still inhabiting North America. Collection of additional material and descriptions will help resolve the relationships of these species within *Gopherus*. The phylogenetic position of the two newly described species remains unresolved within *Gopherus*, as they lack adequate cranial and appendicular material. Phylogenetic analyses place these new species within *Gopherus*.

Romer Prize Session, Thursday 9:15

#### EVOLUTION AND DIVERSIFICATION OF FEEDING APPARATUS IN THE RHYNCHOCEPHALIA (REPTILIA: LEPIDOSAURIA)

JONES, Marc, University College London, London, United Kingdom

Thirty years ago, Rhynchocephalia were widely regarded as a small, conservative, and essentially primitive group. Since then, new discoveries have extended the geographical and temporal ranges of the clade, and have revealed unexpected diversity and sophistication, notably in details of the skull and dentition. However, most reviews have focused on phylogeny rather than functional interpretation. An integrated study of skull shape, tooth morphology and cranial joints reveals a complex but progressive diversification of feeding apparatus. The basal taxa *Cephyrosaurus* and *Diphydontosaurus* exhibit long jaws (outlevers) and short postorbital components (inlevers), indicating fast but relatively weak bites. This correlates with a dentition suited for piercing and puncture-crushing small food items, like insects, with minimal effort. Predictably, their cranial joints generally involve short overlaps with little interdigitation. More derived terrestrial taxa (e.g. 'clevosaurus', sphenodontines) possess skulls with relatively shorter jaws, more space for adductor muscles, and stouter teeth that could apply greater loading forces without tooth failure. Various configurations of dental flanges allowed food to be cut in conjunction with specific jaw movements, notably orthal, tooth-tooth shearing (e.g. *Clevosaurus*) or proral ripping/shredding (e.g. sphenodontines). Their cranial joints have much larger and more complex overlaps than those of 'basal taxa', contributing towards stronger skulls. The increase in food processing and greater bite force would have permitted access to larger, but perhaps slower, prey items (e.g. large arthropods and small vertebrates). Acquisition of these attributes, in conjunction with an increase in body size, allowed the most derived rhynchocephalians, the eilenodontines, to become fully herbivorous. Diversification of feeding strategies in the Rhynchocephalia has wider implications for their contribution to Mesozoic paleoecology and their clade dynamics. Furthermore, Rhynchocephalia provide an independent means of testing supposed correlates (e.g. higher metabolism) of increased food processing in vertebrates.

Technical Session V, Wednesday 2:45

#### A PRIMITIVE TURTLE FROM THE LATE TRIASSIC OF NEW MEXICO AND THE GRADUAL ORIGIN OF THE TURTLE SHELL

JOYCE, Walter, Yale University, New Haven, CT, USA; LUCAS, Spencer, New Mexico Museum of Natural History, Albuquerque, NM, USA; SCHEYER, Torsten, Universität Zürich, Zürich, Switzerland; HUNT, Adrian, New Mexico Museum of Natural History, Albuquerque, NM, USA; HECKERT, Andrew, Appalachian State College, Boone, NC, USA

Phylogenetically placing turtles within Amniota and understanding the origin of the turtle shell have proven to be difficult, because testudinates are molecularly, developmentally, and morphologically isolated from all other groups of amniotes. An extremely poor pre-Jurassic fossil record only exacerbates this situation. Fragmentary remains of a new fossil vertebrate from the Upper Triassic (Reuvelian) Bull Canyon Formation of the Chinle Group in east-central New Mexico, USA, offers insight into the early evolution of basal turtles. The new taxon is clearly diagnosable as belonging to the immediate stem lineage of the turtle crown by the presence of a notably thin carapace that is fused to the neural arches of the vertebrae and the incipient contact of the dorsal ribs with two dorsal vertebrae, a unique synapomorphy of amniotes with a turtle shell. In contrast, the presence of the upright standing ribs seen in all other amniotes clearly indicates that the new taxon is the most primitive unambiguous stem turtle known to date. Like other basal turtles, the new taxon also possesses neck and tail spines, but for the first time it is apparent that these elements are formed by many smaller osteoderms and are composite elements. The animal was thus covered by rows of osteoderms that clustered into spikes along the cervical and caudal vertebrae and into a carapace over

the dorsal series. This observation clearly contradicts the predictions of developmental data that state that the turtle shell formed saltatorially *de novo* during evolution, much as is seen during embryology. Instead, it appears that turtles gradually evolved from animals that were systematically covered by osteoderms and that all elements not associated in the formation of the carapace were lost secondarily.

Technical Session XVI, Saturday 3:00

#### STABLE ISOTOPE AND ELEMENTAL COMPOSITIONS OF EXTANT XENARTHAN TEETH AND THEIR POTENTIAL AS DIET AND HABITAT PROXIES IN FOSSIL XENARTHANS (MAMMALIA)

KALTHOFF, Daniela, Swedish Museum of Natural History, Stockholm, Sweden; TÜTKEN, Thomas, Johannes Gutenberg Universität Mainz, Mainz, Germany

Stable isotopes of carbon, nitrogen and oxygen are valuable proxies for reconstructing animal diets and ecology, as well as environmental and climatic conditions. In this study we analyzed teeth of mainly extant and but also some fossil xenarthans for their carbon, nitrogen and oxygen isotopic composition. We also included dentine from an armadillo, bone from two anteater species and a *Cecropia* leaf for comparison. Xenarthans are mammals with either reduced small teeth like sloths and armadillos or with edentulous jaws like anteaters. Since the Eocene, xenarthran teeth have completely lost enamel and are made up of a composite of different dentine tissues (vaso-, ortho-, and/or osteodentine) as well as cementum. In most geochemical studies tooth enamel, which is the hardest and least altered skeletal tissue, is used for isotopic and geochemical investigations. In this study we investigated the preservation potential of primary isotopic compositions in the dentine of xenarthran teeth. Because of its different microstructure and higher protein content, dentine is known to be much more easily affected by taphonomy and diagenesis than is tooth enamel. The carbon and nitrogen isotope results for teeth from recent xenarthran species show an overall good agreement with their known diet. Preliminary results show that the fossil dentine isotope composition may have potential for the reconstruction of diet and habitat of extinct xenarthrans although diagenetic alteration has to be carefully controlled.

Poster Session IV (Saturday)

#### INFERRING BEHAVIOR FROM PEDAL PHALANGEAL MORPHOLOGY IN THEROPODS

KAMBIC, Robert, Montana State University, Bozeman, MT, USA

Debates about feeding strategies, reproductive behavior, and paleoecology of theropods depend upon behavioral inferences. Previous researchers have identified morphological signals of behavior in the avian hindlimb. Notably, it has been determined that relative lengths of pedal phalanges correlate to broad behavioral categories. This study expands on these results in order to determine whether additional measurements of the pedal phalanges are useful in discriminating among locomotor behaviors and whether they discriminate among more precise behavioral categories. Birds are then used as modern analogues for non-avian theropods. Data consist of a series of linear measurements of the three non-ungual phalanges of pedal digit III. These measurements include 3 lengths, 3 widths, 3 heights, as well as the depth of the distal trochlear groove for each phalanx. 132 extant birds were measured from a variety of orders representing arboreal graspers, predatory graspers, and terrestrial species. The research questions examined are: 1) Are morphological differences in the foot sufficient to discriminate among locomotor behaviors, 2) Do metrics besides length add to the ability to discriminate among behavioral categories, 3) What can be inferred about the behavior of non-avian theropods using these same techniques? Confirming previous studies' findings, morphology of the pedal phalanges is reflective of avian locomotor behavior. Unlike previous studies, principle component analysis does not cluster similar behavioral categories. Discriminant analysis, however, is effective at separating the predatory grasping and perching birds from the terrestrial birds. This trend is independent of body size. The metrics unique to this study, including depth of the trochlear groove as well as the widths and heights of the phalanges, are loaded in the discriminant functions and thus reflect behavior. Finally, these methods are applied to non-avian theropods with an emphasis on the dromaeosaurs and troodontids to infer their behavior.

Poster Session I (Wednesday)

#### FOSSIL VERTEBRATES FROM THE RELOCATED 1936 MOJOKERTO HOMININ SITE, EAST JAVA

KAPPELMAN, John, Univ Texas, Austin, TX, USA; RUEZ, Dennis, Auburn Univ, Auburn, AL, USA; DE VOS, Jon, The National Museum of Natural History, Leiden, Netherlands; HUFFMAN, Frank, Univ Texas, Austin, TX, USA; ZEIM, Yahdi, Institut Teknologi Bandung, Bandung 40132, Indonesia

Relocation of the site near Perning, East Java, Indonesia, that in 1936 produced the fossil hominin calvaria known as the Mojokerto child's skull has resulted in the recovery of about 250 identifiable vertebrate fossils. The fossils were found in a pebbly sandstone in the upper Pucangan Formation, approximately 20 m stratigraphically above a horizon dated at 1.81 +/- 0.04 Ma. This possible late Pliocene fauna contains at least 13 species: one fish, three reptiles, and nine mammals. Two cervids (*Axis lydekkeri* and *Rusa* sp.) numerically dominate the collection at 59% of the identified specimens.

Although some other species are represented by multiple specimens, only the two cervids have a minimum number of individuals greater than one. Other better-preserved specimens include *Panthera tigris*, *Duboisia santeng*, *Hexaprotodon sivalensis*, *Sus* sp., *Crocodylus* sp., *Gavialis*, sp., and *Tionyx* sp. Fossils range in size from <1 to 30 cm, and all are unarticulated specimens. The quality of preservation is quite variable; for example, in some instances the enamel of a large mammal tooth is scratched, heavily abraded, and cracked, while in others the thin infrapinnous bone of a bovid scapula remains intact. This preservational variation suggests that the Peking fossil collection represents a combination of autochthonous and allochthonous assemblages. A better understanding of this fossil fauna will permit a reconstruction of the paleoenvironments that *Homo erectus* encountered when it first reached Java.

Carnivora: Phylogeny, Form and Function Symposium, Saturday 9:45  
AUDITORY BULLA VOLUME IN HERPESTIDS AND ITS RELATION TO  
ECOLOGY, MORPHOLOGY, AND PHYLOGENY  
KAWAKAMI, Alana, Yale University, New Haven, CT, USA

Mammals are able to hear the widest range of frequencies of any vertebrate group. The volume of the middle ear, or auditory bulla, is an important feature of the mammalian auditory system and is partially responsible for the range of frequencies that an organism can hear. Previous studies have shown that larger auditory bullae are more sensitive to low frequency sounds (2 kHz or less), and that species possessing these enlarged bullae are often found in open habitats. The greater sensitivity that an enlarged bulla provides is important for these species and studies of desert dwelling mammals indicate that these species have a selective advantage in these environments. I studied auditory bulla size and its relationship to ecology, ontogeny, and phylogeny in herpestids (mongooses). Herpestids are a group of small to medium sized carnivores, are relatively unspecialized, and found in a wide variety of habitats, ranging from rainforest to desert. My results indicate that species living in open habitats do, indeed, have relatively larger auditory bullae than those living in closed habitats, and that it is very niche specific. Sympatric species living in a varied environment may have relatively different bulla volumes depending on whether they inhabit the open or closed areas of that habitat. Enlarged auditory bullae independently evolved five times in the herpestids, and bulla enlargement occurred through different heterochronic processes in each case. These results all indicate that selection in open habitats is the driving force behind auditory bulla enlargement in herpestids.

Preparators' Session, Thursday 9:30  
FULLY AUTOMATED SORTING OF MICROFOSSILS FROM SEDIMENT  
USING LASER-STIMULATED FLUORESCENCE  
KAYE, Thomas, Burke Museum, Seattle, WA, USA

Screen washing and anthill collecting are the most common methods for discovering microfossils which are predominantly responsible for illuminating the diversity of ancient life. Visual sorting under the microscope is the standard methodology and requires volunteers with extraordinary amounts of time and patience. Some formations produce fossil material that glows under UV light but unfortunately these formations are rare. Raman spectroscopy illuminates the specimen with a laser and when used on minerals, a problematic characteristic is fluorescence. This unwanted characteristic becomes advantageous for detecting microfossils. An industrial bowl feeder normally used to feed small parts, feeds the anthill gravel or sediments out in a single file. The laser illuminates this stream while being examined by a computer vision system. When a specimens' fluorescence exceeds a certain size and brightness threshold, an air puff redirects it to a separate bin. The sorted bin of concentrate is then human sorted in far less time than working through the entire sediments. A working prototype has been developed and will be shown on specimens that do not normally fluoresce under UV light.

Poster Session II (Thursday)  
RECONSTRUCTING A NEW MESOZOIC CROCODILE SKULL USING  
BASIC TECHNIQUES, ADVANCED TECHNOLOGY, AND ARTISTIC  
FINESSE  
KEILLOR, Tyler, University of Chicago, Chicago, IL, USA

A new species of Cretaceous crocodile has been the focus of much work at the University of Chicago's Fossil Laboratory. Upon discovery in the Sahara, it was clear that this specimen represented a new species, and would make a spectacular exhibit piece. The relatively complete skull was preserved with jaws tightly clenched; preparation could not free the jaw from the skull without damage. CT scans revealed numerous small teeth that were completely concealed in occlusion. The prepared skull was molded and cast, as-is. The mold was also used to create a separate jaw and skull cast for an open-mouth display. The teeth from the CT data were sculpted onto the opened jaws. The bisected skull roof was reflected using a reverse-carving machine. The new, reconstructed skull was molded, producing a restored skull cast. This new restored skull served as the understructure for a flesh model. Extant crocodiles served as reference for the soft anatomy of the sculpture; however, speculation was required to flesh out the suite of distinctive features unique to this new fossil skull.

Technical Session XIV, Saturday 8:30  
ON A NEW TAPEJARID (PTEROSAURIA, PTERODACTYLOIDEA) FROM  
THE CRETACEOUS YIXIAN FORMATION (JEHOL BIOTA, CHINA): THE  
OLDEST TOOTHLESS PTEROSAUR

KELLNER, Alexander, Museu Nacional/UFRJ, Rio de Janeiro, Brazil; WANG, Xiaolin, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; ZHOU, Zhonghe, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; CAMPOS, Diogenes, Museu de Ciências da Terra/Departamento Nacional de Produção Mineral, Rio de Janeiro, Brazil

Each year new pterosaur specimens are being found in the Early Cretaceous Jehol Group, coming particularly from Liaoning, making this region one of the most interesting areas for the study of those flying archosaurs. Here we report an incomplete skeleton of a toothless pterosaur (IVPP V 14191) that was collected in the grey shales of the Yixian Formation (~125 Ma). All bones are crushed, a common condition of the Liaoning specimens. The skull (~105mm) is elongated with the anterodorsal margin slightly convex. The nasoantorbital fenestra is very large (~45% of the skull length), a tapejarid synapomorphy. Scapula and coracoid are strongly connected but the sutured is visible, indicating that those bones are still unfused what suggests that this was a sub-adult individual at the time of death. So far all tapejarid taxa from the Jehol Group were collected in the Jiufotang Formation (~120 Ma). IVPP V 14191 differs from *Sinopterus dongi* by the having the premaxillary crest above the anterior margin of the nasoantorbital fenestra distinctively projected and not rounded. It differs from "*Huaxiapterus*" *corollatus* by lacking the hatchet-shaped process of the cranial crest. The Yixian tapejarid further differs by having the rostrum more elongated and less inclined relative to the horizontal margin. This new specimen extends the record of the Tapejaridae to the Barremian, making it the oldest toothless pterosaur known to date.

Technical Session X, Friday 8:00  
CORRELATED PROGRESSION AS A REALISTIC AND USABLE MODEL  
FOR THE THE ORIGIN OF MAJOR VERTEBRATE TAXA  
KEMP, Tom, Oxford University, Oxford, United Kingdom

The origin of a major new crown taxon results from a long trek through morphospace by an evolving lineage, during which many traits evolve, often to a considerable extent. At the same time, it is axiomatic that the sequence of phenotypes all retained the high level of functional integration between traits that is characteristic of organisms. Resolving the apparent conflict between phenotypic evolvability, in which only a single trait at a time can change, and phenotypic integration, in which all the traits are functionally integrated, has long been hampered by the lack of an explicit model of evolution at this level that is realistic, and also usable in the context of interpreting the sequence of acquisition of novel traits inferred from the fossil record. The concept of correlated progression underpins just such a model. It is a systems model, in which all the traits are interconnected, directly or indirectly, by functional linkages whose respective degrees of flexibility and therefore constraining effects vary with small incremental changes in the traits so linked. Some implications of the model are: that the organism as a whole rather than individually identified traits is the focus of selection; that preadaptation and key innovation, if they can be said to exist at all, are properties of the organism as a whole and not of identifiable traits; that the evolving lineage follows a ridge in a Simpsonian adaptive landscape that represents a very general environmental gradient; that the exact sequence of trait-changes is indeterminate; that many trait changes are close to selectively neutral and may evolve by a process of trait drift, analogous to genetic drift. The model has been applied to the origin of Mammalia and Chelonia, where it resulted in novel hypotheses. Here it is provisionally applied to Tetrapoda, in the light of recent new fossil evidence about stem-tetrapods, and other major vertebrate taxa that may benefit from explicit application of the model are mentioned.

Poster Session I (Wednesday)  
PRELIMINARY ANALYSIS OF THE FOSSIL HERPETOFAUNA FROM THE  
KOANAKA HILLS SITE, NGAMILAND, BOTSWANA  
KENNEDY, Alicia, Sam Houston State University, Huntsville, TX, USA; BHULLAR, Bhart-Anjan, University of Texas, Austin, TX, USA

Recent excavations in cave deposits of the Koanaka Hills, western Ngamiland, Botswana produced a diverse fauna. Thermoluminescence methods conservatively date the site to 390,000 BP. The deposits yielded fossils of a variety of taxa including 44 amphibian and reptile elements, making this the first report of an assemblage of Middle-Pleistocene herpetofauna from Botswana. Thus far, specimens have been confidently attributed to Anura and the squamate clades Caenophidia, Gekkonidae, Lacertidae, Scincoidea, and Agamidae. Gekkonids are the most common taxa in the assemblage, consisting of 22 specimens. Botswanan gekkonids today comprise seven genera and sixteen species, all of which are within Gekkoninae. We identified several distinct morphotypes of gekkonids in the assemblage. Among these are forms with relatively tall and relative short teeth and differing cusp morphologies. The facial process of

one maxilla bears an extensive lateral plate dotted with small pits. That of another carries an unusual squarish impression containing several small concavities separated by ridges. In addition to these patterns, some of the dentigerous elements bear an extensive ridged and grooved sculpture. Among the non-gekkonid squamates, one scincoid maxilla bears a very wide palatal shelf of the maxilla posterior to the choanal emargination. Dentigerous elements carrying bicuspid teeth are attributable to Lacertidae, and seven specimens show the distinctive acrodont dentition of Agamidae. The single snake vertebra can be diagnosed to Caenophidia. Neither the various sculpturing patterns in the gekkonids nor the wide palatal shelf of the scincoid are widespread within these respective clades. However, a lack of extant comparative osteological material from the region limits the resolution of identification. Nevertheless, the broad range of lizard taxa in the sample indicates a diverse squamate fauna. In addition to the squamates, five specimens are attributable to Anura, suggesting the past presence of a permanent source of water in a currently dry area. This fauna fills an important spatial and temporal gap in the current understanding of southern African herpetofaunas.

Technical Session X, Friday 8:15

#### ONTOGENETIC LIMB BONE ALLOMETRY: A RELIABLE PREDICTOR OF METABOLIC RATE IN EXTINCT TAXA?

KILBOURNE, Brandon, University of Chicago, Chicago, IL, USA

Ontogenetic scaling remains largely unexplored for the greater majority of terrestrial vertebrates. Out of the few studies performed, a novel hypothesis suggests that ontogenetic limb bone allometry is a reflection of metabolic rate. It has been proposed that ectothermic taxa have limb bones that grow isometrically or more robust during ontogeny, while endothermic taxa have limb bones that grow increasingly gracile during ontogeny. If the link between limb bone allometry and metabolic rate is supported, then ontogenetic limb bone allometry can be a useful tool for predicting metabolic rate in extinct taxa. To test the hypothesis that ontogenetic limb bone allometry can be used to predict metabolic rates, femoral length and circumference data on 10 lizard species and 12 mammal species was analyzed. For each species, bivariate regressions of length on circumference were performed to determine femoral allometry, and the range of allometric exponents (used as a proxy for allometry) within mammals and lizards were compared. The inclusion of mammals with large adult body mass reveals 1) that the range of ontogenetic limb bone allometry in mammals coincides with that of lizards and 2) that adult body mass has an influence upon the postnatal development of limb bones in mammals. Regressions of metabolic rate against femoral exponent were also performed for lizards and mammals separately. These results indicate that limb bone allometry does not accurately predict metabolic rate. Predictions about the metabolism of extinct taxa based upon ontogenetic limb bone allometry should be treated with caution. Other life history parameters such as adult body mass and maximum growth may have a greater influence on the ontogenetic scaling of limb bones than metabolic rate.

Student Poster Session (Thursday)

#### COMPARATIVE ANATOMY OF CAUDAL FIN SKELETON IN A LATE CRETACEOUS SHARK (*CRETOXYRHINA MANTELLI*) AND MODERN LAMNIFORM SHARKS

KIM, Sun, DePaul University, Chicago, IL, USA; SHIMADA, Kenshu, DePaul University, Chicago, IL, USA; RIGSBY, Cynthia, Children's Memorial Hospital, Chicago, IL, USA

CMN 40906 is a caudal fin skeleton of the Late Cretaceous shark, *Cretoxyrhina mantelli* (Lamniformes: Cretoxyrhinidae), housed in the Canadian Museum of Nature, Ottawa, Ontario. A previous study showed that the specimen preserves a series of hypochordal rays suggestive of a lunate (symmetrical) tail with a prominent caudal peduncle in *C. mantelli*. However, the study was based on limited comparative data on the caudal fin skeleton in modern sharks. By using medical imaging techniques (X-ray and computed tomography), we recently examined the caudal fin skeleton in the following 11 modern species of Lamniformes: *Carcharias taurus*, *Odontaspis ferox*, *Pseudocarcharias kamoharui*, *Alopias pelagicus*, *A. superciliosus*, *A. vulpinus*, *Carcharodon carcharias*, *Isurus oxyrinchus*, *I. paucus*, *Lamna ditropis*, and *L. nasus*. Radiographic images reveal that the heterocercal angle at the precaudal-caudal transition in all species of Lamnidae (*Carcharodon*, *Isurus*, and *Lamna*, that are characterized as fast swimming sharks) is high (>30°), which is equal to, or slightly less than that in *Cretoxyrhina mantelli*. In both Lamnidae and *C. mantelli*, the anterior one-third of hypochordal rays shows a vertical alignment and a rapid increase in their length from one ray to the next posteriorly. The hypochordal rays are the longest at the middle section of the ray series and progressively become shorter and oriented more posteroventrally towards the terminal end of the caudal fin. Other examined lamniform taxa (*Carcharias*, *Odontaspis*, *Pseudocarcharias*, and *Alopias*, that are considered to be less efficient swimmers compared to lamnids) have a heterocercal angle of <30°. Throughout the caudal fin, their hypochordal rays are oriented almost perpendicular to the vertebral column with a subtle difference in length from one ray to the next. A previous study has shown that *Cretoxyrhina mantelli* may be closely related to *Alopias* (Alopiidae). However, our radiograph-based study further demonstrates the similarity in caudal fin skeleton between

*C. mantelli* and Lamnidae. This result further strengthens the contention that *C. mantelli* possessed a lunate tail and a prominent caudal peduncle, and that the similarity is a homoplasy due to convergent evolution.

Poster Session III (Friday)

#### NEW LIFE FOR OLD FOSSILS: MICROVERTEBRATE FOSSILS FROM THE GARDEN PARK FOSSIL AREA (LATE JURASSIC, MORRISON FORMATION)

KING, Lorin, Dinosaur Depot Museum, Canon City, CO, USA; FOSTER, John, Museum of Western Colorado, Grand Junction, CO, USA; HECKERT, Andrew, Appalachian State University, Boone, NC, USA

For more than 130 years, the Garden Park Fossil (Paleontological) Area has yielded abundant large dinosaurs, including a relatively "typical" Morrison Formation fauna consisting of the theropods *Allosaurus* and *Ceratosaurus*, sauropods such as *Camarasaurus*, *Apatosaurus* and *Diplodocus*, the thyreophoran *Stegosaurus*, and the ornithomylid *Othnielia*, as well as rarer taxa such as *Flaplocanthosaurus* and *Amphicoelias*. The several dozen quarries have also produced some identifiable, albeit fragmented, small vertebrate remains. The rare, smaller non-dinosaurian vertebrates include pterosaurs, turtles, crocodyliforms, and lungfish fossils, as well as specimens of the mammals *Docodon* and *Amblotherium*, plus the sphenodontian *Eilenodon*. These are represented mainly by disarticulated to fragmentary limb bones, vertebrae, osteoderms, and teeth. There is a scarcity of fish in the Garden Park Fossil Area, which could suggest that standing water was sometimes infrequent, but the abundance of plant material and invertebrate material suggests an often, wet substrate and likely a high local water table. Like most Morrison Formation fossil quarries in the western United States, small vertebrate specimens are not as common as the larger dinosaurian material. The paucity of specimens does not mean that the small vertebrates were not plentiful, but it may be an indication of collecting bias or preferential preservation. Importantly, the microvertebrate fossils, while not frequently recovered and relatively non-diagnostic, still record a greater diversity of taxa (at higher taxonomic levels) than do the more frequently collected large dinosaur elements.

Technical Session I, Wednesday 9:30

#### NEW SPECIMENS OF *MYTONIUS* (PRIMATES, OMOMYOIDEA) FROM THE DEVIL'S GRAVEYARD FORMATION, TEXAS

KIRK, E. Christopher, University of Texas at Austin, Austin, TX, USA; WILLIAMS, Blythe, Duke University, Durham, NC, USA

Early Uintan to Chadronian vertebrate fossils have been recovered from the Devil's Graveyard Formation of west Texas since the 1960s. Beginning in 2004, intensive collecting by field parties from the University of Texas at Austin has yielded numerous new fossil primates from the late Uintan (Ui3) Purple Bench locality. These new specimens include the first known fossils of the genus *Mytonius* to preserve the maxillary postcanine dentition (P4-M2) and anterior mandible (from m1 to the symphysis). These specimens closely resemble previously described specimens of *Mytonius hopsoni* from the northern interior in most aspects of lower molar size and anatomy. However, significant differences in lower fourth premolar size and morphology may warrant specific distinction. In recent decades, most researchers have treated *Mytonius* as a junior synonym of *Ourayia*. The new Texas fossils confirm the validity of the genus *Mytonius* based on comparisons with the upper dentitions of *Ourayia uintensis* and *Macrotarsius*. Unlike *Ourayia* and *Macrotarsius*, *Mytonius* demonstrates upper molars with reduced stelar shelves and enlarged lingual cusps. Similarly, *Mytonius* specimens from Texas and the northern interior exhibit much simpler lower premolars than either *Ourayia* or *Macrotarsius*. Accordingly, although *Mytonius* and *Ourayia* share important lower molar synapomorphies (e.g., centrally-placed M2 paraconid, buccally-shifted cristid obliqua, weak development of shearing crests, etc.), these two genera may be recognized as distinct on the basis of many other dental features. These findings suggest that most prior disagreements about the alpha taxonomy of large-bodied Uintan omomyoids may be attributed to the effects of limited sample size.

Poster Session I (Wednesday)

#### MESOZOIC VERTEBRATES FROM THE ADIGRAT FORMATION OF ETHIOPIA.

KLEIN, Nicole, Museum für Naturkunde, Berlin, Germany; BUSSERT, Robert, Institut für Angewandte Geowissenschaften, Berlin, Germany; ENKURIE, Dawit, Institut für Angewandte Geowissenschaften, Berlin, Germany

The vertebrate fauna of the Early Mesozoic of Ethiopia is poorly known, with only a few records of indeterminate fish and crocodiles, as well as a single jaw fragment of the temnospondyl *Abiadisaurus*. In a recent field expedition to the Tigray Province in northern Ethiopia, the Adigrat Formation, which is Early Mesozoic in age but until now had not been precisely stratigraphically dated, was extensively prospected for vertebrates and an overall assessment of its sedimentology and depositional environment was completed. In the lowermost part of the formation, large fang teeth, jaw material, and ribs of a capitosaurid temnospondyl (cf. *Abiadisaurus*) were recorded, as well as tooth plates of lungfish; in addition, various types of coprolites could be found. The faunal composition changes in the middle and upper part of the Adigrat Formation:

while temnospondyls and lungfish appear to be absent, the vertebrate fauna is largely dominated by actinopterygian fish (cf. *Lepidotes*), hybodontid sharks, as well as thalattosuchian crocodiles, the latter represented by partly associated skull material, isolated teeth, osteoderms, vertebrae, ribs, and limb elements. In contrast to previous assertions, the faunal composition indicates that the Adigrat Formation is, in part, of marine character, particularly in its middle and upper sections. This interpretation is also supported by sedimentological data such as tidal bundles, large-scale symmetrical wave ripples, dolomite horizons overlying intensely bioturbated interlaminated fine-grained sandstones, and siltstones and claystones indicative of a lagoonal setting; furthermore, our findings suggest that at least the younger sediments of the formation are Early Jurassic in age. The results have implications not only for the distribution of epicontinental vertebrates in the Early Mesozoic of southern Pangaea, but also for the paleogeography of the Gondwanan shoreline of the western Tethyan realm.

Technical Session IV, Wednesday 3:30

DIRECT EVIDENCE OF PREDATOR-PREY-RESOURCE INTERACTIONS IN A PERMIAN AQUATIC ECOSYSTEM

KLUG, Stefanie, Museum of Natural History, Humboldt-University of Berlin, Berlin, Germany; KRIWET, Jürgen, Museum of Natural History, Humboldt-University of Berlin, Berlin, Germany; WITZMANN, Florian, Museum of Natural History, Humboldt-University of Berlin, Berlin, Germany

Predation is a behaviour that is normally not preserved for extinct organisms, and trophic levels in the fossil record generally are derived from indirect observations such as tooth morphologies, tooth marks, or coprolites. Here, we present the first direct evidence of a three-level trophic-chain in a fossil aquatic ecosystem as exemplified by the xenacanthid shark *Thiodus sessilis* from the Lower Permian Lake Humberg of the Saar-Nahe Basin in Germany with two different ingested larval temnospondyls. More importantly, one of the amphibians bears the remains of an acanthodian fish in its digestive tract, providing unambiguous evidence of its last meal. A shark with preserved amphibian prey items is exceptional because no other extinct or extant shark is known to feed on amphibians. *Thiodus* is considered to represent a tertiary consumer, and we hypothesize that the two larval temnospondyls, which are secondary consumers, were attacked and swallowed completely by *Thiodus* during their pursuit of juvenile acanthodians, which constitute the prey of larval temnospondyls in the lake. Juvenile acanthodians were primary consumers feeding on ostracods and plankton. The attempt to reconstruct the food web of Lake Humberg shows that it is predator heavy and highly biased towards piscivores and batrachophagous taxa indicating that predator-prey interactions may be more important than planktivore-controlled structures. Absence of herbivores and only few planktivores are indicative for those ecosystems, but it displays trophic complexities very distinct to those found today in fluvio-lacustrine settings. During the Palaeozoic, top predators in piscivore-dominated, fluvio-lacustrine ecosystems, were represented by large xenacanth sharks and adult aquatic temnospondyls. In post-Triassic ecosystems, xenacanth sharks and temnospondyls were ecologically replaced by aquatic amniotes, hybodont sharks, and bony fishes. In the Late Cretaceous and Cenozoic, teleosts, birds and mammals successively filled the positions of top predators in lacustrine ecosystems. Batrachophagous sharks are seemingly absent from post-Triassic ecosystems, and amphibians do not play an important role in post-Triassic lacustrine food webs anymore.

Technical Session XIII, Friday 2:30

LARGEST COLLECTION OF FEATHERS FROM MESOZOIC STRATA OF NORTH AMERICA, INGERSOLL SHALE, EUTAW FORMATION, EASTERN ALABAMA.

KNIGHT, Terrell, Auburn University, Auburn, AL, USA; BINGHAM, Patrick, Auburn University, Auburn, AL, USA

The Ingersoll shale is a thin (<1 m), laterally restricted, olive-black, carbonaceous, clay lens within the Upper Cretaceous (Santonian) Eutaw Formation, Russell County, eastern Alabama. The clay lens represents abandoned tidal creek fill within the bayhead delta of an estuary. Excavation of this marginal marine conservation deposit produced the largest collection of fossil feathers from Mesozoic strata of North America. These fossil feathers are possibly the only Mesozoic feathers from North America preserved in a non-amber host. The fourteen collected contour feathers range in length from 0.43 to 16.50 cm and 0.35 to 3.10 cm in width. Twelve of the feathers are body contour feathers: one appears to be a rectrix (tail feather), and the other is likely a remix (wing feather). Some fossil feathers are exceptionally well preserved, and one even shows the fine detail of barbicel structures (hooklets) on the distal barbules. Scanning electron microscopy (SEM) of two of the fossil feathers indicated replacement by mats of small, rod-shaped structures that compare favorably to bacilliform bacteria; other SEM work is in progress. These rod-shaped structures are preserved in three dimensions and are ~1 µm in length. Energy dispersive spectroscopy (EDS) of the bacilliform mats indicated no mineral replacement, but the analysis showed that a carbon component remains. The carbon spike indicated by EDS is possibly a result of original carbon from the bacteria. This type of preservation is seen in feathers from the Crato Formation, Brazil, where the original organic remains of bacterial cell walls are preserved. The Ingersoll shale fossils add considerably to the sparse record of feathers from Mesozoic strata

worldwide, especially from the Late Cretaceous. In addition, the Ingersoll shale is only the third confirmed site worldwide to preserve feathers from an estuarine setting. We suggest tidal channel fills within estuarine depositional settings should be a focus for future prospecting of theropod feathers.

Technical Session IX, Friday 9:15

THE GROWTH TRAJECTORY AND ADULT SIZE OF *LESOTHOSAURUS DIAGNOSTICUS* (DINOSAURIA: ORNITHISCHIA): TAXONOMIC IMPLICATIONS

KNOLL, Fabien, Museum National d'Histoire Naturelle, Paris, France; PADIAN, Kevin, University of California, Berkeley, CA, USA; DE RICQLÈS, Armand, Collège de France, Paris, France

Questions about the taxonomic status, diversity, and pace of evolution of basal ornithischian dinosaurs persist in part because some historically important taxa have been based on incomplete material of uncertain ontogenetic status. We analyzed the bone tissues of small (~1 m length) specimens of *Lesothosaurus* and determined that they represent young individuals that were rapidly growing. In contrast, a larger (~2 m length) individual that has been referred alternatively to *Lesothosaurus* and to "cf. *Stormbergia* & *Lesothosaurus*" shows the onset of adult histological features. We infer that these and other specimens referred to the two taxa are most reasonably interpreted as representing ontogenetic stages of a single taxon that reached maturity in approximately four years. Of the two character states that are supposed to distinguish the two taxa, one is probably best ascribed to teratological and preservational differences, and the other to ontogenetic change; there seems, therefore, no compelling reason to separate *Stormbergia* from the senior taxon *Lesothosaurus*. Diagnoses of taxa that are based on supposedly unique combinations of character states can be problematic: they often cannot account for possible polarity errors that result from comparing individuals that differ in ontogenetic stage but may belong to the same taxon. For this reason it is important to base taxonomic diagnoses on specimens with well-defined ontogenetic stages, preferably adults. This is one of a very few examples so far where bone histology has been used to determine taxonomic questions.

Poster Session IV (Saturday)

ORNITHOMIMIDS (THEROPODA: DINOSAURIA) FROM THE NEMEGT FORMATION (MAASTRICHTIAN) OF MONGOLIA

KOBAYASHI, Yoshitsugu, Hokkaido University, Sapporo, Japan; BRONOWICZ, Robert, Uniwersytet Warszawski, Warszawa, Poland; BARSBOLD, Rinchen, Mongolian Academy of Sciences, Ulaan Baatar, Mongolia

The Nemegt Formation of Mongolia is well known for the abundance of dinosaur fossils, and two definitive ornithomimids (*Gallimimus bullatus* and *Anserimimus planinychus*) have been reported so far. Since their original descriptions, the diagnoses of *Gallimimus* and *Anserimimus* have been poorly understood, resulting many of ornithomimids from the Nemegt Formation have been simply assigned to these two genera. Re-evaluations of the diagnoses of Nemegt ornithomimids allow us to understand the diversity of ornithomimids of the formation. *Gallimimus bullatus* is one of the best-known ornithomimids, but its diagnoses have been argued previously. It is characterized by having a short manus, as suggested by most of previous studies, and the manus/humerus ratio is 0.61, which is the smallest value in ornithomimosaur (>0.8 in others). *Anserimimus planinychus* is a unique ornithomimosaur in having strong deltopectoral crest of the humerus, dorsoventrally flat (proximal end is wider than high) and nearly straight manual unguals, and long forelimbs. ZPAL MgD65 is a partial skeleton, collected during the Polish-Mongolian Expedition from the Nemegt Formation in 1964, could be a third taxon and has nearly straight but not flat (proximal end is higher than wide) manual unguals, differing from *Gallimimus* and *Anserimimus*. A partial skeleton of an ornithomimid with similar manual unguals was discovered from the same formation by a recent fieldwork by the Korean International Dinosaur Expedition in the summer 2006. Preliminary phylogenetic analyses for an enigmatic ornithomimid, *Deinocheirus mirificus*, are tested in this study based on three large data matrices of Theropoda from previous studies. Two data matrices resulted in that *Deinocheirus mirificus* is a possible ornithomimosaur because it has some ornithomimosaur-like features (e.g., subequal metacarpals and weak deltopectoral crest of humerus), but the phylogenetic status of *Deinocheirus mirificus* as a member of ornithomimosaur is not confirmed because the other matrix placed outside of the clade Ornithomimosauria.

Technical Session XII, Friday 3:45

THE DISTRIBUTION AND ECOLOGY OF SOUTHERN ELEPHANT SEALS AND ADÉLIE PENGUINS ON THE HOLOCENE ROSS SEA COAST

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Radiocarbon dates on skin, hair and mummified carcasses show that southern elephant seals (SES; *Mirounga leonina*) occurred during the Holocene along the western coast of the Ross Sea (the Victoria Land Coast, VLC) from at least Edmonson Point (74°20' S) to Explorer's Cove (77°30' S). The most recent occupation ended only 500 years ago. The closest breeding site to the region today is Macquarie Island (54°30' S), 2500 km to the north. Most SES feed further north as well, in the productive waters of the Subantarctic Front and Antarctic Circumpolar Current (60-70° S). SES feed in open, ice-free water and they haul-out on ice-free beaches to molt and breed. They are largely absent from the VLC today because of abundant pack ice and land fast-ice, even in summer months. Thus the presence of abundant SES along the VLC suggests substantially less pack ice and fast-ice in the Ross Sea at intervals from the middle to late Holocene. This interpretation is supported by the distributions of relict Adélie penguin rookeries. These penguins nest on land but forage in pack ice. From 3800-2300 yr BP penguins typically occur without SES (suggesting conditions similar to today), whereas from 2300-500 yr BP, SES occur but Adélie penguin rookeries are uncommon (indicating less ice than today). From 6200-3800 yr BP, SES and Adélie penguins co-occur at a number of sites along the VLC, suggesting intermediate conditions, with little fast-ice, but with nearby pack ice. Carbon and nitrogen isotope data from SES, other seals, and Adélie penguins provisionally support the interpretation that Holocene SES did not forage in the Ross Sea, but instead fed further north, as they do today. In conclusion, a reduction in pack ice and fast-ice would have allowed SES to occupy VLC beaches. We are still assessing whether these sites were locations where SES went to molt, or if they represent breeding colonies entirely independent from those on sub-Antarctic islands to the north. These hypotheses are being tested with demographic data from mummies and studies of population diversity and perhaps sex ratio from ancient DNA.

Technical Session I, Wednesday 8:45

WELL PRESERVED SKULL OF A EUROPEAN APATEMYID (MAMMALIA) FROM THE PHOSPHORITES DU QUERCY

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A well preserved skull of the European small apatemyid *Heterohyus* from the Phosphorites de Quercy (France) is preserved in the Museum of Natural History in Basel. This skull was mentioned by earlier workers, but never described. It is significant as the only uncompressed apatemyid skull known since the skull of North American *Sinclairiella* was lost. Analysis of micro-CT-scans of the new skull (total length 32 mm) shows important features characterizing apatemyids. The main new features concern the basicranium with the ear region and the turbinalia. An extensive pterygoid crest is present on the basicranium. A large tympanic process of the basisphenoid indicates a large bulla otica, which—most probably—was not ossified, or only partially ossified. The well-preserved turbinal system is similar to that of extant small macrosmatic mammals. The maxillo- and nasoturbinal are in the anterior section. In the posterior section are two fronto- and three ethmoturbinals and one interturbinal between ethmoturbinal 1 and 2. *Heterohyus* combines highly derived characters in the dentition and in the postcranial skeleton, especially in the hand, with mainly undervived skull characters. The skull indicates significant differences within the apatemyids. *Sinclairiella* had two parasagittal crests, but *Heterohyus* has only one crest. Teeth of the present skull differ from those of other European species of *Heterohyus* in having extremely small hypocones.

Poster Session I (Wednesday)

ECOLOGICAL AND EVOLUTIONARY IMPLICATIONS OF ONTOGENETIC CHANGES IN THE MARGINAL DENTITION OF *TYLOSAURUS PRORIGER* (SQUAMATA: MOSASAURIDAE)

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Detailed description of juvenile mosasaur (Squamata: Mosasauridae) anatomy has received little attention in the literature. Here we report on the crown morphology of marginal teeth in a well-preserved juvenile specimen of *Tylosaurus proriger*, one of the largest rüsselosaurine mosasaur species known; the specimen was collected from the lower Mooreville Chalk Formation (Upper Santonian-Lower Campanian) of western Alabama, USA. Compared with the adult dentition, which exhibits closely-spaced, conical, stout tooth crowns having bases that are nearly circular in cross section, the marginal teeth of the juvenile are much more slender and posteromedially recurved, and highly compressed laterally at their bases; there is a proportionally larger gap

between the adjacent crowns in the juvenile as well. The only discernible similarity in the adult and juvenile dental morphology, and thus possibly the only dental character diagnosable of this species, is the intercarinal angle of about 117° on the labial side. The dietary evidence suggests that large *T. proriger* individuals occasionally consumed other, smaller mosasaurs such as *Platecarpus*, but the estimated body length of this juvenile specimen at less than four meters is clearly smaller than a fully-grown *Platecarpus* specimen. Therefore, the ontogenetic changes in dental morphology observed here in *T. proriger* seem to be correlated with change(s) in diet through its ontogeny, as is also known in the extant, large-bodied monitor lizard, *Varanus niloticus*. The change in the spacing between adjacent tooth crowns is here interpreted to represent the positive allometry in the crown size relative to the jawbones, whereas the increase in the size of each alveolus remained largely isometric in relation to the tooth bearing elements (=jaws). The slender, posteromedially recurved tooth crown morphology is observed in the adult/large forms of all the other rüsselosaurine mosasaurs, the suggestion that the above mentioned dental changes in *T. proriger* ontogeny likely represents peramorphosis.

Poster Session I (Wednesday)

THE TYPES OF TAPHOFACIES IN THE LOWER PERMIAN TETRAPOD DEPOSIT "BROMACKER" (GERMANY)

KRAUSE, Torsten, Erfurt, Germany

The flood-plain deposits in the Lower Permian of the Thuringian Forest (Germany) are barely explored, except for the tetrapod deposit of Bromacker. The tetrapod collection includes 12 species of terrestrial adapted tetrapods with potential biostratigraphical significance. In May 2004 a new three-year project was launched, aiming to detect more potential tetrapod deposits outside of the Bromacker, to complete taxonomical knowledge, and to improve biostatigraphical correlation. Explorations and single findings show coherence between the deposits, the conservation of the skeletons, the flood-plain deposits, and the varied pedogene siliciclastic beds. In the Bromacker area, detailed stratigraphical analysis of the pedogene beds were carried out using two drillings (25 m). The sandstone-mudstone sequences in the Tambach Sandstone consist of up to 1 m thick fining-upward sequences of flood-plain deposits. Pebbles and small conglomeratic beds consist of granites, metamorphic rocks and acid volcanic rocks. The carbonatized cross-bedded sandstones are rich in sedimentary marks and trace fossils. The top of the sequence includes micaceous fine sandstones, siltstones and mudstones with diagenetical ruptures (compaction, convolution, local syn- to postdiagenetical faults) and ichnofossils (roots, invertebrates, vertebrates). In particular sequences a soil development (protosol/vertisol) is conserved. Pedogene carbonate is a characteristic feature, which generates grey to green blue nodular calcretes. In the tetrapod deposit Bromacker is to distinguish between four types of taphofacies, comprise the evolution from a deposit of conservation to a deposit of concentration: type 1 - articulated and disarticulated skeletons with conservation in sediments of burrow casts, the Bromacker Type; type 2 - articulated small skeletons in a laminitic; type 3 - bonebed that resultant from fluvial exhumed deposits of conservation from type 1 and type 2 (in combination with stream-transport and/or washout soils); type 4 - isolated and fluvial transported bones and teeth.

Student Poster Session (Thursday)

CHONDRICHTHYANS AND ACTINOPTERYGIANS ACROSS THE K-Pg BOUNDARY IN PATAGONIA, ARGENTINA

KRIWET, Juergen, Museum für Naturkunde, Humboldt-Universität, Berlin, Germany; ABERHAN, Martin, Museum für Naturkunde, Humboldt-Universität, Berlin, Germany; KIESSLING, Wolfgang, Museum für Naturkunde, Humboldt-Universität, Berlin, Germany; SCASSO, Roberto, Departamento de Ciencias Geológicas, FCEN, Universidad de Buenos Aires, Buenos Aires, Argentina; MEDINA, Francisco A., Departamento de Ciencias Geológicas, FCEN, Universidad de Buenos Aires, Buenos Aires, Argentina

Late Cretaceous and Cenozoic fishes are well known from innumerable marine localities throughout the world but are mainly restricted to the Northern Hemisphere. Conversely, the diversity of Southern Hemisphere Late Cretaceous and Cenozoic fishes is still very incompletely known. Most Late Cretaceous and Cenozoic fish remains from Argentina were described in the 19th century. However, this material is very limited due to small outcrops and limited collections. Recent field work in Patagonia provides an improved picture of Late Cretaceous to Paleogene chondrichthyans and actinopterygians in high latitudes, demonstrating important ecologic and biogeographical differences from but also similarities to contemporary faunas north of the Equator. The new material comes from the Lefipán Fm. (Maastrichtian-Paleocene), which overlies the Paso del Sapo Fm. (Campanian-Maastrichtian) in the Middle Chubut River Valley, and from the Jagüel (Maastrichtian) and Roca formations (Danian) of the Neuquén Basin providing important insights into faunistic changes across the K-Pg boundary in southern high latitudes. In the Chubut River Valley, the depositional environment changed from a fluvial to tidally influenced estuarine environment in the Paso del Sapo Fm. to an open marine environment in the lower Lefipán Formation. The K-Pg boundary is located within the Lefipán Fm. and is represented by a tide- to wave-dominated deltaic system. In the Neuquén Basin, the position of the K-Pg boundary is

constrained to the base of a sandstone layer within a 90-m-thick succession of monotonous middle to outer shelf mudstones of the Jagüel Fm. Shallow-marine bioclastic limestones of the Danian Roca Fm overlie the Jagüel Fm. The new fish material not only allows some general interpretations of chondrichthyan and actinopterygian assemblages across the K-Pg boundary (e.g., shifting of lamniform to batoid dominated selachian faunas) but the occurrence of characteristic chimeroid remains in the Maastrichtian of Patagonia also supports previous interpretations that the high latitudes of the Southern Hemisphere acted as an origination centre from where subsequent migrations to lower latitudes started.

Romer Prize Session, Thursday 11:45

#### THE EVOLUTION OF AQUATIC FLIGHT: PHYLOGENY, HISTOLOGY AND FUNCTIONAL MORPHOLOGY OF FOSSIL PENGUINS (SPHENISCIFORMES)

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The shift from aerial to underwater flight is one of the most radical transitions in avian evolution. Penguins, archetypical wing-propelled divers, possess a rich fossil record and yield insight into this transition. Here, data from comparative osteology, dissections, CT imaging and bone microstructure are combined in a phylogenetic framework to explore penguin evolution, emphasizing assembly of the underwater flight apparatus. Taxonomic revision grounded in quantifying intraspecific variation results in invalidation of 4 species and erection of 2 new species. Phylogenetic analysis of 60 penguin taxa utilizing 221 morphological characters and 5 genes yields a well-resolved consensus tree that exhibits strong fit to stratigraphy and indicates numerous Tertiary dispersal events. Synapomorphies of the forelimb are spread throughout the cladogram. Dissection of 5 penguins guides identification of osteological correlates of muscles and retia mirabilia, illuminating key soft tissue transitions. The basal penguin *Waimanu* lacks features related to downstroke efficiency (hyperelongate coracoids) and transfer of thrust from wing to body (paddle-like scapula for expanded scapulohumeralis caudalis) seen in all other penguins. Crownward, proximal displacement of the latissimus dorsi insertion (more efficient thrust transfer), and reduction of intrinsic muscles and joints (immobilizing the wing during the thrust-producing upstroke) occur. Histological sections document significantly lower bone density in basal penguins, demonstrating osteosclerosis progressed in the clade via increased remodeling of peripheral medullary trabeculae into compact bone. Reticulate vascular canals and absence of LAGs imply rapid attainment of adult size in giant (>60kg) fossil taxa. CT-rendered endocasts reveal stem penguins possessed a hypertrophied flocculus and sagittal eminence (suggesting complex diving capability) but retained cranial sinuses lost in extant penguins. This study provides a context to explore whether forelimb reorganization, osteosclerosis and neuroanatomy evolve along a similar or alternate trajectory in other clades of underwater fliers (i.e., Plotopteridae and Alcidae).

Poster Session I (Wednesday)

#### REEVALUATION OF FOOTPRINTS AS AN INDICATOR OF LOCOMOTORY LIMB POSTURE IN THE EVOLUTION FROM SPRAWLING TO ERECT GAIT

KUBO, Tai, the University of Tokyo, Bunkyo-ku, Japan

Evolution of Triassic archosaurs is often described with the change in limb posture from sprawling gait to erect gait. The change is documented in the skeletal morphology, especially in pelvis and hindlimb. Footprints may be as efficient as body fossils to document the change. Pace angulation, the angle between three consequent footprints, has been widely used as an indicator of limb posture of the trackmaker. Laterally directing limbs seem to produce the relatively wide trackway with low pace angulation. This assumption however has not confirmed from kinematic analysis. The relation between pace angulation and limb postural category has never been tested properly either. First, I documented contributions of each hind limb segments to trackway width from the video recording of live crocodylians and lizards. In these taxa, femoral length and direction contribute significantly to the trackway width, and trunk width is less than half of the width of trackway. In contrast, trackways made by fully erect mammals are narrower than the width of trunk as the limbs are tucked underneath the trunk. This explains why pace angulation is relatively lower in more sprawling taxa. Second, I collected pace angulations of modern tetrapods from literature and by neochronological experiments to test for a correlation between limb posture categories and pace angulation. As expected, animals belong to more erect categories tend to show higher pace angulation. Although distribution of pace angulation values significantly differ between most postural categories, semi-erect and sprawling taxa are hard to be distinguished in pace angulation alone. The results strongly argue that limb posture is the principal factor for making differences in the pace angulation value. Nevertheless, sufficient numbers of trackways of the same taxa are needed to decide the limb posture of trackmaker. To establish pace angulation as an efficient tool for reconstructing the posture, more neochronological study combined with kinematic analysis are needed.

Poster Session IV (Saturday)

#### NEW DROMAEOSAURID (DINOSAURIA: THEROPODA) FROM THE UPPER CRETACEOUS BAYANSHIREE FORMATION OF MONGOLIA

KUBOTA, Katsuhiko, University of Tsukuba, Tsukuba, Japan; BARSBOLD, Rinchen, Geological Institute, Mongolian Academy of Sciences, Ulaan Baatar, Mongolia

Two skeletons of a new dromaeosaurid were found from the Bayanshiree Formation (early Late Cretaceous) of Shine Us Khuduk (MPD 100/23; a preorbital skull portion and a fragmentary postcranial skeleton) and Teel Ulaan Jalzai (MPD 100/22; a nearly complete postcranial skeleton with a partial skull) of southern Mongolia. To date, the early Late Cretaceous dromaeosaurid from Laurasia has been limited to *Achillobator* from Mongolia and indeterminate dromaeosaurids from North America and Japan. This new Bayanshiree dromaeosaurid allows us to understand the evolution of dromaeosaurids. The Bayanshiree dromaeosaurid is a new taxon and distinguishable from all other dromaeosaurids in having two shallow subalveolar grooves on the labial surface of dentary, convex posterodorsal edge of ischium with posteriorly curved distal end, and transversely extensive distal end of pedal phalanx II-1. A phylogenetic analysis shows a monophyly of the Bayanshiree dromaeosaurid, *Dromaeosaurus*, and *Achillobator*, sharing a single unambiguous synapomorphy (subequal anterior and posterior denticles in size), as Dromaeosaurinae. The Bayanshiree dromaeosaurid differs from *Dromaeosaurus* in having the limited distribution of the lingually twisted anterior carina of anterior maxillary teeth and is different from *Achillobator*, which is also known from the Bayanshiree Formation, in having two pairs of dorsal pleurocoels, a pair of caudal pleurocoel, high ilium with squared posterior end, and proximally positioned obturator process. The tree topology of Dromaeosauridae (Unenlagiinae + Microraptorinae + (Dromaeosaurinae + Velociraptorinae)) based on our phylogenetic analysis agrees with most of previous studies. The interrelationships within Dromaeosaurinae are unresolved because of few overlapped elements among the component taxa (*Achillobator*, *Dromaeosaurus*, and the Bayanshiree dromaeosaurid). *Adasaurus* from Mongolia has been considered as a dromaeosaurine, but our analysis suggests that it is nested within Velociraptorinae and is a sister taxon to *Tsaagan*.

Poster Session IV (Saturday)

#### A HISTORY OF UNITED STATES PALEONTOLOGICAL LEGISLATION

KUIZON, Lucia, Bureau of Land Management, Washington, DC, USA

Since the early 20th Century there have been many legislative attempts by the United States to manage paleontological resources on federal lands. Legislation ranged from protection to exploitation of paleontological resources. Early legislation such as the Antiquities Act of 1906 protected fossils as "objects of antiquity" or "objects of scientific interest." Current federal statutes protect paleontological resources in context with either archeological or cave resources. Some statutes provide for the salvage of paleontological resources when threatened by federal construction projects. In 1982 the Bureau of Land Management promulgated draft regulations that would limit hobby rock and fossil collecting on public lands but would also allow commercial collection. As a result of vehement protests against the proposed regulations, South Dakota Senator Larry Pressler introduced S.1569 in 1983, which provided a new federal policy for scientific, commercial, and private collecting of vertebrate fossils. In 1990, the *Tyrannosaurus rex* known as "Sue" was found in South Dakota, and that discovery set off the 20th Century "bone wars" between professional paleontologists and commercial collectors. In 1991 a scientifically significant *Allosaurus* discovery ("Big Al" MOR 693) in Wyoming was inadvertently almost lost to science. This incident triggered the introduction of S.3109 in 1992 by Montana Senator Max Baucus to limit vertebrate fossil collecting to paleontologists and amateur collectors by permit. As a result of this bill, amateur rockhounds began lobbying against any legislation that would limit their unrestricted access to collecting on federal lands. Their efforts came to fruition in 1996 with the introduction of H.R.2943 by South Dakota Congressman Tim Johnson which proposed collecting by amateurs, scientists, and commercial collectors with and without permits. In the late 1990's a series of studies by the National Park Service and U.S. Forest Service revealed shocking statistics on the theft of fossils from federal lands. A new legislative attempt then began to protect paleontological resources in the 107th Congress and continues today in the 110th Congress.

Poster Session IV (Saturday)

#### COMBINED MORPHOMETRIC AND PHYLOGENETIC STUDIES OF NEW METATHERIAN PETROSAL BONES FROM THE LATE PALEOCENE OF ITABORAÍ (BRAZIL): EVIDENCE OF THE EARLY EVOLUTION OF THE AUSTRALIDELPHIA (METATHERIA, MAMMALIA) IN SOUTH AMERICA

LADEVÈZE, Sandrine, Muséum National d'Histoire Naturelle, Paris, France

The systematics of extinct mammals is mostly based on teeth, which are better preserved than skull bones. Nonetheless, petrosals (paired bones of the ear) are more frequent than the latter, and proved to bring significant phylogenetic signal. Paleocene layers from Tiupampa (Bolivia) and Itaboraí (Brazil) have yielded partial to complete metatherian skulls with associated petrosal bones and isolated metatherian petrosals, respectively. Both localities are of a primary importance in the understanding of the Notometatheria (South American and Australian metatherians) evolutionary history,



since they provide the most abundant and the oldest metatherian assemblage of South America. The metatherian petrosal bones from the mid to Late Paleocene of Itaboraí belong to eight morphotypes (I to VIII). An attempt at assigning the isolated petrosals to tooth-based taxa from Itaboraí was made by combining parsimony and morphometric methods. Morphometric studies show that molars proportions are correlated with that of petrosals; however, the assignment of an isolated petrosal to a dental-based taxon remains difficult. A parsimony analysis highlighted the close relationship of petrosal Types I, V, VI, VII, *Caenolestes* and Australidelphia. The identification of a stem-Australidelphia (petrosal Type V) among the Paleocene fauna of Itaboraí makes the stratigraphic origin of Australidelphia older than previously thought.

Technical Session XIV, Saturday 11:45

A NEW LARGE-BODIED THERIZINOSAURID (DINOSAURIA: THEROPODA) FROM THE EARLY CRETACEOUS OF NORTHWESTERN CHINA

LAMANNA, Matthew, Carnegie Museum of Natural History, Pittsburgh, PA, USA; YOU, Hailu, Chinese Academy of Geological Sciences, Beijing, China; LI, Daqing, Third Geology & Mineral Resources Exploration Academy of Gansu Province, Lanzhou, China; PENG, Cuo, Third Geology & Mineral Resources Exploration Academy of Gansu Province, Lanzhou, China; HARRIS, Jerald, Dixie State College, St. George, UT, USA

We report a new taxon of large therizinosauroid theropod dinosaur based on two associated partial postcranial skeletons recently recovered from the same horizon of the Lower Cretaceous (?Aptian-Albian) Xinminpu Group in the Yujingzi Basin of Gansu Province, northwestern China. The first specimen preserves multiple dorsal vertebrae and ribs, the complete right scapulocoracoid and humerus, the largely complete left pubis, and additional pelvic fragments. The second specimen consists of a continuous series of caudal dorsal, sacral, and proximal caudal vertebrae, as well as dorsal ribs, chevrons, the nearly complete left pelvic girdle and femur, and the distal end of the right femur. The two specimens are unique among therizinosauroids in possessing a strongly concave cranial margin of the pubis; moreover, all skeletal elements shared between them are essentially identical, justifying the assignment of both to the same species. Additional probable autapomorphies of the new Gansu therizinosauroid include a shallow, poorly demarcated glenoid fossa with a prominent rounded and striated tumescence on the dorsomedial surface of its scapular portion, a laterally deflected, thin and flat iliac preacetabular process with a smoothly curved craniodorsal margin, and a greatly expanded bulge on the caudal margin of the ischium. Phylogenetic analysis of 12 therizinosauroid ingroup taxa and 65 osteological characters recovers the Gansu form within the derived therizinosauroid subclade Therizinosauridae, as the sister taxon of *Nothronychus mckinleyi* from the early Late Cretaceous of the southwestern United States. Along with "*Nanshiungosaurus bohlini*" from possibly correlative beds in the Gongpoquan Basin of northernmost Gansu, the new taxon represents one of the largest-known Early Cretaceous therizinosauroids, demonstrating that the clade attained considerable body size early in its evolutionary history.

Poster Session III (Friday)

ARE THE SHOVEL-TUSKED GOMPHOTHERES (PROBOSCIDEA, GOMPHOTHERIIDAE) MONOPHYLETIC OR POLYPHYLETIC?

LAMBERT, W. David, Louisiana School for Math, Science and the Arts, Natchitoches, LA, USA

Uncertainty exists as to whether the shovel-tusked gomphotheres (i.e., shovel-tuskers) represent a monophyletic group (sometimes referred to as a distinct family, Amebelodontidae), or whether they are an assemblage of separate gomphotherine lineages that have independently converged on the shovel-tusked condition. Beyond their possession of flattened lower tusks the following cranio-dental characters have been proposed as shovel-tusker synapomorphies: 1) loss of a sagittal crest; 2) the possession of both pre-trite and post-trite conules/conulids (features that upon wear yield the double trefoil condition); 3) elongated third molars (greater than 4+ loph/lophids, the condition found in *Gomphotherium*), and 4) a roughly straight surface on the medial edge of the lower tusks. These proposed shovel-tusker synapomorphies are all problematic. Sagittal crests are known to vary widely in mammals depending on the diets of the individual species, and indeed one shovel-tusker (*Platybelodon*) appears to have a sagittal crest. The double trefoiling condition is known to vary significantly in shovel-tuskers, particularly *Amebelodon*. A similar situation exists in *Amebelodon* third molar lengths, with some shovel-tuskers having third molars that are indistinguishable from those of *Gomphotherium*. Finally, the development of the lower tusk medial edge in shovel-tuskers varies, with this feature being almost completely rounded in some shovel-tusker specimens. Thus, no synapomorphies beyond lower tusk flattening reliably unite all of the shovel-tuskers. Flattened lower gomphotherine tusks show an incoherent geographical and chronological distribution, and a shovel-tusker-like condition has been observed in unusual individual *Gomphotherium* lower tusks from both Old and New World sites. The most parsimonious interpretation of this evidence is that flattened lower tusks evolved in parallel from *Gomphotherium* stock multiple times, and therefore that the shovel-tusked gomphotheres do not represent a monophyletic group.

Poster Session I (Wednesday)

IGUANIAN PHYLOGENY AS INFERRED FROM MORPHOLOGY, NUCLEAR AND MITOCHONDRIAL DNA: A NOVEL PLACEMENT OF CRETACEOUS TAXA

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Iguanians are a clade of relatively large-bodied, arid adapted squamates with a significant but discontinuous fossil record beginning in the Cretaceous. Many of the early iguanian fossils are from Asia, but the majority of living taxa are from the New World. The evolutionary relationships among major iguanian groups remain poorly understood. Prior phylogenetic analyses of morphological and molecular data have yielded conflicting results with limited statistical support. In this study, we combine published and new molecular sequence data with the most comprehensive morphological data set for iguanians assembled to date. We present a phylogenetic analysis of 91 taxa comprising 55 extant and extinct iguanians, 28 scincogekkonomorphs and non-squamate outgroup taxa including *Proganochelys*, *Parapladocudus*, *Gephyrosaurus*, *Planocephalosaurus* and *Diphydontosaurus*. Both fossil and living taxa were coded for 239 morphological characters. Additionally, molecular data from four mitochondrial (ND1, ND2, 12S, 16S) and four nuclear (RAG1, C-mos, GAPD, BDNF) genes were obtained for a subset of living species. These data place the Early Cretaceous taxa *Huehuecuetzpalli* and *Hoyalacerta* within Iguanomorpha, rather than among basal squamates as initially proposed. The presence of an extinct clade of Cretaceous iguanians endemic to the Gobi is likewise supported. Moreover, our results suggest a clade comprising Phrynosomatidae, Corytophanidae, Hoplocercidae and Polychrotidae. The monophyly of Polychrotidae, previously called into question, is supported to the exclusion of Corytophanidae. A monophyletic Tropiduridae is not supported.

Poster Session IV (Saturday)

EVIDENCE OF EARLY RADIATION IN SAUROPODA: NEW DATA ON MIDDLE JURASSIC EUSAUROPODS

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Sauropod dinosaurs are mainly documented from Late Jurassic and Cretaceous forms, the Neosauropoda, commonly divided into two monophyletic groups of very well-known sauropods: the Diplodocoidea (Diplodocidae and Rebbachisauridae) and the Macronaria (*Camarasaurus* and titanosauriforms). On the other hand, Early and Middle Jurassic basal Eusauropoda remain poorly known. The rarity of Middle Jurassic sauropods is essentially related to the scarcity of their geological continental deposits. Nevertheless, these are key-taxa in the understanding of the radiation of the Late Jurassic and Cretaceous Neosauropoda and the evolution of Sauropoda in general. However, these sauropods remain poorly represented in cladistic analyses (4 to 7 taxa), since their anatomy is still badly known and they display an 'intermediary' morphology, combination of primitive, derived, and sometimes 'intermediary' anatomical features. Their phylogenetic relationships with the other sauropods remain therefore ambiguous, as they are regarded either as small monophyletic groups (as cetiosaurids or euhelepodids) or as a polyphyletic group. This study proposes here to consider as many Middle Jurassic taxa as possible, including those that are best known as well as new species from Algeria (*Chebsaurus algeriensis*) and from France (not yet named). It also leads to the clarification of the systematic status of some Middle Jurassic sauropods housed in the Muséum National d'Histoire Naturelle, in Paris: the Bathonian Malagasy "*Bothriospondylus madagascariensis*" and *Lapparentosaurus madagascariensis* and the Bathonian Moroccan "*Cetiosaurus mogrebiensis*". Included in a cladistic analysis, these new data improve significantly the knowledge of the Middle Jurassic sauropods and their phylogenetical affinities, but also emphasize a Middle Jurassic adaptative radiation of sauropods in the context of the break-up of Pangea.

Technical Session XIV, Saturday 8:45

THE INCLUSIVITY AND PHYLOGENETIC POSITION OF *GUAIBASAURUS CANDELARIENSIS*: A BASAL DINOSAUR FROM THE LATE TRIASSIC OF BRAZIL

LANGER, Max, USP, Ribeirão Preto, Brazil; BITTENCOURT, Jonathas, USP, Ribeirão Preto, Brazil; SCHULTZ, Cesar, UFRGS, Porto Alegre, Brazil

The basal dinosaur *Guaibasaurus candelariensis*, from the Late Triassic Caturrita Formation, South Brazil, is known from three attributed specimens. These include holotype, paratype, and a newly referred partial skeleton, UFRGS PV0725T. The first-hand and (for the first time) side-by-side examination of all the specimens allowed a better understanding of the taxon they represent. *G. candelariensis* can be diagnosed by at least one autapomorphy, observed in both the holotype and UFRGS PV0725T: an excavation on the lateral surface of the medial acetabular wall of the ilium, just cranial to the ischiadic peduncle. Besides, the three specimens agree in almost any anatomical detail, strongly supporting their referral to a single dinosaur species, the phylogenetic position of which is, however, harder to determine. Merely the scoring of the more complete UFRGS PV0725T into datasets of previous cladistic studies (based only on

the type-series of *G. candeleriensis*) did not resolve its position as either a theropod or a non-eusaurischian saurischian. Yet, new data gathered from that specimen strengthen its position as a saurischian closely related to Eusaurischia. *G. candeleriensis* possesses the hand corresponding to more than 40% of the humerus+radio length, the metacarpal I with asymmetric condyles and shorter than the respective ungual, the twisted first phalanx of digit I as the longest non-ungual phalanx of the hand, and the metacarpal III slightly shorter and narrower than 70% of metacarpal II. Moreover, *G. candeleriensis* shares with theropods in general, and coelophysoids in particular, a distal tibia with oblique cranial margin and excavated caudomedial corner, a tibia-astragalus articulation, and a marked longitudinal groove excavating the lateral surface of the cnemial crest. In this context, features shared by *G. candeleriensis* and *Saturnalia tupiniquim* such as a long iliac postacetabular ala, an ischio-acetabular groove, and a pointed caudomedial prong of the lateral distal tarsal, are interpreted as basal eusaurischian simpliomorphies, and not evidences for a close association between the two taxa, as previously proposed.

Poster Session III (Friday)

#### SKINNING A *TRICERATOPS*

LARSON, Peter, Black Hills Institute, Hill City, SD, USA; LARSON, Matt, Black Hills Institute, Hill City, SD, USA; OTT, Christopher, University of Manchester, Manchester, United Kingdom; BAKKER, Robert, Houston Museum of Natural Science, Houston, TX, USA

The Late Cretaceous Age Lance Formation of Wyoming has produced ornithischian dinosaur integument for the past 100 years. Although *Triceratops* is one of the most abundant faunal components of the Lance and equivalent formations in the Western Interior, integument for *Triceratops* has yet to be reported. In 2002 Black Hills Institute collected one of the most complete skeletons of *Triceratops horridus* (BHI-6273) found to date from the Zerbst Ranch, near the site of the famous *Edmontosaurus annectens* "mummy" (AMNH-5060) collected by C. H. Sternberg in 1908. The presence of skin was noted before excavation, and the specimen was removed in large blocks, one weighing an estimated 8 metric tons. Subsequent preparation has revealed at least six major integument types from different regions of the body, some in excess of one square meter in area, and with tubercles up to 10 cm across. Some of the skin resembles the single patch found with *Chasmosaurus belli*, the only reported integument for chasmosaurinae. However, other textures bear no resemblance what so ever. This discovery, which will be permanently housed at the Houston Museum of Natural Science, paints a very different picture of the living animal than has been imagined.

Romer Prize Session, Thursday 11:00

#### HOW DINOSAURS GREW AND THE RELATIONSHIP BETWEEN GROWTH RATES AND BONE VASCULAR ORGANIZATION

LEE, Andrew, University of California, Berkeley, Berkeley, CA, USA

Recently, comparative ontogeny has advanced studies of dinosaur evolution. A growing body of evidence suggests that body sizes and estimated growth rates of non-avian dinosaurs are correlated. At one extreme, gigantism in some clades occurred by phyletic increases in growth rate, and at the other, nanism occurred by phyletic depressions in growth rate. In contrast, how phyletic changes in growth rates influenced histological features such as vascular canal organization is less understood. Calculations of growth rates, however, are sensitive to the methods of age estimation and choice of growth models. Error in one or both of those affects interpretations of growth rates and other life history traits. Here, I present a framework to reconstruct bone growth in dinosaurs and to account for errors in the estimation of growth rates. Twelve published and unpublished sets of skeletochronological data from the long bones of dinosaurs were analyzed. Annual lines of arrested growth (LAGs) were counted, and their circumferences were measured. However, medullary cavity expansion and cortical remodeling remove or obscure LAGs. Thus, five methods of LAG retrocalculation were used to estimate the number and location of missing LAGs. Median age estimates were calculated, and confidence intervals were constructed through bootstrapping. Furthermore, case-specific information was assessed using information criteria, which provides the statistical means to select the best descriptive model of bone growth for a given data set. From those models, mean growth rates were calculated and phyletic trends were assessed using ancestral state reconstruction. The results suggest that most dinosaur data sets are best described by linear and power models. The results also confirm the coincidence between phyletic increases in bone growth rate and body size. Furthermore, with the exception of birds, the duration of growth is not correlated with size. Phyletic increases in growth rates rather than duration explain why larger taxa have a proportionately greater radial organization of vascular canals than smaller ones.

Poster Session III (Friday)

#### AVIAN EGGSHELL FROM A CARBONATE MUDFLAT SHORELINE OF EOCENE FOSSIL LAKE

LEGGITT, V., Loma Linda University, Loma Linda, CA, USA; BIAGGI, Roberto, Universidad Adventista del Plata, Entre Rios, Argentina; BUCHHEIM, H., Loma Linda University, Loma Linda, CA, USA

Eggshell fragments are common extraclasts in a 0.5 m thick micrite ledge that is stratigraphically located near the top of the Angelo Member of the Green River Formation at Elk Mountain, Lincoln County, Wyoming. The micrite ledge forms a prominent white marker unit that can be subdivided into four subunits at the study site. The XRD carbonate mineralogy of these subunits varies between 5 and 100% dolomite. Oxygen stable isotopes vary between -13.31 and -2.11‰ (V-PDB). Two calcite-dominated subunits are associated with negative oxygen stable isotope excursions, intraclasts (rip-up clasts), extraclasts (eggshell fragments), gastropods, ostracods and root traces. These paleoenvironmental proxies indicate rapid freshwater transgression events. Two dolomite-dominated subunits are associated with positive oxygen stable isotope excursions. These proxies are interpreted as indicators of subaerial exposure. The eggshell was studied by light microscopy, polarized light microscopy and scanning electron microscopy. The resultant micrographs were compared with published reports of modern and/or fossil ornithoid, crocodyloid, testudoid, dinosauroid and geckoid eggshell. 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. The columnar layer to mamillary layer ratio is 3:1. These findings are consistent with modern Neognathous eggshell. The avian eggshell fragments indicate proximity to an avian nesting site that produced eggshell fragments (subaerially produced extraclasts) that were later incorporated into calcimicrite deposited during a subsequent freshwater flooding of the carbonate mudflat.

Poster Session III (Friday)

#### NEW THEROPOD AND ORNITHISCHIAN FOOTPRINTS AT THE DINOSAUR FOOTPRINT STATE RESERVATION (EARLY JURASSIC, PORTLAND FORMATION), HOLYOKE, MASSACHUSETTS, USA.

LEPORE, Taormina, University of Massachusetts Amherst, Winchester, MA, USA

The Dinosaur Footprint State Reservation, Holyoke, MA, has been known to paleoichnologists for over 170 years, and has been the subject of a variety of studies throughout this time. The large footprints of the ichnogenus *Eubrontes* in particular exhibit a curious directionality that may indicate gregariousness in the dinosaurs they represent. However the smaller, more poorly preserved footprints at this site have received comparatively little attention. I have examined 38 square meters of the site, mapping 343 partial or complete bipedal dinosaur footprints, all of which, with the exception of *Eubrontes*, are individual prints with no preferred orientation. Tracks that could be accurately identified to the genus level include the theropod ichnogenus *Eubrontes*, *Anchisauripus* and *Grallator*, as well as the ornithischian ichnogenus *Anomoepus*. A new map demonstrates the abundance of identifiable footprints previously overlooked due to poor preservation, the spatial relationship between *Eubrontes* and non-*Eubrontes* tracks, and the ecological diversity represented at this site.

Poster Session I (Wednesday)

#### VERTEBRATE PALEONTOLOGY OF THE TINAJAS LOCALITY, UPPER PENNSYLVANIAN (MISSOURIAN) ATRASADO FORMATION, SOCORRO COUNTY, NEW MEXICO

LERNER, Allan, New Mexico Museum of Natural History, Albuquerque, NM, USA; LUCAS, Spencer, New Mexico Museum of Natural History, Albuquerque, NM, USA; IVANOV, Alexander, Dept. of Paleontology, St. Petersburg University, St. Petersburg, Russia

New Mexico has an important Late Pennsylvanian vertebrate record that is primarily known from the early Virgilian Kinney Brick Quarry. We add to this record by documenting here a moderately diverse assemblage of actinopterygians, sarcopterygians, acanthodians and a chondrichthyan from the Tinajas locality (NMMNH 4667) in Upper Pennsylvanian (Missourian) strata of the Atrasado Formation of Socorro County. The fossils occur in a 4-m thick interval of thinly laminated, dark gray shale that is stratigraphically low in the Atrasado Formation. The sediments, fauna and flora within this interval indicate that deposition took place within a coastal lacustrine environment that had some limited exchange with shallow marine waters. Fossil assemblages above this 4-m-thick interval indicate a transition to fully marine conditions. The most abundant remains of the Tinajas locality fish fauna are palaeonisciform elements. These include disarticulated scales and bones belonging to *Elonichthyidae*, *Haplolepididae* and cf. *Platysomidae*. Palaeonisciform scales are also found within vertebrate coprolites at this locality, which indicates that they were probable prey items. A single, partially preserved palaeonisciform caudal fin with squamation and fin rays has also been found. Sarcopterygian remains at this locality consist of rhizodontiform scales, teeth and bones that are probably referable to *Strepsodus*. Osteolepiform scales that are probably referable to *Greiserolepis* or *Megalichthyes* also occur. The sarcopterygian elements are relatively less abundant than the actinopterygians. Acanthodian

remains are relatively scarce and include a scapula belonging to *Acanthodes* and isolated fin spines. The chondrichthyan is represented by a single xenacanth tooth assignable to *Orthacanthus*. The fishes from the Tinajas locality represent a predominantly freshwater to brackish assemblage. This locality is unique as it is the only lacustrine deposit known from the Paleozoic of New Mexico.

Student Poster Session (Thursday)

GETTING A LEG UP ON THE COMPETITION: DECIPHERING THE DIFFERENCES AND SIMILARITIES OF LIMB PROPORTIONALITY IN OLIGOCENE AND MODERN MAMMALS

LEVERING, David, University of Oregon, Silverton, OR, USA

Limb proportionality is a measurement often linked to an organism's cursoriality, or running capability, in which a longer distal bone relative to the proximal infers greater cursorial capacity. As the forests of Oligocene North America opened up, converting to grasslands and wooded savannas, ability to run at distance and speed was selected for escape from predators, and to minimize energy expenditure during locomotion. In this study, limb proportions were measured in a variety of modern and Oligocene taxa. ANOVA and regression analysis were used as the primary methods of statistical analysis. Comparisons have been made in limb proportionality within predator and prey taxa, both within time periods and between time periods. The results of this study have revealed unforeseen patterns of limb evolution between the modern and Oligocene taxa, both in predators and prey. Significant difference in the forelimb is found in Oligocene predators and prey, which is mirrored in their modern counterparts. Significant difference is also seen in the proportionality of the hindlimb between Oligocene and modern taxa. The first of these differences is thought to be correlated to supinatory requirements in the predator forelimb versus the restriction of rotation seen in the prey forelimb. The second is believed to reflect the advancement of straightening the back, providing additional surface area for muscle attachment, and helping increase the overall stride length. All of these characters are known factors in bolstering an organism's cursorial capacity.

Student Poster Session (Thursday)

PRELIMINARY REPORT ON THE VERTEBRATES OF THE WESTPHAL QUARRY, WYOMING (MORRISON FORMATION: LATE JURASSIC), WITH SPECIAL ATTENTION TO THE HYPsilOPHODONTID MATERIAL

LEVITT, Carolyn, The University of Wisconsin-Madison, Madison, WI, USA

The Westphal Quarry (Morrison Formation: Late Jurassic) is located on the eastern edge of the Bighorn Basin near Hyattville, Wyoming. Over the past five field seasons the quarry has yielded the remains of a diverse vertebrate assemblage including lungfishes, ray-finned fishes, turtles, lizards, numerous dinosaurs, and possible amphibians. More specifically, the dinosaur fauna consists of small theropods, *Allosaurus*, *Apatosaurus*, *Camarasaurus*, an ankylosaur, and a variety of small ornithischians including the "hypsilophodontid" *Othnielosaurus*. The sedimentology at the site is dominated by fine-grained sandstone and siltstone representing a fluvial depositional environment. It also features thin conglomerate layers with soil clasts and rounded dinosaur bone fragments. Apart from these, the bones show little or no evidence of transport. Much of the "hypsilophodontid" material is pending more specific identification, but two specimens are tentatively assigned to *Othnielosaurus*. One is a nearly complete left dentary measuring 78 mm in length with nine teeth, eight of which are *in situ*. The teeth appear to have about ten denticles each and are lacking the trifold cusp pattern diagnostic of *Drinker*. The other is a right complete femur measuring 142 mm in length. The minimal distance from its proximal end to the distal edge of the fourth trochanter is 61 mm. Both measurements are consistent with published descriptions of *Othnielosaurus* femora, especially those of BYU ESM163 and USNM 8397.

Poster Session IV (Saturday)

A DIVERSE NEW MICROVERTEBRATE FAUNA FROM THE UPPER CRETACEOUS (LATE SANTONIAN-EARLY CAMPANIAN) MENELEE FORMATION OF NEW MEXICO

LEWIS, Caleb, University of New Mexico, Albuquerque, NM, USA; HECKERT, Andrew, Appalachian State University, Boone, NC, USA; LUCAS, Spencer, New Mexico Museum of Natural History and Science, Albuquerque, NM, USA; WILLIAMSON, Thomas, New Mexico Museum of Natural History and Science, Albuquerque, NM, USA

The Upper Cretaceous (late Santonian-early Campanian) Menefee Formation represents a time period that is largely unrepresented by the fossil record of Western North America. The Menefee Formation represents a fluvio-deltaic depositional environment that encompasses a variety of sub-environments. A recently discovered microvertebrate site (L-5636) in the Allison Member of the Menefee has yielded a surprisingly abundant and diverse vertebrate faunal assemblage that greatly expands our knowledge of the Menefee fauna. Taphonomic analysis indicates little transportation of the aquatic faunal material, but the terrestrial fauna represents a unique assemblage that was collected with the aquatic fauna. Aquatic vertebrates, principally chondrichthyans and osteichthyans, dominate the assemblage. Multiple genera of sharks and rays were recov-

ered, including *Lonchidion*, *Squatina*, *Squatirhina*, *Ischyrhiza*, *Ptychotrygon*, *Dasyatis*, *Myledaphus*, *Cretodus*, *Scapanorhynchus*, *Serratolamna*, *Cretolamna*, *Carcharias*, and very rare *Chiloscyllium*, and *Cretorectolobus*, and possibly new taxa. Generically indeterminate osteichthyans (lepisosteids, amiids, pycnodontids, and phylloodontids) are also common. Numerous *Brachychampsia*-like crocodylian teeth also occur at the site. Theropod dinosaurs recovered include Tyrannosauridae indet., *Saurornitholestes*, *Richardoestesia isosceles* and *R. gilmorei*, although these taxa are still relatively rare and represented only by teeth. Other dinosaur remains include two embryonic or neonatal hadrosaur dorsal vertebrae and numerous hadrosaur teeth. Significant in the assemblage are the oldest confirmed mammal fossils from New Mexico, represented by a four multituberculate, and three cf. *Marsupialia* premolars. Other vertebrate remains from the site include squamate lizard scales, a possible sphenodontid lizard jaw fragment, turtle shell fragments, indeterminate fish scales, fish bone fragments, chondrichthyan dermal denticles, and possible lissamphibian remains. Biostratigraphic estimates for the age of the site are most probably 83 Ma, and definitely to 80-83.5 Ma, rendering it earliest Campanian in age.

Carnivora: Phylogeny, Form and Function Symposium, Saturday 11:15

FUNCTIONAL SIGNIFICANCE OF SKELETAL ALLOMETRY IN CARNIVORA: IMPLICATIONS FOR MACHAIRODONT FELIDS

LEWIS, Margaret, The R. Stockton College of NJ, Pomona, NJ, USA; LAGUE, Michael, The R. Stockton College of NJ, Pomona, NJ, USA

Little attention has been paid to the impact of body size on machairodont felid morphology except when reconstructing body mass. The extent to which variation among these extinct felids reflects allometric scaling trends is unknown. This study investigates machairodont postcranial morphology in light of scaling patterns in extant felids and other carnivorans. Linear measurements (limb bone lengths, midshaft diameters, and articular dimensions) were made in various extant and fossil carnivorans including *Dinofelis*, *Homotherium*, *Megantereon*, and *Smilodon*. Linear regressions were used to quantify scaling relationships and to test the null hypothesis of geometric similarity. Extant felid skeletal dimensions exhibit strong correlations, with notable outliers (e.g., cheetahs and servals). Midshaft diameters scale with positive allometry, with some close to elastic similarity or beyond. Scaling trends vary within a given articular surface and even between midshaft diameters of the same bone. Forelimb features typically exhibit scaling coefficients exceeding those in the hindlimb. While most long bone lengths scale isometrically, tibial length is negatively allometric (i.e., larger extant felids have relatively shorter hindlimbs). We discuss these results in light of known interlimb loading differences and recent experimental research on scaling of felid limb posture. Among machairodonts, some exhibit forms predicted by extant regressions, while others do not. Separate regressions for subsets of machairodonts displaced from the extant regression line often show similar scaling trends to extant felids (i.e., similar slope with a different y-intercept), suggesting similar responses to mechanical factors. A given machairodont taxon may fall on the extant regression line for one character pair, yet may not do so for others. In sum, shape variation among machairodont taxa is not strictly due to differences in habitual limb use, but also involves design differences related to body mass variation. Future functional investigations of these taxa must take these multiple influences into account.

Poster Session I (Wednesday)

A PLEISTOCENE FAUNA FROM THE KOANAKA HILLS, BOTSWANA: IMPLICATIONS FOR REGIONAL PALEOENVIRONMENT

LEWIS, Patrick, Sam Houston State University, Huntsville, TX, USA; STIDHAM, Thomas, Texas A&M University, College Station, TX, USA; KENNEDY, Alicia, Sam Houston State University, Huntsville, TX, USA

Recent excavations in cave deposits of the Koanaka Hills, Botswana have produced a diverse fauna conservatively dated using thermoluminescence to 390 ka. These deposits yielded fossils of many taxa, including a large microfaunal component. Among the many rodent taxa are the genera *Otomys* sp. (vlei rat) and *Statomys* sp. (fat mouse), both associated with swampy environments today. Among the nonmammalian taxa recovered are several birds, including buttonquail, rails, and passerines, as well as reptiles and amphibians. The presence of *Turnix* sp. (buttonquail) and several amphibians are suggestive of wet habitats and the likely presence of a permanent water source. When the paleoenvironmental signature of this fauna is compared to other fossil faunas in the vicinity, a clearer picture of environmental change through the Plio-Pleistocene is possible. Prior excavations in the Koanaka Hills deposits in sediments dated to 2 Ma indicate an arid environment without a significant year round availability of water. Excavations from Drotsky's cave, a terminal Pleistocene site 20 km from the Koanaka Hills, however, preserves a fauna again suggestive of a moister habitat with a permanent water source. The present climate in this region of the Kalahari is semi-arid, with annual rainfall of 400-450 mm per year. The Plio-Pleistocene paleoclimatic pattern, therefore, appears to be one of semi-arid conditions in the earliest Pleistocene, with wetter conditions prevailing by the late middle Pleistocene. These conditions persist until the Holocene, when there is a return to semi-arid conditions. The general drying trend for southern Africa, therefore, does not appear in the Koanaka Hills region. The modern Okavango Delta, however, is 150 km from the site. The pattern of prolonged

wetter conditions at Koanaka Hills may be the result of a mesoscale pattern where the Okavango Delta is exhibiting a stronger influence on the mid to late Pleistocene environments. Alternatively, the Koanaka Hills and Drotskys Cave faunas may be indicative of cyclic changes in the region's environment.

Technical Session XIII, Friday 1:15

LOWER CRETACEOUS VERTEBRATE FAUNA FROM THE SINUIJU BASIN, NORTH KOREA AS EVIDENCE OF GEOGRAPHIC EXTENSION OF THE JEHOL BIOTA INTO THE KOREAN PENINSULA

LI, Quanguo, Peking University, BEIJING, China; GAO, Ke-Qin, Peking University, Beijing, China

The Lower Cretaceous Sinuiju Series exposed in the Amnok River Basin, North Korea, yielded a potentially important vertebrate fauna as part of the renowned Jehol Biota. The fossil-bearing beds of the Sinuiju Series consist of a set of clastic deposits of fine-grained sandstone, mudstone, tuffaceous shale, and andesite with a total thickness of over 1000 meters. The Series rests unconformably on top of the underlying Paleo-proterozoic metamorphic rocks, and underlies the Cretaceous Taobo System and Palaeogene strata. Vertebrate fossils collected from the Sinuiju Series include fish, frogs, choristoderes, birds, theropod dinosaurs, and pterosaurs. Among these, probably the most significant are the so-called "Archaeopteryx of Korea" and the "ancient frog." The "Archaeopteryx of Korea" shows the first metacarpal not fused with the second metacarpal or the semilunate plate, the first phalanx of manual digit III much shorter than the remaining nonungual phalanges, and the claw of the manual digit II smaller than the claws of digits III and I. These characters indicate a confuciusornithid relationship of this Korean bird. The "ancient frog" can be best identified as "Anura incertae sedis." In addition, several other specimens represent an enantiornithine bird. The best-preserved material so far collected from the Sinuiju Series is a pigeon-sized anurognathid pterosaur skeleton, with a skull broader than long. The fossil beds contain the characteristic *Eossetheria-Ephemeropsis-Lycoptera* complex of the Jehol Biota; therefore, the Sinuiju fauna represents a geographic extension of the Jehol Biota from western Liaoning of China into the Korean Peninsula.

The Dissorophoidea - Early Amphibian Radiation Symposium, Friday 8:45  
FINALLY GROWN UP - THE SIGNIFICANCE OF ADULT MICROMELERPETON

LILLICH, Rabea, Staatliches Museum fuer Naturkunde, Stuttgart, Germany; SCHOCH, Rainer, Staatliches Museum fuer Naturkunde, Stuttgart, Germany

The primitive dissorophoid *Micromelerpeton credneri* has been long known from hundreds of larval specimens. Its poorly ossified skeleton, the presence of lateral line sulci and branchial denticles suggested that it was neotenic. Specimens collected from a different lake deposit than the classical *Micromelerpeton* are markedly larger than those from the type horizon. They differ in having a longer snout, polygonal ornament, presence of a quadrate, a stout humerus, incipient ossification of carpals, bony centra and a pubic bone. In both their size and morphology, the smallest specimens of the new sample overlap with the largest individuals previously known, showing that they belong to the same species. Unlike branchiosaurids and lissamphibians, *Micromelerpeton* did not undergo a drastic metamorphosis. Rather, late larval ontogeny involved gradual changes, with adults being merely more strongly ossified and lacking lateral line sulci. This suggests that adult *Micromelerpeton* was capable of land excursions. The adult features indicate that *Micromelerpeton credneri* nests at a rather basal position within the Dissorophoidea. Plesiomorphic character-states not shared by other dissorophoids are the short stout humerus and the elongated posterior skull table in which supratemporal and squamosal have a long sutural contact. Unlike the larvae, adults of *Micromelerpeton* developed a laterally exposed palatine separating the lacrimal from the jugal, which is one synapomorphy of dissorophoids that was formerly not known from the genus.

Poster Session IV (Saturday)  
TWO DINOSAUR MUSEUMS AS SUCCESS AND HEYDAY OF KOREAN VERTEBRATE PALEONTOLOGY

LIM, Jong-Deock, National Natural Heritage Center, Daejeon, Korea, South; HUH, Min, Chonnam National University, Gwangju, Korea, South; YANG, Seong-Young, Kyungpook National University, Daegu, Korea, South

The history of Korean vertebrate paleontology can be distinguished into four periods. The first period, beginning in 1915, was the time when Japanese paleontologists began to research on Cenozoic mammals. The second period is from the end of World War II to 1981. Only a few scientific papers on Pleistocene vertebrates from limestone caves and Cretaceous bird trace fossils were published. The actual research and fieldwork on vertebrate fossils, including large-scale excavations, began between the third (1982-1996) and the fourth (1997-present) periods. During this time, vertebrate paleontologists, as well as international joint-research collaborators, reported eggs, trackways, skeletons, isolated teeth of dinosaurs. Korean vertebrate paleontologists discovered teeth and wing-bones of pterosaurs, crocodilian skulls, complete skeletons of fishes, and skeletons of turtles from Mesozoic beds. The southern coast of the Korean Peninsula brought the world-renowned sites for Cretaceous dinosaur footprints and

bird tracks. Korea is also well known for the world's largest Late Cretaceous pterosaur tracks. The total of 443 pterosaur footprints was excavated from the Uhangri Formation in Haenam area. Those sites are designated as an UNESCO World Heritage Candidate. The fourth period is considered as the golden age for Cenozoic vertebrate fossils, such as whales, rodents, fishes. The Goseong Dinosaur Museum (2004) is the first of its kind to be constructed in the image of a dinosaur's body in Korea. The museum is *in situ*; the Deokmyongri site is widely well-known for dinosaur footprints, including tracks of sauropod, theropod, and ornithopod. The Haenam Dinosaur Museum (2007), is also an *in situ* museum, opened to public in order to educate the public on Korean vertebrate fossils and local geology.

Poster Session I (Wednesday)

THE DEVELOPMENT OF A DATABASE COMPRISING THE LATE-QUATERNARY MAMMALIAN PALEONTOLOGICAL RECORD FOR SOUTHERN SOUTH AMERICA

LINDSEY, Emily, University of California, Berkeley, Berkeley, CA, USA; BARNOSKY, Anthony, University of California, Berkeley, Berkeley, CA, USA

A promising opportunity for evaluating the potential ecological impact of contemporary climate change is through analysis of ecological community response to the most recent major global climatic shift, i.e., the Pleistocene-Holocene transition. In North America, data from Quaternary mammalian sites are well documented and are assimilated in databases such as FAUNMAP (for the United States and Canada) and the Quaternary Mexican Mammals Database (for Mexico). However, no Quaternary fossil data set comparable in organization or scope yet exists for the South American continent, which hinders efforts to conduct intra- and intercontinental biogeographical analyses relating to ecological community changes during this period, particularly the extinctions of the Pleistocene megafauna and concomitant community shifts. In an effort to address such questions, we are establishing a database of late-Quaternary (late-Pleistocene to Holocene) mammalian fossils, including taxonomic, geographical, stratigraphic and chronological information, for Southern South America (Chile and Argentina). This database is intended to parallel FAUNMAP and to coordinate with the Quaternary Mexican Mammals Database and other ongoing efforts in Central and South America. We are in the initial stages of this project, which include 1) compiling faunal occurrences and associated information from published literature; 2) evaluating radiocarbon and other dates; 3) identifying areas from which additional records will be beneficial; and 4) establishing collaboration with other researchers interested in this effort. Such a database will facilitate investigations relating to the timing, logistics and causes of the end-Pleistocene megafaunal extinctions in this region, as well as allow comparisons between mammalian community responses to this ecological shift in North and South America.

Poster Session III (Friday)

FIRST DISCOVERY OF FACULTATIVE PAEDOMORPHOSIS IN AMPHIBIAN FOSSILS

LIU, Jun, Peking University, Beijing, China

Facultative paedomorphosis refers to environmentally induced intraspecific polymorphism that denotes the coexistence of aquatic, paedomorphic adults and terrestrial, completely metamorphic adults. This system is often used as a model to assess fundamental issues of evolution, development, and ecology. The first discovery of this phenomenon in Early Cretaceous salamander fossils is reported here. Numerous salamanders were recovered from a volcanic lacustrine deposit at Xintaimen in Liaoning, China. They share derived characters such as two ossification centers of nasals, large fontanel between separate nasals and uncapitate ribs that differentiate them from all other Mesozoic salamanders. Developmental investigation in these specimens shows preservation of an ontogenetic sequence of larval, metamorphosing, and postmetamorphic stages. These fossil salamanders exhibit the most characteristic feature of metamorphosis in living salamanders—the disintegration of pterygoid and vomer due to the resorption of so-called palatine and the patterning of a new palate. Some paedomorphic individuals retain an unossified mesopodium, gill rakers, well-ossified bones, including ceratobranchial 1-4, longer maxillae and larger skulls compared with fully metamorphic specimens, denoting the aquatic life of the adult. Others retain the well-ossified bones, including the mesopodium, and lose ceratobranchial 3-4, implying the terrestrial life of the adult. The paedomorphic and fully metamorphic specimens show similar shapes, relationships, and degree of ossification of bones except the hyobranchial apparatus and mesopodium. Preservation conditions such as high density of conspecifics and absence of the interspecific competition (e.g., other species of salamanders and fishes) strongly favor this intraspecific polymorphism as in certain living salamanders. Facultative paedomorphosis has been hypothesized as being the first step in speciation events. The discovery of this phenomenon in Early Cretaceous salamander fossils reveals that facultative paedomorphosis has played an important role in the evolution of salamanders and shows such phenotypic plasticity has existed since Early Cretaceous.

Poster Session III (Friday)

NEW INTERPRETATIONS OF *IGNOTORNIS*, THE FIRST BIRD TRACK EVER REPORTED FROM THE MESOZOIC

LOCKLEY, Martin, University of Colorado, Denver, CO, USA; CHIN, Karen, Santa Barbara, Boulder, CO, USA; MATSUKAWA, Masaki, Tokyo Gakugei University, Tokyo, Japan; KUKIHARA, Reiji, University of Colorado at Denver, Tokyo, Japan

*Ignotornis mcconnelli*, the first reported Mesozoic bird track, was described on the basis of a single holotype trackway from the Dakota Group (Late Albian-Early Cenomanian) near Golden, Colorado. Topotype samples, in two separate University of Colorado collections reveal <140 footprints comprising multiple (~ 20) trackways. The long reversed hallux and incipient 'semi-plamated' webbing associated with the digit III-IV hypex, makes *Ignotornis* distinct from any other Cretaceous bird tracks known from North America. Although tracks can not be used to identify extinct Mesozoic track making species, comparison with modern tracks indicates that *Ignotornis* differs from the typical tracks of most extant shorebirds (plovers and sandpipers) and is more reminiscent of small herons. At least 14 purported avian ichnogenera have been named from the Mesozoic, mostly from the Cretaceous of East Asia. However, because bird tracks often occur in high densities with overlapping trackways, most ichnotaxa are based on isolated tracks, not well-preserved trackways. By contrast, the *Ignotornis* sample, however, allows discrimination of more distinct trackways than any other Mesozoic avian assemblage. Many parallel and sub parallel trackway suggest gregarious behavior.

Poster Session III (Friday)

PRELIMINARY RESULTS OF A LONG-TERM SURVEY OF PALEONTOLOGICAL RESOURCES OF THE KAIPAROWITS FORMATION WITHIN GRAND STAIRCASE-ESCALANTE NATIONAL MONUMENT

LOFGREN, Don, The Raymond M. Alf Museum of Paleontology, Claremont, CA, USA; CRIPE, Jeffrey, The Webb Schools, Claremont, CA, USA; EVERHART, Duncan, Alf Museum, Alum Bank, PA, USA

Since 1998, Raymond Alf Museum of Paleontology crews, comprised largely of high school students from The Webb Schools, have developed an ever expanding list of faunal data in a long-term survey of paleontological resources within Grand Staircase-Escalante National Monument from outcrops of the Kaiparowits Formation within the headwaters of Wahweap Creek. The project has a unique educational aspect as Webb students learn field techniques, experience the excitement of discovery, and assist in preparation and study of Kaiparowits fossils, thus making a significant contribution to scientific knowledge. In the study area, vertebrate fossils are most abundant in a 60 m stratigraphic interval in the Middle Unit, about 450 m below the top of the formation. In this interval, a series of very thick, indurated conglomeratic sandstones yield isolated elements of vertebrates that vary from fragments that are heavily weathered and water-worn, to pristine isolated elements. Less common are articulated or associated elements of hadrosaur and ornithomimosaur, which usually occur in less indurated, thick-medium sandstones. An exception to this is the recently discovered Cripe Site, a multi-species bone bed where hadrosaur and tyrannosaur elements are both present in a very thick conglomeratic sandstone. Examples of significant dinosaurian material recovered include a partial skeleton of *Ornithomimus*, a nearly complete hadrosaur skull with articulated jaws, and associated lower leg elements of a mid-sized tyrannosaur about the size of *Albertosaurus*.

Poster Session IV (Saturday)

FIRST *POTWARMUS* (MUROIDEA) FROM THE MIOCENE OF SAUDI ARABIA AND NEW INSIGHTS INTO THE ORIGIN OF MURIDS

LOPEZ-ANTONANZAS, Raquel, Museo Nacional de Ciencias Naturales, Madrid, Spain

During Miocene times, muroid rodents knew a tremendous increase in their diversity. Also, during this period, they took advantage of the establishment of land bridges connecting Eurasia with Afro-Arabia to attempt to diversify onto the latter plate. The muroids from the Saudi Arabian site of Al Jadidah (~MN6) provide us with a unique window to appreciate this phenomenon. First results indicate that several muroid species are present at Al Jadidah. One of them is a new species of *Potwarmus*. A preliminary cladistic analysis provides evidence that *Potwarmus* (exclusive of "*P.*" *minimus*) is a clade and not a paraphyletic assemblage on the lineage leading to murids. It suggests that the new species and (*P. thalaidicus* + *Potwarmus* sp. nov. from Jebel Zelten) are sister taxa. These three species form a clade, which is sister group to *P. primitivus* (type-species of the genus). This analysis also hints at the improbability that a species of *Potwarmus* could be a direct ancestor of *Antemus chinjiensis*. In fact, at least *Paradakkamys chinjiensis*, a handful of species possibly close to it and, especially, "*Myocricetodon*" *eskihaisarensis* and "*M.*" *liui* are closer to *Antemus*, Progonomys, and more derived murids than *Potwarmus* is. Thus, the tree topology strongly reinforces the idea according to which murids deeply root in Asia. The presence of *Potwarmus* in the Middle Miocene of Saudi Arabia and Libya establishes that representatives of this genus crossed what is nowadays the Arabian Peninsula. However, the precise timing of this dispersion remains to be determined. The derived position of the oldest species of the genus suggests that the fossil record of *Potwarmus* is highly deficient in late Early

Miocene times. Hopefully, material under study from the Lower Miocene of As-Sarrar (Saudi Arabia) will offer some clues to the question. At any rate, the Afro-Arabian record of *Potwarmus* is presently restricted to a handful of isolated teeth and no specimen is known further West and South than Libya in Africa. This record, together with the results of our phylogenetic analysis, suggests that this genus did not find excellent environmental conditions in its new land of adoption.

Poster Session I (Wednesday)

TRAMPLED BY TURTLES: TURTLE TRACKS FROM THE TRIASSIC RED PEAK FORMATION (SOUTHERN BIG HORN BASIN, WYOMING)

LOVELACE, David, Big Horn Basin Foundation, Thermopolis, WY, USA

A single slab (1x2m) of fine-grained sandstone located 8m below the Alcova Limestone in the Triassic Red Peak Formation contains more than 50 tracks preserved as natural casts. The probable origin of the slab was along the margin of a small (20cm thick) channel fill with adjacent paleosols. Further study should clarify the specific environmental context. Features in the Red Peak tracks strongly resemble those made by turtles (cf. *Emydhipus*) including: wide trackways (16-18 cm), low pace angle (60-70 degrees), inline manual and pedal tracks, and elongate scratch marks. The tracks exhibit tridactyl to pentadactyl impressions; tridactyl prints are the most abundant on the slab and are preserved as three parallel scratch marks slightly offset at initiation and completion. Scratch mark morphology and the apparent digitigrade condition of most tracks indicate the animals were either partially buoyed by water, or walking on a firmer substrate. Tridactyl tracks are found in the same trackway with quadractyl and pentadactyl footprints, reflecting variability in substrate behavior rather than different trackmakers. Several distinct quadractyl prints display two middle digits of equal length with slightly reduced medial and lateral digits and an arched structure joining them together; all digits are subparallel to the track midline. Turtle traces are known from the Triassic of Germany, as well as Jurassic and Cretaceous from both the European and North American continents. The Red Peak tracks expand the North American record to include the Triassic Chugwater Group.

Poster Session III (Friday)

NEW NODOSAURID ANKYLOSAUR FROM THE CRETACEOUS OF HENAN PROVINCE, CHINA

LÜ, Junchang, Beijing, China; XU, Li, Henan Geological Museum, Zhengzhou, China; ZHANG, Xingliao, Henan Geological Museum, Zhengzhou, China; JI, Qiang, Institute of Geology, Chinese Academy of Geological Sciences, Beijing, China

Compared with other dinosaurs from China, ankylosaurid dinosaurs are rare. The earliest described Chinese ankylosaur is from Shandong Province. Most ankylosaurs have been found from Ningxia Hui Autonomous Region, Xinjiang Uygur Autonomous Region, Inner Mongolia Autonomous Region, Shanxin, Liaoning and Zhejiang provinces. Except for one juvenile ankylosaur from Liaoning Province and one from Zhejiang Province, which are described as nodosaurid ankylosaurs, all others are ankylosaurids. However, the assignments of the two above-mentioned ankylosaurs to Nodosauridae are uncertain, due to incomplete (no skull or distalmost caudal vertebrae preserved) or juvenile specimens. Herein we report the first indisputable nodosaurid ankylosaur. The new specimens include a nearly complete skull, part of the front limb, vertebrae including cervicals, dorsals and caudals, and dermal scutes. The end of the tail is also well preserved. The new nodosaur is from the Cretaceous (possible early Late Cretaceous) of Ruyang, Henan Province. It displays typical nodosaurid characters of the skull and distalmost caudal vertebrae. The skull is longer than wide and the tail does not bear a club. The new nodosaur is distinguished from other nodosaurid ankylosaurs by the ratio of skull length to width of about 1.4:1; parietal area flat; posterior margin and the lateral margins lateral to the orbits straight in dorsal view, width of humerus subequal in both the proximal and distal ends, attachments of *M. latissimus dorsi* and *M. teres major* on the posterior surface of the proximal end of the humerus are concave, and the shaft of the ischium straight. The discovery of a new nodosaurid ankylosaur from central China provides important information for the understanding of ankylosaurid dinosaurs' evolution, distribution and migration in Asia.

Poster Session IV (Saturday)

THE TRIASSIC TIMESCALE BASED ON TETRAPOD EVOLUTION

LUCAS, Spencer, New Mexico Museum of Natural History, Albuquerque, NM, USA; HUNT, Adrian, New Mexico Museum of Natural History, Albuquerque, NM, USA; HECKER, Andrew, Appalachian State University, Boone, NC, USA; SPIELMANN, Justin, New Mexico Museum of Natural History, Albuquerque, NM, USA

The global Triassic timescale based on tetrapod biochronology remains a robust tool for both global and regional age assignment and correlation. The Lootsbergian and Nonesian land-vertebrate faunachrons (LVFs) are of Early Triassic age; cross correlation of part of the Lootsbergian to the Olenekian and all or part of the Nonesian to the Anisian lacks support. In the South African Karoo basin, both the Lootsbergian and the Nonesian can and should be subdivided into sub-LVFs. The upper part of the South African *Cynognathus* zone, previously considered Nonesian in age, is younger, of Perovkan age. We redefine the beginning of the Perovkan as the first appearance datum

of the temnospondyl *Eocyclotaurus*, which resolves uncertainties in the correlation of *Eocyclotaurus* assemblages and shansiodont assemblages. The Perovkan LVF corresponds to most or all of Anisian time. The Berdyankian LVF equates to parts of Ladinian and Carnian time. Rejection of recent cladotaxonomy of phytosaurs and an incorrect claim of a Revueltian record of the temnospondyl *Metoposaurus*, as well as newly established stratigraphic ranges and additional discoveries of aetosaurs, have improved correlation and temporal resolution within the Late Triassic interval (Otischalkian-Apachean LVFs). This further supports separation of the Otischalkian and Adamanian and runs contrary to suggestions to merge the two LVFs as a single Ischigualastian LVF. The Adamanian LVF is readily subdivided into an older St. Johnsian and a younger Lamyian sub-lvf in western North America. Though readily recognized and correlated in western North America, the Apachean LVF remains the most problematic LVF for global correlation. A purported test of the Triassic LVFs based on GIS is rejected as invalid because it is replete with internal inconsistencies and errors. Continued careful biostratigraphy in the field and improved alpha taxonomies that are not cladotaxonomies will further develop, elaborate and test the Triassic timescale based on tetrapod evolution.

Student Poster Session (Thursday)

PRELIMINARY REVISION OF AGRIOCHOERID OREODONTS OF TRANS-PECOS TEXAS AND CHIHUAHUA

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Agriocherids represent the earliest and morphologically most primitive grade of oreodont evolution. Fossil localities from Trans-Pecos Texas and Chihuahua have a reasonably large amount of agriocherid material. In addition, some of these localities are from the poorly understood Duchesnean - Chadronian interval of agriocherid evolution. No endemic agriocherid species have ever been formally described from these localities, and many published specimens have not been identified to species level. Specimens reported as *Protoreodon petersoni* from the late Uintan Candelaria local fauna, while highly similar in size to that species consistently have a P4 with a grooved parametacone. As this character state is not shown in specimens of *Protoreodon petersoni* from the slightly older Myton Pocket of the Uinta Formation, the Candelaria form should not be included in that species. A similar dental morphology is also evident in specimens from the late Uintan Serendipity local fauna and the earliest Chadronian Rancho Gaitan local fauna. A larger form, originally attributed to *Protoreodon pumilus*, is known from the late Duchesnean Porvenir local fauna. The Rancho Gaitan local fauna also has the only known lower dentition from the enigmatic taxon "*Agriocheris*" *maximus*. Specimens from the early Duchesnean Skyline Channels have recently been identified as *Agriocheris crassus* and this identification appears to be valid. This species has a P4 with an unsplit parametacone and unmodified upper molar paraconules. Late Duchesnean sediments from the Montgomery bonebed and Porvenir local fauna can be attributed to *Agriocheris* "new species a", which possesses a P4 with split parametacone and has greatly reduced upper molar paraconules. The earliest Chadronian Little Egypt local fauna and the late early or middle Chadronian Coffee Cup local fauna yield slightly different morphologies of *Agriocheris* "new species b", which has a P4 with a more pronounced split of the parametacone and seems to lack upper molar paraconules.

Technical Session XV, Saturday 8:00

DEVELOPMENTAL HETEROCHRONY AND TRANSFORMATION OF THE DEFINITIVE MAMMALIAN MIDDLE EAR AMONG MESOZOIC MAMMALS

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An ossified Meckel's cartilage preserved in some eutriconodonts connects the ectotympanic to the mandible. Because eutriconodonts are nested within extant mammals, this corroborates the hypothesis that some Mesozoic mammals had homoplastic evolution of the definitive mammalian middle ear, defined by detachment of the ectotympanic from the dentary. This sheds light on how ontogenetic heterochrony could impact on the phylogenetic evolution of the mammalian middle ear. In pre-mammalian outgroups, the middle ear is attached via the prearticular to the Meckel's sulcus of the dentary, by the ectotympanic in contact with the dentary angular process, and by the petrosal-incus contact. In extant mammals, the petrosal-incus contact is developmentally conserved, but the dentary-prearticular connection is lost in adult, due to the reabsorption of embryonic Meckel's cartilage, the homolog to part of the prearticular. Also lost is the ectotympanic-dentary contact because of negative allometric growth of the ectotympanic and the malleus during ontogeny, relative to skull size. The ossified Meckel's cartilage of eutriconodonts is morphologically similar to the embryonic Meckel's cartilage of extant monotremes, and can be regarded to be paedomorphic by resemblance to embryonic condition of extant mammals. Relative to the mandibular length, the ectotympanic and the malleus are significantly larger in the eutriconodont *Yanoconodon* than in extant mammals, suggesting a lesser negative allometry of the malleus and the ectotympanic during the growth in *Yanoconodon* than in extant mammals. The middle ear's attachment to the mandible in *Yanoconodon* (and possibly in eutriconodonts as a whole) are attributable to differences in developmental timing and rate between *Yanoconodon* and extant mammals. As reabsorption of the Meckel's cartilage and the negative allometry of the ectotympanic are crucial for extant mammals to complete the

ontogeny of their middle ear, an early ossification of Meckel's cartilage and the reduced rate of negative allometric growth of the ectotympanic also influenced the retention of the ectotympanic-dentary connection in some major groups of Mesozoic mammals.

Student Poster Session (Thursday)

VARIATION, GROWTH, AND ALPHA TAXONOMY OF BAENID TURTLES: INSIGHTS FROM A LATE CRETACEOUS DEATH ASSEMBLAGE

LYSON, Tyler, Yale University, New Haven, CT, USA

A locality from the Hell Creek Formation (latest Maastrichtian) of North Dakota has yielded an unsurpassed number of slightly disarticulated baenid turtle specimens including 70 shells, 35 skulls, and various postcranial remains. The sedimentology of the locality and close association of the baenid skeletons indicate that the turtles were deposited near their place of death in a single flooding event. A morphological review of the specimens found reveals the presence of three distinct skull morphotypes and two shell morphotypes, which are interpreted herein as three distinct species, *Palatobaena bairdi* and two new taxa. Ninety percent of the sample belongs to one of the undescribed taxa. *P. bairdi* is represented by four skull and two shells. Given the locality's temporal and spatial restrictions, the individuals of each species can be interpreted as belonging to true biological populations, one of which is the first ever documented in the fossil record of turtles that has a sample size larger than 10. Such a large number of individuals from two of the populations, one of the new taxa and *P. bairdi*, provides unprecedented access to the morphological and ontogenetic variation found in Baenidae. For instance, a dimorphic plastral shape indicates sexual dimorphism in one of the new taxa. Similarly, both taxa show similar developmental changes to the skull, namely the late exclusion of the jugal from the orbit, a character previously used to diagnose species. However, no variation was found in shell suture contacts or in the overlying scute pattern, refuting the notion that shell characters are uninformative in all baenids. In light of the stability of shell morphology, knowledge of baenid growth, and the availability of shell-skull associations, new insights into alpha taxonomy are possible to help resolve the current parataxonomic conflict of described shell and skull species. In particular, the shell taxon *Baena hatcheri* can be synonymized with the skull taxon *Stygiochelys estesi* and the traditionally accepted referrals of shell material to *Eubaena cephalica* can be refuted.

Technical Session III, Wednesday 1:45

REASSESSMENT OF A LATE PLIOCENE (LATE BLANCAN) AGE FOR MAMMOTH FROM FLORIDA: EVIDENCE FROM REE DIAGENESIS

MACFADDEN, Bruce, University of Florida, Gainesville, FL, USA; HULBERT, Richard, University of Florida, Gainesville, FL, USA

The dispersal of mammoth (*Mammuthus*) into North America defines the base of the Irvingtonian NALMA and also is roughly coveal with the base of the Pleistocene. Some recent reports, however, assert that *Mammuthus* from stream lag deposits at the Santa Fe River 1B locality, north-central Florida, indicates a late Blancan (late Pliocene, ~2.5 Ma) age for this important index fossil. If this older age is correct, then the hypothesis of an Irvingtonian FAD for mammoth is falsified, or the age of the Blancan-Irvingtonian boundary will have to be significantly revised downward, to about 2.5 Ma. In taphonomically mixed fossil vertebrate deposits, rare earth elemental (REE) signatures are useful in determining the relative ages of individual faunal components. Although early publications stated that the Santa Fe River 1B site produces only Blancan mammals, a reassessment indicates a mixture of diagnostic Blancan and Rancholabrean (RLB) species. REE signatures from samples of bone, dentine, and enamel from age-diagnostic taxa from the Santa Fe River 1B and other nearby localities show no significant between-site differences, but in all three tissue types Blancan and RLB REE samples are significantly different and can reliably be classified using discriminant analysis. REE values from dentine are more similar to bone than those of enamel. REE signatures of dentine and enamel from eight mammoth teeth from Santa Fe 1B were all assigned to the RLB group by discriminant analysis using either combined values of bone plus dentine or using only enamel. REE analysis confirms traditional mammalian biochronological techniques that two separate faunal components are present at the Santa Fe River 1B locality. Discriminant analysis of REE signatures of *Mammuthus* dentine and enamel places this taxon securely in the Rancholabrean component of the fauna, in agreement with its morphology. There is no evidence to support the claim of Blancan *Mammuthus* from Florida. The use of REE analyses has great utility in separating ages of taphonomically mixed faunas in the vertebrate fossil record.

Poster Session III (Friday)

FROM AN ISCHIUM TO A RIB: REVIEW OF THE OSTEOLOGICAL EVIDENCE OF THE SUPPOSED ORNITHISCHIAN DINOSAUR FROM THE ARARIPE BASIN, BRAZIL

MACHADO, Elaine, Museu Nacional/UFRJ, Rio de Janeiro, Brazil; KELLNER, Alexander, Museu Nacional/UFRJ, Rio de Janeiro, Brazil

The first evidence of a dinosaur from the Santana Formation (Aptian-Albian), Araripe Basin, was described as a possible Ornithischian ischium and constituted the only osteological record of this dinosaur clade from Brazil known so far. This material was previously kept in a private collection and was recently donated to the Museu Nacional/UFRJ (Rio de Janeiro, MN 7021-V), where it could be fully prepared. Contrary to the original description, we identify this bone as an incomplete left rib. The proximal part is expanded, showing the basal part of the capitulum and tuberculum. Proximally, the shaft is compressed anteroposteriorly until about the middle region, where it changes to become more flattened dorsoventrally/lateromedially. Close to the proximal margin, the posterior surface of the rib is excavated forming a deep pocked which ends in an opening, possible for a pneumatic foramen. The shaft is strongly curved, directly ventrally and slightly anteriorly. In several regions grooves and ridges form rough surfaces that are likely marks of muscle attachments. Based on the bone texture, size (length ~320mm) and comparatively thick bony wall, this specimen is regarded as representing a dinosaur. Up to date only four species of dinosaurs, all theropods, were described from this deposit. Two are small taxa, known by a pelvis (*Mirischia asymmetrica*) and the posterior part of a skeleton (*Santanaraptor placidus*), differing from the much larger animal represented by MN 7021-V. The remaining two are spinosaurids (*Irritator challengeri* and *Angaturama limai*), known from cranial material only. Although the true taxonomic identity of this rib cannot be established, it likely represents a Spinosauridae which is the largest dinosaur clade found in the Santana Formation. Unfortunately there are no specific features that diagnose spinosaurid ribs and therefore this assignment is regarded as tentative. In any case, MN 7021-V is not part of an ischium and unlikely represents an ornithischian dinosaur. Therefore the presence of these herbivorous reptiles in Brazilian deposits is still based only on footprints and trackways.

Student Poster Session (Thursday)

DENTITION OF THE EUGNATHOSTOMATA FROM THE EARLY DEVONIAN OF THE MACKENZIE MOUNTAINS, NORTHWEST TERRITORIES, CANADA

MACKENZIE, Lindsay, University of Alberta, Edmonton, AB, Canada

The origin of teeth is a heavily debated topic in which there are two main hypotheses. The first is that teeth evolved from denticles lining the oro-pharyngeal cavity of fishes, and the second is that they evolved from body scales that migrated into the oral region and became specialized. There is also a great deal of debate on what constitutes a "true tooth" versus a denticle. This study clarifies both of these problems. The specimens being studied constitute early members of Eugnathostomata (Chondrichthyes and Teleostomi), with a focus on putative chondrichthyan and acanthodians from the Man On The Hill locality (MOTH) in the Northwest Territories, Canada. These are early Devonian (Lochkovian) fishes that show much diversity in their teeth and tooth-like structures. The focus of this study is to compare and contrast the dentigerous and non-dentigerous jawbones, the tooth whorls and associated structures, and the possible tooth precursors of these groups by studying their morphology, histology, and distribution on the body as well as among the taxa. There are at least 6 taxa with tooth whorls found among the acanthodians and putative chondrichthyan. Within the putative chondrichthyan, there is evidence for ontogenetic change in tooth morphology, as well as variation in the number of rows of teeth in the whorls. There is also a great deal of variation in the histology of the whorls within all of the taxa. Within the acanthodians, there are at least two distinct types of dentition: tooth whorls and dentigerous jawbones. The dentition of the jawbones varies from pointed teeth found in many rows, to small and rounded, to reduced and restricted to the lingual side of the jaw. These new kinds of dentitions affect the interpretation of the evolution and development of teeth, jawbones, and associated structures within the Eugnathostomata.

Technical Session IX, Friday 9:30

LIFE HISTORY OF *PROTOCERATOPS ANDREWSI* FROM BAYN ZAG, MONGOLIA

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The basal neoceratopsian *Protoceratops andrewsi* is abundant at several Djadokhtan localities in the Gobi Desert of Mongolia, most notably Bayn Zag (Flaming Cliffs) and Tögrögün Shiree. Because it is represented by many (>100) specimens at different growth stages, *Protoceratops* has been the subject of several paleobiological studies looking at growth, sexual dimorphism, and behavior. Until now, however, relatively little

has been determined regarding the life history of this dinosaur. To address this issue, we histologically sampled postcranial bones from the growth series of *Protoceratops* collected by the Central Asiatic Expeditions of the American Museum of Natural History in the 1920's. Preliminary results indicate that growth in these animals slowed around 9 to 10 years in age, and ceased or became negligible around 11-13 years as indicated by presence of decreased vascularization and External Fundamental Systems, although individual variation in these life history parameters are observed in our sample. Maximum development of features such as frill expansion and nasal arching occur in the largest and oldest individual in our study, confirming previous hypotheses that such traits are ontogenetically variable. Further sampling of adult and senescent individuals is required to test whether such traits show dimorphic development as has been previously proposed. Individual variation in the age at which somatic growth plateaus and the fact that these features are most prominent in the oldest and largest individual we sampled suggests that differentiating dimorphism from late-stage ontogenetic changes may prove to be complicated.

Poster Session III (Friday)

NEW EARLY MIOCENE LOCALITIES AT NAPAK, UGANDA

MACLATCHY, Laura, University of Michigan, Ann Arbor, MI, USA; COTE, Susanne, Harvard University, Cambridge, MA, USA; KINGSTON, John, Emory University, Atlanta, GA, USA; WINKLER, Alisa, Southern Methodist University, Dallas, TX, USA; ROSSIE, James, SUNY, Stony Brook, Stony Brook, NY, USA

Early Miocene fossil sites on the remnants of the Napak volcano in Uganda chronicle the evolution and diversification of catarrhine primates, as well as many other mammals. The Napak localities (~19-20 Ma) NAP I-IX were studied by W. Bishop from 1958-1965, with last decade seeing renewed collection. Bishop localities NAP II, III, VI, VII and VIII rest on basement rock, consist of sands, gravels and tuffs and are not very fossiliferous. They are overlain by nephelinite lavas and bedded pyroclastic rocks consisting of agglomerates and calcareous tuffs. These overlying volcanoclastic sediments include sites NAP I, IV, V and IX, which are richly fossiliferous and have a high proportion of small bodied mammals. In 2001 and 2003, two localities were discovered at Napak, designated NAP CC and NAP CCI respectively. The stratigraphic relationships of these new localities to the Bishop localities have not yet been firmly established, as distance to the nearest Bishop locality (from 700 - 1200 m) and heavy vegetation complicate tracing the sediments laterally. However, structural orientation of the volcanic sequence locally suggests NAP CC is laterally correlative with the upper Bishop localities. The faunal composition of NAP CC is also very similar to those of NAP I and IX. Over 1400 mammalian fossils have been collected at NAP CC, attributable to 9 orders and including 5 primate species and 9 rodent species. Of special interest is an associated distal humerus/proximal radius of the poorly known large (~75 kg) catarrhine *Proconsul major*. NAP CCI is more enigmatic. It is most likely to group with the lower Bishop localities stratigraphically, and thus far has yielded a relatively small number of mammal fossils (~430) with a low proportion of small taxa. However, the fauna is diverse for such a small sample, with nine mammalian orders represented. There is also a high proportion of artiodactyls, including the pecoran *Wálangania africanus* (28 specimens), tragulid *Dorcatherium songhorensis* (7 specimens) and suid *Nguruvu kijivium* (9 specimens). We are investigating how taphonomic, depositional, and ecological factors may have influenced faunal composition.

Technical Session XVI, Saturday 2:00

HYPERDISEASE REDUX: INTRODUCED TRYPANOSOMIASIS AND EXTINCTION OF ENDEMIC MURINES ON CHRISTMAS ISLAND

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The hyperdisease hypothesis asserts that, under specific circumstances, novel infectious diseases can provoke extinction by causing rapid, ultimately irrecoverable collapses in populations. Instances of extinction under hyperdisease conditions have been demonstrated in land snails and frogs, but there are no empirically satisfactory examples among mammals. Here we present a plausible test case using ancient DNA probes and relevant historical records. In 1909, Charles Andrews argued that the complete disappearance of two recently-discovered rodents endemic to Christmas Island (105°45'E, 10°30'N), *Rattus macleari* and *R. nativitatis*, was "the result of some epidemic disease, possibly caused by a trypanosome, introduced by the ship-rats [*R. rattus*]", a conclusion "supported by an observation made by the medical officer...who told me that some five or six years ago he frequently saw individuals of the native species of rats crawling about the paths in the daytime, apparently in a dying condition. Last year [1908], in spite of continual search, not a single specimen of either species could be found in any part of the island." Using a variety of primer combinations for different regions of the trypanosome genome, we found sequence evidence (independently corroborated subsequently) for the murine-specific trypanosome *T. lewisi* in 4 of 16 skin samples of *R. macleari* and alleged *macleari-rattus* hybrids, all collected around 1900. No *nativitatis* specimens were available for study. Application of similar probes in explicitly paleontological

logical contexts, such as end-Pleistocene mammal extinctions, will involve a number of complications. However, the advent of new techniques and instruments, such as emulsion PCR, pyrosequencing, and the Roche/454 Life Sciences genomic sequencer, permits the acquisition of enormous quantities of sequence information from ancient samples, including associated microbial genetic material. Distinguishing "environmental" microbial signals from those that are truly pathogenic will be a substantial challenge, but meeting it will ultimately pave the way for a greater understanding of disease and its impacts in the late Quaternary.

Technical Session VI, Thursday 2:45

STUDY OF A LARGE SAMPLE OF NATURAL ENDOCRANIAL CASTS OF OREODONTS WITH IMPLICATIONS FOR APOMORPHY-BASED DIAGNOSIS OF ISOLATED ENDOCASTS AND THE STUDY OF INDIVIDUAL VARIATION

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A collection of over 100 natural endocranial casts of oreodonts from a single Eocene locality in West Texas (Reeves Bonebed, hereafter 'RBB') is perhaps the largest known sample of endocasts from a single fossil species. All specimens were referred to *Bathygerys reevesi*, the only oreodont of appropriate size known from this locality. However, nearly all of the RBB endocasts lack the relevant dental or cranial osteology to diagnose these specimens to this species. Our study attempted to (1) diagnose the RBB endocasts to the smallest possible clade using endocast apomorphies, and (2) to assess the level of individual variation in morphometrics and discrete characters present in this sample. To accomplish the first goal we compared a digital endocast extracted from CT scans of the holotype of *B. reevesi* to the RBB endocasts. Comparisons were also made with natural endocasts of other oreodonts. For the second goal, we examined discrete endocranial characters that are known to be phylogenetically variable to determine the degree of individual variation in scoring these characters based on our sample. We found no discrete characters that unequivocally diagnose the RBB endocasts to *Bathygerys reevesi*. However, based on overall form and measurements, it is highly likely that the RBB endocasts are indeed specimens of *B. reevesi*. Of 14 linear measurements taken on the endocasts, 11 of the measurements on the holotype fell within one standard deviation of the mean determined from the RBB sample. Based on preliminary comparison with other mammalian endocasts, presence of large tuberculum olfactoria casts on the ventral surface diagnose the RBB endocasts as oreodonts. The orientation of the suprasylvian sulcus with respect to the median and lateral sulci suggests the RBB are merycoidodonts and not agriochoriid oreodonts. None of the qualitative endocranial characters we examined on the RBB endocasts showed any individual variation; however, there is variability in the preservation of the posterior portion of the rhinal fissure and the hypophyseal cast. We suggest that an apomorphy-based diagnosis approach be used to identify other isolated mammalian endocasts.

Poster Session I (Wednesday)

A NEW RECORD OF THE EARLY PERMIAN PELYCOSURIAN-GRADE SYNAPSID *DIMETRODON* (EUPELYCOSAURIA: SPHENACODONTIDAE) FROM THE LOWER CUTLER GROUP (EARLY PERMIAN) OF JEMEZ PUEBLO, NORTH-CENTRAL NEW MEXICO

MADALENA, Kevin, Jemez Pueblo, NM, USA; SUMIDA, Stuart, California State University, San Bernardino, CA, USA; ZEIGLER, Kate, University of New Mexico, Albuquerque, NM, USA; REGA, Elizabeth, Western University of Health Sciences, Pomona, CA, USA

The Early Permian pelycosaurian-grade sphenacodontid synapsid *Dimetrodon* is among the most recognizable of Late Paleozoic amniote taxa. Specimens are known predominantly from north-central Texas and Oklahoma. Rare records are known from the Four Corners region of the southwestern U.S. and central Germany. For the first time, significant vertebrate material has been recovered from lands belonging to the Pueblo of Jemez in north-central New Mexico. Recently, fragmentary vertebrate fossil material has been recovered from the upper half of the El Cobre Canyon Formation of the Lower Permian Cutler Group, which is comprised of thick bedded, laterally pervasive trough crossbedded, arkosic sandstones. Although fragmentary, this material may be assigned to the genus *Dimetrodon* with certainty. Partial neural spines exhibit the dumbbell shaped cross-section typical of most of the species in the genus. Previous reports of *Dimetrodon* in New Mexico are very rare. The most significant is that of a small partial specimen of a single individual of *D. occidentalis* from nearby Jemez Springs. Morphology of the distal spine fragments conforms to the pattern described for *D. occidentalis*. Proportions of both the base and distal segments of the new specimens are similar to those of *D. occidentalis*. However, the Jemez Pueblo fragments are approximately 25% larger. In the basal segment of a Jemez Pueblo spine, the cranial grooves are more broadly and deeply developed than those on the caudal surface. More distal fragments also show differences in groove development, but the cranial versus caudal orientation cannot be determined with certainty. A fragmentary tibia and possible maxillary fragment are probably assignable to *Dimetrodon* as well. These fragmentary specimens probably support D. S. Berman's original suggestion that all *Dimetrodon* material from the Four Corners region is assignable to *D. occidentalis*. Histological sec-

tioning of the subquadrangular spine base in one Jemez Pueblo specimen allows comparison with similarly shaped regions of Texas specimens assigned to the presumably different and significantly larger taxon *D. giganhomogenes*.

The Dissorophioidea - Early Amphibian Radiation Symposium, Friday 9:30  
BRAINCASE ONTOGENY OF A NEW LARGE TREMATOPIID (TEMNOSPONDYL: DISSOROPHOIDEA) FROM RICHARDS SPUR, OKLAHOMA

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As developmental data are used increasingly in investigations into lissamphibian origins, there arises a need for new data on critical outgroup taxa to constrain ontogenetic inferences. We report the first cranial elements of a large trematopid only known previously from isolated limb elements from Richards Spur, Oklahoma. A single uncrushed adult skull and four specimens preserving the braincase and middle ear region represents a partial ontogenetic series and provides a unique opportunity to examine detailed braincase and middle ear anatomy and growth in a dissorophoid temnospondyl. In the most immature specimen, the ossified portion of the dorsal process of the epipterygoid is widely separated from the wall of the braincase. Through ontogeny the separation is reduced until the apex firmly abuts the pleurosphenoid region of the basisphenoid in the largest specimen. Ossified basal tubera of the parasphenoid are absent in the smallest specimen then progressively elongate posteriorly as thin wing-like plates of bone. Palatal dentition on the parasphenoid also becomes more extensive posteriorly through ontogeny. The oval window is relatively large in the smallest specimen and its dorsal and ventral margins are incompletely ossified. Fusion of the opisthotic and prootic to complete the dorsal margin of the oval window is achieved in the second smallest specimen, though the paroccipital process of the opisthotic remains short, reaching its adult lateral extent in the second largest specimen. Sutural contact of the dorsal process of the exoccipital to the occipital flange of the postparietal is incomplete medially in the two smallest specimens and contact between the exoccipitals above the foramen magnum is first seen in the second largest specimen. A partial stapes is preserved in the second smallest specimen and both stapes are completely preserved in the adult skull. In both specimens the stapes are anteroposteriorly flattened, tapering blades of bone directed towards the slitlike temporal embayment, which was possibly closed posteriorly in this taxon. A small dorsoventrally oriented stapedia foramen is present close to the footplate.

Technical Session XV, Saturday 11:00

FOSSIL MARSUPIALS OF CENTRAL ANATOLIA AND THEIR BIOGEOGRAPHICAL SIGNIFICANCE

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Over the last several years, the Old World Tertiary marsupial fossil record has been augmented by a series of intriguing discoveries from Turkey. Four isolated marsupial molars that show affinities with *Asiadidelphis* and *Garatherium* were described from Central Turkey. Even though they were not named, they were tentatively classified as a new herpetotheriid marsupial. Again from the same sediments, an isolated upper molar as that of a bunodont marsupial was described. More recently an exceptionally complete marsupial fossil (AUJM 2002-25) from the same sediments, which was very different from the previously described marsupials was announced. The new evidence for the antiquity of herpetotheriids, and particularly their occurrence in the Late Cretaceous of Europe raises new questions about the affinities and biogeographic history of marsupials from the early Tertiary of Africa and Asia. The phylogenetic relationships of the Anatolian marsupials are of particular importance, given their geographically intermediate occurrence between Africa, Asia, and Europe. Here I examine the systematic relationship of these Old World marsupials, specifically the position of the putative Turkish herpetotheriid. Like the other early Paleogene mammals described from central Anatolia, the herpetotheriid marsupial is not closely linked with contemporaneous forms from Europe or Asia. Its closest ties appear to lie with the enigmatic *Garatherium* from the early Eocene of Africa, but the position of both of these forms relative to other Paleogene Old World marsupials is problematic. Likewise, the large, undescribed specimen (AUJM 2002-25) is basal to later herpetotheriids from North America and Asia. Nevertheless, the analysis does suggest that both peradectids and herpetotheriids have distinct and long lineages in the Old World, suggesting that new forms are yet to be found. With the current fossil record, it is not possible to determine the geographic origins of herpetotheriids or peradectids unequivocally, although Old World might have been an important center of diversification for these groups.



Poster Session III (Friday)

#### HOMOLOGY AND FUNCTION OF THE ORNITHISCHIAN DINOSAUR PALPEBRAL

MAIDMENT, Susannah, University of Cambridge, Cambridge, United Kingdom; PORRO, Laura, Department of Earth Sciences, Cambridge, United Kingdom

The palpebral is a small ossification on the anterodorsal margin of the orbit. It is ubiquitous among basal ornithischian dinosaurs, but absent in most derived members of the clade; instead, derived ornithischians exhibit neomorphic ossifications along the orbital margin termed supraorbitals. Although the homology of the palpebral to one or more of the supraorbitals is widely accepted, there is no explanation as to how or why the palpebral was incorporated into the skull roof. Furthermore, no work has been done to explain the function of the palpebral element. This study has two principal aims. First, the skulls of basal and derived ornithischians were examined, noting the occurrence of the palpebral and osteological correlates of associated soft tissue in order to clarify the homology of the palpebral and supraorbitals. Second, finite-element analysis (FEA) was used to construct a three-dimensional stylized ornithischian skull. Several versions of this model were created with the palpebral absent, present but incomplete, and complete (spanning the orbit). Bite loads were applied at various points along the tooth row to test the hypothesis that the palpebral was functionally adapted to feeding in ornithischians. Observations revealed the palpebral of basal ornithischians and anterior supraorbital of derived forms are homologous, while posterior supraorbitals are neomorphic ossifications. Abundant osteological correlates suggest that the palpebral supported a membrane of connective tissue which stretched to the dorsal orbital margin; ossification of this membrane allowed the element to be incorporated into the skull roof in derived ornithischians. Preliminary FEA results reject our hypothesis that the palpebral performed a functional role during feeding. The palpebral remained unstressed during most trials with compressive stress instead being routed through the skull roof. However, during biting on the premaxillary teeth, a complete palpebral resulted in significantly lower stress values and a 'stronger' skull. This interdisciplinary study increases our understanding of the evolution of this unique ornithischian synapomorphy.

Technical Session I, Wednesday 8:15

#### EVIDENCE FROM CLAW MORPHOLOGY FOR A DIVERSITY OF POSITIONAL BEHAVIORS IN PLESIADAPID "PLESIADAPIFORMS"

MAIOLINO, Stephanie, Stony Brook University, Stony Brook, NY, USA; BOYER, Douglas, Stony Brook University, Stony Brook, NY, USA

Postcranial evidence suggests that stem members of Primates ("plesiadapiforms") exhibited a wide range of arboreal positional behaviors, but this is not generally documented with extensive quantitative comparisons to extant mammals. Qualitative comparisons of claw morphology have been used to suggest that some late-occurring members of the "plesiadapiform" family, Plesiadapidae, used antipronograde postures in the trees more frequently than the earlier-occurring, more basal members of the group. The claw morphology of five plesiadapid species [*Nannodectes (N) intermedius*, *Pronothodectes (Pr) gaoi*, *Plesiadapis (P) churchilli*, *P cookie*, *P tricuspidens*] was quantified by taking measurements from digital photographs using Sigma Scan Pro 5.0. These data were examined in the comparative context of a sample of extant eutherian mammals currently including terrestrialists (*Spermophilus* n = 4, *Marmota* n = 5), scansorialists (*Sciurus* n = 6, *Tupaia* n = 6), committed arborealists that mainly use pronograde and orthograde postures (*Ratufa* n = 5, *Anomalurus* n = 4), and committed arborealists that utilize antipronograde postures (*Choleopus* n = 6, *Pteropus* n = 7). Both a Principle Components Analysis and Discriminant Function Analysis of 12 size-standardized variables show that extant specimens cluster by behavioral category. All plesiadapids analyzed can be characterized as committed arborealists based on claw morphology. As a group, plesiadapid claws are characterized by relatively mediolaterally broad unguis shafts, small to nonexistent extensor tubercles, and large flexor tubercles. Furthermore, *N intermedius*, *Pr gaoi*, and *P churchilli* (small-bodied taxa) were separated from *P cookie* and *P tricuspidens* (large-bodied taxa) by having a claw shaft that forms a lower angle with the articular facet (i.e., a more dorsally projecting shaft). Among extant taxa, a high shaft angle characterizes antipronograde arborealists. These data suggest that evolution of larger body size in late Paleocene arboreal plesiadapids may have correlated with more frequent reliance on antipronograde or suspensory postures.

Evolutionary History of Bats Symposium, Thursday 11:30

#### NECROMANTIS: NEW DATA AND RELATIONSHIPS

MAITRE, Elodie, Université Claude Bernard, Villeurbanne, France; SIGÉ, Bernard, UMR CNRS 5125, Villeurbanne, France; HAND, Suzanne, School of Biological Science, Sydney, Australia

*Necromantis adichaster* Weithofer is a large bat, described on the basis of fragmentary material of uncertain age from the Paleogene Quercy Phosphorites fillings, SW France (19th Century collections). Revised by Revilliod, *Necromantis* has been attributed to the paleotropical family Megadermatidae as its oldest member. Additional material of *Necromantis* from past Quercy collections has become available, and modern fieldwork in the Quercy has provided further specimens from three well-dated localities. The

presence of *Necromantis* in Western Europe is documented from at least the Middle to Late Eocene (~44 to 36 Ma). Dental, cranial and postcranial morphology indicates that *Necromantis* was a large, robust bat adapted to predation on hard prey including small vertebrates and possibly also carrion (as suggested by Weithofer's name for the taxon). The spherical condyle of the elbow joint is unspecialized, retaining the ability to rotate the forearm around the humeral axis and enabling manoeuvrable flight, ground-based predation, and take off with a heavy load. Striking dental features, such as the markedly median ectoflexus, lingually displaced mesostyle, and large and median hypoconulid, as also seen in early Eocene bats such as *Ageina* and *Honrovits* and retained in *Palaeophyllophora*, further suggest that *Necromantis* was a relict form specialized in carnivory and bone-crushing. The new data indicate that some similarities between *Necromantis* and recent paleotropical bats such as megadermatids are convergent. Phylogenetic analysis of craniodental and postcranial data for 50+ extinct and extant bats also indicates that many features shared by *Necromantis* and megadermatids may be plesiomorphic. Collectively, the current evidence does not support the referral of *Necromantis* to Megadermatidae. In dated molecular phylogenies *Necromantis* is commonly used as a calibration point for minimum age of the split between megadermatids and other rhinolophoids. Our research suggests that this calibration is invalid, and its removal may lead to revisions in molecular estimates for divergences within bats.

Poster Session III (Friday)

#### DENTAL MICROWEAR AND ITS IMPLICATIONS FOR NODOSAURID FEEDING MECHANICS AND PALEOECOLOGY

MALLON, Jordan, University of Calgary, Calgary, AB, Canada; RYBCZYNSKI, Natalia, Canadian Museum of Nature, Ottawa, ON, Canada; VICKARYOUS, Matthew, University of Calgary, Calgary, AB, Canada; ANDERSON, Jason, University of Calgary, Calgary, AB, Canada

Ankylosaurs, and other non-ornithomorph ornithischians, have traditionally been considered "orthal pulpwers," effecting a strictly vertical movement of the jaws when feeding. This interpretation has helped perpetuate the idea that these animals were limited to eating soft plants of aquatic origin. Recent work on the ankylosaurid *Euoplocephalus* has suggested that its jaw movements were more complex than previously assumed, with a power stroke that was largely retractive. The present study uses dental microwear evidence to investigate feeding behavior in the sister group to the ankylosaurids, the Nodosauridae. A survey of isolated nodosaurid ankylosaur teeth from the Dinosaur Park Formation of Alberta, Canada using stereophotomicroscopy reveals bidirectional microstriae oriented mesiodistally and apicobasally across the occlusal surface of the enamel. This is in contrast to the pattern of dental microwear noted previously in the sympatric *Euoplocephalus*, in which predominantly unidirectional microstriae were found oriented mesiodistally across the teeth (an observation confirmed in this study). The difference in dental microwear patterns between the two taxa is significant for a couple of reasons. First, it supports the interpretation that the ankylosaur feeding mechanism was derived relative to the strict orthal action of more basal ornithischians. It also suggests that the various ankylosaurian subclades employed a diversity of community systems not previously appreciated. The ankylosaurid *Euoplocephalus* and the nodosaurids of the Dinosaur Park Formation have distinct patterns of dental microwear, indicating that they each employed different jaw movements. Combined with morphological differences of the rostrum and secondary palate, these distinctive jaw actions are hypothesized to be associated with differences in diet, and may have reduced interspecific competition for food. Such resource partitioning likely would have been necessary in light of the rich diversity of the Judithian herbivore fauna of North America.

Technical Session XIV, Saturday 9:30

#### BIOMECHANICS OF DROMAEOSAURID CLAWS: APPLICATION OF X-RAY MICROCTOGRAPHY, NANOINDENTATION AND FINITE ELEMENT ANALYSIS

MANNING, Phillip, University of Manchester, Manchester, United Kingdom; ALLI, Joshim, University of Manchester, Manchester, United Kingdom; MCDONALD, Sam, University of Manchester, Manchester, United Kingdom; MUMMERY, Paul, University of Manchester, Manchester, United Kingdom; SELLERS, William, University of Manchester, Manchester, United Kingdom

Dromaeosaur theropod dinosaurs, such as *Velociraptor*, possess strongly recurved, hypertrophied and hyperextensible unguis claws on both the pes (digit II) and manus. The claws of dromaeosaurs have been strongly linked to the capture and despatching of prey in this group of predatory dinosaurs. However, the mechanical properties, or more importantly the mechanical potential, of these structures has not been explored. By generating a 3D finite element (FE) stress/strain contour map of a fossil *Velociraptor* manus claw it has been possible to quantitatively evaluate the mechanical behaviour of a dromaeosaur claw for the first time. The use of X-ray micro-tomography allowed an accurate 3D finite element mesh to be generated. This mesh reliably reproduced the material microstructure of a *Velociraptor* claw. Analogue claw material from an extant avian theropod, pedal digit and claw from an Eagle Owl (*Bubo bubo*), were analysed to provide input data for the *Velociraptor* claw FE model. The resultant FE model confirms that dromaeosaur claws were well-adapted for climbing where forces are primarily

tension. However, the claws would have had limited strength when subjected to forces perpendicular to the long-axis of the claw. The tip of the claw functioned as the puncturing and gripping element of the structure, whilst the expanded proximal portion transferred the load stress across the trabeculae and cortical bone of the claw. The FE analysis, morphology and microstructure of the claw all support the interpretation of a climbing function for these structures. The enhanced climbing ability of dromaeosaur dinosaurs might also support the importance of a scansorial phase in the evolution of flight.

Poster Session III (Friday)

THE BROMACKER QUARRY - THE MOST IMPORTANT LOCALITY OF LOWER PERMIAN TERRESTRIAL VERTEBRATE FOSSILS OUTSIDE OF NORTH AMERICA

MARTENS, Thomas, Museum der Natur, Gotha, Germany; BERMAN, David, Carnegie Museum of Natural History, Pittsburgh, PA, USA; HENRICI, Amy, Carnegie Museum of Natural History, Pittsburgh, PA, USA; SUMIDA, Stuart, California State University, San Bernardino, CA, USA

The Early Permian Bromacker quarry, located in the Upper Rotliegend Tambach Formation, near Gotha, central Germany, is a highly prolific site that yields terrestrially adapted invertebrate and vertebrate fossils. They far surpass in numbers of individuals, diversity of taxa, and quality of preservation those of all other European sites of comparable age. Whereas the Bromacker taxa are unique to Europe, they are identical or very closely related to forms known elsewhere almost exclusively from the Lower Permian of the U.S. To date, thirteen vertebrates, eight to ten invertebrates, and three invertebrate and five vertebrate traces 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 fauna: 1) lack of any obligatory aquatic or semi-terrestrial forms (fish and most amphibians); 2) the amphibians, which include two to four dissorhoids and *Seymouria*, are widely viewed as highly adapted to an active, terrestrial existence; 3) presence of four taxa of terrestrial herbivores presumably capable of consuming high-fiber vegetation doubles that for any assemblage of comparable age; 4) herbivores outnumber the only two top predators by a ratio of 7:1; 5) herbivores represent nearly 50 % and top predators 7 % of the total number of specimens collected; 6) presence of the ephemerally-adapted invertebrate *Conchostraca*.

Poster Session III (Friday)

POLAR DINOSAUR TRACKS IN THE CRETACEOUS OF AUSTRALIA: THOUGH MANY WERE COLD, FEW WERE FROZEN

MARTIN, Anthony, Emory University, Atlanta, GA, USA; VICKERS-RICH, Patricia, Monash University, Clayton, Australia; RICH, Thomas, Museum of Victoria, Melbourne, Australia; KOOL, Lesley, Monash University, Clayton, Australia

Lower Cretaceous strata of Victoria, Australia have yielded a sizeable amount of dinosaur skeletal material since the late 1970s, resulting in the best-documented polar dinosaur assemblage in the world. This assemblage is dominated by hypsilophodontid-grade dinosaurs (e.g., *Leaellynasaura*, *Atlascoposaurus*, *Qantassaurus*) but is also represented by rare fragments of theropods (*Timimus*) and a protoceratopsian (*Serendipaceratops*). Much of this material was recovered from the Otway Group (Aptian) at Dinosaur Cove, but is supplemented by recent finds from the Strzelecki Group (Albian) at the "Dinosaur Dreaming" dig site. Surprisingly, dinosaur tracks have barely augmented this body fossil record of polar dinosaurs; until 2006, only one, small dinosaur track had been found from Otway Group. Our reassessment of this track confirms that it likely was made by an ornithomimid, based on its length-width ratio and digital divarification. Its unusual preservation (epichnial but in positive relief, filled with a coarse-grained sand) provided a search image for similar tracks. As a result, several more isolated tracks were found in the Strzelecki Group at the "Dinosaur Dreaming" site in 2006 and 2007. Moreover, some of these tracks are attributable to large theropod tracemakers, verifying body fossil evidence only supported previously by a single allosauroid astragalus. Preservation modes of these Victorian dinosaur tracks may represent a combination of environmental and seasonal variations that affected where and when tracks were made, respectively. Sedimentological evidence of permafrost in the Strzelecki Group suggests that tracks would have had lower preservation potential during polar winters, but higher potential during spring and summer thaws. Facies in both groups are of fluvial (braided-stream) channel and overbank deposits; tracks were more likely to have been preserved in overbank deposits and along channel margins after ebbing of seasonal floods. In summary, we expect that more dinosaur

tracks will be recognized in both groups through application of better search images and a better understanding of processes that affected track preservation in polar environments.

Poster Session I (Wednesday)

A JUVENILE MOSASAUR (*TANIWHASAUROS ANTARCTICUS*) FROM THE LATE CRETACEOUS OF ANTARCTICA

MARTIN, James, SD School of Mines and Technology, Rapid City, SD, USA; KIHM, Allen, Minot State University, Minot, ND, USA; FERNANDEZ, Marta, Museum of Geology, La Plata, Argentina; REGUERO, Marcelo, Museo de La Plata, La Plata, Argentina; CASE, Judd, Eastern Washington University, Cheney, WA, USA

A juvenile mosasaurid (Squamata) was found by A.J. Kihm during a joint American-Argentine expedition to Vega Island east of the Antarctic Peninsula funded by the National Science Foundation and the Instituto Antártico Argentino. The skull of the mosasaur was found only following preparation of a concretion. Much of the anterior and dorsal portion of the cranium was preserved, as well as a quadrate and partial lower jaws. Diagnostic characters of the dentition and quadrate indicate the small skull represents that of the tylosaurine mosasaur, *Taniwhasaurus antarcticus*. The juvenile skull is approximately half the size of adult representatives of the species. The holotype of *T. antarcticus* was originally found in the late Campanian Santa Marta Formation on James Ross Island, whereas the juvenile was found in the early Maastrichtian Cape Lamb Member of the Snow Hill Island Formation, extending the stratigraphic range upward as had been expected. Remains of other tylosaurine mosasaurs had been recovered from late Maastrichtian deposits east of the Antarctic Peninsula but were not identifiable to generic level. *Taniwhasaurus* had originally been found in New Zealand and indicates the taxon was part of the austral Weddellian paleofaunal province. Moreover, this taxon and other juvenile marine reptile remains indicate that juvenile marine reptiles remained in the area until they were able to face open marine environments. Evidence of this behavior was recovered from the early Maastrichtian Cape Lamb Member of the Snow Hill Island Formation into the later Maastrichtian Sandwich Bluff Member of the Lopez de Bertodano Formation, a longer interval for the existence of such a refuge than heretofore known.

Student Poster Session (Thursday)

AN ANTILOCAPRID FROM THE LATE ARIKAREEAN (LATE MIOCENE) OF WYOMING

MARTIN, Larry, University of Kansas, Lawrence, KS, USA; BEATTY, Brian, New York College of Osteopathic Medicine, Old Westbury, NY, USA

The discovery of a mandible of an extinct merycodontine pronghorn (KUVF 48020) in the lower portion of the Harrison Formation just north of Van Tassel, Wyoming, extends the documented range of antilocaprids to over 21 million years. This mandible is not only the earliest known antilocaprid, but appears to have dental characteristics that do not fit in the range of variation within early forms of *Paracosoryx* or *Merycodus*. Its size appears to be intermediate between these two early genera, and while early *Paracosoryx* have metastylids but lack other accessory features, and early *Merycodus* completely lack accessory features, only ectostylids are found on KUVF 48020. Studies of variation within early *Merycodus*, along with comparisons with the previously reported *Merycodus prodromus* Cook 1934 (only represented by undiagnostic upper dentition), indicate not only a need to revise the genus *Merycodus*, but also that KUVF 48020 is not *Merycodus*. The appearance of antilocaprids in the fossil record is one of the characteristic events of the beginning of the Hemingfordian North American Land Mammal Age and this new discovery indicates that their emigration to North America from Asian ruminants is actually part of an earlier emigration pulse, probably contemporaneous with that of the appearance of other North American endemic ruminants.

Poster Session IV (Saturday)

PRELIMINARY EXAMINATION OF SELECT ARVICOLID RODENT SEQUENCES: RECOGNIZING GLOBAL AND REGIONAL PATTERNS

MARTIN, Robert, Murray State University, Murray, KY, USA; TESAKOV, Alexey, Russian Academy of Sciences, Moscow 109017, Russia; MARCOLINI, Federica, University of Pisa, Pisa, Italy

Biostratigraphic hypotheses based on the chronological distribution of Pliocene and Pleistocene arvicolid rodents were examined from the Central Great Plains of the USA, various basins of southern Spain (Baza, Guadix, Zujar, Jucar), eastern Europe and various short sections in Italy. These sequences were compared to the European Neogene rodent biochronology in an initial attempt to identify global versus regional patterns in arvicolid evolution and dispersal. The correlated appearance of various evolutionary stages on a global scale is astounding, testifying to rapid dispersal of adaptive dental morphotypes and, presumably, behaviors and reproductive strategies. One of the most coordinated/synchronous events of the middle latitudes in Old and New World arvicolid record is the decline and extinction of many lineages of voles with molar roots during the Late Pliocene, and the subsequent nearly synchronous appearance of *Microtus* throughout the Holarctic realm. Nevertheless, it is likely that the *Microtus* immigration event occurred later in Spain than elsewhere, testifying to the filtering

effect of the Pyrenees Mountains. *Borsodia* is more common in the steppe belt of western Asia and Eastern Europe and only occasionally occurs in Western Europe. *Pliomys* appears in the south of Europe in Late Early Pliocene but its subsequent evolution occurs in Western Europe. The Pliophenacomyinae is an endemic North American group. The systematics of early *Ognodontomys*, *Ophiomys* and *Mimomys* needs to be reviewed; some of these taxa may be better viewed as slightly advanced *Promimomys* related to *P. antiquus* Zazhigin.

Technical Session XV, Saturday 8:15  
JURASSIC MAMMALS OF CENTRAL ASIA

MARTIN, Thomas, Universität Bonn, Bonn, Germany; AVERIANOV, Alexander, Russian Academy of Sciences, St. Petersburg, Russia; PFRETZSCHNER, Hans-Ulrich, Universität Tübingen, Tübingen, Germany

New findings from the Fergana Valley in Kyrgyzstan and the Junggar Basin in north-west China greatly improved the record of Jurassic mammals in Central Asia. A diverse mammalian assemblage mainly of teeth has been recovered from the Middle Jurassic (Callovian) Balabansai Svita of the Fergana Valley. Up to now, this assemblage has ten taxa: Three docodonts (cf. *Simpsonodon*, *Tashkumyrodon desideratus*, and *Tegotheriidae* indet.), four eutriconodonts (*Amphilestidae* indet., the klameliid *Ferganodon narynensis*, cf. *Ferganodon* sp., and *Triconodontidae* indet.\*), an undetermined "symmetrodontan" (*Tinodontidae* indet.\*), and two cladotherians (*Paurodontidae* indet.\* and *Amphitheriidae* indet.) (asterisk denotes oldest occurrence of the group). Among these, cf. *Simpsonodon* and the undetermined amphitheriid indicate relationships to the Bathonian Forest Marble mammal assemblage from Kirtlington in Great Britain. "*Shuotherium*" *kermacki* from the Forest Marble, based on a lower molar, actually belongs to a tegotheriid docodont, similar to that from the Balabansai assemblage. The next younger stage of mammalian evolution in Central Asia is exemplified by an assemblage from the Upper Jurassic (Oxfordian) Qigu Formation in the southern Junggar Basin of Xinjiang Province, northwestern China which includes the haramioid *Eleutherodon* sp., the docodonts *Dsungarodon zuoi* and cf. *Tegotherium*, as well as the cladotherian cf. *Nanolestes*. Presence of *Eleutherodon* ties this fauna to the Middle Jurassic Forest Marble assemblage, while the *Nanolestes*-like cladotherian indicates affinities to the Late Jurassic Guimarota and Porto Pinheiro localities in Portugal. The faunal change from the Middle to the Late Jurassic in Central Asia and possibly worldwide affected mostly derived cladotherian mammals (replacement of amphitheriids by more advanced stem-lineage zatherians), whereas more basal mammals, such as docodonts and tinodontid "symmetrodontans" persisted in Asia into the Early Cretaceous. Apart from this endemic development, Jurassic mammals indicate closer paleobiogeographical interrelationships between Central Asia and Western Europe than previously expected.

Poster Session IV (Saturday)  
LITHOSTRATIGRAPHY AND VERTEBRATE BIOSTRATIGRAPHY OF  
THE UPPER TRIASSIC DOCKUM GROUP, SOUTHERN GARZA COUNTY,  
WEST TEXAS

MARTZ, Jeffrey, Texas Tech University, Lubbock, TX, USA

The lithostratigraphy of the Upper Triassic Dockum Group in southern Garza County provides a framework for vertebrate biostratigraphy. The Santa Rosa Sandstone at the base of the Dockum is truncated by micaceous sandstones that have been called both the Boren Ranch Sandstone and the Trujillo Sandstone. Above this is the type section of the Cooper Canyon Formation, consisting of interbedded micaceous sandstones, mudstones, and intrabasinal conglomerates. Physical tracing of the Trujillo Formation from Crosby County to the north suggests it is equivalent to one or more sandstones within the Cooper Canyon Formation rather than the Boren Ranch Sandstone, and that the lowermost Cooper Canyon Formation is correlative with the Tecovas Formation. The vertebrate biostratigraphy of southern Garza County is broadly consistent with the Late Triassic land vertebrate faunachrons (lvfs) established by workers in New Mexico. The phytosaurs *Paleorhinus* and *Leptosuchus*, the aetosaurs *Desmatosuchus*, *Paratypothorax*, and *Stagonolepis*, dicynodonts, trithelodonts, rhynchosaurs, trilophosaurs, the protorosaur *Malerisaurus*, and the temnospondyls *Metoposaurus bakeri* and *Apachesaurus*, many of which considered characteristic of the "Otischalkian" and "Adamanian" lvfs, are thus far known only from the Santa Rosa Sandstone, Boren Ranch Sandstone, and lower Cooper Canyon Formation (late Carnian?). The phytosaur *Pseudopalatus* (mostly characteristic of the "Reuveltian" and "Apachean" lvfs), a new aetosaur, and the procolophonid *Libognathus*, are found so far only in the upper Cooper Canyon Formation (Norian?). The rauisuchids, shuvosaurids, the aetosaur *Typothorax*, and indeterminate dinosauriforms, drepanosaurs, and large metoposaurus, are found in both the upper and lower parts of the Dockum Group in southern Garza County. These findings support faunal overturns among terrestrial vertebrates during the Late Triassic, but available sample sizes for various taxa are too scanty to determine whether this is due to attrition or mass extinction. Local endemism must be considered in intercontinental correlations, and may exist even within the western United States.

Poster Session IV (Saturday)  
MORPHOLOGICAL AND MOLECULAR ANALYSIS OF VERTEBRAL  
VARIANTS IN THE TWO-TOED SLOTHS *CHOLOEPUS HOFFMANNI* AND  
*CHOLOEPUS DIDACTYLUS*

MASLIN, Anthea, Wellesley College, Wellesley, MA, USA; STEPIEN, Courtney, Wellesley College, Wellesley, MA, USA; BUCHHOLTZ, Emily, Wellesley College, Wellesley, MA, USA

The living two-toed ground sloth *Choloepus* is phylogenetically isolated from other living xenarthrans, but shares with *Bradypus* deviation from the traditional cervical count of seven. In this project we documented variation in cervical count and a wide range of accompanying costal and sternal abnormalities in both *C. didactylus* and *C. hoffmanni*. All *C. hoffmanni* individuals in the data set had 5.5 (left/right asymmetrical) or 6 cervical vertebrae, and total precaudal counts average 39. *C. didactylus* cervical counts range from 5.5 to 8, and total precaudal counts average 41. The pattern of variation suggests a hypothesis of meristic reduction in both cervical and (thoracic + lumbar) series counts in *C. hoffmanni* relative to that of outgroups, among individuals of different precaudal count in *C. didactylus*, and of homeotic developmental variants in both species. Comparisons with the literature reveal that observed costal and sternal variants in both *C. didactylus* and *C. hoffmanni* strongly resemble those generated by knockout experiments of the patterning genes Hox a-4, Hox a-5 and Hox a-6 in mutant mice. The first steps in a test for the presence of mutant Hox genes in *Choloepus* individuals with aberrant cervical morphology have now been completed. DNA was extracted from skin snips of multiple individuals of both species using the protocol of the Hoekstra lab. Success of extraction was tested using the known sequence of part of the *C. didactylus* rRNA gene. The published sequences of Hox a-4 in living mammalian species and first-run genomic traces for *C. hoffmanni* and were used to reconstruct the predicted partial sequence of the *Choloepus* Hox a-4 gene. Amplification of that sequence is now being attempted.

Poster Session II (Thursday)  
CONTINUITY AND REANIMATION OF A FOSSIL PREPARATION  
LABORATORY: A REPORT FROM FLORIDA.

MASON, Jane, Florida Museum of Natural History, Gainesville, FL, USA; POYER, Art, Florida Museum of Natural History, Gainesville, FL, USA; HULBERT, Richard, Florida Museum of Natural History, Gainesville, FL, USA

Continuity and reanimation: this is a report following the retirement of a long-time preparator about the redevelopment of a useful and productive fossil preparation lab engaged in salvage fossil recovery from a working limestone quarry, Haile 7G, bearing a beautifully preserved, late-Pliocene, mixed lacustrine/forest fauna preserved in unconsolidated clays. Until prepared, it is critical to keep the contents of the plaster jackets wet while the fossils are still in their matrix. Cleaning and sorting the specimens is crucial to the expeditious flow of fossil material through the lab and requires coordination with the collection's manager and supervising the volunteers. A screen-washing operation for microfauna from this locality must also be integrated into the prep lab's ongoing activities. Meanwhile, protocols for the acid preparation of faunally-rich Paleocene limestone blocks from Wyoming must be developed, using cyclododecane as a resist and encapsulant. This technique will be a critical component of the lab's new activities. After establishing some primary laboratory priorities and becoming more comfortable with the concept of triage in reference to fossil recovery, developing a rapport with the seasoned volunteers is among the most critical steps in maintaining an active research program with the least historical disruption.

Poster Session I (Wednesday)  
INTERVERTEBRAL SPACING IN A JURASSIC ICHTHYOSAUR

MASSARE, Judy, SUNY College at Brockport, Brockport, NY, USA; BLASIOLO, Maryalice, SUNY College at Brockport, Brockport, NY, USA

The spacing between centra in ichthyosaur vertebral columns is rarely reported and consequently poorly known. Articulated vertebral columns (UW 34786, UW24205, UW39529) from the Sundance Formation provide an opportunity to look at intervertebral spacing in one species of parvipelvic, *Ophthalmosaurus natans*. Intervertebral 'disks' of sediment occur between adjacent centra. The width of the disk at the outer edge of the centra was used as a measure of spacing. Spacing is fairly uniform in the trunk but decreases abruptly at the beginning of the tail stock. Spacing then increases from the anterior to middle of the tail stock, as the centrum length itself decreases. At this point, centrum spacing decreases abruptly and remains fairly uniform (as centrum length decreases) for the remainder of the tail stock. In one specimen that preserved the posterior portion of the tail stock, centra were separated by unconsolidated sediment, so some displacement may have occurred. The spacing (presumably filled with soft tissue) affects the vertebral column flexibility and thus has implications for assessing swimming capabilities. Moreover, because the spacing can be fairly wide in comparison to centrum length, especially in the posterior tail stock, it needs to be considered in estimates of body proportions. Whether this pattern of spacing is unique to *O. natans*, ophthalmosaurids, or parvipelvians in general will require further study.

Student Poster Session (Thursday)

**ALLOSAURUS HUMERUS MORPHOLOGY: FUNCTION OR PHYLOGENY?**  
MASTERS, Simon, Western Illinois University, Macomb, IL, USA

Theropod limb function has been the focus of numerous studies in the past two decades. This research has concentrated on maniraptoran theropods and specifically on the origin and evolution of flight. Non-maniraptoran theropod functional morphology studies have focused on the hindlimb and its role in locomotion, whereas non-maniraptoran theropod forelimb function remains poorly understood. The common Late Jurassic theropod, *Allosaurus*, provides an opportunity to investigate forelimb function in a non-maniraptoran theropod. Forelimb use can be inferred using the humerus as an indicator. The proximal end of the humerus is the insertion site for shoulder and pectoral musculature, whereas the distal condyles are the origination site for the lower forelimb flexor and extensors. *Allosaurus* (n=35), *Columba livia* (Pigeon) (n=44), and *Alligator mississippiensis* (n=51) humeral data were collected from institutions across North America. Using reduced major axis (RMA) linear regression and principal components analysis (PCA), allometric changes in humeral landmarks (proximal and distal breadth, lateral and medial condyle breadth and height, delto-pectoral crest length, and medio-lateral and anterior-posterior midshaft least diameter) were measured in relation to the maximum length. RMA revealed an overall positive allometric signal for all taxa. Assuming a class-two lever system, over the ontogenetic spectrum of the *Allosaurus* specimens the musculature associated with humeral landmarks increased their mechanical advantage while overall forelimb mobility may have decreased. *Allosaurus* PCA results revealed size as the major component, but humeral landmarks (medio-lateral and anterior-posterior midshaft least diameter, medial condyle breadth and height) also contributed significantly to variation. These results support previous interpretations of a possible predatory function for *Allosaurus* forelimbs. Ultimately, the exact forelimb use of *Allosaurus* remains a mystery, but these results provide a base from which further research into non-maniraptoran theropod and archosaurian forelimb function can be conducted.

Technical Session IX, Friday 8:00

**NOTES AND REVIEW OF THE ORNITHISCHIAN DINOSAURS OF PORTUGAL**

MATEUS, Octávio, Museu da Lourinhã, Lourinhã, Portugal

The record of ornithischian dinosaurs from Portugal is substantial but incomplete in terms of our understanding of taxonomic composition and details of the anatomy of many forms. New data and reinterpretation of these forms are provided. The basal thyreophoran from the Lower Jurassic (the nomen dubium "*Lusitanosaurus liasicus*") is the most primitive dinosaur from Iberia. Concerning the Late Jurassic, new material from the Lourinhã Formation (Kimmeridgian/Tithonian) referable to the stegosaur *Dacentrurus* provides additional information on the systematic position and osteology. The new material shows two rows of paired triangular plates, with a notch in the anterior rim. A maxillary of an ankylosaur from the Vale Frades (Lourinhã Fm.) is here reported, but cannot be referable to *Dracopelta*, the only ankylosaur genus currently known from Portugal. The ornithomimid *Alocodon kuehnei* reported as Middle Jurassic (Callovian) is probably Oxfordian in age. A right dentary (ML768 from Zimbral) from the Lourinhã Formation, Kimmeridgian/Tithonian, and shares affinities with *Dryosaurus* but possesses more denticulation and no secondary ridges, suggesting the occurrence of a new or unreported species for the Late Jurassic of Portugal, which is here tentatively ascribed to aff. *Dryosaurus* sp. In summary, the Late Jurassic ornithischians species/genera from Portugal include *Dacentrurus armatus*, *Stegosaurus cf. ungulatus*, *Dracopelta zbyzsewskii*, *Phyllodon henkeli*, *Hypsilophodon* sp., *Alocodon kuehnei*, *Timucrodon cuneatus*, aff. *Dryosaurus* and *Draconyx loureiroi*. The Lower Cretaceous (Hauterivian / Barremian) of Praia das Aguncheiras, in Cabo Espichel, provided a partial left maxillary (CPGP1.99.7) of a basal iguanodontid that shows affinities with *Campotaurus*, and is tentatively assigned to this genus. The maxillary teeth denticles differ from Iguanodon or other *Iguanodontoides* because not show mammillations. More material is necessary to validate but, to be true, that would confirm the presence of this genus in the lower Cretaceous. The *Iguanodon* has been well reported in the Lower Cretaceous of Cabo Espichel.

Poster Session III (Friday)

**TAPHONOMY AND SEDIMENTOLOGY OF THE FIRST KNOWN TRICERATOPS BONEBED, CARTER COUNTY MONTANA**

MATHEWS, Joshua, Northern Illinois University, Milton, WI, USA; HENDERSON, Michael, Burpee Museum of Natural History, Rockford, IL, USA; WILLIAMS, Scott, Burpee Museum of Natural History, Rockford, IL, USA

Bone bed accumulations of ceratopsian dinosaurs are not uncommon in Cretaceous age strata. There are several localities that provide strong evidence that these animals congregated in herds. Bonebeds have been found for *Centrosaurus*, *Styracosaurus*, *Torosaurus*, and *Chasmosaurus*. Many of the bonebeds discovered contain the remains of hundreds to possibly thousands of individuals that died during a cataclysmic event, such as a flood. While bonebeds for these animals are common, perhaps the most famous of the horned dinosaurs, *Triceratops*, has only been found as individual speci-

mens. *Triceratops* is one of the most common dinosaurs found in the Hell Creek Formation, second only to *Edmontosaurus*. Until now, there has never been a documented case involving a *Triceratops* bonebed. The Homer Site, excavated by the Burpee Museum of Natural History in the summer 2006, has yielded the remains of two sub-adult *Triceratops* within the same quarry. Over 110 bones and bone fragments have been recovered from the site, a majority of which is skull material, pectoral and pelvic girdles, and ribs. Excavation of the site resulted in 3 postorbital horncores, 4 squamosals, 2 parietals, 3 scapulae, and numerous ribs. Limb elements were represented by only one femur. The enclosing rock type at the Homer Site is an organic rich mudstone, interpreted as an overbank flood deposit along a paleo-river or stream. Although at first glance, there appears to be a preferred direction within the quarry that would show current direction, there is no statistical evidence to support it. The bones are well preserved and show minimum signs of abrasion. Most of the breakage present can be attributed to the excavation and collection process as well as compaction of the bone bearing layer over time. The lack of cervical and caudal vertebrae, along with the lack of phalanges and metapodials, suggest that the current was strong enough to carry away the smaller skeletal elements, however unable to carry away the larger, heavier skeletal elements. Most of the bones in the quarry were assigned to Voorhies Transport Groups 2 and 3, which are representative of a lag deposit.

Technical Session XII, Friday 2:45

**STABLE ISOTOPIC RECORD OF MESSINIAN MAMMALS FROM THE CIRCUM-MEDITERRANEAN REGION**

MATSON, Samuel, University of Minnesota, Minneapolis, MN, USA; FOX, David, University of Minnesota, Minneapolis, MN, USA

During the Late Miocene Messinian Salinity Crisis (MSC), severance of the Mediterranean-Atlantic corridor coupled with a negative hydrological budget for the Mediterranean region, resulted in widespread desiccation of the Mediterranean Sea. We measured stable carbon and oxygen isotopes preserved in latest Miocene and early Pleistocene ungulate fossils from southeastern Spain and northern Libya to explore the potential environmental and ecological effects of a large, desiccated marine basin on nearby terrestrial environments. Tooth enamel  $\delta^{13}C$  values from Librilla (MN-13, Spain) range from -11.5‰ to -9.4‰ VPDB and those from Sahabi (MN-13/14, Libya) range from -10.4‰ to -8.6‰ VPDB, suggesting ungulates at both localities consumed  $C_3$  vegetation in a relatively arid climate. These latest Miocene enamel  $\delta^{13}C$  values are within the range (-8.0‰ to -12.1‰ VPDB) of Lower Pleistocene ungulates from the Baza Basin in southeast Spain, suggesting that large herbivore diets were not significantly different during the MSC. Relatively positive tooth enamel  $\delta^{18}O$  values further support the interpretation of an arid circum-Mediterranean climate during both the latest Miocene and the early Pleistocene. Mean  $\delta^{18}O$  of tooth enamel from Sahabi (31.5‰ VSMOW) is more positive than that of Librilla (29.9‰ VSMOW) or the Baza Basin (26.8‰ VSMOW), consistent with either a more arid climate or more  $^{18}O$ -enriched precipitation in northern Libya during the MSC. Hippopotamuses from Sahabi and the Baza Basin are depleted in both  $^{13}C$  and  $^{18}O$  relative to other taxa in the fauna, which is consistent with their semiaquatic habitat and diet. This observation also suggests that primary  $\delta^{18}O$  values are preserved in enamel carbonate. However, a lack of covariation between intra-individual enamel and dentine carbonate  $\delta^{18}O$  values suggests diagenetic alteration has taken place in one or both skeletal materials. Analysis of enamel and dentine phosphate  $\delta^{18}O$  will provide further insight into interpretations drawn from carbonate  $\delta^{18}O$ .

Student Poster Session (Thursday)

**THE EARLY CRETACEOUS CHORISTODERAN REPTILE, MONJUROUSUCHUS, IN CHINA AND JAPAN**

MATSUMOTO, Ryoko, University College London, London, United Kingdom

New material of the Lower Cretaceous choristoderan reptile, *Monjurosuchus*, has been recovered from the Tetori Group, Japan. This genus was first described from the Lower Cretaceous Jehol Biota of China, but has only recently been recognised as a choristodere. The new material provides the first record of the genus in Japan, but the same deposits produced the first long-necked choristodere, *Shokawa*. The Japanese *Monjurosuchus* material is broadly similar to specimens of the type species, *M. splendens*, but differs in details of the parietal and temporal region. Cladistic analysis supports the monophyly of Neochoristodera, and also the sister group relationship of *Shokawa* and *Hypphalosaurus*, forming a Sino-Japanese clade of long necked choristoderes. The placement of the European Tertiary *Lazarussuchus* remains problematic but the analysis supports its placement within Choristodera rather than on the stem, as in some other recent studies. Although the Jurassic *Cteniogenys* and all neochoristoderes possess large, fully open, lower temporal fenestrae, these fenestrae are closed in *Monjurosuchus*, *Hypphalosaurus*, *Philydrosaurus*, and *Lazarussuchus*. The identification of *Monjurosuchus* from the Tetori Group provides an important link between the fossil assemblages of Japan and those of the roughly contemporaneous, and better known, Jehol Biota of China.

Technical Session XIII, Friday 1:45

THE PHYLOGENETIC SIGNIFICANCE OF OSSIFICATION SEQUENCE DATA IN BIRDS, AND ITS RELEVANCE TO FOSSIL TAXA

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Ossification sequence is influenced by numerous factors, including evolutionary history, developmental constraint, adult morphology, and physical factors such as muscle development and embryonic movement. Life history constraints, for instance adaptation to post-embryonic life, migration, and the degree of altriciality of the hatchling may also play a role. All of these variables may affect skeleton formation in different ways, and are difficult to tease apart since they also influence each other. Not all factors are equally important in determining ossification sequence in all taxa. For instance, in organisms with a feeding larval stage, it has been suggested that the early ossification of maxillary and palatal elements is important to permit efficient feeding and to prevent damage to the brain by large food items. In birds, however, the palatal elements ossify long before any feeding activity, and so an adaptationist hypothesis does not explain their early formation. Developmental constraint or phylogenetic retention of these traits from an ancestor in which they were selectively advantageous may explain the pattern observed. Analysis of the ossification sequences of selected avian genera demonstrates a high degree of sequence conservation both within and between taxa, indicating that phylogenetic information is present. Preliminary results indicate that older splits may be resolved, but intraordinal relationships remain poorly supported. While precociality influences the degree of ossification of the hatchling skeleton, it cannot explain any of the observed ossification sequence changes. There are large differences in the number and the identity of late-stage ossifications between closely related precocial birds, which suggests that there are other factors involved in determining the final state of the hatchling skeleton. These observations not only provide information on phylogeny and skeletogenesis of extant birds, but can also be applied to fossil taxa in order to better understand their development, ecology and evolution. The future extension of these results to the embryos of fossil archosaurs will be discussed.

Poster Session IV (Saturday)

BITE ME: INVESTITIONS OF SLOTH BITE FORCES AND FEEDING STRATEGIES

MCAFFEE, Robert, Northern Illinois University, DeKalb, IL, USA; HOUSEHOLDER, Mindy, Northern Illinois University, DeKalb, IL, USA

Within the Xenarthra, the diversity of form and function is quite high, especially among the sloths where extinct genera greatly outnumber the living tree sloths. Interpretation of feeding behaviors in the extinct forms has been varied and difficult to assess due to retention of characters from an insectivorous ancestor, which have been secondarily adapted to an herbivorous lifestyle. A modification of methods used to investigate bite force in cingulates (armadillos, glyptodonts, pampatheres) was performed on the two genera of living tree sloths, *Bradypus* and *Choloepus*, and also on the extinct Miocene genera, *Hapalops* and *Nematherium*. All taxa show a diversity of form and represent the major sloth families: Mylodontidae, Megalonychidae and Megatheriidae. The methodology involved interpreting lines of action for the temporalis and masseter musculature, based on dissections of the extant taxa and using the corresponding muscle scars in the extinct taxa to establish homology. Comparison of the forces generated by the muscles and the ratios from the moment arms of the dentition exhibit variable patterns, some which are indicative of taxonomic relationships. *Bradypus* and *Hapalops* show a strong similarity in their posterior forces due to the deep, ventrally bowed mandible, which characterizes the megatheriids. The greatly reduced the input force of *M. temporalis* relative to *M. masseter* can be attributed to the lack of a premental spout in *Bradypus*. While *M. masseter* generates the most force across all taxa, the values for *M. temporalis* are nearly equivalent in *Choloepus* due to a dorsoventrally compressed jugal for the origin of the masseter. The larger bite force ratios for the posterior dentition reflect a strong masticatory stroke, typical to herbivores for slow grinding. Comparison of the relative anterior bite force ratios at the premental spout also provides an implication about feeding strategy, with larger values for *Choloepus* and *Nematherium* suggesting a greater ability for cropping sturdy vegetation, while the lower ratio for *Hapalops* suggests an increased selection for softer foods.

Technical Session I, Wednesday 11:30

FIRST FOSSIL CHIMPANZEE

MCBREARTY, Sally, University of Connecticut, Storrs, CT, USA

The chimpanzee (*Pan*) is the closest living relative to humans, but until recently there were no known chimpanzee fossils. Here I report chimpanzee fossil teeth discovered in 2004-2006 in the Middle Pleistocene Kapthurin Formation, Kenya. The strata containing the fossils are bracketed by  $^{40}\text{Ar}/^{39}\text{Ar}$  dates of  $545 \pm 3$  ka and  $284 \pm 12$  ka. Depositional context for the *Pan* fossils is the shore of a fluctuating saline-alkaline lake, in proximity to an extensive fresh water spring. Associated fossil fauna consists of aquatic forms, including fish and hippopotamus, as well as closed habitat indicators, including the monkey *Colobus*, the bushpig *Potamochoerus*, and the cane rat *Thryonomys*. Because most living chimpanzee populations inhabit wooded West and Central Africa, while many fossil hominin sites occur in the semiarid Rift Valley of

East Africa, explanations for the divergence of the human and chimpanzee lineages at 5 to 7 Ma have focused upon biogeography or climate change as the causal mechanism for their separation. A shift from wooded to savanna vegetation, driven by climate change, has been thought to have driven the split, and to have played an essential role in the origin of bipedalism. The Rift Valley itself has been seen as an obstacle to chimpanzee occupation in some scenarios. Because fossils of *Homo* have been found in the same stratigraphic interval of the Kapthurin Formation as those of *Pan*, it is now clear that habitats suitable for both hominins and chimpanzees were present in East Africa during the Middle Pleistocene, and that the Rift Valley did not present an impenetrable barrier to chimpanzee occupation.

Student Poster Session (Thursday)

ON DYROSAURID (CROCODYLOMORPHA: MESOEUCROCODYLIA) POSTCRANIAL REMAINS FROM THE LATE CRETACEOUS AND PALEOCENE OF MALI

MCCARTNEY, Jacob, Stony Brook University, Stony Brook, NY, USA; HILL, Robert, New York College of Osteopathic Medicine, Old Westbury, NY, USA

Dyrosaurid crocodyliforms constitute a Late Cretaceous to Eocene clade diagnosed and known primarily from cranial material. Although crocodyliform postcrania have been described as anatomically conservative, recent descriptions of dyrosaurid postcrania allow taxonomic assignment of some newly discovered fossils from three localities in Mali. The discovery of dyrosaurid postcrania is particularly important in light of recent hypotheses that address dyrosaurid phylogeny and functional morphology. The new material represents individuals with a wide range of body sizes, and some elements indicate that dyrosaurids provided a food source for contemporaneous carnivores. The specimens that can be positively assigned to Dyrosauridae mainly comprise vertebral material, with representative elements from each part of the column: cervical (including an axial centrum), dorsal, sacral (two distinct morphologies), and caudal. Also recovered is a left scapula that is very similar to the North American *Hyposaurus*, and several coracoids. A single ventral and numerous dorsal osteoderms were recovered. These are pitted and lack a central keel, as is the case in dyrosaurids. Additional crocodyliform postcranial elements recovered from the Mali localities are only tentatively referred to Dyrosauridae because no other crocodylians are yet known from these deposits. The recovered material includes a cervical rib, partial humeri of varying sizes, two radiales of very different size, several partial femora and tibiae, and metapodials. Three of the long bones exhibit evidence of postmortem scavenging: a series of closely spaced, parallel grooves etched onto the shafts near the proximal and distal ends. The spacing of these marks does not match the spacing of teeth or alveoli on any of the known cranial dyrosaurid material recovered from the site. Postcranial evidence of smaller crocodyliforms, as well as some shark teeth, suggest that these animals may have been the carnivores that made these marks. In the absence of juvenile dyrosaurid material, however, intraspecific cannibalism cannot be ruled out as a possible explanation for the tooth marks.

Poster Session III (Friday)

PRELIMINARY INVESTIGATIONS ON THE VERTEBRATE ICHNOFAUNA OF THE LOWER CRETACEOUS (VALANGINIAN) GORMAN CREEK FORMATION, NORTHEASTERN BRITISH COLUMBIA: FILLING THE GAP IN THE TERRESTRIAL VERTEBRATE TRACK RECORD OF WESTERN CANADA

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In the summer of 2005 and 2006, research was conducted on a fossil track site in the remote alpine of Kakwa Provincial Park near the Alberta/B.C. border. Geological maps of the area place the track site within the Gorman Creek Formation (Lower Cretaceous: Valanginian). The track site (greater than 3000m<sup>2</sup>) is on a near-vertical north-facing anticline limb and contains a diverse vertebrate track fauna (exclusively those of dinosaurs so far) with thousands of prints. To date the Gorman Creek vertebrate ichnofauna includes a large theropod ichnotaxon (cf. *Irenesauripus*), the ichnotaxa of at least two medium theropods (cf. *Columbosauripus* and cf. *Irenesauripus*), at least one ichnotaxon of small theropod (as yet unassigned), one small quadrupedal ornithomorph ichnotaxon (*Anomoepus*-like), and one ankylosaur ichnotaxon (*Tetrapodosaurus* ichnosp.) which is one of the largest examples of this ichnotaxon yet reported (avg. footprint length of 63cm). The Kakwa Provincial Park track site has the potential to fill a conspicuous gap in the vertebrate track record as Valanginian track sites are uncommon on a global scale. The Gorman Creek ichnofauna also helps to bridge a substantial gap in the regional ichnological record that existed between the stratigraphically lower Mist Mountain Formation (Tithonian-Berriasian) of southeastern B.C. and the stratigraphically higher Gething Formation (Aptian-Albian) of northeastern B.C. The ichnofaunas of the Mist Mountain Formation and the Gething Formation are, with the possible exception of cf. *Irenesauripus*, completely different in composition from each other. The Gorman Creek ichnofauna is intermediate in age between the Mist Mountain and Gething Formations and appears to contain a transitional ichnofauna as it has some ichnotaxa in common with the Mist Mountain Formation (the *Anomoepus*-like prints),

and the Gething Formation (the *Tetrapodosaurus* prints). To date the tracks of neither sauropods (only known from the Mist Mountain Formation) nor large ornithomorphs have been observed within the Gorman Creek Formation, the latter of which first appear in the Gething Formation and are absent from the Mist Mountain Formation.

Poster Session III (Friday)

A NEW BASAL HADROSAUROID (DINOSAURIA: ORNITHOPODA) FROM THE TURONIAN (LATE CRETACEOUS) OF NEW MEXICO

MCDONALD, Andrew, University of Nebraska, Springfield, IL, USA; WOLFE, Douglas, New Mexico Museum of Natural History and Science, Phoenix, AZ, USA; KIRKLAND, James, Utah Geological Survey, Salt Lake City, UT, USA

The Moreno Hill Formation of New Mexico has recently produced a remarkable fauna of Turonian dinosaurs, elucidating a sparsely known interval of dinosaur history. This fauna includes *Zuniceratops*, the earliest North American ceratopsian known to have sported supraorbital horns; *Nothronychus*, the first North American therizinosaurian theropod to be described; a new basal coelurosaur currently under study; and a new basal hadrosauroid ornithomorph. The hadrosauroid comprises a new genus and species represented by the holotype, MSM P4166, an associated partial skull and fragmentary postcranium. The new taxon is distinguished by an extremely slender and elongate dentary (length to height ratio = 6.1). MSM P4166 is also remarkable for its possession of a unique combination of primitive and derived characters. Plesiomorphic features include a paraquadrate foramen; accessory ridges, albeit reduced, on the dentary teeth; a dentary tooth row that does not extend caudal to the apex of the coronoid process; a short diastema; and asymmetrical maxillary tooth crowns. Derived aspects include a lack of accessory ridges on the maxillary teeth, a high count (32) of dentary alveoli, at least two replacement teeth per dentary alveolus, a coronoid process formed mostly by the dentary, and a strong rostral expansion of the coronoid process. The new taxon appears similar to *Altirhinus* and *Penelopognathus* in having a gracile and elongate dentary, but is more derived than these Asian taxa in several respects. The new species is quite like *Eolambia* from the Albian-Cenomanian of Utah, but differs by showing a rostrally expanded coronoid and posteriorly curved quadrate. MSM P4166 also differs from *Protophadros* from the Cenomanian of Texas in lacking an extremely deep anterior dentary. In the possession of such a mixture of the primitive and the derived, the new hadrosauroid closely mirrors the condition of *Zuniceratops*; both species powerfully demonstrate the significance of the Moreno Hill fauna in comprehending the origins of the characteristic North American dinosaurs of the latest Cretaceous. Study is underway to determine the precise relationship of the new taxon to other hadrosauroids, as well as the ontogenetic status of the holotype.

Ernie Lundelius Symposium (Faunal Dynamics and Extinction), Wednesday 8:15  
CLIMATIC PARAMETERS AND THE PALEOECOLOGY OF PLEISTOCENE MAMMALS: THE USE OF THE MACROPHYSICAL CLIMATE MODEL

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The Macrophysical Climate Modeling (MCM) is predicated on orbital forcing, variations in atmospheric transparency, and the principles of synoptic climatology. The model has previously been applied to archeological sites and has been referred to as archaeoclimatology. Extending the use of the model into the late Pleistocene permits an examination of the relationship of the paleoecology and distribution of the North American fauna to various climatic parameters, such as seasonal changes in temperature and precipitation, although the model allows the calculation of other climatic parameters as well. Site specificity is the key component to the model as it lets us examine climatic parameters at individual sites with extinct fauna and compare multiple sites to look at shared climatic parameters. Calculations from the model can be done for 100-year averages. When coupled with specimens with AMS dates the model allows us to examine specific climatic parameters that may be related to an extinct species' paleoecology and critically examine climatic events that may be related to the extinction of species at the end of the Pleistocene.

Poster Session III (Friday)

*CORYPHODON LOBATUS* (MAMMALIA: PANTODONTA) FROM DEARDORFF QUARRY, PICEANCE BASIN, COLORADO: ADDITIONAL EVIDENCE OF A *CORYPHODON* PAUCISPECIFIC DEATH ASSEMBLAGE

MCGEE, Elizabeth, San Jose State University, San Jose, CA, USA; TURNBULL, William, Field Museum, Chicago, IL, USA; SIMPSON, William, Field Museum, Chicago, IL, USA

*Coryphodon* assemblages are one of the few exceptions to the operational rule that the fossil record, while long on history, is often short on detail, particularly at the level of the population. There are several instances of mass death assemblages of *Coryphodon* from Eocene deposits in the Western Interior of North America, e.g., Roehler's *Coryphodon* Catastrophe Quarry (RCCQ) in Wyoming and AMNH Quarry 242 in New Mexico. Here we report an additional early middle Wasatchian assemblage from Deardorff Quarry in the Piceance Basin of Colorado. Originally excavated in the 1940s by Bryan Patterson and colleagues, this assemblage provides tantalizing details on

intraspecific and interspecific variation in *Coryphodon*. The Deardorff Quarry assemblage contains a minimum of 11 individuals, ranging in age from subadult "yearlings" with deciduous teeth at different stages of eruption and wear, to old individuals with molars exhibiting near complete erosion of the enamel. The preponderance of *Coryphodon* material in this assemblage (600+ complete bones) and the relative absence of material from other species (21 specimens total, representing 8 species of mammals, plus a small assortment of turtle fragments) argue for a "catastrophic" origin for this assemblage. This assemblage preserves one of the most complete dental eruption sequences reported to date for *Coryphodon*, and allows interpretation of demographic attributes not ordinarily observable, e.g., evidence of seasonality in births. In addition, females are disproportionate in number to males, further confirming that this species had a polygynous social structure. Autochthonous assemblages are also useful in eliciting a better understanding of the range of variation in single populations. Metrically, the molars of *C. lobatus* specimens from Deardorff have coefficients of variation (CV) ranging from 5 to 13. CV values for Deardorff, however, are comparable to metric variation observed in RCCQ and AMNH Quarry 242. Information on the range of variation in this highly variable taxon is of particular importance in the taxonomy of this ubiquitous Eocene mammal.

Technical Session XVI, Saturday 1:45

GEOMETRIC MORPHOMETRICS ENABLES DISCRIMINATION AMONGST FIVE MICROTINES AND ALLOWS REASSESSMENT OF CALIFORNIA'S QUATERNARY PALEOECOLOGY

MCGUIRE, Jenny, UC-Berkeley, Berkeley, CA, USA

Detailed fossil identification is often necessary to analyze the biostratigraphic, evolutionary and paleoecological importance of a paleontological site. Rodents of the genus *Microtus* are of particular importance in this regard. Their pervasiveness in the fossil record makes them useful biostratigraphic markers, a role enhanced by higher-resolution identification. Microtines are well-represented throughout their recent diversification events, making them excellent candidates for investigating evolutionary changes in morphology through time. Finally, their role as key paleoecological indicators facilitates our understanding of community shifts in response to historic events. The full potential of *Microtus* fossils in informing paleobiology and evolutionary theory has been limited by the difficulty for identifying paleontological specimens to species. *Microtus* fossils are typically preserved only as isolated teeth, which lack the cranial, dental, and external characters typically used to diagnose extant microtine species. Previous studies attempting to identify fossil microtines to species using traditional morphometrics have been unsuccessful, particularly amongst Pacific-coast species. Here I demonstrate that geometric morphometric analyses can distinguish between the five species of *Microtus* living in California today (*M. californicus*, *M. longicaudus*, *M. montanus*, *M. oregoni* and *M. townsendii*) using only their lower first molar (m1). I expand an approach developed by Wallace, who distinguished between molars of *M. xanthognathus* and *M. pennsylvanicus*. I performed a geometric morphometric analysis on the m1 of >150 specimens from throughout the geographic range of each species. Discriminant analysis on the resulting projected shapes correctly classifies the extant specimens to species enabling microtine identification from several important Quaternary California fossil localities. These techniques open new possibilities for ecological and evolutionary studies that require tracing the history of extant species into deeper time and can act as a basis for future species-level investigations into the impacts of past climate change in California.

Poster Session IV (Saturday)

THE RELATIONSHIP OF GEOTHERMAL ALTERATION AND RELICT ORGANICS TO THE COLOR OF FOSSIL BONE

MCKEAN, Adam, Brigham Young University, Provo, UT, USA; BRITT, Brooks, Brigham Young University, Provo, UT, USA; NELSON, Stephen, Brigham Young University, Provo, UT, USA; SCHEETZ, Rodney, Brigham Young University, Provo, UT, USA

Fossil bone occurs in a wide array of colors but is poorly understood. In this study we are concerned with the integral color of the bone visible on fresh, broken or cut surfaces - not colors imparted by mineral coatings or stains. Integral colors range from white, through shades of brown, to gray and black. Fresh bone is a composite material consisting of roughly equal parts of inorganic hydroxylapatite that forms the rigid lattice, and interstitial organics, primarily collagen. We hypothesize that the integral color of bone is a function of the degree of geothermal alteration of relic organic compounds. Thus bone color, like the colors of conodonts and palynomorphs, can be used as a guide to the maximum temperature to which the bone was subjected, which is usually a function of the depth of burial and the geothermal gradient. To test the hypothesis that bone color is related to organic content we tested six fossil bones ranging from Pleistocene to Late Jurassic in age. The Total Organic Content (TOC) by weight of the specimens tested ranges from 27 to 0.6%. In this limited sample size, bone color generally correlates to calculated depth of burial with an assumed geothermal gradient of 27.5°/1000 m. The color, depth of burial and maximum temperatures we observed are: yellowish white (<10 m, 15° C); medium brown (1400 m, 37° C);

black (3500 m, 96° C). Grey-colored bones relate to depths of burial >2000 m and a TOC less than 1%. To further test the relationship of temperature and color, modern and subfossil bone will be heated and held at a range of temperatures in a laboratory kiln.

Technical Session XI, Friday 2:30

PREY SIZE AND PREY-KILLING STRATEGIES IN THE FELIDAE

MEACHEN-SAMUELS, Julie, UCLA, Los Angeles, CA, USA; VAN VALKENBURGH, Blaire, UCLA, Los Angeles, CA, USA

Unlike canids and canid-like predators, cats display a relatively weak relationship between the body sizes of predator and prey. This might reflect the fact that canid and canid-like predators, such as hyenas, kill with jaws alone, whereas felids kill with a combination of jaws, claws, and paws. Large felids rely on muscular forelimbs to grasp and immobilize large prey, and often kill with a forceful bite that suffocates the prey. By contrast, smaller felids use lighter, rapid, and more precise limb movements to capture small prey that are killed by bites to the skull or cervical vertebrae. Consequently, cats that kill large prey should have adaptations for increased bite force and relatively more robust forelimbs than those that take small prey, where adaptations for speed might be favored. Here I explore the relationships among forelimb and paw strength, skull strength, and prey size in living felids using morphometric analyses of bones. Extant felids are used as proxies to infer the habits of extinct felids. Results suggest that felids that kill large prey have relatively robust canines and incisors, more robust metacarpals and relatively wider paws. There are also morphological distinctions between cats that kill predominantly large prey and those that kill both large and small prey. Average prey size was determined in fossil felids based on these same measurements. Other characteristics such as degree of arboreality or extent of forelimb grappling of prey were also elucidated in enigmatic cats such as *Smilodon fatalis* and *Homotherium crenatidens*.

Ernie Lundelius Symposium (Faunal Dynamics and Extinction), Wednesday 9:45  
LATE PLEISTOCENE *CYNOMYS* (RODENTIA, SCIURIDAE, PRAIRIE DOG) FROM NORTHWESTERN SONORA, MEXICO

MEAD, Jim, Northern Arizona University, Flagstaff, AZ, USA; WHITE, Richard, International Wildlife Museum, Tucson, AZ, USA; HOLLENSHEAD, Marci, Northern Arizona University, Flagstaff, AZ, USA; BAEZ, Arturo, University of Arizona, Tucson, AZ, USA; CARPENTER, Mary, National Park Service, Hagerman, ID, USA

The greater evolutionary history of *Cynomys* (Rodentia, Sciuridae) is well established. Earliest members are recorded from the late Blancan LMA, but have not been assigned to either of the two defined subgenera (*Cynomys*: black-tail; *Leucocrossomys*: white-tail). The fossil history for *Cynomys* is well understood for the Great Plains of the USA and Canada; however, it is inadequately studied for the arid Southwest USA and almost entirely unknown for northern Mexico. Two species of prairie dogs live today in Mexico, both within the subgenus *Cynomys*: *C. ludovicianus* and the endemic *C. mexicanus* (thought to have evolved from *C. ludovicianus* and occurs in a restricted area of approximately 500 square km in Coahuila, Nuevo Leon, Zacatecas, and San Luis Potosi). Here we report on the remains of *Cynomys* recovered from the paleontological site of La Playa, northern Sonora, where no prairie dogs live today. We have plotted the data from our modern and the La Playa specimens with that of modern and other fossil specimens from the USA. Assuming that *Cynomys mexicanus* was not larger during the Pleistocene, the La Playa specimens clearly plot with modern *C. ludovicianus*. The La Playa prairie dog remains were recovered in association with normal Bison, *Mammuthus*, camel, along with extinct pronghorn and tortoise remains indicating that the entire fauna is part of the RanchoLabrean Land Mammal Age. A review of RanchoLabrean faunas indicates that *Cynomys* is rarely identified from deposits immediately north of La Playa in Arizona. Both *C. ludovicianus* and *C. mexicanus* are reported from western New Mexico during the RanchoLabrean. The recovery of *Cynomys ludovicianus* from La Playa represents the first report of RanchoLabrean prairie dog from Sonora. Its occurrence at La Playa is indicative of an environment and supporting climate that no longer exists in the hot, arid desert of northwestern Sonora today.

Poster Session III (Friday)

RESULTS OF RECENT PALEONTOLOGICAL FIELDWORK IN THE MIDDLE MIOCENE ANCENEY LOCAL FAUNA, (BARSTOVIAN NALMA) GAL-LATIN VALLEY, MONTANA

MICHALIES, Sarah, Bozeman, MT, USA

A group of localities west of Bozeman, Montana, serve as the basis for the Anceney Local Fauna, which has historically been an important source for knowledge of late Cenozoic mammals in the northern United States. The Anceney Local Fauna occurs in the Middle Miocene Madison Valley Formation (Barstovian NALMA equivalent). It is contemporaneous with other Miocene rock units in Southwestern Montana including the Six Mile Creek Formation and strata at Hepburn Mesa. Previous research has yielded a diverse assemblage, including a vespertilionid bat, 16 species of rodents including castorids, cricetids, heteromyids, and mylagaulids, and sciurids; carnivorans have been represented by two distinct mustelids, including a marten, and the bizarre *Hypsoparia*.

Larger mammals have included the three-toed horse *Merychippus*, the strange dome-headed chalicothere *Tylocephalonyx*, and an indeterminate camel. Recent student-led fieldwork in the Madison Valley Formation has added several taxa to the presently known Anceney Local Fauna. New finds include a well preserved but as-yet unidentified tortoise skeleton, a partial shell from a pond turtle, a feloid carnivoran, additional remains of *Merychippus* including a partial limb, possible specimens of the diminutive antilocaprid *Merycodus*, and additional camel fossils. These additional finds may help to more completely identify certain members of the Anceney Local Fauna assemblage. Continuing research at this site will prove important for studying high latitude Miocene land mammal localities.

Technical Session VI, Thursday 3:45

SEXUAL DIMORPHISM AND MORTALITY BIAS IN EARLY MIOCENE RHINOS, *DICERATHERIUM* AND *MENOCERAS*, AND THEIR BEARING ON THE EVOLUTION OF SOCIALITY IN THE RHINOCEROTIDAE

MIHLBACHLER, Matthew, New York College of Osteopathic Medicine, Old Westbury, NY, USA

The coevolution of sexual dimorphism and sociality in mammals is largely understood through a ruminant artiodactyl paradigm that predicts a correlation between the degree of dimorphism and the intensity of male competition. No such correlation is found among perissodactyls or other diminished ungulate clades. The effects of extinction or human disturbance on the sociality of endangered clades are unknown. Several lineages of rhinos evolved cranial weapons similar to those of ruminants, suggesting that a stronger correlation between dimorphism and sociality might have once existed among extinct rhinos. The small early Miocene rhinos *Diceratherium* and *Menoceras* independently evolved nasal bones (and presumably horns) that were more dimorphic than living rhinos and more like those of ruminants. These rhinos might have evolved more gregarious social structures with intensified male competition and elevated mortality rates. Age- and sex-specific mortality rates were examined in large Arikarean assemblages of *Diceratherium* and *Menoceras* from the Harrison and Marsland formations of Nebraska. The mortality biases evident in the *Menoceras* assemblage reveal a heightened risk of mortality among young adult males in areas conducive to fossilization (ponds, lakes, rivers) and strongly resemble the mortality demographics of modern rhino populations where young males suffer frequent mortalities from horn and tusk wounds. Much lower mortality rates for young adult males were found in the *Diceratherium* assemblage, suggesting decreased levels of male competition in comparison to more monomorphic living rhinos. When these results are combined with similar studies of the later Miocene rhinos, *Teleoceras* and *Aphelops*, the severity of sex-biased mortality appears to be uncorrelated to the degree of sexual dimorphism in both living and extinct rhinos. Thus, the absence of correlated dimorphism and sociality among modern rhinos seems normal rather than an artifact of extinction or human disturbance. Confounding factors such as body size and other phylogenetic factors should be further considered if a universal theory on the evolution of sexual dimorphism is to be developed.

Technical Session IV, Wednesday 1:45

HABITAT DIFFERENTIATION BASED ON TAXON-FREE ANALYSIS OF SKELETAL REPRESENTATION IN YELLOWSTONE NATIONAL PARK, WY  
MILLER, Joshua, The University of Chicago, Chicago, IL, USA

The distribution of skeletal elements across a landscape is non-random. Scavengers disarticulate carcasses in systematic and stereotypical ways and will remove portions to consume elsewhere (e.g. a shade tree out of the way from competitors). Variation in principal factors of different habitats, including soil chemistry, soil moisture, and degree of vegetative cover (i.e. variation in bone exposure to UV radiation), may also lead to differential survival among skeletal elements due to variation in mineralogical densities and morphologies. Such biotic and abiotic taphonomic factors may have enough biasing potential within one ecosystem to generate skeletal assemblages that are different with respect to skeletal element distribution between habitats (some habitats may be sources of skeletal elements, while others may be sinks). Using the modern surface accumulation of ungulate bones from the Northern Range of Yellowstone National Park, I test whether the differences in taphonomic factors between four habitat-types (grasslands, lake margins, river margins, and forests) generate quantitatively different skeletal assemblages with respect to patterns of skeletal elements. Data on death assemblage composition was collected in Yellowstone using standardized transects within each habitat. Skeletal element representations for the habitats, irrespective of species, are compared using an index of completeness for each element - the ratio of the number of a specific skeletal element found to the number expected given the Minimum Number of Individuals found in each transect. Based on patterns of bone representation, the four habitats distinguish themselves in bivariate and multivariate space. The Yellowstone forests have the most distinct bone assemblages. Grasslands and aquatic margins are more similar in their bone accumulations - which may be due to their similarly open terrain. Taphonomic factors affecting modern ecosystems have the potential to generate quantitatively different skeletal assemblages. Fossil assemblages may also be examined in this manner to discriminate habitats and microenvironments that will contribute to paleoenvironmental reconstructions.

Poster Session IV (Saturday)

BIRD-LIKE BEHAVIOR AND ANATOMY IN AN EARLY JURASSIC (MOENAVE FORMATION: HETTANGIAN) THEROPOD DINOSAUR EXHIBITED BY A WELL-PRESERVED CROUCHING TRACE IN SOUTHWESTERN UTAH

MILNER, Andrew, St. George Dinosaur Discovery Site at Johnson Farm, St. George, UT, USA; HARRIS, Jerald, Dixie State College, St. George, UT, USA; LOCKLEY, Martin, Lockley, University of Colorado at Denver, Denver, CO, USA; KIRKLAND, James, Utah Geological Survey, Salt Lake City, UT, USA; MATTHEWS, Neffra, USDOI-Bureau of Land Management, Denver, CO, USA

Dinosaur tracks made by Early Jurassic (Hettangian) theropods were first discovered by Dr. Sheldon Johnson in February, 2000. The St. George Dinosaur Discovery Site at Johnson Farm (SGDS) has since produced thousands of unique and scientifically significant traces and body fossils since the initial discovery. These fossils are from the Moenave Formation and all represent animals and plants that lived within or along the shores of Lake Dixie, a large freshwater lake that once covered what is now most of southwestern Utah. Of the many important discoveries made at the SGDS, one of the most significant is a long, *Eubrontes*-type theropod trackway that displays intermittent tail drag marks and a rare crouching trace along the trackway. This crouching trace is comprised of parallel pes tracks with manus and hallux impressions, ischial callosities, and most importantly, clear left and right manus impressions. This crouching trace suggests a bird-like sitting posture in early theropods, and the hands were held with their palms facing medially. This specimen strongly suggests that avian-style hand configuration and resting behavior evolved early in theropod dinosaurs. Globally, crouching theropod traces have only been reported from about four localities in the Lower Jurassic of North America and East Asia. To date, the St. George occurrence is the oldest and most complete, and the only one to show two diagnostic manus traces.

The Dissorophoidea - Early Amphibian Radiation Symposium, Friday 9:00  
*MORDEX LATICEPS* AND THE BASE OF THE TREMATOPIDAE

MILNER, Andrew, The Natural History Museum, London, United Kingdom

About half of the dissorophoid amphibian specimens from N\_rany, Czech Republic belong to the taxon *Mordex laticeps*. This includes many larvae previously assigned to *Branchiosaurus salamandroides*, though not the lectotype of that taxon. The largest *Mordex* specimen has a skull 12 cm long but others range down to 6 mm skull length. The taxon is most similar to *Ecolsonia cutlerensis* from the Lower Permian of New Mexico, sharing with it the combination of large elongate external nares and a large ovoid tympanic embayment, which is almost or completely closed in large specimens. The two genera are not members of the family Dissorophidae as previously proposed but are the most primitive members of the family Trematopidae that can still be diagnosed by a unique external naris and modifications to the tympanic embayment. It appears that some medium-size trematopid genera with open otic notches are subadults of genera defined on larger skulls with closed notches and may have been diagnosed by ontogenetically changing character-states. *Mordex* larvae have filter-feeding adapted branchial ossicles suggesting that metamorphosis was a feature of the Trematopidae. Representatives of at least four Palaeozoic dissorophoid families were present in late Middle Pennsylvanian / Westphalian D strata implying diversification of the Dissorophoidea prior to this time.

Technical Session XIV, Saturday 12:00

A TALL-SPINED SPINOSAURID THEROPOD FROM THAILAND AND THE BIOGEOGRAPHY OF SPINOSAURS

MILNER, Angela, The Natural History Museum, London, United Kingdom; BUFFETAUT, Eric, CNRS (UMR 8538), Paris, France; SUTEETHORN, Varavudh, Bureau of Geological Survey, Bangkok, Thailand

Spinosaurs were large theropods exhibiting a suite of unusual dental cranial and postcranial characters, including elongate, somewhat crocodile-like jaws. They are known from the Barremian (*Baryonyx*) to Cenomanian (*Spinosaurus*) with the earliest records from Europe, later extending to North and West Africa and South America. Isolated teeth described in 2003 as *Siamosaurus suteethorni* from the Early Cretaceous of Thailand have been tentatively referred to a spinosaur and constitute the first but equivocal record from Asia. However, a recently discovered partial postcranial skeleton of a large theropod dinosaur, excavated from the Aptian Khok Kruat Formation at a new locality near the city of Khon Kaen in northeastern Thailand, clearly belongs to a spinosaur on the basis of vertebral morphology and provides conclusive evidence that spinosaurid theropods were present in Asia in the Early Cretaceous. The vertebrae resemble those of *Baryonyx* in some respects and *Spinosaurus* in others, thus suggesting the differences between spinosaurines and baryonychines are less marked than previously accepted. A tooth found with the bones belongs to *Siamosaurus*, but whether it is from the same individual or is evidence of scavenging remains uncertain. This new taxon demonstrates that the palaeogeographical distribution of spinosaurs was considerably wider than previously understood and must be re-evaluated in terms of the Late

Jurassic/Early Cretaceous isolation of eastern Asia. The spinosaur distribution pattern and the presence of iguanodontians in the Khok Kruat Formation might indicate a dispersal route from western Laurasia in Aptian times.

Poster Session III (Friday)

PALEOFAUNA FROM THE LATEST EOCENE CHADRON FORMATION, HIGHWAY 44 LOCALITY, IN SOUTHWESTERN SOUTH DAKOTA, AND ITS IMPLICATIONS CONCERNING THE EOCENE/OLIGOCENE TRANSITION

MINKLER, Heidi, South Dakota School of Mines and Technology, Rapid City, SD, USA

The Chadron Formation has been extensively studied for 150 years, but the assemblage from the Peanut Peak Member (late Chadronian) remains relatively poorly known. The Highway 44 local fauna from the upper Chadron Formation is important to understand the climatic shift that occurred at the Eocene/Oligocene boundary. This assemblage aids in the determination of the proposed faunal turnover that has been given as evidence for climatic change. Within the Highway 44 assemblage are the first documented appearances in the South Dakota Chadron Formation of Serpentes and Cricetidae. The range of *Metanoiamys*, an eomyid known from the Uintan and Duchesnean of southern California and Saskatchewan, is extended upward to the late Chadronian. Ranges of the florentiamyid rodent, *Ecclesimus*, and the anguid lizard, *Peltosaurus* are extended downward from the Orellan to the late Chadronian. The paleoecology of the Highway 44 assemblage is either a cutoff channel or an overbank deposit based on the lithology, fossil preservation, and organic evidence. This assemblage when compared to other Chadronian paleofaunas was found to be most similar to Late Chadronian assemblages. The Highway 44 assemblage was also compared to that from the superposed Scenic Member of the Brule Formation and was found to be more similar to this assemblage than to the preceding Chadronian assemblages indicating the faunal turnover may have occurred earlier than at the Eocene/Oligocene boundary.

Poster Session IV (Saturday)

FOSSIL VERTEBRATES OF IRAN

MIRZAIIE ATAABADI, Majid, University of Helsinki, Helsinki, Finland; HAIRAPETIAN, Vachik, Islamic Azad University, Esfahan, Iran

The first fossil vertebrates in Iran were excavated in the mid 19th century from the famous Maragheh bone beds. However, in spite of their potential, vertebrate fossils and vertebrate paleontology have never been at the centre of interest in Iran. Rich late Devonian deposits are the source of the oldest Iranian fossil vertebrates. Research on these Devonian faunas was initiated in the 1970's and focused on fish from the central and northern parts of the country. In recent years focus has shifted toward the study of vertebrate micro-remains from these deposits as well as from the Silurian and Carboniferous. Dinosaurs have been the focus of a few expeditions in Iran; vast terrestrial outcrops of Rheto-Jurassic sediments in the central parts of the country were the target of an early 1970's investigation that resulted in the discovery of dinosaur footprints. More recently, late Jurassic/early Cretaceous red beds in the same areas have produced the first dinosaur body fossils from Iran, including a theropod tooth. Eocene Mammal and bird tracks in the eastern and northwestern parts of Iran provide the only evidence for Paleogene vertebrates and Miocene marine beds of Makran range in the southeastern parts the only source of marine mammals. Contemporaneous Lagerstätten faunas of Oligocene age are known from three different localities in the Zagros basin, yielding mainly teleostean fishes. Among these sites, the most recently discovered one has been the source of interesting new taxa such as *Iraniplectus bakhtiari* (tetraodontoid puffer fish) and *Frigidafons babaheydariensis* (procellariid bird). The classical Pliocene fauna of the Maragheh Formation, located in the north west of country have been the sole source of information on the prehistoric mammals in Iran. Nevertheless, recent discovery of new fossil sites in this area brings hope for new insights into these faunas. Although paucity of Neogene body fossils covers the vast areas of central Iran, recent discovery of mammal and bird tracks in the Miocene red beds of these areas and occurrence of Quaternary proboscideans shows the existence of such faunas in this region.

Technical Session X, Friday 8:45

THE LATE PALEOCENE SUBENG MAMMALS OF INNER MONGOLIA, CHINA AND THE GASHATAN-BUMBIANIAN TURNOVER

MISSIAEN, Pieter, Ghent University, Ghent, Belgium; SMITH, Thierry, Royal Belgian Institute of Natural Sciences, Brussels, Belgium

The Chinese Subeng site is situated in the Erlian Basin of Inner Mongolia, nearby the Bayan Ulan and Nomogen localities. Although it had been mentioned before in literature, the study of the site only started in 2000. Our study clearly demonstrated its Late Paleocene age, placing it in the Gashatan Asian Land Mammal Age. It also quickly revealed the presence of several new taxa with unexpected affinities. A multidisciplinary study of the site showed that it had a more humid and closed paleoenvironment than any other Gashatan site, and we suggested this may be responsible for the presence of these particular taxa. Here we provide the first full faunal list for the Subeng mammal fauna, containing important precisions from the previous preliminary identifications.



The presence of *Tribosphenomys minutus*, *Eomylos bayanulanensis*, *Pseudictops lophiodon*, *Palaeostylops iturus* and *Hyracolestes ermineus* decisively confirms the Gashatan age of this fauna. The presence of the carpolestid *Subengius*, the neoplagiaulacid *Mesodmops* and the cimolestid *Tsaganius* however narrows the faunal gap with the Early Eocene Bumbanian faunas of Asia. Finally, the presence of *Subengius*, *Mesodmops* and the nyctitheriid *Asionyctia*, links the Asian Subeng fauna to older or contemporaneous North American faunas. The overall fauna thus seems to be a mixture of endemic and immigrant taxa and we provide a paleobiogeographic analysis of this complete fauna. We also present an analysis of the paleoenvironment based on the mammals, and compare the results with our previous paleoenvironmental data inferred from sedimentology and microfossils. Based on this, we evaluate how the paleoenvironment influenced the endemism of mammal faunas in the Gashatan and their transition into the Bumbanian.

Poster Session III (Friday)

NEW INFORMATION ON THE INTERNAL CRANIAL ANATOMY OF *EUO-PLOCEPHALUS* (ORNITHISCHIA, ANKYLOSAURIDAE)

MIYASHITA, Tetsuto, University of Alberta, Edmonton, AB, Canada; ARBOUR, Victoria, University of Alberta, Edmonton, AB, Canada

Because of their highly ossified skulls, the internal cranial morphology is the most poorly understood aspect of the ankylosaurid anatomy. A partial ankylosaurid skull from the Dinosaur Park Formation (Campanian, Late Cretaceous), southern Alberta, provides an opportunity to document the lower side of the skull roof and the upper half of the braincase in detail. Identified as *Euoplocephalus* sp., this specimen aids reconstruction of the soft tissues and homology of the ossified elements inside the ankylosaurid skulls. Clear vascular impressions on the roof of the nasal cavity are noted for the first time in ornithischians. Unlike *Talarurus*, there is no evidence of the canal for the olfactory nerve on the ossified nasal septum of the nasal cavities. Although no sutures are visible, the orbitosphenoid-preshenoid, the sphenethmoid, and the interorbitalis all seem to be distinct elements, arranged differently from previously proposed schemes. The paranasal cavity is connected with the endocranial cavity posteriorly, with a descending process of the frontal in the way of this communication between the two cavities. This connection implies a functional relationship between the paranasal cavity and the endocranial cavity. The descending process houses a deep groove occupied by hitherto unknown soft tissue. The specimen's incomplete endocast is nearly identical to that of AMNH 5337, which represents the morphotype of *Euoplocephalus* with four osteoderms on the first cervical half ring. No endocast has been prepared for specimens of the other *Euoplocephalus* morphotype with six osteoderms on the first cervical half ring, including the holotype of the genus. These new data open the possibility of more extensive comparison among ankylosaurs in the understudied lower side of the skulls, and will contribute to future taxonomic and phylogenetic studies. Variation in internal cranial anatomy would be particularly important in *Euoplocephalus* to resolve the problem of two recognized morphotypes within the genus.

Poster Session III (Friday)

PHYLOGENETIC ANALYSIS OF TROGOSINAE (TILLODONTIA, MAMMALIA)

MIYATA, Kazunori, Fukui Prefectural Dinosaur Museum, Katsuyama City, Fukui, Japan

The subfamily Trogosinae, which has been viewed as a monophyletic group, is primarily composed of large tillodont species having rootless second incisors (I2s and i2s): *Trogosus* and *Tillodon* from the late Early to early Middle Eocene in North America, and three genera (*Kuanchuanius*, *Chungchienia*, and *Higotherium*) from the possible late early and middle Eocene in East Asia. Previous hypotheses of tillodont relationships suggest the monophyly of the *Trogosus* + *Kuanchuanius* + *Tillodon* clade, but the relationships within the clade and the phylogenetic positions of the more hypsodont *Higotherium* and *Chungchienia* have been unclear because of the lack of comprehensive comparisons at the species level and the incompleteness of their fossil materials. A parsimony analysis using PAUP\*4.0 beta 10 Win and employing an exhaustive search for all possible tree topologies was performed based on 12 taxa (including the closely related *Azygonyx*, *Ethonyx*, *Adapidium*, and *Megalestonyx*) and 31 characters (27 dental and four mandibular characters). *K. danjiangensis*, *Higotherium*, and *Chungchienia* were excluded from the analysis owing to their incompleteness. The PAUP analysis produced two equally parsimonious trees of 44 steps with a consistency index (CI) of 0.932. The two trees indicate the stable monophyly of the *Kuanchuanius* + *Trogosus* + *Tillodon* clade and agree with each other in topology except for the relationships among an unnamed new species of *Trogosus*, *Trogosus latidens*, and *Tillodon fodiens*. The result produces a solution for previously unresolved relationships of the *Kuanchuanius* + *Trogosus* + *Tillodon* clade; it shows that the non-monophyletic genus *Trogosus* consists of successive species to *Tillodon fodiens*. *Kuanchuanius* is allocated as a sister taxon to the *Trogosus* + *Tillodon* clade, or as a basal trogosine, suggesting the Asian origin of North American trogosines.

Poster Session I (Wednesday)

NEW MATERIAL OF THE PARAREPTILE *COLOBOMYCTER PHOLETER* FROM THE LOWER PERMIAN OF OKLAHOMA

MODESTO, Sean, University of Cape Breton, Sydney, NS, Canada; REISZ, Robert, Department of Biology, Mississauga, ON, Canada

A new specimen of *Colobomycter pholeter* from the Lower Permian Dolese Brothers Quarry near Richards Spur, Oklahoma, preserves previously unknown portions of the skull of this aclestorhinid parareptile. It consists of much of the snout, preserving elements of the skull roof, the palate anterior to the orbit, and the sphenethmoid. The premaxilla has two teeth, of which the first is the largest tooth of the marginal dentition. Fortuitous damage to the maxillary caniniform teeth reveals that the crown bases of the marginal teeth are unusually thin, and infolding of the bases of these teeth may have served to strengthen the crowns. The serial pattern and the morphology of the upper dentition, with the conspicuous caniniforms of the premaxillary and the maxilla probably forming the upper part a 'food trap', suggests that *C. pholeter* was as a rare faunivorous member of the Richards Spur fauna that specialized in the predation of other small tetrapods, most likely the small captorhinids that dominate the assemblage numerically.

Poster Session II (Thursday)

IDENTIFYING THE CAUSES OF TAPHONOMIC VARIATION IN FOSSIL BONES USING X-RAY DIFFRACTION: A CASE STUDY FROM THE OLIGOCENE OF SOUTH DAKOTA

MOORE, Jason, University of Cambridge, Cambridge, United Kingdom; MARRON, Alan, University of Sheffield, Sheffield, United Kingdom; REDFERN, Simon, University of Cambridge, Cambridge, United Kingdom

A large sample of vertebrate material (approximately 2800 specimens) was collected from a previously unstudied horizon within the Scenic Member of the Brule Formation, White River Group in Badlands National Park, South Dakota. The specimens were preserved in reworked loessic mudstones with extensive evidence of palaeosol development, primarily alfisols. The sampled bones take one of two distinct morphologies - white and robust (type 1) or pink/brown and friable (type 2). Mammalian bones of both morphologies were common, however the sampled chelonian bones were almost entirely of a type 1 morphology. X-ray diffraction analysis of bones of both morphologies, teeth and the Scenic Member sediments was used to investigate any mineralogical differences between these morphologies. Type 2 bones were found to be mineralogically similar to type 1 bones, irrespective of taxon, but were also found to contain clinoptilolite: a zeolite mineral commonly formed by the devitrification of volcanic glass. It is suggested that, during diagenesis, the growth of clinoptilolite crystals precipitating within micro-scale cavities in the bone is causing the breakdown of the bone structure converting type 1 into type 2 bones. The variation in the abundance of type 2 bones between mammalian and chelonian elements is attributed to the thicker, less porous compact bone layer found in the chelonian elements.

Poster Session III (Friday)

DINOSAUR ICNOCENOSIS AND THE CAMEROS BASIN AS AN OBLIGE PASS AREA DURING THE LOWER CRETACEOUS OF THE IBERIAN PLATE

MORATALLA, Jose, Instituto Geologico y Minero de España, Madrid, Spain; HER-NAN, Javier, Escuela Tecnica Superior de Ingenieros de Minas, Madrid, Spain

The Cameros Basin is especially well known by its abundant Early Cretaceous dinosaur tracksites (more than 300 already known). This basin (about 8000 Km<sup>2</sup>) was developed during the early Tithonian-Albian rifting phase at the northwestern part of the Iberian Range (Spain). This synrift infill (about 8000-m-thick) consists of continental (fluvial and/or lacustrine) sediments with occasional marine influences, displaying abundant dinosaur tracksites. The Enciso Group, predominantly lacustrine and Aptian in age, yields the best and greatest number of dinosaur track localities (about 150). During the Aptian, the extensional regime facilitated the marine transgression of the Atlantic sea from the north (Basque Cantabrian Basin) and the Tethys from the south-east (Maestrat Basin), resulting in a partition of the Iberian Plate in two main emerged areas bounded by the sea: the Ebro Massif (north-east) and the Iberian Massif (south-west). Therefore, the Cameros Basin constituted the only continental area connecting both and, as a result, it was the unique oblige/required pathway for dinosaurs (and others terrestrial fauna). An analysis of three Enciso Group significant areas with abundant dinosaur trackways (Enciso, Cornago and Munilla) has been carried out. The directions of these trackways have been measured on the outcrops and subsequently these data have been unfolded to horizontal. The studied areas illustrate that the trackways show a preferential bidirectional pattern of movement on each tracksite, especially evident with the theropod ones. This fact would be consistent with the presence of the mentioned restricted pass area that would also explain the existence of such amount of dinosaur tracks in the Enciso Group. Moreover, the dominion of medium-big theropod dinosaur tracks (about 85%) in the Cameros icnocoenosis could be consequence of the superior movement capability for these searching-hunting predatory dinosaurs.

Their behaviour probably made the theropods to move through relatively long distances and, in consequence, they were potentially capable of producing a higher number of tracks than those made by other no theropod dinosaurs from the Cameros area.

Poster Session I (Wednesday)

#### KOMODO DRAGON CRANIAL MECHANICS AND KINESIS AS REVEALED BY HIGH-RESOLUTION FINITE ELEMENT ANALYSIS

MORENO, Karen, University of New South Wales, Sydney, Australia; WROE, Stephen, University of New South Wales, Sydney, Australia; MCHENRY, Colin, University of Newcastle, Sydney, Australia; CLAUSEN, Philip, University of Newcastle, Sydney, Australia; D'AMORE, Domenic, Rutgers University, New Brunswick, NJ, USA

The Komodo dragon (*Varanus komodoensis*) is among the most charismatic of living taxa. However, although its biology and ecology have received considerable attention, and despite the potential to elucidate feeding behaviour in dinosaurs and other extinct reptiles, there have been no detailed investigations into its cranial mechanics. Cranial kinesis, feeding kinematics and jaw adductor anatomy in living and extinct reptiles have also generated interest and a large body of research, but how, or in many cases, even whether movement between skull bones occurs is also not well understood. Here, using anatomical dissection data combined with newly developed high resolution 3-D computer-modelling and finite element (FE) techniques, we show that the skull of the Komodo dragon is moderately kinetic, with surprisingly weak masticatory muscles and that the structure is optimised to resist tensional loads. Postcranial, particularly cervical, musculature plays a major role. These mechanical attributes are consistent with detailed observational data on feeding behaviour. Our findings expand understanding of extant reptilian feeding ecology and provide insight into the behaviour of carnivorous dinosaurs with which *V. komodoensis* shares many cranial and dental features.

Student Poster Session (Thursday)

#### SIZE AND PALAEOECOLOGY OF GIANT MIOCENE SOUTH AMERICAN CROCODILES (ARCHOSAURIA: CROCODYLIA)

MORENO-BERNAL, Jorge, Universidad Nacional de Colombia, Bogotá, Colombia

This work is intended to provide body length and mass estimates for the Tropical South American Miocene crocodiles *Purussaurus* (Alligatoroidea) and *Gryposuchus* (Gavialoidea). Size estimates were done from skull and femoral measurements, using regressions published for extant crocodile species. Most *Purussaurus* specimens were estimated at lengths between 7-8 meters, with body masses between 1.7-2.7 metric tones. A *P. brasiliensis* specimen was estimated in a maximum of 10 meters and 5 tones. *Gryposuchus* length was between 7 and 10 meters, without accurate body mass estimates, due to the lack of proper studies in longirostral forms such as *Gavialis* and *Tomistoma*. *Purussaurus* and *Gryposuchus* are longer and heavier than the biggest extant *Crocodylia* (with maximum sizes of 6 meters and 1 ton), and close to giant Cretaceous forms such as *Deinosuchus* or *Sarcosuchus*. Comparisons between skull-based and femur-based estimates suggests that while in *Purussaurus* femur size, relative to body size, is as expected in crocodylians, *Gryposuchus* has reduced femora, suggestive of more aquatic habits. Robustness of *Purussaurus* limbs can be related to the foraging of big terrestrial prey on the shores of water bodies. Gigantism in crocodylians implies higher and more stable body temperatures, with a risk of overheating, and reduced basking habits. Huge nares seen in giant fossil Crocodyliformes such as *Sarcosuchus*, *Mourasuchus amazonensis* and *Purussaurus* could have been related with a heat exchange mechanism. This study was possible thanks to the collaboration of the Smithsonian Tropical Research Institute.

Evolutionary History of Bats Symposium, Thursday 9:15

#### EVOLUTIONARY HISTORY OF THE NEOTROPICAL CHIROPTERAN FAUNA

MORGAN, Gary, New Mexico Museum of Natural History, Albuquerque, NM, USA; CZAPLEWSKI, Nicholas, Oklahoma Museum of Natural History, Norman, OK, USA

Our work on bats from the Oligocene and Miocene of Florida and the Miocene of Colombia has produced fossils representing 8 of the 9 New World (NW) chiropteran families, only 3 of which (Phyllostomidae, Vespertilionidae, Molossidae) were known previously from pre-Pleistocene faunas in North America (NA) or South America (SA). Paleokarst deposits in Florida have produced the oldest fossils of 3 Neotropical groups: Mormoopidae (new genus) and a basal noctilionoid (new genus) from the Oligocene (28-30 Ma) I-75 and Brooksville 2 (Br2) faunas and Natalidae (†*Primonatalus*) from the early Miocene (18 Ma) Thomas Farm (TF) fauna. Eocene bats from western NA now under study may be crucial to resolving the origin of the Noctilionoidea (Noctilionidae, Mormoopidae, Phyllostomidae, Thyropteridae, Furipteridae) and the NW Vespertilionoidea (Vespertilionidae, Molossidae, Natalidae). Two new genera from the Florida Oligocene and Miocene are the earliest NW records of the pantropical Emballonuridae. Pre-Pleistocene records of the pantropical Molossidae from NA include: the earliest member of the family from the Eocene of Saskatchewan (†*Wallia*), an undescribed genus from Br2, *Tadarida* or *Mormopterus* from TF, *Eumops* from the Pliocene of Arizona, and *Tadarida* from the Pliocene of Florida. A Pliocene vampire

bat (*Desmodus*) from Florida is the oldest NA phyllostomid. The oldest bats from SA are teeth (indet. family) from the Eocene of Argentina and Peru and the molossid *Mormopterus* from the Oligocene of Brazil. The mid Miocene (12-13 Ma) La Venta (LV) fauna in Colombia documents the earliest SA records of 4 Neotropical families: Emballonuridae (*Diclidurus*), Noctilionidae (*Noctilio*), Phyllostomidae (†*Notonycteris*, †*Palynephyllum*, genus near *Tonatia* or *Lophostoma*), and Thyropteridae (*Thyroptera*). LV also has 3 genera of molossids (*Eumops*, *Mormopterus*, †*Potamops*) and the only pre-Pleistocene vespertilionid from SA. Beginning in the early Pliocene, the Great American Biotic Interchange led to an extensive mixture of NW chiropteran faunas, including Pliocene records of *Eumops* and *Desmodus* in NA (both of SA origin) and the migration of mormoopids and natalids to SA (both of NA origin).

#### Carnivora: Phylogeny, Form and Function Symposium, Saturday 11:30 MORPHOLOGY OF PATRIOFELIS AND SARKASTODON: TRENDS IN LARGE-BODIED OXYAENIDAE (CREODONTA)

MORLO, Michael, Forschungsinstitut Senckenberg, Abt. Messelforschung, Frankfurt am Main, Germany; GUNNELL, Gregg, University of Michigan, Ann Arbor, MI, USA;

NAGEL, Doris, University of Vienna, Vienna, Austria  
Oxyaenidae (Creodonta) is a group of carnivorous mammals encompassing three to four subfamilies, including Tytthaeninae and Oxyaeninae. Tytthaenines (late Paleocene, North America) are small and primitive and may be ancestral to all other oxyaenids. Oxyaenines, best represented in North America, first appear in the late Paleocene in the form of small, carnivorous *Dipsalidictis*. The last occurrence of North American oxyaenines is in the early middle Eocene represented by large, hypercarnivorous *Patriofelis*. Oxyaenines are known from the European early Eocene and perhaps the Asian late middle Eocene (very large, bone and meat eating *Sarkastodon*) but were neither diverse nor abundant in the Old World. We compared cranial, postcranial, and dental morphology of tytthaenines, oxyaenines and *Sarkastodon* with a sample of extant carnivores including canids, felids, viverrids, mustelids, hyaenids and ursids. Results document an evolutionary tendency towards shorter and broader skulls in terminal taxa (*Patriofelis* and *Sarkastodon*); a trend towards increased shearing capacity in P4 and m1 with *Tytthaena* and *Dipsalidictis* possessing limited shearing, *Patriofelis* with highly developed carnassial shearing, and *Oxyaena* and *Sarkastodon* with intermediate shearing capacities; *Oxyaena* and *Patriofelis* (only taxa represented by postcrania) resemble living felids and ursids in having somewhat longer femora compared to humeri. In general, oxyaenines exhibited tendencies towards shorter and wider skulls, better development of dental shearing mechanisms, and overall increases in body size from the late Paleocene into the late Eocene - in most cases converging on extant felid morphology in end members of lineages. In all oxyaenids, however, p4 is much more hyena-like than cat-like and was probably used for bone crushing. The pattern of increasing skull breadth with increasing body mass is similarly found in large mesonychids, hyaenodontids, and felids, but not in giant hyaenas (skull higher instead of broader). An additional observation based on our analysis is that if *Sarkastodon* is derived from North American oxyaenines it must have split from the *Oxyaena* lineage in the early Eocene.

Poster Session II (Thursday)

#### ARCHIMEDES' GIFT: X-RAY FLUORESCENCE IMAGING, A NEW PALEONTOLOGICAL TOOL FOR SOFT TISSUE ANALYSIS AND A TEST FOR FOSILIZATION PROCESS HYPOTHESES

MORTON, Robert, Children of the Middle Waters Institute, Bartlesville, OK, USA; HUNTLEY, Ken, Children of the Middle Waters Institute, Bartlesville, OK, USA; MORTON, Nick, Missouri Western State University, Bartlesville, OK, USA; LARSON, Peter, Black Hills Institute, Hill City, SD, USA; BERGMANN, Uwe, Stanford Linear Accelerator Center, Menlo Park, CA, USA

X-ray fluorescence spectrometry (XRF) has been used since the early 1990s to generate elemental images of chemically nonuniform and irregular shaped materials. However, conventional XRF imaging techniques have proven too limited and time consuming for the retrieval of sufficient data for the study of fossils. The XRF surface imaging techniques modified and utilized in recovering the only surviving manuscript of Archimedes (287-212 BC) have been applied to the study of fossils with spectacular results. The high-energy monochromatic beam of x-rays generated by the Stanford Linear Accelerator (where the Archimedes manuscript was scanned) provides an opportunity to create elemental x-ray area maps for large (0.5 m<sup>2</sup>) specimens. Single element and composite multi-element images reveal soft tissue information not available through other techniques. Because the elemental x-ray images depict the chemical fossil, the potential for unraveling the secrets of fossilization processes is unprecedented.

Technical Session V, Wednesday 2:30  
GENERIC DIVERSITY OF MARINE REPTILES THROUGH THE MESOZOIC  
AND SEA LEVEL CHANGES

MOTANI, Ryosuke, University of California Davis, Davis, CA, USA; HIRAYAMA, Ren, Waseda University, Tokyo, Japan; SATO, Tamaki, Tokyo Gakugei University, Koganei, Japan; KONISHI, Takuya, University of Alberta, Edmonton, AB, Canada; MONTANEZ, Isabel, University of California Davis, Davis, CA, USA

Mesozoic marine reptiles comprise about a dozen clades of diapsids, several of which may be related with each other. Although polyphyletic, they share common characteristics of being reptilian air-breathing predators in marine environments and therefore are expected to occupy limited types of niches. It is therefore important to understand if there was any clade-independent pattern to their emergence and diversification through the Mesozoic, especially relative to specific environmental changes. However, taxonomic segregation of researchers has prevented a collective view of marine reptile evolution from emerging. We compiled stratigraphic occurrences of marine reptile genera at a resolution of stage level for the entire Mesozoic. There are currently 243 genera coded for the 30 Mesozoic stages in the database. We calculated their generic diversity for each stage, which we then tried to compensate for biases arising from the differences among stages in duration and fossil collection intensity. Three patterns emerged regardless of bias correction schemes. First, the oldest record of each marine reptile clade is found within four specific time periods during the Mesozoic, which correspond to endhalves of major marine transgressions. This is in contrast to marine endotherms, such as whales, whose emergence does not follow a specific pattern in regard to the sea level. Second, durophagous marine reptiles became completely extinct twice during the Mesozoic. Each time, different clades of marine reptiles than before gave rise to durophages that re-occupied the niche. Third, there is an overall correspondence between the major transgression/regression cycle and marine reptile generic diversity peaks, even after the collection and duration biases are removed. We infer that the large-scale sea level change is one of the major factors that affected the evolution of marine reptiles in the Mesozoic, although it is very difficult to clearly establish a cause-effect relationship. Other factors, such as the mean temperature reflected in  $d^{18}O$  ratios, need to be scrutinized in the future.

Student Poster Session (Thursday)

ECOLOGICAL CORRELATES OF INFRAORBITAL FORAMEN SIZE:  
EXPLORING DIETARY DIVERSITY AMONG EUROPEAN ADAPIFORMES  
MUCHLINSKI, Magdalena, University of Texas at Austin, Austin, TX, USA

For decades, the size of the infraorbital foramen (IOF) has been used to interpret the ecology fossil primates. However, to date it is unclear what is indicated by intra/inter taxonomic variation in IOF size. This study sought to identify the functional significance of IOF size variation among extant primates, and to apply the results to the fossil record. IOF area was measured and size standardized for 122 extant and 4 extinct ( $n = 16$ ) primate species. An ecological profile (diet, substrate preference, & activity pattern) was created for each extant species. Nonparametric statistics were run to test for correlation between IOF area and each of the ecological parameters. The data show a significant correlation between IOF area and diet ( $p=0.004$ ). Tests indicate that frugivores have significantly larger IO foramina than either folivores or faunivores, and that the IO foramina of folivores and faunivores do not differ significantly from one another. The IO nerve passes through the IOF innervating specialized touch cells (mechanoreceptors) of the maxilla. Animals, like frugivores, that depend more on maxillary mechanoreception in food selection have relatively larger IO nerves, and therefore larger IO foramina. The size corrected IOF measurements of extinct primates plotted among the extant primates to draw inferences regarding the diets of early primates. *Pronycticebus gaudryi* has a large IOF similar to extant frugivores. *Smilodectes gracilis* has a relatively small IOF, similar to IOF values of extant folivores. *Adapis parisiensis* and *Leptadapis magnus* both show an interesting within-species dietary pattern. The smaller specimens within each genera have relatively large IO foramina, like extant frugivores, while the larger specimens have smaller IO foramina similar in size to extant folivores. These results suggest (1) size variation in IOF size in each species is bimodally distributed and/or greater than one would expect for a single species and (2) that this finding supports prior suggestions that the hypodigm for each species includes material for more than one closely related taxon.

Poster Session I (Wednesday)

DICYNODONTS (SYNAPSIDA:THERAPSIDA) FROM THE LATE TRIASSIC  
DOCKUM GROUP OF TEXAS

MUELLER, Bill, Museum of TTU, Lubbock, TX, USA; CHATTERJEE, Sankar, Museum of TTU, Lubbock, TX, USA

Dicynodonts are some of the most well known herbivores of the Permian and Triassic throughout the world and are useful for continental biostratigraphy. Dicynodonts have been found in the western and southwestern United States and in eastern North America. The *Placerias* quarry in Arizona has produced the majority of the material and information on North American Triassic dicynodonts. The dicynodont material in eastern North America includes elements from *Placerias* and a non-*Placerias* dicyn-

odont. However, no dicynodont fossils were known from Texas until recently. The Museum of Texas Tech paleontology collection now contains over 20 dicynodont elements from five localities in the Dockum Group of West Texas. The new material includes elements that represent a new taxon of tusked dicynodont based on a partial skull, additional cranial elements, a mandible, and post-cranial elements from one locality. The new dicynodont has tusks projecting from the ventral aspect of the caniniform process and has elongate preparietals and frontals extending posteriorly past the pineal foramen. The new taxon and material are described and compared to other Late Triassic dicynodonts showing both primitive and derived characters. The new material expands the knowledge and geographic range of Late Triassic dicynodonts.

Technical Session II, Wednesday 9:30

A PASSAGE TO INDIA: A SMALL CAPTORHINID FROM THE UPPER PERMIAN KUNDARAM FORMATION AND THE POSTGLACIAL DISPERSAL OF EARLY REPTILES.

MUELLER, Johannes, Humboldt-Universität zu Berlin, Museum für Naturkunde, Berlin, Germany; REISZ, Robert, University of Toronto at Mississauga, Mississauga, ON, Canada; CHATTERJEE, Sankar, Texas Tech University, Lubbock, TX, USA; KUTTY, T. S., Indian Statistical Institute, Geological Studies Unit, Calcutta, India

The Upper Permian Kundaram Formation of India has produced a well-preserved but poorly studied fauna of Late Paleozoic amniotes, resembling in its composition the well known *Cistecephalus* Assemblage Zone fauna from the Karoo Basin, South Africa. It is therefore surprising that several specimens of a new captorhinid reptile are part of the fauna that includes several species of dicynodont synapsids. The new captorhinid is similar to the large-sized *Moradisaurus* from the Upper Permian of Niger, but is much smaller in size and has only three rows of teeth in the upper and lower jaw. Further characteristics are a greatly reduced supratemporal, a tall quadratojugal, an enlarged suborbital foramen, and a distinct reduction of the ventral crests on the parasphenoid. A phylogenetic analysis of captorhinids places the new taxon unequivocally within the derived Moradisaurinae, representing the only small-sized taxon of the clade—a feature likely to be a secondary phenomenon as indicated by cladogram topology. The quality of the fossil record and the phylogenetic resolution of Captorhinidae are unique among basal amniotes, allowing for a biogeographic interpretation that is not possible for other, contemporaneous lineages. Our results indicate that captorhinids originated during the Carboniferous in the paleo-equatorial belt of Laurasia and later colonized the higher latitudes of Pangaea. More specifically, Moradisaurinae evolved in the North American part of equatorial Laurasia in the Early Permian, and from there diversified into Russia, China, Central and South Africa, and India. In the course of this diversification, moradisaurines evolved distinctive features such as an increased number of tooth rows indicative of a specialized diet, large size, but also secondary size reduction. Thus, moradisaurines, and captorhinids in general serve as an example of how early amniotes spread across Pangaea after the end of the Permo-Carboniferous glaciation.

Poster Session IV (Saturday)

THE HOLOCENE DISTRIBUTION OF THREE CARNIVORANS (EUPLERIDAE: GALIDIINAE) ON MADAGASCAR

MULDOON, Kathleen, Dartmouth Medical School, Hanover, NH, USA; SIMONS, Elwyn, Duke University, Durham, NC, USA

Fieldwork at Ankilitelo Cave on Madagascar's southwestern plateau has yielded an abundant and diverse mammalian fauna dating from the late Holocene. Four endemic carnivorous species are present in the sample, representing half of the known extant Malagasy taxa. We report on the unusual occurrence of three species, *Galidia elegans*, *Mungotictis decemlineata*, and *Galidictis grandidieri*. *Galidia elegans* is one of the most widely distributed of the Malagasy carnivores on the island today. However, its modern range does not include the succulent woodland and spiny thicket habitats of the southwestern and southern regions. The presence of *G. elegans* at Ankilitelo represents the first report for this species from subfossil deposits in the southwest. *Mungotictis decemlineata* and *Galidictis grandidieri* are the most geographically limited and rare carnivores in Madagascar today. *M. decemlineata* is currently restricted to the Menabe region from the Tsiribihina River south to the Mangoky River. The Ankilitelo remains indicate that 500 years ago, the range of *M. decemlineata* extended approximately 150 km further south of its modern distribution. *G. grandidieri* was described in 1986, and until 1989 was known only from two museum specimens. The only confirmed extant locality for this species is in southwestern Madagascar at Tsimanampetsotsa. However, subfossil remains of *G. decemlineata* were recently reported from Ankazoabo Cave, approximately 50 km south of its modern distribution. The presence of *G. grandidieri* in the subfossil deposits at Ankilitelo suggests that this species may have also occurred well to the north of its current range in the recent past. The presence of these allopatric carnivores at Ankilitelo indicates that they once lived in sympatry, and that these species have experienced considerable reductions in geographic distribution in the last 500 years. Possible explanations for these distributional changes are evaluated in light of evidence for ecological change and human impact in southwestern Madagascar.

Poster Session IV (Saturday)

SOME DELPHINOIDS (MAMMALIA: CETACEA) FROM THE UPPER MIOCENE THROUGH THE UPPER PLIOCENE OF HOKKAIDO, NORTHERN JAPAN

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Comprehensive studies of the early stage of most Delphinoidea except "Kentriodontidae" were limited in the eastern North and South Pacific. They were absent in the Atlantic Ocean and Mediterranean Sea before Pliocene. We need more information about them in the western Pacific and ultimately to make more comprehensive morphological phylogenetic analyses of Delphinoidea including many extant and extinct taxa to understand their early evolution. Japan is the best field to accomplish those works since there are many Neogene marine beds yielding plenty of odontocete fossils. We described five skulls with postcranial skeletons of Delphinoidea from the upper Miocene through the upper Pliocene of the Wakkanai and Koetoi formations in Hokkaido, Northern Japan. NMV (Nakagawa Museum of Natural History)-56 and NMV-6 shares the character that the posterior edge of the ascending process of the left premaxilla is reduced with Delphinidae. Therefore, NMV-56 and NMV-6 belong to the Delphinidae but those specimens are distinguished from each other by the degree of the dorsally elevating maxilla in the supraorbital region, and morphology of the nasal. NMV-7 has the lateral plate of the palatines, and supraorbital process of the frontal and temporal fossae completely overlain by maxillae. So NMV-7 belongs to Delphinida at least, probably Delphinoidea. Ascending process of the premaxilla of NMV-7 significantly elevates on maxilla, and prominently projects laterally. NMV-57 shears dorsal extension of the air sinus into the frontal with Phocoenidae. Columnar crown, blunt cusp with no denticles and accessory of teeth of NMV-5 are close to those of genus such as *Haborophocoena*. Hence, last two specimens belong to Phocoenidae. Our specimens except NMV-5 are clearly different from any known delphinoid taxa. Some extinct delphinoid genera had both eastern and western North Pacific distributions like those of modern delphinoids in pre-Late Miocene. On the other hand, there are no common genera and species between two regions from Late Miocene through Early Pliocene. The present and past studies indicate that the different delphinoid faunas were formed in these two regions at that time.

Student Poster Session (Thursday)

CRETACEOUS SELACHIANS FROM THE BRIDGE CREEK MEMBER OF THE MANCOS SHALE (UPPER CENOMANIAN), SOCORRO COUNTY, NEW MEXICO

MURPHY, James, New Mexico Tech, Socorro, NM, USA; LUCAS, Spencer, New Mexico Museum of Natural History and Science, Albuquerque, NM, USA; SPIELMANN, Justin, New Mexico Museum of Natural History and Science, Albuquerque, NM, USA

Selachians provide a vertebrate-based biostratigraphy of the Upper Cretaceous throughout the North American Western Interior. Here, we report a selachian assemblage from the Bridge Creek Member of the Mancos Shale near the town of Carthage in Socorro County, New Mexico (sec. 8, T05S, R02E). The selachian fossils are in a 0.3-0.6 m-thick bed of sandy limestone/calcarene at the top of the Bridge Creek Member that yields numerous shells of the bivalves *Ostrea beloiti* and *Mytiloides mytiloides*. This fossil assemblage occurs within the Upper Cenomanian *Sciponoceras gracile* ammonite zone. Specimens of *Ptychodus* dominate the assemblage, with rare and fragmentary remains of blade-shaped shark teeth, some of which can be identified as *Squalicorax* sp. *Ptychodus* specimens belong to *P. occidentalis* and *P. anonymous* and further confirm their presence in Upper Cenomanian strata. The *P. occidentalis* specimens are characterized by their overall square shape and their transverse ridges bifurcating numerous times distally, grading into finer and finer parallel to subparallel ridges. The *P. anonymous* specimens are characterized by their transverse ridges that extend down the cusps then divide and curl around as they enter the marginal area. In addition, numerous *P. anonymous* specimens have a prominent cusp that superficially resembles *P. whipplei*, though the presence of transverse ridges that extend down the sides of the cusp confirm these specimens pertain to *P. anonymous*. The lithology of the site indicates deposition in deep-water, which suggests that *Ptychodus* had a preference for deep water, as previously noted by some other workers.

Poster Session I (Wednesday)

A LATE CRETACEOUS ACTINOPTERYGIAN FAUNA FROM MOROCCO

MURRAY, Alison, University of Alberta, Edmonton, AB, Canada; WILSON, Mark, University of Alberta, Edmonton, AB, Canada; CHATTERTON, Brian, University of Alberta, Edmonton, AB, Canada

A collection of about 35 actinopterygian fish specimens from southeastern Morocco indicates the presence in the area of a number of new species. The fauna is generally similar at the familial level to that of Cenomanian and Turonian sites long known from Lebanon and northern Africa, but includes elements (e.g., Macrosemiidae) that have not previously been reported from deposits of this age in northern Africa or the Tethys

basin. Taxa represented include a macrosemiid (cf. *Notogogus*), at least two different paralupeids (*Clupeomorpha*), the dercetid *Rhynchodercetis*, a euteleost, and an acanthomorph. Some of these taxa are essentially circum-Tethyan, such as the Dercetidae; however, others, such as the Paralupeidae, are known from Cretaceous deposits worldwide, including Mexico, Europe, Canada, and China. Macrosemiids are more common in Jurassic and Early Cretaceous deposits. This new fauna is similar, in the presence of the dercetid and paralupeids, to a small ichthyofauna reported from Oued Daoura, but the exact locality of the specimens in that report is unknown. However, they were reported as preserved in sandstones, whereas the fishes we report are preserved in carbonates, proving that they come from a different site. Some of the specimens reported here were collected in the field by one of us, and are thus from a known outcrop. The locality of these new Moroccan fishes is farther south than most other similar-aged Moroccan localities such as Jbel Tselfat, and, based on palaeogeographic reconstructions, would likely have been at the southern end of an inlet of the Tethys.

Poster Session III (Friday)

EFFECTS OF DATA IMPROVEMENT TECHNIQUES ON FOSSIL TAXONOMIC DISTRIBUTION IN VALLECITO CREEK-FISH CREEK, CALIFORNIA

MURRAY, Lyndon, The University of Texas at Austin, Austin, TX, USA

Digital technologies provide continually improving quality and precision of new paleontological data gathered in the field and laboratory. Examples include satellite imagery and positioning, mapping or simulation via computerized laser and X-ray devices, plus software used to process the digital data. These technologies can be used to improve the quality and precision of data acquired prior to the digital age. Fossils of the Vallecito Creek-Fish Creek (VCFC) drainages of the Anza-Borrego Desert have been important in discussions of North American biochronology since the 1960s. Most VCFC specimens cited in publication were collected prior to the 1980s. Localities were plotted by hand onto aerial photographs. Field and taxonomic information was entered by hand onto preprinted curatorial forms. Preliminary digitization involved transcribing handwritten notes and forms to database formats. Over the last 50 years many small errors accumulated during handprinting, transcription, and translation of information. The multiplicity of small errors resulted in serious problems with reported taxonomic identifications and distributions. Many of the errors can be pinpointed and corrected by careful perusal of databases, satellite imagery, and GIS maps, in combination with a direct examination of specimens and original field notes and locality maps. Comparison of the improved data to the accumulated errors is dramatically demonstrated in GIS. For example: The Bovidae (*?Euceratherium*) LSD previously published at ~1.13 and ~2.6 Ma is closer to 1.4 Ma; and the Cervidae LSD published as 2.11 Ma and appearing on the database at about 4.3 Ma is closer to 2.7 Ma.

Student Poster Session (Thursday)

FISH REMAINS FROM THE MIDDLE-UPPER PERMIAN CORUMBATAI AND TERESINA FORMATIONS IN THE STATE OF SAO PAULO (SOUTHERN BRAZIL)

MUTTER, Raoul, Natural History Museum, London, United Kingdom

Localized outcrops of the Teresina Formation along the southern rim of the Parana Basin have been suggested to be Middle or Late Permian in age. The microremains recovered by means of screen washing from several localities include predominantly chondrichthyan and osteichthyan teeth, in particular actinopterygian and also acanthodian scales as well as a few skeletal elements of these groups along with other, much rarer fossil groups. According to the currently accepted age of these formations, the acanthodian remains represent the youngest currently known record and are shown here to co-occur in the pencontemporaneous Corumbatai Formation in the same realm of the Parana basin. Complete fish remains are exceedingly rare but bioclastic lenses containing isolated and often fragmentary fish remains are relatively abundant throughout the Permian Parana Basin in Brazil. Complex taphonomic processes in oxidized burial conditions and rapid allochthonous depositional circumstances have to be taken into account and certainly limit conclusions with respect to assessment of absolute faunal diversity in this former epicritic sea. Nevertheless, systematically collected sedimentary rock samples and varying rates of abundances of the abovementioned fish groups have been closely examined in these rocks and show interesting changes in size classes of teeth and scales and in ratios of types of actinopterygian scales. The preserved fish remains suggest the southern rim of the latest Paleozoic Parana epicritic sea basin represented an extreme biotope. The aquatic realm of the southern rim of the basin was probably characterized by an impoverished fauna, but a localized and varying degree of regional diversity cannot be excluded. Suggested changes in fish diversity in this mixed freshwater/seawater environment contribute significant data in the light of the stratigraphic proximity to the Permo-Triassic Boundary and the allegedly global extinction event.

Poster Session IV (Saturday)

WHAT GOOD IS HALF A FEATHER? A NEW HYPOTHESIS FOR THE EVOLUTIONARY ORIGIN OF EPIDERMAL STRUCTURES

MYHRVOLD, Conor, University of Washington, Seattle, WA, USA; SIDOR, Christian, University of Washington, Seattle, WA, USA; DANIEL, Thomas, University of Washington, Seattle, WA, USA

Over the past decade, numerous fossils from China have demonstrated that feathers, or hair-like protofeathers, were likely common among terrestrial theropod dinosaurs. The recognition that this evolutionary novelty phylogenetically predated the earliest volant theropods, such as *Archaeopteryx*, has begged for an evolutionary explanation. To date, hypotheses related to insulation or display have garnered the most support. Here, we propose a novel hypothesis: the earliest fur and feathers evolved to disperse heat, not conserve it. The conservation of heat, i.e., limiting heat transfer between an animal and its ambient environment, was tested in wind tunnel experiments using brass cylinders and dinosaur models imbued with varying densities and lengths of an artificial epidermal structure. Each variation was heated and placed in the wind tunnel, undergoing two replicates at ten different wind speeds. A thermocouple placed in the center of the model measured how it cooled over time, producing a cooling curve. Nusselt-Reynolds plots were constructed to determine the relationship between heat loss and the convective environment for each model. While thick uniform layers and thick densities decrease heat transfer (i.e., create insulation), results from thin uniform layers and sparse densities provide no support for heat conservation. Theory suggests that the latter should increase heat transfer (i.e., disperse heat.) Considering protofeathers to be related to heat loss has several interesting implications, including the timing of theropod origins during a warm period in Earth history and thermodynamic problems associated with large body size (i.e., surface area to volume scaling). The same heat loss principles can be extended to all epidermal structures including the evolution of protohairs on mammals. Any epidermal structure that acted as a heat transfer mechanism was likely not preserved in the fossil record, so more experimental analysis in this area would be intriguing to pursue.

Poster Session III (Friday)

RECONSTRUCTION OF THE MUSCULATURE OF THE HIND LIMB OF *XENOMILUS HODSONAE* AS COMPARED TO THE DOMESTIC CAT, *FELIS CATUS*

NAPLES, Virginia, Northern Illinois University, DeKalb, IL, USA; SPEARING, Kurt, Northern Illinois University, DeKalb, IL, USA; MOLOKWU, Ruth, Northern Illinois University, DeKalb, IL, USA; BABIARZ, John, B.I.O.P.S.I., Mesa, AZ, USA; MARTIN, Larry, Department of Ecology and Systematics, Lawrence, KS, USA

*Xenomilus hodsonae*, a scimitar-toothed cat from the Pleistocene is known primarily from two partial skeletons discovered in Irvingtonian deposits from Florida. As this animal is without living analogs, the myology of the distantly related domestic cat was dissected to reveal general patterns and muscle proportions as a basis for our reconstruction of the habits of *X. hodsonae*. We compared muscle scars on the pelvis and hind limbs of *X. hodsonae* with muscle maps we created for *Felis catus*. These comparisons showed a similar muscle division pattern, although the position, character, and proportions of bony attachments differed. Long bones of *X. hodsonae* are strikingly more robust than are those of *F. catus*, having larger proximal and distal heads, and more rugose and extensive muscle attachments. Although origins of the gluteal muscles cannot be determined for *X. hodsonae*, because of the fragmentary condition of the pelvis, the femoral greater trochanter is significantly larger than in *F. catus*, making reasonable the assumption that these muscles were also more robust. The short lateral hip rotators of *X. hodsonae* insert into a relatively larger and deeper posterior "pocket" on the greater trochanter of the femur. They enhance lateral rotation of the extended thigh, abduction of the flexed thigh, and steady the femoral head in the acetabulum, indicating a greater ability to move the hind limb mediolaterally, and to control the position of the trunk in making lateral movements when the pelvis is fixed. The hamstring and quadriceps muscles were more robust and distally inserted according to muscle scars for *X. hodsonae*. The relative size, arrangement and actions of the muscles reconstructed indicate that these animals had a greater ability to assume a stable bipedal stance than do domestic cats, and that more robust quadriceps and hamstring muscles allowed them to flex and extend the hind limbs with greater relative force. This ability would have been of particular importance if the animals were ambush predators capturing large prey.

Poster Session IV (Saturday)

THREE-DIMENSIONAL SCANNING AND ANALYSIS OF THE FIRST DIAGNOSTIC ORNITHOMIMID FORELIMB MATERIAL FROM THE LATE CRETACEOUS KAIPAROWITS FORMATION

NEABORE, Scott, College of the Holy Cross, Worcester, MA, USA; LOEWEN, Mark, University of Utah, Salt Lake City, UT, USA; ZANNO, Lindsay, University of Utah, Salt Lake City, UT, USA; GETTY, Mike, University of Utah, Salt Lake City, UT, USA; CLAESSENS, Leon, College of the Holy Cross, Worcester, MA, USA

Ornithomimid fossils are among the most numerous theropod skeletal remains recovered from the Late Cretaceous Kaiparowits Formation, yet few of these elements are diagnostic at lower taxonomic levels. Here we describe the first diagnostic ornithomimid forelimb material recovered from the Kaiparowits Formation. The articulated specimen (UMNH VP 16385) is represented by a distal antebrachium, carpus, and manus, including complete first and second metacarpals, a nearly complete third metacarpal, three unguals, and portions of all remaining phalanges. Three-dimensional scans of the manus were made using a Roland LPX-1200 non-contact 3-D laser scanner and compared to a metacarpus (YPM 548) associated with the holotype of *Ornithomimus velox* (YPM 542). Scans were subsequently edited and analyzed with the imaging software *Rapidform*. The metacarpus of YPM 548 is approximately two-thirds the length of UMNH VP 16385 and has been suggested to represent a juvenile individual. Accordingly, isometric rescaling of YPM 548 in *Rapidform* was undertaken to compare both specimens. The relative lengths of the metacarpals of UMNH VP 16385 place the specimen within the genus *Ornithomimus*. The questionable association of YPM 548 with the holotype of *O. velox* and morphological similarity between UMNH VP 16385 and *O. edmontonicus* currently precludes species-level identification of UMNH VP 16385. Given the problems associated with the diagnostic utility of *O. velox*, the new Kaiparowits forelimb material provides an important opportunity to reexamine the validity of diagnostic characters within the hypodigm *Ornithomimus*.

Technical Session XIV, Saturday 9:00

BASAL DINOSAURMORPHS FROM NORTH AMERICA AND THEIR IMPLICATIONS FOR ARCHOSAUR PHYLOGENY

NESBITT, Sterling, American Museum of Natural History, New York, NY, USA; IRMIS, Randall, University of California Museum of Paleontology, Berkeley, CA, USA; PARKER, William, Division of Resource Management, Petrified Forest National Park, Petrified Forest National Park, AZ, USA; ROWE, Timothy, Department of Geological Sciences and Vertebrate Paleontology Laboratory, University of Texas, Austin, TX, USA

Early pseudosuchian archosaurs are well represented in the Triassic fossil record of the world, whereas basal dinosauriforms are only represented by *Lagerpeton* and *Marasuchus* from a single locality in the Middle Triassic of Argentina. New fieldwork in the Upper Triassic Chinle Formation in northern New Mexico in conjunction with the reexamination of existing Triassic vertebrate collections has revealed that basal dinosauriforms were present in North America during most of Chinle Formation and Dockum Group deposition. Two forms are present, one from the lower part of the Chinle Formation and Dockum Group and one from the upper portion of the Chinle Formation. Early dinosauriform material includes femora, tibiae, and astragalocalcaneae that share the following derived character states with *Lagerpeton*: a hook-shaped femoral head, a lateral emargination ventral to the femoral head, an enlarged posteromedial tuber of the proximal end of the femur, an enlarged fibular condyle of the distal end of the femur, an anteromedial corner of the distal end of the femur that is near or >90°, and an astragalus with a posteriorly-placed ascending process. The North American basal dinosauriforms add new information regarding character polarization and clarify poorly understood features of *Lagerpeton*. An ontogenetic series of the femur of one of the North American dinosauriforms strengthens previous arguments that character states in early dinosaur phylogenies may be dependant on the ontogenetic stage of the individual. Basal ornithomimids remained relatively small throughout the Triassic relative to pseudosuchian archosaurs. These new basal dinosauriforms were found associated with basal dinosauriforms, basal saurischians, and theropods in quarries at a variety of geographical and stratigraphic positions, demonstrating that they were contemporaries with dinosaurs and other basal archosaurs during the Late Triassic.

Poster Session I (Wednesday)

PALATINE MORPHOLOGY AND THE PRESENCE OF FIXED CANINE TEETH IN CENOZOIC *ESOX* (TELEOSTEI: ESOCIDAE) OF NORTH AMERICA

NEUBREY, Michael, University of Alberta, Edmonton, AB, Canada; MURRAY, Alison, University of Alberta, Edmonton, AB, Canada; WILSON, Mark, University of Alberta, Edmonton, AB, Canada; CUMBAA, Stephen, Canadian Museum of Nature, Ottawa, ON, Canada

*Esox* has distinctive palatines that are covered with depressible teeth. *Esox masquinongy* is unique among extant species in also having a few fixed canine teeth on their palatines. The objectives of this research are to assess the presence of fixed canine teeth in extinct and extant taxa and to compare anterior palatine morphology among those

with and without canine teeth. Four dimensions from fossil (n = 17) and extant (n = 96) palatines are used to characterize morphology of *Eoxx*. It is predicted that palatines with fixed canine teeth would be morphologically similar as fixed teeth can be large and may require a distinctive morphology to support them. Fixed canine teeth are present in some fossil taxa extending back to the Paleocene Bullion Creek Formation. However, some taxa of the Paleocene, such as *E. tiemani* from the Ravenscrag Formation, lack fixed canine teeth. A principal components analysis identified three axes that explain 99.6% of the variation in palatine morphology. Paleocene and Pliocene palatines of *Eoxx* with fixed canine teeth greatly overlap with those of extant *E. masquinongy*, but middle and late Miocene palatines with fixed canine teeth do not. *Eoxx tiemani* have palatine morphologies similar to extant *E. niger* and *E. lucius* and all of them lack fixed canine teeth on the palatines. There is no distinct palatine morphology consistent with the presence of fixed canine teeth. However, Paleocene *Eoxx*, whether with or without fixed canine teeth, tend to have a longer antero-posterior ethmoid-maxillary facet length and a longer maxillary facet compared to those of the extant species. This suggests that Paleocene *Eoxx* had more posteriorly extending premaxillaries and a maxillary that articulated farther away from the medial margin of the palatine than those of extant species.

Preparators' Session, Thursday 9:45

#### LASER SCANNING & 3D RECONSTRUCTION AS A TOOL FOR PREPARATION AND ARCHIVAL DOCUMENTATION

NEWMAN, Kent, Southern Methodist University, Dallas, TX, USA; WINKLER, Dale, Southern Methodist University, Dallas, TX, USA; POLCYN, Mike, Southern Methodist University, Dallas, TX, USA

Laser scanning and 3 dimensional surface reconstruction has been employed in the study and analysis of fossils in recent years. New innovations in 3D scanners and reconstruction software have yielded significantly reduced cost and now allow the application of this technology to fossil preparation. We applied this technology preparation planning and archival documentation of the skull and anterior postcrania of a semi-articulated mosasaur discovered during quarry operations for building stone. The limestone containing the specimen was irregularly fractured along various planes of weakness, often splitting bones along their length. The specimen was collected as a number of irregularly shaped blocks ranging in size from 1 m to 20cm. Each block was scanned and a three dimensional model was constructed, including surface color. Dimensional data was retained. The virtual blocks were fitted together to form the reassembled fossil and surrounding matrix. Fitted virtual surfaces were examined for voids or problematic fits prior to reassembly and reattachment of the actual blocks. Using the virtual model as a guide, an approximation of the three dimensional extent of the fossil was constructed based on known dimensions of other specimens. These surfaces were then used to create a depth map for each preparation surface, indicating surface to fossil distance, and allowed bulk removal of matrix while minimizing risk of damage to the fossil. The three dimensional models taken at the onset of the project and updated scans taken at various steps in the preparation process allows documentation of the entire preparation process and retains precise dimensional data and surface color for archival purposes.

Poster Session IV (Saturday)

A JUVENILE DESMOSTYLID DENTARY FROM UNALASKA ISLAND, ALASKA, AND AN APPLICATION OF THREE-DIMENSIONAL LASER SCANNING  
NISHIDA, Yosuke, Southern Methodist University, Dallas, TX, USA; POLCYN, Michael, Southern Methodist University, Dallas, TX, USA; JACOBS, Louis, Southern Methodist University, Dallas, TX, USA; FIORILLO, Anthony, Museum of Nature and Science, Dallas, TX, USA

A nearly complete right dentary of a juvenile desmostylid from the Unalaska Formation of Unalaska Island, Alaska, is described facilitated by laser scanning. The preserved portion of the dentary was discovered in two separate blocks, exposing the sagittal surfaces. The sagittal surfaces exposed on the two blocks were laser scanned and photographed. This was followed by preparation and scanning of the external surface of the specimen. Scans of the sagittal and external surfaces were aligned and transformed into Quicktime(tm) so that images of the complete specimen can be rotated and opened to view the internal structure provided by sagittal views. The anterior tip of the dentary is broken off, and the ventral surface is damaged. The dentary is 133 mm long from the preserved anterior tip to the posterior surface of the condyle and 26 mm wide at the third transverse row of the erupting tooth. There are three teeth preserved in this dentary. The anterior tooth appears to be fully erupted, situated at the anterior tip of the dentary although it is damaged and represented only by a single, 5 mm-long root, which is split sagittally. The central tooth consists of three transverse rows of two columns and a single distal column. The distal column is not erupted beyond the dorsal surface of the dentary. The posterior tooth is unerupted inside the dentary. The arrangement of the columns of the posterior tooth is discernable in the sagittal view and has two columns aligning anteroposteriorly. This specimen cannot reasonably be referred to any named taxon. The age of the Unalaska desmostyliid fauna is latest Oligocene or earliest Miocene. The desmostyliids of Unalaska occur with an undescribed whale specimen and a carnivore maxilla referred to *Kolponomos*.

Poster Session IV (Saturday)

#### THE BRAINCASE OF *GALLIMIMUS BULLATUS* (COELUROSAURIA: ORNITHIMIMIDAE)

NORELL, Mark, American Museum of Natural History, New York, NY, USA; BEVER, Gabe, American Museum of Natural History, New York, NY, USA

Ornithimimidae is a clade of coelurosaurian theropods known largely from the late Cretaceous of Asia and North America. Their phylogenetic position near the base of the coelurosaurian tree as a close relative of Maniraptora is well established and relatively stable historically. More recently, however, alternative hypotheses were offered that place ornithimimids in a close relationship with alvarezsaurids—a seemingly derived group of bird-like coelurosaurs that include such well known taxa as *Mononykus* and *Shuvuuia* and that traditionally are considered more closely related to Aves. The disparity between these hypotheses provides the impetus for critical evaluation of the ornithimimid skeleton especially internal cranial anatomy, which until now has remained largely undescribed. The purpose of this study was to provide the first description of an ornithimimid braincase using computed tomography. The scanned specimen is a partially crushed but remarkably complete skull of *Gallimimus bullatus* from the Late Cretaceous Tsaagan Khushu locality, Nemegt Basin, Mongolia. Emphasis was placed on internal features and details of neurocranial pneumaticity. Results indicate a number of previously unrecognized cranial features that include, for example, a division of the recessus scalae tympani so that the glossopharyngeal IX nerve exits the skull through a foramen distinct from that transmitting the vagus X and accessory XI nerves, and a basicranial morphology in which the basitubera are penetrated by pneumatic sacs that also apparently excavate the basioccipital contribution of the occipital condyle internally. The descriptive morphology provided in this study will form the basis of an expanded reevaluation of coelurosaurian braincase anatomy and its phylogenetic significance.

Poster Session III (Friday)

#### A JUVENILE SKULL OF *HETERODONTOSAURUS TUCKI* FROM THE 'STORMBERG' OF SOUTH AFRICA

NORMAN, David, University of Cambridge, Cambridge, United Kingdom; PORRO, Laura, University of Cambridge, Cambridge, United Kingdom; BUTLER, Richard, The Natural History Museum, London, United Kingdom

Heterodontosauridae is an enigmatic clade of primitive ornithischian dinosaurs. Because fossil material is rare and often poorly preserved, the taxonomy, systematics and paleobiology of this clade are controversial. Here we describe a new partial skull of a juvenile *Heterodontosaurus tucki* from the Early Jurassic 'Stormberg Group' of South Africa, with an estimated maximum length of 50 mm indicating a total body length of less than 400 mm. The skull is relatively complete anterior to the left orbit, well preserved, and referred to *H. tucki* on the basis of numerous dental and cranial autapomorphies. Direct examination of the specimen, combined with information from CT and X-ray imaging, provides new information on the cranial anatomy of *H. tucki* as well as new insights into cranial ontogeny and sexual dimorphism in heterodontosaurids. The anteromedial process of the maxilla is pneumatized via an accessory foramen in the anterior region of the antorbital fossa. CT data for adult specimens confirms the presence of this feature, which may be homologous with the promaxillary foramen/recess of theropods and some basal saurischians (*Herrerasaurus*). The following ontogenetic changes are recognised: decrease in the relative size of the orbit; increase in relative length of snout; fusion of cranial bones; increase in maxillary/dentary tooth number. Few ontogenetic changes in dental morphology occur, supporting previous suggestions that tooth characters are informative for species-level taxonomy in heterodontosaurids. The presence of well-developed caniniform teeth in the juvenile specimen does not support the hypothesis that these represent secondary sexual characteristics in heterodontosaurids; furthermore, caniniforms are present in ten out of the eleven 'Stormberg' heterodontosaurid specimens we have examined, and their absence in the heterodontosaurid *Abrictosaurus* is likely to be of taxonomic rather than sexual significance.

Romer Prize Session, Thursday 12:00

#### EXPERIMENTAL TAPHONOMY AND ENVIRONMENTAL CONTROL OF VERTEBRATE PRESERVATION

NOTO, Christopher, Stony Brook University, Stony Brook, NY, USA

Differential preservation of bone due to varying local-to-global terrestrial environmental conditions is recognized as a pervasive bias throughout the fossil record. Furthermore, the distribution of these environments have varied considerably through time, profoundly affecting what is preserved in the fossil record, and where. Little is known regarding how environment-specific decay and diagenesis affect terrestrial bone preservation, and ultimately, our reconstructions of paleoecology, diversity, and biogeography. To investigate short-term processes critical in the decay and diagenesis of buried bone, I performed a 14-month controlled taphonomic experiment which explored the individual and collective effects of 1) sediment hydrology and organic content [sand vs. clay/humus], 2) bone size [deer vs. rabbit vertebrae], and 3) plant

association [gymnosperm vs. angiosperm] in controlled laboratory microcosms. Analyses included the measurement of leachate for calcium (Ca) using DCP-AES, and use of CT scanning to measure changes in bone density. Results show that plant presence had little effect on bone decay, plants leach significant amounts of Ca, and bone size had no effect on decay rate. Sediment type strongly influenced a number of changes. Bones in clay/humus leached on average 15 times more Ca than those in sand. Bone mass loss and density change was greatest in sand. Bone surfaces from sand appear eroded, while bones from clay/humus are stained brown but otherwise intact. This experiment suggests that the process of bone decay: 1) is not affected by the presence of plant material, 2) occurs at a constant rate independent of size, and 3) is sediment specific: high-flow sand-dominated sediments erode bone from the outside in at a high rate, while low-flow clay/humus-dominated sediments leach Ca interiorly and promote surficial mineral deposition. This study has important implications for taphonomic interpretation of individual fossil sites, facies control of fossil preservation, and even large-scale paleobiogeographic reconstructions. Therefore, local and global climate may be considered not only a driver of species diversity, but also fossil preservation.

Poster Session I (Wednesday)

ANGUIMORPHAN AND NON-BORIOTEIIOID SCINCOMORPHAN LIZARDS FROM THE KAIPAROWITS FORMATION (MID-CAMPANIAN), SOUTHERN UTAH

NYDAM, Randall, Midwestern University, Glendale, AZ, USA; FLANAGAN, Brigitte, Midwestern University, Glendale, AZ, USA; HICKMAN, Michael, Midwestern University, Glendale, AZ, USA

The lizard component of the microvertebrate fauna recovered from the Kaiparowits Formation includes a combination of scincomorphan and anguimorphan taxa. Previously described are the boriotieioid lizards *Peneteius*, *Chamrops*, *Leptochamrops*, *Meniscognathus*, and *Tripennaculus*. Here we present numerous specimens of distinct taxa/morphotypes of anguid and varanoid anguimorphans and non-boriotieioid scincomorphans. The scincomorphan jaw material represents several distinct morphotypes (primarily distinguished by dental morphology) that can be grouped as either cordylid grade or indeterminate. This also includes a single morphotype of osteoderm that is relatively thick, keeled, and has a weakly tuberculate ornamentation (also cordylid-like). Anguimorphans are represented by two morphotypes of jaws and osteoderms attributable to the anguid *Odaxosaurus*, and at least one indeterminate anguid. There are also multiple morphotypes of varanoid jaws present with teeth ranging from gracile (*Parasaniwa*-like) to robust (*Labrodioctes*-like). Some varanoid teeth also exhibit incipient "venom grooves." Osteoderms with a pronounced, irregularly rugose ornamentation are most likely attributable to an anguimorphan, possibly a xenosaurid. In addition to lacertilians there are also teeth (?) and vertebrae of at least one taxon of snake in the fauna. Although many of the non-boriotieioid specimens are too fragmentary for formal identification they represent a wide range of clearly distinguishable morphotypes. As such, the lacertilians from the Kaiparowits Formation appears to be one of the most morphologically (and likely taxonomically) diverse faunas from any single depositional unit from the Upper Cretaceous of North America.

Poster Session I (Wednesday)

PLEISTOCENE PECCARIES FROM GUY WILSON CAVE, SULLIVAN COUNTY, TENNESSEE

NYE, April, East Tennessee State University, Johnson City, TN, USA; SCHUBERT, Blaine, East Tennessee State University, Johnson City, TN, USA; WALLACE, Steven, East Tennessee State University, Johnson City, TN, USA

A recent donation of fossil material from Guy Wilson Cave (Sullivan County, Tennessee) to the East Tennessee Museum of Natural History collection (at East Tennessee State University) represents the largest single faunal assemblage from this important site. This collection is rich in Pleistocene megafauna and is dominated by peccaries (Tayassuidae) and deer (Cervidae). Descriptive and taphonomic analyses of the peccary remains from this sample and another collection from the same deposit (housed at the Frank H. McClung Museum) are reported here. Two peccary taxa are represented, *Platygonus compressus* (flat-headed peccary) and *Mylohyus* sp. (long-nosed peccary). A MNI (minimum number of individuals) was calculated for both based on femora and teeth. This showed that *P. compressus* (MNI of sixteen) was far more abundant in the deposit than *Mylohyus* (MNI of two). Age profiles show a predominance of *P. compressus* adults. Upper canines, which all appear to represent *Platygonus*, suggest sexual dimorphism. Long bones were analyzed for carnivore damage and revealed wolf-like modification features. We suggest that the cave was used as a carnivore den, and that *Canis dirus* (dire wolf) was the most likely inhabitant.

Technical Session V, Wednesday 2:15

JURASSIC INFANTICIDE? FIRST EVIDENCE OF PLESIOSAUR PREDATION ON NEONATAL ICHTHYOSAURS

O'KEEFE, F. Robin, Marshall University, Huntington, WV, USA

Recent field work in the upper Sundance Formation (Oxfordian) of the Bighorn Basin, Wyoming, has resulted in the collection of significant new material from two plesiosaur taxa. The plesiosaur fauna of the Sundance Formation is relevant because it is coeval with the classic Oxford Clay fauna of England, and therefore provides comparative and biogeographic data for comparison with that fauna. Highlights of the material include two partial skeletons, one that is referable to *Pantosaurus striatus*, a poorly known animal thought to be closely related to the long-necked English taxon *Muraenosaurus leedsi*. The *Pantosaurus* partial skeleton comprises 15 articulated vertebrae spanning the mid-dorsal to mid-caudal region (including the sacrum), many well-preserved ribs and gastralia, and a complete pelvic girdle, all previously unknown for this taxon. Unlike *Muraenosaurus*, the dorsal and sacral vertebrae have neural spines angled backward, and the chevrons in the caudal series articulate with one vertebral centrum rather than two. The ribs and gastralia were found beneath the pelvic elements, and all were jumbled together atop the vertebral column in a dense mass. During preparation of this mass, a small pile of nine ring-shaped bones was discovered, five of which were stacked. The rings were found ten centimeters away from the main mass of ribs and gastralia. The rings are round with an outside diameter of 16-18 mm and an inside diameter of 12-14 mm. They are essentially identical to recently described vertebral centra from embryonic ichthyosaurs, and are therefore identified as a partial axial column of a very young ichthyosaur. The jumbled state of the skeleton when found prevents exact location of the ichthyosaur material within the body cavity, and the occurrence may be a fortuitous coincidence. However, the close association of the ichthyosaur with a plesiosaur thorax suggests the ichthyosaur may be stomach contents. The ichthyosaur is a very young juvenile based on the poor ossification of the centra and on their size. This find is therefore the first evidence of possible predation by plesiosaurs on neonatal ichthyosaurs.

Poster Session IV (Saturday)

A LATE PLIOCENE LARGE MUSTELID *FERINESTRIX* FROM THE UDUNGA FAUNA, TRANSBIKAL AREA, RUSSIA.

OGINO, Shintaro, Primate Research Institute, Inuyama, Japan; NAKAYA, Hideo, Kagoshima Univ., Kagoshima, Japan; TAKAI, Masanaru, Primate Research Institute, Inuyama, Japan; MASCHENKO, Evgeny, Paleontological Institute, Russian Academy of Sciences, Moscow, Russia; KALMIKOV, Nikolai, Southern Scientific Center Russian Academy of Science, Rostov on don, Russia

The large fossil mustelid from the late Pliocene Transbikal area is comparable to North American *Ferinstrix* by the characters of lower teeth. *Ferinstrix* is extinct Ischyrtictini (Mustelidae, Carnivora) discovered from Black Hills and Hagerman Fossil Bed, South Dakota. This genus is known solely from a lower jaw with incomplete lower teeth. In this study, we report newly discovered more than 200 of specimens including upper teeth of *Ferinstrix* form the late Pliocene Transbikal area Udunga fauna. Wrinkled teeth are massive and the muzzle is very short. Upper and lower canines are large. P1 is absent. P2 has single root. P2 and P3 are simple and small. P4 has Well-developed hypocone on the posterolingual side. P4 is smaller than that of M1. M1 has distinct metaconule, reduced parastyle, and posteriorly expanded hypocone. Mandible is very short. The p1 is absent. The p2 has single root. The p4 is small, simple and wide. The m1 trigonid is robust but the metaconule is reducing. The talonid basin is surrounded by cuspidate rim. Average length of ?1 is 27.2mm (N=4) and these size are close to 27.0mm of North American *Ferinstrix vorax*. Principal component analysis using four dental measurements shows that *Ferinstrix* is estimated moderately carnivorous diet. However, highly robust teeth imply that *Ferinstrix* might have been adapted for dealing with hard tissues such as bone. *Ferinstrix* is not limited to North America but distributed in the Palaearctic region during the Pliocene. This genus has been found in Mongolia, but Mongolian *Ferinstrix* have not yet been fully studied until now. Transbikalian *Ferinstrix* reported in this study provide us new information of teeth morphology and statistical data.

Poster Session III (Friday)

APOMORPHIC IDENTIFICATION OF FOSSIL CAUDATE VERTEBRAE FROM OREGON AND CALIFORNIA: FUTILE OR FRUITFUL?

OLORI, Jennifer, The University of Texas at Austin, Austin, TX, USA; BELL, Christopher, The University of Texas at Austin, Austin, TX, USA

Disarticulated or isolated salamander vertebrae are common components of fossil deposits in western North America. However, due to difficulties associated with taxonomic identification, at many localities few vertebrae are assigned to a low taxonomic level (genus, species). Frequently, these specimens are reported only as an indication of the presence of a caudate (or amphibian) in a fauna and provide no meaningful measure of taxonomic distribution or diversity. We investigated isolated fossil salamander vertebrae from Oregon and California in conjunction with a survey of vertebral morphology in extant salamanders. We attempted to identify apomorphic characters that

would allow for consistent and repeatable identification, independent of known (or inferred) spatial and temporal distribution. In most cases, apomorphic characters permit identification to the level of traditional family groups, but even at that broad level some supposedly unique characters were found to be undiagnostic when used alone. For example, unless multiple regions of the vertebral column are preserved, the derived pattern of innervation in plethodontids is indistinguishable from that of ambystomatids, salamandrids, and sirenids. At more refined levels, a few taxa were found to possess derived features that permit generic or specific identification, such as in *Aneides lugubris*, which exhibits a well-developed ventral lamina of bone extending from the anterior and posterior margins of the centrum to the distal tips of the parapophyses. In many cases, however, strict reliance on apomorphic identification resulted in less refined taxonomic resolution than traditional identification methods that utilize unique combinations of features (including plesiomorphies), modern geographic distributions, and known temporal ranges of taxa. Traditional methods of diagnosis improve taxonomic resolution, but often at the expense of meaningful evolutionary insights. Interesting results obtained from both apomorphic and traditional methods include the identification of a large fossil vertebra from Oregon that represents a new taxon possibly related to the Ambystomatidae.

Poster Session I (Wednesday)  
DEVELOPMENTS IN THE PALEONTOLOGY OF QUATERNARY TAR SEEPS (MENES) IN VENEZUELA

ORCHARD, David, Foundation for Quaternary Paleontology of Venezuela, Houston, TX, USA; RINCÓN, Ascanio, Instituto Venezolano de Investigaciones Científicas (IVIC), Caracas 1020-A, Venezuela

Two sites confirm that Venezuelan tar seeps have rich assemblages of Quaternary fossils. Several hundred seeps (called menes in Venezuela) exist across the country, some exceeding one square kilometer in area. The richness of the current sites and the huge tar seep resource indicate that a world-class program is developing in this area. The two sites are Inciarte on the western margin of Maracaibo Basin near the mountain front of La Sierra del Perijá, and La Breal de Orocuá in Monagas State in the far northeast of the country. The Universidad del Zulia conducted a small excavation at Inciarte in 1997, yielding 93 vertebrate taxa. Radiocarbon dating of this material provided dates of 25,000 to 27,000 years BP. La Breal de Orocuá was discovered in 2006 and is being excavated by the Instituto Venezolano de Investigaciones Científicas (IVIC) with funding provided by Petróleos de Venezuela (PDVSA). Initial sampling has uncovered 34 taxa. The deposit is in the La Mesa Formation, which according to published reports comprises fluvial-deltaic strata of Early to Middle Pleistocene age. Thermoluminescence dates of 0.5 to 1.0 million years BP and the taxa identified to date are consistent with that age assignment. The sites have yielded extensive faunas of mammals, birds, reptiles, and amphibians, as well as invertebrates and plant remains. Pleistocene megafauna are well represented, as are many species of small taxa. These diverse taxa provide comprehensive representations of terrestrial environments of the Venezuelan Quaternary. The presence of tar seeps at Inciarte and La Breal de Orocuá is understandable in the context of the petroleum geology of these regions. Reconnaissance, excavation, and collection of fossils in Venezuela are administered by the Instituto del Patrimonio Cultural (IPC), the department of the national government that is responsible for paleontological, archeological, architectural, and other cultural resources of Venezuela.

Poster Session I (Wednesday)  
TETRAPOD EXTINCTION ACROSS THE JURASSIC-CRETACEOUS BOUNDARY

ORCUTT, John, University of Oregon, Eugene, OR, USA; SAHNEY, Sarda, University of Bristol, Bristol, United Kingdom; LLOYD, Graeme, University of Bristol, Bristol, United Kingdom

In recent years, several studies have focused on the effects of the "Big Five" mass extinctions. Fewer workers have addressed the many smaller extinction events that have occurred throughout the Phanerozoic. Here we present the results of an analysis of tetrapod diversity across one of these events, the Jurassic-Cretaceous extinction. Rather than constructing global diversity curves, our analysis is based upon  $\alpha$ - (within-community) diversity within well-preserved and well-studied sites from the Late Jurassic and Early Cretaceous (e.g. Como Bluff, Tendaguru, Galve, Lujiatun). Our method minimizes the effects of preservation bias, commonly cited as a weakness of global diversity curves. While it has been suggested that many apparent minor extinction events are in fact only artifacts of an incomplete and poorly sampled fossil record, patterns of tetrapod  $\alpha$ -diversity across the Jurassic-Cretaceous boundary are consistent with a mass extinction. A decrease in richness can be observed at all taxonomic levels. Large taxa, particularly theropods, experienced the greatest drop in diversity, though mammals underwent a significant turnover as well. Some groups, such as turtles and crocodylians, were largely unaffected. Widespread changes in the composition of communities occur at the Jurassic-Cretaceous boundary as well, most notably the increased abundance of ornithischian dinosaurs relative to sauropods.

Poster Session III (Friday)  
PALEOECOLOGY OF THE CLOVERLY FORMATION (LOWER CRETACEOUS) VERTEBRATE FAUNA FROM MICROVERTEBRATE SITES IN THE BIGHORN BASIN, WYOMING

ORESKA, Matthew, College of William & Mary, Richmond, VA, USA; CARRANO, Matthew, Smithsonian Institution, Washington, DC, USA; LOCKWOOD, Rowan, College of William & Mary, Williamsburg, VA, USA

The terrestrial Early Cretaceous of North America is represented by several productive and widespread formations that document major faunal changes between the Late Jurassic and Early Cretaceous. Although recent discoveries have significantly improved our knowledge of these important terrestrial faunas, considerably less is known about their paleoecology. Our work has focused on analyzing several newly discovered microvertebrate sites in the Cloverly Formation. These sites offer important new data on the paleoecology of this formation by providing large, diverse samples of parautochthonous vertebrate taxa. Samples were collected in bulk, screenwashed, and sorted. Each recovered specimen was identified to the lowest possible taxonomic level, and then grouped into successively higher taxonomic categories. Due to the depositional nature of the sites, we used a variety of taxon abundance estimates, including minimum numbers of individuals and total numbers of specimens. We analyzed each site individually, as well as the formation assemblage in aggregate, using several standard diversity measures. Currently our total sample includes 41 taxa, including several forms not previously reported from the Cloverly Formation. Rarefaction indicates that most sites are similar in total diversity at a given sample size, but also that increased sampling is unlikely to deliver many more taxa. In agreement with this, diversity measures were similar across most sites, with a predominance of aquatic and semi-aquatic taxa over purely terrestrial forms. The diversity of these latter species has been underestimated in past studies, leading to an overly terrestrial reconstruction of Cloverly vertebrate paleoecology.

Student Poster Session (Thursday)  
'A PIG'S TALE': MORPHOLOGY, PHYLOGENY AND SYSTEMATICS OF THE LISTRIODONTINAE (SUIDAE, MAMMALIA).

ORLIAC, Maeva, Muséum National d'Histoire naturelle, Paris, France

The members of the Listriodontinae, an Old World subfamily of Miocene suids, exhibit peculiar dental and cranial morphologies such as lophodont cheek teeth or frontal horns. This group received special attention among the Suidae and various classifications, often divergent, were proposed. A revision of the listriodontine species together with new cranial and dental material from Kenya and Pakistan allow here to assess the dental, cranial and postcranial characters of Listriodontinae. An unexpected diversity of the otic area is described, together with a peculiar morphology of the face, triggering the question of the anatomy of the snout of those suids. Postcranial elements reveal to be discriminant characters at the specific, generic and subfamilial level. A phylogenetic analysis including 200 anatomical characters (96 dental, 53 cranial and mandibular, and 51 postcranial) controlled for 50 taxa is undertaken at the Suidae level. This analysis, taking into account for the first time the diversity of the Listriodontinae, leads to the establishment of a classification based on common ancestry and to the determination of the position of the Listriodontinae among the Suidae. Listriodontinae appear to be among the first suids to differentiate and gather three clades corresponding to Namachoerini, Kubanochoerini and Listriodontini; the controversial genus *Bunolistriodon* shown to be paraphyletic, is here considered as junior synonym of the genus *Listriodon*. Moreover, if the question of the paleogeographic origin of the subfamily remains open, the African origin of Namachoerini and Kubanochoerini indicates a diversification of Listriodontinae in Africa. These results contribute to a better understanding of the phylogeny of the Suidae and raise once more the question of the relationships between Suidae, Old World Tayassuidae and American Tayassuidae as well as the question of the position of Suoidea among Artiodactyla and the definition of "Suiformes", directly correlated to the problematic of Cetartiodactyla.

Technical Session VII, Thursday 3:00  
MICROSTRATIGRAPHIC ANALYSIS OF A RAPID REPLACEMENT EVENT IN MIOCENE STICKLEBACKS (*GASTEROSTEUS DORYSSUS*)

OSTROWSKI, Summer, Michigan State University, East Lansing, MI, USA

A stickleback assemblage from a Miocene lake deposit in the Truckee Formation of Nevada provides an exceptional opportunity to study microstratigraphic variation. One exposure contains 108,000 years of annually coupled (varved), undisturbed sedimentation containing abundant, well-preserved stickleback fossils. Stickleback morphotype frequencies change dramatically in this exposure. Rock was split in the field to expose specimens and their stratigraphic positions were estimated and recorded. Stratigraphic position was converted to approximate year of deposition using the varve counts. Two morphotypes initially occur in this deposit, common, low-armored limnetics and rare, highly armored benthics. These morphotypes are distinguished by how heavily armored the fish are using their pelvis (full or reduced) and number of dorsal spines (3 or less than 3) as indicative features for benthics and limnetics respectively. Limnetic sticklebacks dominate the first 93,000 years of deposition, during which they gradually



evolved less armor. At approximately 93,000 years there was a rapid transition (~100 years) to predominantly benthic forms, followed by a gradual re-evolution of the limnetic morphotype. I measured 23 morphological variables of specimens from the time interval during which the benthics rapidly replaced the limnetics. Most morphological variables changed in synchrony and there are few intermediate specimens during this transition. This transition most likely represents the replacement of a limnetic population by a benthic population.

Technical Session VIII, Thursday 2:15  
HIGH LEVELS OF THYROID HORMONES INDUCE A DETERMINATE GROWTH PATTERN IN JUVENILE CROCODYLIANS

OWERKOWICZ, Tomasz, UC Irvine, Irvine, CA, USA; CROMPTON, Fuzz, Harvard University, Cambridge, MA, USA

Endo- and ectothermic vertebrates show drastically different growth patterns. Mammals and birds exhibit fast growth as juveniles, but stop growing once they reach sexual maturity. Ectothermic vertebrates, on the other hand, grow much more slowly as juveniles, and continue to grow (albeit at a slower rate) as sexually mature adults. It has been suggested that a high resting metabolic rate is necessary for juveniles to achieve high growth rates, but no explanation has been offered as to why only mature endotherms exhibit a determinate growth pattern. We propose that differences in plasma levels of thyroid hormones (FT3 and FT4) between ecto- and endotherms may explain both growth phenomena. Thyroid hormones are known to increase rates of bone formation and resorption in mammals, but their effects on skeletal development and maturation have not been studied in reptiles. In order to determine the effects of FT3 and FT4 on growth of ectothermic reptiles, we raised hatchling estuarine crocodiles with or without exogenous thyroid hormones. Experimental animals received oral doses of thyroid hormones twice a day, while control animals received saline. Over the course of 12 weeks, animals were weighed and measured regularly, injected with fluorescent dyes to calculate bone deposition rates, and assayed for plasma FT3 and FT4. Animals with high FT3 levels grew significantly faster than controls. Initially, animals with very high FT3 and FT4 levels grew the fastest, but their growth trajectory leveled off after several weeks. Histological analysis of limb bones revealed beginnings of growth plate fusion in the latter group, but not in control or high FT3 animals. These results suggest that T3 stimulates bone formation, while T4 accelerates bone resorption. When resorption overtakes new bone formation at the growth plate, growth cessation occurs. We posit that endothermy and a determinate growth pattern are mechanistically linked, both supported by high levels of thyroid hormones. This finding offers a new method to infer endothermy in extinct vertebrates - fossils with features of determinate growth (e.g., lack of calcified cartilage at epiphyses) must have been endothermic.

Technical Session I, Wednesday 12:15  
HOW VERTEBRATE PALEONTOLOGISTS CAN CHANGE THE PUBLIC UNDERSTANDING OF EVOLUTION

PADIAN, Kevin, University of California, Berkeley, Berkeley, CA, USA

An important lesson from the 2005 Dover "Intelligent Design" trial is that anti-evolutionists can easily distort and misrepresent paleontological evidence and methods to the public, because public understanding of macroevolution is so poor. Creationists desperately need to perpetuate the myth that macroevolution is a myth. Particularly misunderstood are the concepts of exaptation, of the origins of major new adaptations and taxa, and how scientists use many independent lines of evidence to illuminate these questions. Because creationists accept microevolution but not macroevolution, it is particularly incumbent upon paleontologists to explain the major features of macroevolution to the public. However, a survey of leading college textbooks in introductory biology and upper division courses in evolution, vertebrate paleontology, and comparative vertebrate anatomy discovers virtually no effective coverage of our knowledge and methods. I show how illustrations that incorporate phylogeny, homology, paleontology, and adaptive change can communicate both knowledge and methods of approaching macroevolutionary questions. For people who are uninformed but interested, such illustrations neutralize creationist claims that we have no major evolutionary transitions. I explain how we can change textbooks easily and rapidly to accomplish this goal, and how we can use the Worldwide Web to deliver our knowledge to a public that desperately needs to understand it.

Poster Session III (Friday)  
A RETURN TO BIJOU HILL: NEW INVESTIGATIONS IN THE MIDDLE MIOCENE FORT RANDALL FORMATION OF SOUTH DAKOTA  
PAGNAC, Darrin, South Dakota School of Mines, Rapid City, SD, USA; PAPPAS, John, South Dakota School of Mines, Rapid City, SD, USA

Three new fossil localities have been identified in the Middle Miocene Fort Randall Formation in Charles Mix County, central South Dakota. The "Northern Exposure" locality is located in a new slump exposure on the northwest face of south Bijou Hill. The "Foothold Hill" locality and "McConnell-Trenholm (MT)" site are located on the edge of a large terrace approximately one mile southeast of south Bijou Hill. The Fort

Randall Formation consists of approximately twenty-five meters of characteristic fluvial conglomerates, sandstones, and clays. It unconformably overlies the DeGrey Formation of the Upper Cretaceous Pierre Shale Group and is capped by sands of the Middle Miocene Valentine Formation. Fossil material is typically associated with white concretionary sand and silt layers possibly subjected to subaerial exposure after deposition. New fossil material is taxonomically similar to that previously described. The fossil assemblage has been assigned to the late Barstovian (Ba2) NALMA. Lower vertebrate material includes Ictaeluridae, Serpentes, and Testudines. Avian fossils have been identified but are rare due to high-energy fluvial deposition. Megafaunal mammalian representatives include *Leptarctus* (Mustelidae), cf. *Merychippus* sp. (Equidae), cf. *Cormohipparion* sp. (Equidae), rhinocerotids, camelids, and antilocaprids. Mammalian microfaunal constituents include *Plesiosorex* (Soricidae), castorids, mylagaulids, heteromyids, and cricetids. Taphomomically the new sites are typical of fluvial deposition. Fossil material is characterized by isolated elements with no articulation, little size sorting indicating short transport distance, and abundant water-worn bone material.

Technical Session XIV, Saturday 8:15  
REVISED OSTEOLOGY OF *REVUELTOSAURUS CALLENDERI* (ARCHOSAURIA: PSEUDOSUCHIA) BASED ON NEW MATERIAL FROM PETRIFIED FOREST NATIONAL PARK, ARIZONA

PARKER, William, Petrified Forest National Park, Petrified Forest, AZ, USA; BROWN, Matthew, Petrified Forest National Park, Petrified Forest, AZ, USA; NESBITT, Sterling, Columbia University, Palisades, NY, USA; STOCKER, Michelle, University of Iowa, Iowa City, IA, USA; IRMIS, Randall, University of California Museum of Paleontology, Berkeley, CA, USA

*Revueltosaurus callenderi* is a pseudosuchian archosaur from the Upper Triassic of North America, which was until recently considered to represent an ornithischian dinosaur. Previous descriptions of this taxon were based on diagnostic but variably preserved material including isolated teeth and partial skeletons from Arizona and New Mexico. In the summers of 2005 and 2006 two new specimens were collected from the Petrified Forest Member of the Chinle Formation in Petrified Forest National Park. The 2006 specimen is virtually complete and well preserved, providing key descriptions of elements that were previously unknown or incomplete. Especially important is a disarticulated but nearly complete skull. This new skull material demonstrates that previous hypothesized reconstructions of the skull were not entirely correct. For example, the dorsal border of the antorbital fenestra is formed by the lacrimal, not the maxilla, and the isolated element interpreted to be the lacrimal is actually the postorbital. A well-preserved mandible shows that a lateral mandibular fenestra was present. Other key elements preserved in the new material that were previously incomplete or unknown include the braincase, palate, premaxilla, dorsal vertebrae, ischium, pubis, and many of the limb elements. The 2005 specimen possesses an articulated ventral armor carapace, supporting proposed relationships between *Revueltosaurus* and aetosaurs. Other synapomorphies of these taxa include a horn-like posterior process of the squamosal, a laterally rotated squamosal with a broad tab-like anterior process, rectangular paramedian plates with a well-developed anterior bar, and a proximal end of the humerus that is greatly expanded mediolaterally. A preliminary phylogenetic analysis suggests that *Revueltosaurus* is the closest sister taxon to Aetosauria within Pseudosuchia.

Poster Session I (Wednesday)  
DENTAL FUNCTION IN LUNGFISHES (CERATODONTIDAE) FROM THE CRETACEOUS OF NORTH TEXAS

PARRIS, David, New Jersey State Museum, Trenton, NJ, USA; GRANDSTAFF, Barbara, University of Pennsylvania, Philadelphia, PA, USA; BANKS, Nathan, Shuler Museum of Paleontology, Dallas, TX, USA

Scant though it may be, published information on Cretaceous North American ceratodontid lungfishes suggests that crushing-toothed lineages dominated the last-surviving North American representatives of the family. However, most *Ceratodus* specimens from the Albian (Comanchean, Early Cretaceous) of north Texas belong to an as yet unnamed species that exhibits distinctive, sharp dental crests (denticulate in unworn teeth) regardless of ontogenetic stage of development. These blade-like crests, indicative of a slicing and shearing adaptation, distinguish this lineage from the crushing dentitions of most other known North American Cretaceous dipnoans. In living dipnoans, the larger size and crushing capability of the dentition enables more opportunistic faunal exploitation, including predation on vertebrates. The functional adaptation of the north Texas lungfish dentitions (slicing/chopping) and the relatively small size of these fishes are indicative of predation primarily upon small invertebrates. Representative specimens of this lungfish taxon are recognized from the Antlers Formation at Butler Farm (Wise County) and Greenwood Canyon (Montague County), and from the Twin Mountains Formation at the Jones Ranch Locality (Hood County). Although poorly known as yet, a similar dentition (presumably from lungfish descendent from this species) is also known from the Cenomanian Woodbine Formation of north Texas. The natural history of dipnoans in the eastern North American Cretaceous subcontinent

remains largely unstudied, but it is now certain that eastern lungfish populations, after formation of the central seaway, included taxa possessing both crushing and sectorial dentitions.

Poster Session IV (Saturday)

AVIAN-LIKE MANUAL PHALANX FOUND WITHIN GUT CONTENTS OF LOWER CRETACEOUS DROMAEOSAURID: NEW DATA ON THE FEEDING BEHAVIOR OF *DEINONYCHUS ANTIRRHOPUS* (SAURISCHIA: THEROPODA)

PARSONS, William, Buffalo Museum of Science, Buffalo, NY, USA; PARSONS, Kristen, Buffalo Museum of Science, Buffalo, NY, USA

Two partial specimens of *Deinonychus antirrhopus*, from the Lower Cretaceous Cloverly Formation of central Montana, discovered within a monospecific site, were found to be closely associated with preserved gut contents. The gut contents consisted of several small nodules composed of densely packed bone fragments. Many of the bone fragments that appear upon the surface of these nodules exhibit erosion of the outer periosteal layers and acid etching, which are indications of the digestive process. The acid etching is similar to the result of the action of digestive acids and enzymes found within the gut contents of modern amniotes. Although no gastroliths are present at this site, the highly fragmented nature of some of the bones in this gut material may indicate digestive processing by a muscular gizzard. Color differences between gut content material and associated bone have been noted in the descriptions of other fossil gut contents. Almost all of this gut content material are a deep shade of orange and can be easily distinguished from the pinkish-gray coloration of the associated *Deinonychus* bone material. Although some of the larger bone fragments within these conglomerates were of the size that would be expected from the remains of a medium-sized dinosaur, many fragments are from much smaller individuals. An avian-like manual phalanx found among these conglomerates indicates the original source of at least some of the smaller bones. The morphology of this phalanx indicates a forelimb/wing from a taxon that is very likely to have been capable of sustaining some form of flight. Although the discovery of this forelimb element is notable, it is also significant in that it indicates that *Deinonychus* not only fed upon the carcasses of larger dinosaurs, but that its predatory behavior included the acquisition of much smaller prey. *Deinonychus* was an opportunistic feeder, probably capable of catching prey species that possessed some form of flight.

Poster Session I (Wednesday)

FUNCTIONAL MORPHOLOGY OF THE *EQUATORIUS AFRICANUS* HAND

PATEL, Biren, Stony Brook University, Stony Brook, NY, USA; ROSSIE, James, Stony Brook University, Stony Brook, NY, USA; BIECHELE, Molly, Stony Brook University, Stony Brook, NY, USA; HILL, Andrew, Yale University, New Haven, CT, USA

Functional assessments of the postcranial anatomy of known early Miocene hominoids (*Proconsul*, *Afropithecus*, *Nacholapithecus*) have suggested that these diverse primates utilized positional behaviors dominated by arboreal quadrupedalism similar to the extant New World monkey *Alouatta*. Preliminary descriptions of the *Equatorius africanus* partial skeleton (KNM-TH 28860), however, argued that this animal relied more on terrestrial locomotion compared to its contemporaries. We reevaluate this conclusion based on new qualitative and quantitative analysis of the *Equatorius* hand bones. The anatomy of the hand is particularly revealing of locomotor behaviors because it forms a biomechanical link between the substrate and forelimb. Specifically, we examined the morphology of the proximal phalanges, metacarpal V, and pisiform in *Equatorius* in reference to a sample of catarrhine and platyrrhine species. The *Equatorius* hand displays mostly arboreal characteristics including relatively long proximal phalanges that are moderately curved. The only quantitative similarity to semi-terrestrial primates is a relatively large metacarpal head, but this has little significance due to its large variation among all primates. The hand bones are most different from the highly suspensory hylobatids and display no sign of suspensory locomotion (i.e., less curved fingers, long pisiforms). Several discrete characters of the hand resemble monkeys rather than extant hominoids. These include a dorsally canted base of the proximal phalanx and base of metacarpal V, and a metacarpal head that is more expanded on the palmar than the dorsal surface. Because these resemble both arboreal and terrestrial monkeys, they offer little value to functional interpretations of the *Equatorius* hand. *Equatorius* may have been capable of terrestrial locomotion, as implied by the distal humerus, but it retains many fundamentally arboreal traits. *Equatorius* was clearly not suspensory, or a knuckle-walker. This further confirms the primitive nature of the early hominoid postcranial skeleton, and that the terrestrial and suspensory locomotion utilized by living hominoids evolved later in the Miocene.

Evolutionary History of Bats Symposium, Thursday 11:00  
CEPHALOMETRY & EVOLUTIONARY CONSTRAINT WITH RESPECT TO THE MODE OF ECHOLOCATION IN BATS

PEDERSEN, Scott, SDSU, Brookings, SD, USA

The fundamental construct of the head is strongly influenced by the growth of the brain & pharynx early in development. Differential growth of the two determines the shape of the chondrocranium & overlying bones. Spatial competition among other components within the confines of the fetal head imposes spatial & mechanical constraints on the adult skull. Cephalometric relationships among skull components in both embryos & adults distinguish taxa that echolocate nasally (Rhinolophidae, Phyllostomidae) from those that echolocate orally. During ontogeny, skulls of nasal-emitters are distorted by the rotation of the basicranium ventrally about the cervical axis, depression of the rostrum below the basicranium, and rotation of the lateral semi-circular canals to a near-horizontal orientation. These actions align the nasal cavity with the axis of the body in flight. Heads of oral-emitting taxa are instead constructed around an axis aligned with the oral cavity. Brain size is poorly correlated with skull cephalometry, rather brain size is associated with the occupation of a specific aerial niche, rather than skull shape. In sum, the skull mechanics of echolocating bats are constrained by the demands of vocalization & have been canalized along two distinct developmental paths: oral & nasal-emitting bauplan. An extreme example of the nasal-emitting bauplan is found in rhinolophid bats where the nasal cavity has been extensively modified as an acoustical horn (loud vocalization). Subsequent distortion of the rhinolophid maxillae results in unique rostral fontanelles, loss of lacrimal bones and infraorbital foramen, & reduction of the anterior palate such that the premaxillae are kinetic. In contrast, rostra of phyllostomid nasal-emitters exhibit large eyes & extensive turbinate development (quiet vocalization). Given the spatial restrictions of the mid-face, the anatomical correlates of olfaction & echolocation have apparently worked at cross-purposes during the evolution of the nasal-emitting rostrum. Perhaps we need to step back and reevaluate development as a way of understanding the evolution of an organism- perhaps we can no longer see the forest for all the gene-trees.

Poster Session III (Friday)

HINDLIMB STRUCTURE OF THE RARE LOWER PERMIAN DIADECTOMORPH *TSEAJAIA CAMPI* VAUGHN

PELLETIER, Valerie, California State University, San Bernardino, San Bernardino, CA, USA; SUMIDA, Stuart, California State University, San Bernardino, San Bernardino, CA, USA; WALLISER, James, Phoenix Community College, Phoenix, AZ, USA; BERMAN, David, Carnegie Museum of Natural History, Pittsburgh, PA, USA

*Tseajaia campi* Vaughn is the only representative of the monospecific diadectomorph family Tseajaiidae. The initial description of its postcranium was based exclusively on the type specimen, UCMP V4225/59012, which includes much but not all of the left hindlimb and only a partial right femur. New information, primarily from the femur and pelvic girdle (CM 38086) has since become available. Combined with recent new interpretations of the hindlimb in the families Limnoscelidae and Diadectidae, a better understanding of the hindlimb in the Tseajaiidae specifically and Diadectomorpha in general are now possible. The external iliac shelf is a shared derived feature of Diadectomorpha. However, the shelf is more completely developed in Tseajaia and diadectids than in *Limnoscelis*. A pubic foot is well developed at the anterolateral corner of each pubic bone and appears to be an autapomorphic feature in *Tseajaia*. A posterior emargination of acetabulum is well developed in *Tseajaia* and diadectids, though not in *Limnoscelis*. Previously unknown, the proximal head of the femur can now be reconstructed as rounded as opposed to narrow and angular. The femoral shaft has a well-developed ventral adductor crest - a feature common to Diadectomorpha. Angulation of the adductor crest relative to the long axis of femoral shaft in *Tseajaia* is much more similar to that in diadectids than that in *Limnoscelis*. The tibia and fibula are approximately subequal in length. The only pes preserved is not complete. It shows no significant departures from the pattern known from other taxa near the amphibian-amniote transition. The degree of development of external iliac ridge, posterior emargination of acetabulum, and angulation of adductor crest support existing hypotheses of Berman and others suggesting that *Tseajaia* and Diadectidae share a more recent common ancestor with one another than with *Limnoscelis*. All known elements of the hindlimb in *Tseajaia* confirm the terrestrial nature generally ascribed to Diadectomorpha.

Technical Session X, Friday 11:45

NORTH AMERICAN CONDYLARTH DIETS ACROSS THE PALEOCENE-EOCENE BOUNDARY: PALEOECOLOGICAL RESPONSE OF ONE ARCHAIC GROUP OF MAMMALS TO GLOBAL WARMING

PENKROT, Tonya, Marshall University, Huntington, WV, USA

The effects of global warming on biological systems are of great concern today. The global warming event marking the boundary between the Paleocene and Eocene epochs was among the most pronounced of the Cenozoic. With regard to North American mammalian faunas, this episode produced an abrupt turnover event: some taxa disappeared, others suddenly appeared. Some mammals, such as the order "Condylarthra",

are known both before and after the P-E boundary. The immediate paleoecological effects of the global warming event on this grade of archaic mammals are not known. One aspect of condylarthran paleoecology during this interval that may be interpretable is diet, as inferred from dental morphology. The dental morphologies of late Paleocene (Clarkforkian) and early Eocene (Wasatchian) North American condylarths have been analyzed using a combination of linear and three-dimensional morphometrics, to document and quantify dietary change among condylarths across the Paleocene-Eocene global warming event. PCA and DFA were used to characterize the dental morphology of the late Paleocene and early Eocene condylarths, and to classify each taxon according to most likely diet, based on a comparative dataset of extant mammals. Results of this study suggest that, within Condylarthra, a significant dietary shift did occur across the Paleocene-Eocene boundary, but this shift was not equally distributed across families. Within the Arctocyonidae, a dietary shift occurs in *Thryptacodon*. Phenacodontid dietary diversity changes little, despite the arrival of *Meniscotherium*. The dietary preferences of "hyopsodontids" shift in favor of omnivore-herbivory, due largely to the appearance of *Hyopsodus*. *Hyopsodus* occupies a region of dental morphospace, and has a likely diet, that is not congruent with the preexisting "hyopsodontids". One change common among the condylarths is a general broadening of dental morphospace occupation (and dietary diversity) in the early Eocene. Following this brief spike in ecological diversity early in the Eocene, condylarths gradually wane and disappear by the end of the epoch.

#### Poster Session I (Wednesday)

##### THE MASTICATORY APPARATUS OF EUROPEAN EOCENE ADAPINAE (PRIMATES) UNDERSTOOD IN COMPARISON TO THAT OF EXTANT STREPSIRRHINE PRIMATES

PERRY, Jonathan, Duke University, Durham, NC, USA

The masticatory adaptations of the adapines *Adapis* and *Leptadapis* are extreme. They appear to have possessed enormous chewing muscles. In addition, their teeth seem adapted to processing tough foliage. A study of the chewing muscles in extant strepsirrhines (lemurs and lorises) has revealed that folivorous strepsirrhines do not have especially massive chewing muscles, nor do these muscles possess large cross-sectional areas (a measure of forcefulness). However, the shape of the skull in these folivores confers considerable mechanical advantage on the chewing muscles. Fruit-eating lemurs have especially long chewing muscle fibers because they must be able to gape (open their mouths) sufficiently to ingest large food items. One diet that would favor the elaboration of massive chewing muscles includes foods that require considerable force and considerable gape. Perhaps the European adapines ate both resistant foods and large foods. A competing hypothesis is that adapines required large gapes for gouging into trees to harvest gum. However, adapines do not possess the suite of craniomandibular adaptations seen in extant primate gougers. Their high degree of prognathism suggests that adapines did not possess the mechanical advantage seen in the extant folivorous strepsirrhines. Lacking a mechanically advantageous skull shape, perhaps these early primates required extremely large chewing muscles to process resistant foods. A model is described wherein the primary anatomical response to a shift in diet relates to muscle size, and a secondary response relates to bony adaptations for mechanical advantage. This model has implications for paleobiological inferences in general.

#### Poster Session II (Thursday)

##### METHODS FOR LABELING SILICONE MOLDS

PERSON, Jeff, Oklahoma Museum of Natural History, Norman, OK, USA; BAKER, Charles, Oklahoma Museum of Natural History, Norman, OK, USA

Finding efficient ways to label external surfaces of a large and small silicone molds using common materials is a problem in Vertebrate Paleontology labs. Eight lab practices were used to label the exterior of silicone molds both retro and pro-actively. Materials used included markers, Paleobond, plastics (Butvar B-76, paper cement), tapes, paint, and silicone-based compounds (silicone "smooth-on" and Vinyl Polysiloxane). The best retro- and pro-active labeling technique is the silicone-based material Vinyl Polysiloxane.

#### Poster Session IV (Saturday)

##### FACE BITING ON A JUVENILE TYRANNOSAURID

PETERSON, Joseph, Northern Illinois University, DeKalb, IL, USA; HENDERSON, Michael, Burpee Museum of Natural History, Rockford, IL, USA; VITTORE, Christopher, Rockford Memorial Hospital, Rockford, IL, USA; SCHERER, Reed, Northern Illinois University, DeKalb, IL, USA

In the summer of 2002, a team from the Burpee Museum of Natural History, Rockford, IL, collected a well-preserved seven-meter long tyrannosaurid skeleton from the Hell Creek Formation (latest Maastrichtian) of southeastern Montana. Based on the degree of skeletal fusion and on histological characters, BMR P2002.4.1 is a juvenile animal. Synapomorphies of *Tyrannosaurus rex* are preserved in the skull of BMR P2002.4.1, which, combined with its undoubted juvenile status, support the position that it is a juvenile *Tyrannosaurus rex*. BMR P2002.4.1 possesses a series of four partially healed oblong punctures along its left maxilla and nasal bones. The puncture marks

have an average length of 18.5mm and an average maximum width of 4.5mm. The total punctures occur along a gently arcuate line approximately 110mm long. The most anterior puncture is located approximately 15 mm posterior to the left nasal opening, at the articulating surface of the nasal and the left maxilla. The puncture marks are evenly distributed along the left maxilla, ceasing at the anterior edge of the antorbital fenestra. The morphology of the punctures, their positioning and orientation are compatible with the spacing and morphology of the anterior maxillary teeth of the specimen, suggesting that the punctures may have been the result of a bite from an attacker of similar size and species as the bite victim. The distribution of punctures is consistent with the attacker facing the victim. CT scanning and morphological examination demonstrates partial healing, evident by ossification of the punctures, indicating the bite was not fatal. Previous authors have noted injuries on the skulls of theropods, which they have attributed to intraspecific fighting. However the majority of these injuries occur in adult animals. The presence of bite wounds on a juvenile has the potential to yield insight into the behavior of juvenile theropods, as well as providing new information on the paleobiology and ontogeny of tyrannosaurids.

#### Poster Session II (Thursday)

##### "FLY THROUGH THE GROUND" SUBSURFACE TOMOGRAPHY OF DINOSAUR QUARRIES USING A COMBINATION OF LIDAR AND PHOTOGRAMMETRY

PETERSON, Nels, Museum of the Rockies, Bozeman, MT, USA

The excavation of a paleontological specimen is a time consuming and destructive process in which the complete picture can remain hidden from even the people who excavate it. Loss of data is compounded by the need to remove specimens from the surface of the ground as soon as possible to prevent destruction by weather or nearby excavation. Hand drawn maps have provided excellent references for later research but suffer from filtering of artists' individual perspectives and lack of consistent high resolution scaling due to the difficulty of setting up long term grids in the field. Time lapse imaging can provide an excellent review of the details and progress of a site but without extensive preparation does not provide sensible spatial information. In this talk I will demonstrate that by using LIDAR (Light Detection And Ranging) one can attain survey grade high-resolution point cloud data for large areas and use it as a framework to support high resolution photography. By scanning at different time intervals and taking advantage of the material and geometry exposed by those doing the excavation we can generate a post excavation map of the subsurface. This map of the subsurface, although only in existence after the site's excavation, provides an accurate representation of the quarry in 3 spatial dimensions as well as time. By adding all of these data together in one digital world we can produce a map of the quarry that is time independent, and thus yield a level of "fly through the ground" interactivity. This fly through the ground interactivity can yield perspective to a 5 year old or allow a scientist to reexcavate over and over and acquire upwards of 2mm spatially accurate data on features within the quarry.

#### Technical Session V, Wednesday 2:00

##### A CENOMANIAN MARINE BONEBED FROM THE NORTHEASTERN MARGIN OF THE WESTERN INTERIOR SEAWAY, CANADA: DEPOSITIONAL ENVIRONMENT, TAPHONOMY & FAUNAL COMPOSITION

PHILLIPS, Aaron, Carleton University, Ottawa, ON, Canada; CUMBAA, Stephen, Canadian Museum of Nature, Gatineau, QB, Canada; SCHRODER-ADAMS, Claudia, Carleton University, Ottawa, ON, Canada

Throughout the Western Canadian Sedimentary Basin, concentrations of the remains of fossilized marine vertebrates & invertebrates occur as bioclastic and bonebed horizons. In Manitoba and Saskatchewan, Canada, these horizons are particularly abundant within the Belle Fourche Member of the Ashville Formation, deposited along the eastern margin of the Late Cretaceous Western Interior Seaway (WIS). These Cenomanian age horizons, containing abundant bones, teeth, and scales of marine and, very rarely, terrestrial vertebrates are found along with bivalve-rich horizons such as the *Ostrea beloiti* layer along the length of the Manitoba Escarpment. A newly discovered site near the southern end of the escarpment yields elements that are completely disarticulated and randomly oriented. Vertebrate fragments rarely exceed one centimeter in length, nor do the abundantly preserved piscine coprolites. Compared to previously described sites, abrasion of elements is more common, however still relatively rare. The matrix supporting the vertebrate remains in the new locality consists entirely of prismatic calcite crystals originating from the disaggregated valves of inoceramid bivalves. To date, 9 species of sharks, 6 bony fish, and 2 reptiles have been identified (based largely on the identification of teeth and jaw elements, though occasionally on vertebrae and other postcranial remains). In contrast to previously described localities along the escarpment, diversity is lower here and no avian remains have yet been found. Interpreted as originating from transgressive lag deposits, this bonebed is thought to have accumulated in relatively shallow, nearshore marine conditions indicative of Cretaceous shoreline fluctuations at the eastern margin. The random orientation of biogenic clasts within the deposit suggests deposition during storm events, though these may have been infrequent as indicated by the abundance of inoceramid-derived prismatic calcite; inno-

ramids preferentially inhabiting dyoxic to anoxic bottom waters. Cretaceous bonebeds are widespread in the WIS and may eventually serve as stratigraphic and sequence stratigraphic markers integrated into a basinwide framework.

Poster Session I (Wednesday)

PAIRED FISH OTOLITHS FROM POSSIBLE COPROLITES IN THE GLENDON LIMESTONE (OLIGOCENE, RUPELIAN) OF CENTRAL MISSISSIPPI  
PHILLIPS, George, Mississippi Museum of Natural Science, Jackson, MS, USA;  
STRINGER, Gary, University of Louisiana at Monroe, Monroe, LA, USA

Paired actinopterygian otoliths are essentially unknown in the paleontological record except in the case of *in situ* earstones in skeletons. Matched pairs of fish otoliths were extracted from two possible coprolites in the Glendon Limestone (Oligocene, Rupelian) at the Smith County Lime Plant quarry in central Mississippi. Fish otoliths are very rare, although not unknown, in indurated sediments. The probable coprolites contained excellently preserved fish otoliths and fragmented skeletal remains of fish. One sample (MMNS VP-3854) contained otoliths from *Aplodinotus distortus*, *Sciaena pseudoradians*, and *Paraconger sector*. It yielded 15 otoliths, and 12 of these otoliths appear to be matched pairs from *Aplodinotus distortus* and *Sciaena pseudoradians*, both sciaenids or drums. The other sample (MMNS VP-3841) contained only otoliths from the drums *Aplodinotus distortus* and *Sciaena pseudoradians*. It had 27 otoliths, and 20 appear to represent matched pairs from the two drum taxa. Parameters for matched pairs of teleostean otoliths, determined from modern studies, include 1) same species, 2) right and left sagittae, 3) one millimeter or less difference in right and left sagittae length, 4) found in same stratigraphic interval, and 5) similarity of miscellaneous features (preservation, coloration, ostium width, maculae patterns, etc.). Possible originators of the suspected coprolites include piscivorous taxa such as sharks and bony fish. Oligocene sharks known from the Glendon Formation include *Isurus* (mako shark), *Carcharhinus* (bull shark), *Carcharias* (sand tiger shark), *Galeocerdo* (tiger shark), *Abdouia* (catshark), *Carcharocles* (white shark), and *Hemipristis* (snaggletooth shark). Piscivorous bony fish are represented primarily by *Sphyrna* (barracuda). Comparisons of the length of the fossil sagittae to Recent otoliths of *Aplodinotus grunniens* indicate that the fish were quite small (70 to 170 mm) and probably juveniles. Fish size may indicate the barracuda rather than sharks as the originator of the coprolites, but the number of fish represented in each sample (minimum of nine and seventeen) may point to a larger predator such as a shark.

Poster Session III (Friday)

INCREASES IN SACRAL VERTEBRAE IN NON-AVIAN DINOSAURS: A PERVASIVE, HOMOPLASTIC, DRIVEN EVOLUTIONARY TREND  
PINE, Sarah, University of California, Berkeley, Berkeley, CA, USA; WEDEL, Mathew, Museum of Paleontology, Berkeley, CA, USA

Increase in the number of sacral vertebrae is a pervasive evolutionary trend in non-avian dinosaurs. The primitive sacral count for Dinosauria is three. Increases in the number of sacra occurred across Dinosauria as a clade, and also as repeated parallel events within clades. For example, the number of sacra increased to five in basal theropods, and this count persisted along the 'backbone' of theropod phylogeny from the base of Neotheropoda to the base of Aves (including *Archaeopteryx*). However, increases to six or more sacra occurred independently in ceratosaurs, alvarezsaurids, therizinosaurids, oviraptorosaurs, troodontids, and dromaeosaurids. The number of sacral vertebrae also increased independently in sauropodomorphs, thyreophorans, ornithomorphs, and ceratopsians (and in many subclades thereof). The increase in sacral vertebrae in Dinosauria passes all of the standard tests for a driven evolutionary trend (i.e., moving minimum, subclade, and ancestor-descendant tests). Further, it is homoplastic, with increases occurring independently in every major dinosaurian clade and in many of the subclades. Remarkably, the trend shows few or no reversals in non-avian dinosaurs; sacral count increases in all lineages but decreases are limited to a handful of singleton taxa, and even these reductions are doubtful (i.e., because of ontogenetic or preservational factors). The incorporation of large numbers of vertebrae into the sacrum in the evolution of birds can now be seen as an instance of this pervasive, homoplastic, apparently irreversible, driven evolutionary trend.

Technical Session IV, Wednesday 2:00

TAXON SPECIFICITY IN BONE DAMAGE LEVEL AND TOOTH MARK FREQUENCY INFLICTED BY EXTANT AFRICAN CARNIVORES  
POBINER, Briana, Smithsonian Institution, Washington, DC, USA

The use of bone modification data to identify the taxon or size of carnivore(s) involved with fossil bone assemblages is increasingly becoming a common goal of taphonomic analyses. A large sample of bones from kills made by several free-ranging African carnivore species (lion, spotted hyaena, leopard, cheetah, and jackal) were analyzed to assess potential inter-specific variability in bone damage level and tooth mark frequency inflicted by these carnivores. Differences in bone damage level and tooth mark frequency on different prey sizes, skeletal regions and elements, and long bone classes and portions were evaluated using chi-square tests. Results support the hypothesis that in some instances either bone damage level or tooth mark frequency, or both, can be used to

infer the identity of the carnivore that caused the bone modification. This methodology can be useful when investigating fossil assemblages with clear evidence of carnivore involvement, especially where body fossils of more than one species of carnivore have been found, and where the identity of the carnivore accumulator(s) and/or modifier(s) of the fossil assemblage are in question.

Poster Session I (Wednesday)

HALISAURUS (SQUAMATA: MOSASAURIDAE) FROM THE MAASTRICHTIAN OF ANGOLA

POLCYN, Michael, Southern Methodist University, Dallas, TX, USA; JACOBS, Louis, Southern Methodist University, Dallas, TX, USA; ANNE, Schulp, Natuurhistorisch Museum Maastricht, Maastricht, Netherlands; MATEUS, Octavio, Museu da Lourinhã, Lourinhã, Portugal

Recent fieldwork in the Namibe province in southern Angola yielded cranial and post-cranial elements of at least two individuals of the rare and enigmatic mosasaur *Halisaurus* from a single small excavation. The genus *Halisaurus* is unique in retaining a primitive configuration of the temporal arcade, specifically a broad, vertically oriented contact between the parietal and the supratemporal. The supratemporal is broadly sutured to the opisthotic and prootic, unlike the condition in varanoids in which the simple lunate element lies between the parietal ramus and the squamosal and does not form a sutural contact with the opisthotic or prootic, but as in other halisaurines retains a plesiomorphic, vertically oriented contact with the parietal rami. The squamosal is lightly built and broadly arched as in *Varanus*. Comparison with known halisaurines indicates the new material is referable to the species *Halisaurus arambourgi*. The locality that yielded the new specimens has also yielded a large number of isolated teeth, bones, articulated, and associated skeletons of *Mosasaurus*, *Prognathodon*, *Globidens*, and *Platiplatycarpus*, which with *Halisaurus* comprise a mosasaur assemblage most similar to that reported from the Maastrichtian of Morocco.

Carnivora: Phylogeny, Form and Function Symposium, Saturday 11:00  
TIPTOEING THROUGH THE TROPHICS: MEASURING DIGITIGRADY IN CARNIVORA FOR PALAEOENVIRONMENTAL INFERENCE  
POLLY, P. David, Indiana University, Bloomington, IN, USA

That ankle posture in Carnivora is linked to substrate is well known. Large species from open settings like grasslands are often cursorial with digitigrade stance, whereas smaller species from closed woodlands are often arboreal with plantigrade or semidigitigrade stance. Digitigrade species typically have feet that are proportionally longer than plantigrade species. It is less well known that the proportional length of the foot varies within mammalian species according to substrate, as demonstrated by previous authors. Taken together, these two observations suggest that a simple index of digitigrady calculated either for a single species or an entire fauna across a broad geographic range could reveal variation in palaeocommunity types. But practical difficulties beset measuring variation in digitigrady because fossil carnivorans are seldom represented by unbroken metatarsals and femora with which to measure it. Recent work on the 3D structure of the calcaneum by the author showed that calcaneum shape, particularly the proportions of the in- and out-levers and the position of the sustentacular facet, are closely related to locomotor posture. Here, 34 terrestrial carnivoran species were studied to determine whether femur/metatarsal III length ratios are correlated with two simple linear ratios: the in-lever to the out-lever of the calcaneum, and the position of the sustentacular facet (measured from the proximal end of the calcaneum) to the total length of the calcaneum. The ratio of in- to out-lever was not correlated ( $R^2=0.02$ ,  $P=0.52$ ), but the position of the sustentacular facet was ( $R^2=0.30$ ,  $P=0.003$ ). Either 3D surface analysis or the sustentacular facet ratio thus has potential for measuring digitigrady from a single, commonly preserved bone.

Poster Session III (Friday)

A NEW IGUANODONTID SPECIMEN FROM THE CEDAR MOUNTAIN FORMATION, GRAND COUNTY, UTAH  
POOLE, Karen, Washington University, Saint Louis, MO, USA

The Stikes Quarry, near Green River, Utah, contains remains of two iguanodontids and a small theropod. The lithology of the quarry consists mostly of fine grained, green to gray sandstone with abundant chert pebbles, but mudstones are also present. Bedding is discontinuous, with sharp lateral transitions between sandstones and mudstones. While further excavation is needed, material from the smaller iguanodontid is described here, and includes an ilium, ischium, femur, four articulated caudal vertebrae, and a dentary. Unfortunately, no teeth are preserved in the dentary. Initial study of the pelvic elements, though, shows some interesting features. The preacetabular process of the ilium is straight in both lateral and dorsal views, and there is no curvature between it and the blade of the ilium. In contrast, DMNH 45857 from the Yellowcat Member of the Cedar Mountain Formation, and the holotype of *Planicoxa venenica* from the overlying Poison Strip Sandstone Member, have preacetabular processes that run craniolaterally from the blade of the ilium. This creates an ilium that is strongly concave laterally, as in *Iguanodon*. The ischium from the Stikes Quarry is

very straight and laterally compressed, with a small boot. This indicates that this specimen may be more basal than *Iguanodon*. The differences between the Stikes Quarry specimen and *P. venenica* offer more evidence that there are multiple species of iguanodontids in the Cedar Mountain Formation.

Romer Prize Session, Thursday 10:15  
FEEDING AND JAW MECHANISM IN *HETERODONTOSAURUS TUCKI*  
USING FINITE ELEMENT ANALYSIS

PORRO, Laura, University of Cambridge, Cambridge, United Kingdom

Ornithischian dinosaurs evolved a range of feeding mechanisms to process vegetation. The heterodontosaurids constitute one of the most basal ornithischian clades and are uniquely positioned to provide information on the early development of herbivory within Ornithischia. Despite a number of proposed hypotheses (such as long-axis rotation of the lower jaws, scissoring of the lower jaws, and propaliny), the jaw mechanism used by heterodontosaurids remains uncertain. This study analyzed the mechanical behavior of the skull and lower jaw of *Heterodontosaurus tucki* using finite-element analysis (FEA) in order to determine which jaw mechanism which best corresponded to cranial morphology. FEA is an engineering technique increasingly used in the field of biomechanics to visualize stress and deformation within a structure during function. Using CT data, 3D finite-element models of the skull and lower jaw were created and adductor muscle and bite forces were estimated and applied to the models. Deformation of finite-element models demonstrate that the lower jaws of *Heterodontosaurus* flexed along their length, generating a transverse power stroke as the dentary teeth moved medially against the maxillary teeth. This flexure of the lower jaws caused the quadrate of the skull to splay outwards. Results from FEA are independently validated by evidence from cranial anatomy (including suture morphology), dental morphology, and tooth wear, and suggest that *Heterodontosaurus* achieved a transverse power stroke without long-axis rotation of the lower jaws or cranial kinesis. This interdisciplinary approach indicates a novel jaw mechanism for *Heterodontosaurus* and highlights structural changes in the cranium during the transition to herbivory. The findings allow a greater understanding of the origins and early evolution of herbivory within the highly successful Ornithischia.

Poster Session III (Friday)  
NEW DATA ON EUROPEAN HADROSAURIDAE (DINOSAURIA:  
ORNITHOPODA) FROM THE LATEST CRETACEOUS OF SPAIN

PRIETO-MARQUEZ, Albert, Florida State University, Tallahassee, FL, USA; GAETE, Rodrigo, Museu de la Conca Dellà, Lleida, Spain; GALOBART, Angel, Institut de Paleontologia "Miquel Crusafont", Barcelona, Spain; RIERA, Violeta, OMS, Oriol, Universitat Autònoma de Barcelona, Facultat de Ciències (Georgia), 08193 Bellaterra, Barcelona, Spain

Missing in phylogenetic and biogeographic studies of hadrosaurid dinosaurs is a greater detail of information on the taxonomic diversity and anatomical variation of these animals outside North America and Asia. We report new hadrosaurid material from Maastrichtian strata from various new localities of the Tremp Formation (south-central Pyrenean Foredeep Basin, near Isona, Lleida province, northeastern Spain). The majority of the material comes from the Basturs Poble bonebed and consists of disarticulated remains from at least five individuals with femoral lengths ranging from 20 to 70 cm. The maxilla is cranio-caudally short and the dorsal process is wide and tall. The jugal is cranio-caudally short and has a truncated and expanded rostral process. The rostral end of the dentary is elongated medially and is nearly as long as that of *Koutalisaurus kohlerorum* (a contemporary hadrosaurid from the same region). Tooth crowns are 2.5 as tall as they are wide and the primary ridge is offset caudally. Some teeth also show a secondary ridge. Most postcranial elements are represented. The aforementioned jugal and maxillary characters lead us to provisionally refer this material to the Lambeosaurinae. These specimens may represent *K. kohlerorum*; however, the discovery of an adult dentary is required to test this hypothesis. The Eudora Nord locality produced a partial maxilla with a premaxillary shelf and caudally positioned dorsal process. This stands in contrast with the centered position of the dorsal process in the Basturs maxilla and suggests the presence of two taxa in the basin. The Serrat del Corb locality produced a nearly complete lambeosaurine pelvis from an individual of 7-8 m in body length. This finding is remarkable in that other contemporaneous taxa from Eastern Europe are posited to exhibit dwarfism. The study of these materials is allowing a more complete knowledge of the taxonomic diversity, individual and ontogenetic variation, life history, and biogeographic and phylogenetic relationships of European hadrosaurids. A more complete understanding of the origin and evolution of the clade as a whole stands to be gained.

Poster Session III (Friday)  
MAGNETIC STRATIGRAPHY OF THE UPPER MIOCENE (EARLY  
HEMPHILLIAN) THOUSAND CREEK FORMATION, NORTHWESTERN  
NEVADA

PROTHERO, Donald, Occidental College, Los Angeles, CA, USA; DAVIS, Edward, UC Berkeley, Berkeley, CA, USA

The Thousand Creek Formation in northwestern Nevada yields an important late Miocene (early Hemphillian) mammalian fauna that has been studied for over a century. The dating on this unit has been very confused, with the capping basalt giving a date of 9 Ma, but the underlying Rattlesnake Ash Flow Tuff giving 40Ar/39Ar dates of 7.05 or 7.26 Ma, and tephrochronology suggesting that the bottom of the section may be as old as 8 Ma. A magnetostratigraphic section was sampled on the longest exposed section along the roadcuts on the north side of Highway 140 just east of Thousand Creek. Combined alternating field and thermal demagnetization yielded a stable remanence held in magnetite with minor goethite overprints. Except for the top site, the entire 40 m of section was of reversed polarity. Based on the dates on the Rattlesnake Ash Flow tuff at the top of the section, we correlate the Highway 140 roadcut section with Chron C3Br1n to C3Br (7.1-7.3 Ma). If the tephrochronology is correct, then the lower part of the section (too poorly exposed for paleomagnetic sampling) may be as old as 8.3 Ma.

Student Poster Session (Thursday)  
THE ANCESTRY OF *CARCHARODON CARCHARIAS REVISITED*  
PURDY, Robert, Smithsonian Institution, Washington, DC, USA

A recent study of the teeth of *Carcharodon carcharias*, *Isurus hastalis* (*sensu lato*), and "*Carcharodes*" *megalodon*, using 11 data points in Procrustes analysis, claimed to show an ancestor-descendant relationship between *Carcharodon* and *Isurus*. The authors of that study used insufficient data points to resolve this question. In this paper I will attempt to show that even a non-statistical, careful study of the teeth of these sharks offers evidence contrary to their findings. I will show that the dental synapomorphies for *Carcharodon* published prior to their study are valid, that, other general form, the "transitional" Sacaco specimen, cited in the Procrustes study, does not possess any of the dental synapomorphies for *Carcharodon*, and that the morphologies and development of the teeth of *Carcharodon* and "*Carcharodes*" share characters in common that are not found in *Isurus hastalis*. In summary an ancestral-descendant relationship between *Carcharodon* and *Isurus hastalis* has not yet been substantiated.

Technical Session IV, Wednesday 3:45  
TESTING FUNCTIONAL HYPOTHESES - TOOTH MICROWEAR AS A  
PROXY FOR DIRECT OBSERVATION OF FEEDING IN LIVING AND FOS-  
SIL NON-MAMMALIAN VERTEBRATES

PURNELL, Mark, University of Leicester, Leicester, United Kingdom

Analysis of diet and trophic ecology in fossil organisms is problematic. Experimental and field evidence indicates that feeding and competition for trophic resources play key roles in driving speciation and diversification, yet analyses of feeding in fossils exemplify the difficulties of conducting robust functional investigation. Without independent evidence of how a fossil taxon actually fed, hypothesis testing can become reliant on circular arguments resting on the form-function relationship from which inferences of feeding were derived in the first place. Obviously, this creates significant obstacles to realising the full potential of the fossil record for testing evolutionary hypotheses. Analysis of tooth microwear in two model organisms, used widely to investigate the relationship between trophic ecology, diversity and evolution, indicates that microwear provides a reliable guide to diet and feeding mechanisms. In stickleback and cichlid fishes raised under controlled experimental conditions, differences in feeding result in significant differences in microwear. The same relationship holds for wild stickleback and cichlids. Analysis of Miocene stickleback reveals that rapid, directional morphological change was associated with shifts in feeding and habitat, providing the first direct evidence from the fossil record for changes in trophic niche and resource exploitation coupled with microevolution. Analysis of Jurassic pycnodont fishes suggests that current hypotheses of diet and biomechanical models of feeding are oversimplified, and that the relationship between tooth morphology and trophic ecology is more complex than has been realised. Microwear analysis of ornithomorphs demonstrates that quantitative methods are applicable to dinosaurs, providing a robust test of models of jaw mechanics and feeding. The power of quantitative microwear analysis for investigating diet in mammals, primates in particular, is well known. This new work on non-mammalian taxa indicates that these methods have great potential for analysis of feeding and trophic ecology - and thus adaptation, speciation, and evolution - in a broad range of vertebrates.

Technical Session XVIII, Saturday 2:45

RARE FOSSIL BALEEN FROM THE PURISIMA FORMATION OF CALIFORNIA: IMPLICATIONS FOR SOFT TISSUE PRESERVATION IN SHALLOW MARINE ENVIRONMENTS

PYENSON, Nicholas, University of California, Berkeley, Berkeley, CA, USA; BRUDVIK, Kyle, University of California, Berkeley, Berkeley, CA, USA

Living baleen whales (or crown Mysticeti) filter-feed using racks of keratinized plates that hang from the palatal epithelium. All living mysticetes have baleen, but early stem mysticetes had teeth, and possibly incipient proto-baleen. The presence of baleen in fossil mysticetes is usually inferred from the absence of alveoli and a radiating pattern of sulci on the ventral side of each maxilla. In rare instances, fossil baleen has been documented in the literature, although this rarity may be explained by its poor preservation potential, lack of reporting, or both. Here we report fossilized baleen impressions, associated with mysticete cranial bones, from the Purisima Formation of the Point Reyes National Seashore, California, USA. The specimens were discovered as part of a concretion originating from high in the section at Drakes Estero (likely Early Pliocene in age). The impressions are regularly spaced, discrete and orthogonal to the margin of exposed maxillary bone. No original keratin is preserved; rather, the plates have been replaced with fine-grained sediment, and the spaces between the plates with even finer grained sediment. Some parts of the impressions are distorted, likely because of weight of the skull on the original baleen during burial. The spacing, length and orientation of the Drakes Estero baleen impressions closely match those in extant balaenopteroids and other fossil baleen specimens (from Late Tertiary deposits in Oregon, California and Peru). Soft-tissue seems to be poorly preserved in marine environments, and to preserve impressions of fossil baleen with the skull, we propose a two-step model: after death, the intact cranium was quickly buried in a shallow, shelf environment, with the oral cavity and spaces between the plates filled with fine grained sediment; later, after the plates decomposed, the empty spaces were filled with finer sediment. Fossil baleen can also be preserved with its original structure, suggesting that local water-chemistry conditions may ultimately control the degree of soft tissue preservation in shallow marine environments.

Technical Session XVIII, Saturday 3:00

MORPHOLOGY OF A BIZARRE NEW FOSSIL PORPOISE (CETACEA: PHOCOENIDAE) FROM THE PLIOCENE SAN DIEGO FORMATION OF SOUTHERN CALIFORNIA, USA

RACICOT, Rachel, San Diego State University, San Diego, CA, USA; DEMÉRÉ, Tom, San Diego Natural History Museum, San Diego, CA, USA; ROWE, Tim, The University of Texas at Austin, Austin, TX, USA

A new species of fossil porpoise (Cetacea: Phocoenidae) from the marine Pliocene San Diego Formation has unique external morphological characteristics, such as lower jaws that extend much farther beyond the maxillae than in any known fossil or living delphinoid. High-resolution X-ray computed tomographic (HRXCT) scans of the skull and tympanoperiotics revealed details of its internal cranial architecture. Discernable features in the HRXCT scans include the remnants of the ossified tentorium and falx cerebri; pterygoid sinuses with preorbital lobes extending dorsally and posteriorly to a notable degree; and differences in bone density including higher density in the premaxillae and lower density in the maxillae, nasals, and certain sutures in the posterior region of the skull. The apomorphically long posterior and dorsal extension of the pre-orbital lobe of the sinus suggests a deep history for this derived feature. Density differences in the premaxillae and maxillae are similar to differences reported in the literature and in scans of *Tusiops truncatus* and all other extant phocoenids, and could have functional significance related to biosonar propagation. Digitally isolated inner ear structures in the fossil are similar in form to those of *Neophocoena phocoenoides*, the sister taxon to all other extant porpoises. The mandible of the new fossil porpoise has a long, fused and nearly edentulous symphysis, while the horizontal rami possess numerous, small conical teeth with sharply oblique wear facets. Postcrania include unfused atlas and axis vertebrae, associated thoracic and lumbar vertebrae and anterior through posterior ribs, as well as pectoral elements, including a nearly complete right forelimb. A preliminary phylogenetic analysis places the new fossil taxon as sister to species of *Piscolithax* from the late Miocene and early Pliocene of the North and South Pacific. This new fossil porpoise, with its extreme mandibular elongation, is testament to the dramatic range in morphological diversity achieved by delphinoids.

Poster Session III (Friday)

A NEW EARLY PALEOCENE MAMMAL LOCALITY FROM SOUTHERN ALBERTA

RANKIN, Brian, University of Alberta, Edmonton, AB, Canada; FOX, Richard, University of Alberta, Edmonton, AB, Canada

The importance of the early Tertiary as a transitional phase in the evolution of mammals has been, historically, clearly recognized, owing largely to the rapid diversification and increase in body size of eutherians during this period. However, early Paleocene (Puercan Land Mammal Age) mammal assemblages, presenting direct paleontological evidence of the supposed pattern and timing of this change, remain poorly document-

ed in Canada (a deficiency also true for the U.S. succession). An isolated outcrop in the upper portion of the Scollard Formation of southern Alberta, called the Wintering Hills locality, preserves the first known Paleocene mammal assemblage in this geological formation and the first of Puercan age in the province. Preliminary identifications, to date, include: *Ectypodus* sp., *Mesodma* cf. *M. thompsoni*, *Mesodma* sp., *Parectypodus* sp., *Ptilodontidae* genus and species indeterminate, *Carcinodon aquilonius*, *Oxyclaenus* cf. *O. corax*, *Oxyclaenus* cf. *O. cuspidatus*, *Loxolophus* cf. *L. schizophrenus*, cf. *Desmatoclaenus* sp., *Anisonchus* cf. *A. oligistus*, *Prodiacodon* sp., *Palaeoryctes* sp. and *Pantolestidae* genus and species indeterminate. Additionally, the identification of an as yet unknown species of *Purgatorius* at the Wintering Hills represents the first and only known occurrence of this taxon in Alberta. Faunal comparisons of this assemblage fall closest to the Rav W-1 fauna (Ravenscrag Formation) in southern Saskatchewan, suggesting, based on tentative biostratigraphic correlations, a middle Puercan Land Mammal Age (interval-zone Pu2). Puercan mammals from the Wintering Hills locality are the most northerly of this age known and provide important faunal data of a unique geological period previously unknown in the region.

Technical Session XIII, Friday 2:15

BEYOND THE BEAK: CAN WE DETECT ECOMORPHOTYPES IN THE AVIAN SKULL?

RAYFIELD, Emily, University of Bristol, Bristol, United Kingdom

Significant modifications in cranial morphology are observed across the theropod-bird transition. Encephalisation, skull lightening and fusion and beak development are traditionally allied with the acquisition of a volant lifestyle. Feeding is an additional selective pressure potentially shaping cranial morphology, and it would be expected that factors such as musculoskeletal reorganisation and tooth loss would notably influence the feeding behaviour of the earliest birds (and beaked non-avian theropods too). The kinetic behaviour of the avian skull has been extensively debated, but little is known of how different feeding behaviours manifest themselves in structural modification beyond simply changes in beak shape (or indeed if there is a correlation in the first place). Here I address the question of how far do two different feeding behaviours - simple biting and pecking - influence the mechanical behaviour of the bird skull? This will act as a step towards elucidating if either of these behaviours results in characteristic cranial ecomorphotypes. Ostriches are chosen as a model system as they retain a paleognathous palate and open cranial sutures in-keeping with their theropod ancestors. A finite element model of the ostrich skull was created and loadings were applied to the beak based on (i) preliminary in-vivo pecking forces, and (ii) biting forces calculated from musculoskeletal architecture. Results show that the stress-strain behaviour of the skull is fundamentally different during pecking versus biting. Rhynchokinetic bending occurs tipping the beak upwards during biting but ventrally in pecking. In both instances rhynchokinesis is markedly reduced by the contractile action of the jaw adductors, including the *M. pterygoideus* as suggested previously. Streptostylic movement at the quadrate would further assist in alleviating strain, but it is still not clear yet whether kinesis is active or passive. Results suggest a deviation from biting towards pecking behaviour in early avian evolution may be detected from characters of bony morphology and by a shift in the role of the *M. pterygoideus* moving from feeding towards stabilisation.

Poster Session IV (Saturday)

VARIATION AND SEXUAL SIZE DIMORPHISM IN PLEISTOCENE GROUND SLOTHS (XENARTHRA)

RAYMOND, Kristina, Occidental College, Los Angeles, CA, USA; PROTHERO, Donald, Occidental College, Los Angeles, CA, USA

According to the paleontological literature, ground sloths (especially megatheres) show unusually high variability compared to other mammals. We evaluated this hypothesis by measuring all the common limb elements of the mylodont *Paramylodon* (= *Glossotherium*) *harlani* from the late Pleistocene Rancho La Brea tar pits in Los Angeles, and the megatherer *Nothrotheriops shastensis* from Rancho La Brea and also from late Pleistocene San Josecito Cave, Nuevo Leon, Mexico. We find no evidence of unusually large variability (as measured by coefficient of variation and other statistics) in any postcranial element of either of these taxa. We also evaluated change in size through time in the different aged pit samples from Rancho La Brea, and found no significant size changes in *P. harlani* from 40,000 to 10,000 years ago. This is consistent with the fact that some megatheres (such as *Eremotherium laurillardii*) show clear evidence of sexual size dimorphism, but *P. harlani* skulls exhibit shape, but not size, dimorphism. We conclude that sexual size dimorphism is not as widespread in sloths as once assumed.

Student Poster Session (Thursday)  
THE HISTOLOGY OF *STEGOSAURUS* LONG BONES: IMPLICATIONS FOR GROWTH AND LIFE HISTORY  
REDELSTORFF, Ragna, Bonn, Germany

Stegosaur long bone histology has not been studied in detail before. We sampled four individuals of *Stegosaurus* sp. from the Morrison Formation of Wyoming (USA) collected by the Sauriermuseum Aathal, Switzerland. The individuals have an estimated body length of 4.8, 4.85, 5.73, and 7 m. Using a recently developed core drilling method, each individual was sampled from several bones at midshaft, including humerus, femur, lower limb bones, and scapula. Histology of the primary cortex is rather uniform, and the bone tissue consists of longitudinal primary osteons in a matrix of woven and parallel-fibered bone, in varying proportions. In the inner cortex, woven bone dominates the matrix between the primary osteons, indicating fast growth. Towards the outer cortex, parallel-fibered bone dominates, indicating a gradual slow-down in growth. This tissue cannot be called fibrolamellar bone we refer to it as "bone with a fibrolamellar architecture". Three histologic ontogenetic stages (subadult, adult I, adult II) were established based on vascularity, amount of woven bone, and degree of secondary remodelling. At the subadult stage, growth was still rapid, decreasing in adult stage I, and ceasing in adult stage II. In three individuals, body size correlates well with histologic ontogenetic stage while, surprisingly, the second-largest individual shows the earliest stage (subadult). This discrepancy may be due to intraspecific variability, sexual dimorphism, or taxonomic differences, but the answer requires a larger samples size and osteological study of the sampled *Stegosaurus* individuals. Comparison of the long bone histology of *Stegosaurus* with that of the stem group thyreophoran *Scutellosaurus* indicates that evolutionary body size increase in this lineage was brought about by an increase in growth rate. Comparison of the histology of *Stegosaurus* bones to that of other dinosaur taxa suggests that this dinosaur grew more slowly because of the common occurrence of parallel-fibered bone and poor vascularization in *Stegosaurus* bone vs. the highly vascularized fibrolamellar bone seen in non-thyreophoran dinosaurs.

Student Poster Session (Thursday)  
THE EFFECTS OF TAXONOMIC-LEVEL OF IDENTIFICATION ON BIOGEOGRAPHIC STUDIES  
REDMAN, Cory, Texas A&M University, College Station, TX, USA

Community analyses of modern and extinct taxa are typically performed at the genus or species-level of identification. These studies generally sample a small geographic area, over a short temporal duration, and typically do not have more than one species per genus. Studies of extinctions and changes in biodiversity are usually conducted at the family or genus-level due to the volatile nature of species and systematic difficulties in comparing species across a wide geographic area, since most species have a limited geographic distribution. When comparing modern and extinct communities that are biogeographically isolated from one another, does the level of taxonomy (i.e. species, genus, or family) used in the analyses greatly affect the results? This study utilizes Bray-Curtis ordination to determine whether the taxonomic level of identification greatly influences the relationship of 13 United States national parks in ordination space, based on the presence/absence of modern, vertebrate, terrestrial taxa. Bray-Curtis was chosen for the preliminary analysis given its better performance in capturing non-linear ecological gradients and decreased sensitivity to outliers. The ordination was performed using Variance-Regression and Relative Sorensen with Euclidean distance. The data set consisted of 378 species, 173 genera, and 58 families of taxa. Using Bray-Curtis ordination, no major differences were seen between using species or genus-level identifications. The robustness of the clustering pattern in ordination space also holds up when using family-level identification, only axis 1 using genus and species-level identification becomes axis 2 using family-level identification. The reason for the axes rotation has yet to be determined. The robustness of the clustering patterns also needs further testing using multiple methodologies (i.e. principle component & detrended correspondence), but preliminary results show promise. These results are especially exciting when applied to the fossil record, since many taxa can only be identified to the family-level due to poor preservation or a poor understanding of the groups' systematics.

The Dissorophoidea - Early Amphibian Radiation Symposium, Friday 8:30  
TERRESTRIAL VERTEBRATE FAUNA OF THE LOWER PERMIAN CAVE DEPOSITS NEAR RICHARDS SPUR OKLAHOMA WITH EMPHASIS ON DISSOROPHOIDS  
REISZ, Robert, University of Toronto at Mississauga, Mississauga, ON, Canada

The Lower Permian karst fills from the Dolese Quarry, near Richards Spur, Oklahoma have produced for more than 70 years the skeletal remains of terrestrial vertebrates. Much of the fossil material is preserved as isolated bones, with occasional, but relatively rare occurrence of specimens in articulation. Notable among these are the skulls and partial skeletons of the reptile *Captorhinus*, the small dissorophoid *Dolesepeton*, and the microsaur *Cardiocephalus* and *Euryodus*. Most other vertebrate taxa are represented by isolated skeletal elements, making precise identification difficult, but the known fauna is comprised of 26 distinct terrestrial vertebrate taxa. Recent excavations at the quarry have yielded a wealth of new materials, but most significantly, the taphonomy appears

to be slightly different, resulting in very large numbers of articulated skulls and partial skeletons. This new assemblage allows us not only to identify more precisely the taxa that have been previously based on isolated bones, but new forms have also been discovered, increasing significantly the faunal list for this locality to 36 fully terrestrial tetrapods. Notable among these are several new small parareptiles, microsaur, and dissorophoids. The articulated dissorophoid specimens that are now known from this locality include the enigmatic *Dolesepeton*, a new small amphibamid, a small new dissorophoid similar to *Tersomius*, a large dissorophoid similar to *Cacops*, and a very large trematopid similar to *Acheloma*. Interestingly, the latter four dissorophoids can now be identified as distinct new taxa because their anatomy is based on complete articulated skulls and partial skeletons. Two more dissorophoid taxa are represented by articulated armor. A similar pattern is emerging for most of the taxa that have now been identified, with more than 75 percent of the terrestrial vertebrates from the Dolese Quarry being endemic. This is consistent with the reconstruction of the locality as a complex of caves that resulted from a Pennsylvanian and earliest Permian uplift and deformation, preserving a unique, upland terrestrial vertebrate fauna that includes a particularly rich and diverse assemblage of small and large dissorophoids.

Poster Session I (Wednesday)  
DREPANOSAURID FOSSILS FROM THE LATE TRIASSIC (ADAMANIAN) PLACERIAS QUARRY OF EASTERN ARIZONA AND THE BIOSTRATIGRAPHIC DISTRIBUTION OF THE DREPANOSAURIDAE  
RENESTO, Silvio, Università degli Studi dell'Insubria, Varese, Italy; SPIELMANN, Justin, New Mexico Museum of Natural History and Science, Albuquerque, NM, USA; LUCAS, Spencer, New Mexico Museum of Natural History, Albuquerque, NM, USA

The Drepanosauridae is a family of Late Triassic archosauromorphs with skeletons that are highly modified for arboreality. The Drepanosauridae consist of *Vallesaurus censis*, *Hyuronector limnaios*, *Drepanosaurus unguicaudatus*, *Dolabrosaurus aquatilis* and *Megalancosaurus preonensis*, plus indeterminate material from Upper Triassic fissure deposits at Cromhall Quarry, England. Here, we report drepanosaurid material (three vertebrae and a neural spine) from the Late Triassic (Adamanian) *Placerias* quarry of eastern Arizona. This material is one of the few occurrences of the family in North America and its oldest occurrence. Drepanosaurids are known from localities in the American Southwest, eastern coast of North America northern Italy and Great Britain. Indeterminate drepanosaurid fossils are known from the early Adamanian *Placerias* quarry of eastern Arizona (material reported here) and possibly from the early Revueltian Post quarry of West Texas (portions of the holotype of *Protoavis texensis*). *Hyuronector limnaios* is known from numerous specimens from the Granton quarry, in the late Adamanian ?Ewing Creek and Nursery members of the Locketog Formation, northern New Jersey. *Dolabrosaurus aquatilis* is known from middle to late Revueltian Painted Desert Member of the Petrified Forest Formation of northern New Mexico. *Vallesaurus censis*, *Drepanosaurus unguicaudatus* and *Megalancosaurus preonensis* are from the Revueltian Calcare di Zorzino of northern Italy. Drepanosaurids thus have a temporal range from early Adamanian through late Revueltian.

Poster Session III (Friday)  
CANALICULAR DENSITY IN SAURISCHIANS AND ITS IMPLICATIONS FOR RATES OF BONE OSTEOGENESIS

RENSBERGER, John, University of Washington, Seattle, WA, USA; COLLIER, Sarah, Cornell University, Ithaca, NY, USA; LEE, Tammy, Oregon Health and Science University, Beaverton, OR, USA

Rates of growth vary for different types of bone tissue. While many factors affect the actual rate of osteogenesis, there are indications that structural organization, including proximity of forming regions to the vascular system, limits the maximum rate. Vascular transport systems in soft tissues branch with increasing fineness in a pattern that minimizes the distances nutrients must diffuse after leaving the terminal branches. The lacunar-canalicular system terminates the vertebrate vascular system within bone tissue. We measured characteristics of the lacunar-canalicular system in primary bone in a variety of vertebrates and found that the density of canaliculi in the Saurischia is higher than in most other groups and more uniformly subdivides the matrix into small regions, resulting in a higher ratio of canalicular surface area to volume of the forming bone matrix. The structure in saurischian dinosaurs and birds sets a higher limit to the maximum rate of diffusion of ions into forming bone than in ornithischians, more primitive archosaurs and other vertebrates examined except modern mammals. The canalicular networks of modern mammals are as dense as in saurischians but enclose interspaces of more variable dimensions.

Poster Session III (Friday)

MAMMAL TRACKWAYS FROM MIDDLE MIOCENE (LATE BARSTOVIAN NALMA) VOLCANICLASTIC SEDIMENTS IN SOUTHWESTERN UTAH  
REYNOLDS, Robert, LSA Associates, Inc., Riverside, CA, USA; MILNER, Andrew, St. George Dinosaur Discovery Site, St. George, UT, USA; HUNT, Gary, New Mexico State University, Las Cruces, NM, USA; BRINTON, Jared, Southern Utah University, Cedar City, UT, USA

The Enterprise Reservoir tracksite is located southwest of Enterprise in southwestern Utah, within unnamed stratified basin-fill deposits that interfinger with the tuff of Honeycomb Rock (11.9 Ma), and are unconformably above the Ox Valley Tuff (13.5 Ma). This suggests that the tracksite is approximately 12-12.5 Ma. The tracks are consistent with those made by mammals from the Middle Miocene, Late Barstovian North American Land Mammal Age (NALMA) or possibly from the Early Clarendonian NALMA. The tracks are in basin-filling sediments described as reworked volcanic ash that forms flat layers of silty volcanoclastic sandstone. One bed containing many camel tracks (*Dizygopodium* sp.) can be used as a marker bed across the outcrop. Another bedding plane panel contains an excellent trackway of a large felid (*Felipeda* sp.) paralleling a coyote-sized canid trackway (*Canipeda* sp.). Other tracks and impressions include camelids (*Lamaichnum* sp., *Dizygopodium* sp., *Bijugopeda* sp.), a *Bifurculapes*-like beetle trackway, invertebrate burrows, and pine needles. Small mammal tracks include five ichnomorphs representing small tree squirrels (two sizes), cricetids (*Copenys?*), Dipodomysinae (*Cupidinimus?*) and a soricid. Track resolution is good and digits and claws can be distinguished. The soft substrate occasionally preserves drag marks from small mammal limbs and tails. Variable strides of rodent trackmakers indicate different rates of saltatorial travel. Ripple marks and raindrop impressions suggest shoreline conditions near grassland and parkland. The Enterprise Reservoir tracksite is the only Miocene tracksite currently recognized in Utah. Tracks of the small mammals are previously undescribed, and those at the Enterprise locality may be unique to western North America.

Student Poster Session (Thursday)

CROCODYLIFORMS FROM THE LATE CRETACEOUS (TURONIAN) BISSEKTY LOCAL FAUNA OF KYZYLKUM DESERT, UZBEKISTAN  
REZVYI, Anton, The State Museum of Nature and Man, Khanty-Mansiysk, Russia  
Four crocodyliform taxa have been identified from the Late Cretaceous (Turonian) Bissekty Formation at Dzharakuduk, central Kyzylkum Desert, Uzbekistan based on numerous isolated cranial and postcranial remains, including several brachia and partial skulls. The largest species, *Kansajsuchus borealis* (= *Turanosuchus aralensis*) with an estimated skull length of about 50 cm, belongs to Paralligatoridae, represented in Mongolia by several species of *Shamosuchus*. *Kansajsuchus* shares with *Shamosuchus* the absence of the external mandibular fenestra, open cranioquadrate canal, and having a large osteoderm fused to the lateral surfaces of the surangular. *Kansajsuchus* differs from *Shamosuchus* in having a distinctly longer mandibular symphysis. *Tádzhikosuchus kizylkumensis* (= *Zhyrasuchus angustifrons*) is a basal eusuchian having the choanae surrounded mostly by the pterygoids and only anteriorly by the palatines. It also has procoelous vertebrae with the first caudal being biconvex. *Zhobsuchus procerus* is known from a few fragmentary specimens, suggesting that it was a longirostrine form. Its unique characteristics are a strongly increased third (most posterior) premaxillary tooth and an oblique dorsal surface of the supraoccipital. The fourth crocodyliform from Dzharakuduk is an unnamed member of Protosuchia represented by numerous amphicoelous vertebrae, dental fragments, and several cranial elements. It has an edentulous anterior end of the dentary, like in the Early Cretaceous protosuchians of Siberia (*Tagarosuchus* and *Kyasuchus*). This character, however, was possibly ontogenetically controlled.

Poster Session I (Wednesday)

THE MANDIBLE OF *MORADISAURUS GRANDIS* (REPTILIA: CAPTORHINIDAE) AND ITS IMPLICATIONS FOR HERBIVORY IN MORADISAURINES  
RICHARDS, Courtney, University of Washington, Seattle, WA, USA; SIDOR, Christian, University of Washington, Seattle, WA, USA; O'KEEFE, Robin, Marshall University, Huntington, WV, USA; STEYER, J. Sébastien, CNRS, Museum national d'Histoire naturelle, Paris, France; TABOR, Neil, Southern Methodist University, Dallas, TX, USA

The description of the giant captorhinid, *Moradisaurus grandis* in 1969 provided the first evidence that the tetrapod fauna of the Upper Permian Moradi Formation of Niger was strongly dissimilar to those from southern African rocks. Among captorhinids, *Moradisaurus* was considered most closely related to the Russian form, *Gecatogomphius*, and the North American form, *Kahneria*. Early research also suggested that *Moradisaurus* was the culmination of evolutionary trends in the family towards an increased number of tooth rows, a broader, more equilateral skull shape, and larger body size. Recent expeditions to northern Niger in 2003 and 2006 have recovered several new specimens of *Moradisaurus*, including cranial and postcranial material. Here we provide data on the mandible of this poorly known genus, concentrating on fea-

tures that may shed light on the evolution of herbivory in the family. *Moradisaurus* is distinguished from other captorhinids by virtue of its larger size, a relatively small foramen intermandibularis medius, the extreme medial extension of the dental plateau to accommodate at least eight rows of teeth, relatively broad spacing of the tooth rows, and a less precise anteroposterior alignment of the tooth rows than is seen in other multiple-tooth-rowed moradisaurines. In addition, *Moradisaurus* has a robust coronoid process and remnants of an ossified Meckel's cartilage anteriorly. The adductor fossa is more elongate than in the closely related *Rothianiscus*, but occupies much smaller total area than in *Captorhinus*. In contrast to the condition in *Labidosaurikos meachami*, prominent wear facets have not been observed in *Moradisaurus*, although the articular cotyle is anteroposteriorly elongate, which suggests propalinal movement of the lower jaw. The relatively small size of the postcanine teeth and the overall body proportions suggest that *Moradisaurus* was an herbivore specializing on soft plant material.

Technical Session IX, Friday 8:30

"HAPPY FEET": A NEW LOWER CRETACEOUS DINOSAUR TRACKSITE FROM MÜNCHHEGAGEN, GERMANY

RICHTER, Annette, Lower Saxonian State Museum, Hannover, Germany; WINGS, Oliver, University of Tübingen, Germany; RICHTER, Ute, Lower Saxonian State Museum, Hannover, Germany; KNÖTTSCHKE, Nils, Dinosaurier-Freilichtmuseum Münchhegagen, Rehburg-Loccum, Gibraltar

Lower Saxony in northern Germany has long been known for dinosaur tracks preserved in storm induced, semi-terrestrial sandstones of the Lowermost Cretaceous ("Wealden" facies, Berriasian, "Hauptsandstein" of the Bückeberg-Formation). The former quarry of Münchhegagen, a nationally protected area, is well known for sauropod tracks since the 1980s. Since 2004, a neighbouring quarry revealed two new spectacular track-bearing layers, with very high numbers of iguanodontid tracks and different theropod track types. The layers are stratigraphically about 2.5 m apart and are situated above the sauropod track horizon in the classic Münchhegagen locality. *Iguanodontipus* tracks belong to at least 3 different ontogenetic stages, ranging from very small, flat "baby" trackways, some with pronounced toe tips (mean length (ml) 25 cm, mean width (mw) 27 cm), to juvenile sized tracks with deeper footprints (ml 30 cm, mw 32 cm), and adult sized tracks (ml 40 cm, mw 42 cm), occasionally with in situ fore hand preservation. At least 4 theropods produced another beaten track. Their tracks belong to a large sized, massive type similar to *Megalosauropus* as well as to more gracile ichnospecies. No unambiguous *Bueckeburgichnus* has been identified yet. The lower track layer (currently uncovered area: 60 m<sup>2</sup>) is composed of mudstones, showing magnificent original track preservation with 740 single footprints of 7 individuals.

Approximately 2.000 m<sup>2</sup> of the upper track layer, the uppermost sandstone layer in the quarry profile, are uncovered now. 257 footprints in undertrack preservation of at least 24 individuals have been found so far. Although preservation is relatively poor, trackways are extremely common. With 57 pes and 6 manus imprints, they include the longest *Iguanodontipus* trackway known world-wide. The fore hand track shape of that individual differs from that of two other trackways, possibly reflecting a different taxon instead of mere size differences. Iguanodontid track patterns suggest a trail used only by juveniles in the lower layer and a mixed adult-baby-group in the upper layer. Some theropod tracks may represent a passway towards prey.

Technical Session III, Wednesday 3:15

A NEW PLEISTOCENE VERTEBRATE ASSEMBLAGE IN A TAR PIT FROM EL BREAL DE OROCUAL, NORTHEASTERN VENEZUELA

RINCÓN, Ascanio, Instituto Venezolano de Investigaciones Científicas, Caracas 1020-A, Venezuela; PARRA, Gilberto, Petroleos de Venezuela S.A., Maturin, Venezuela;

PREVOSTI, Francisco, Museo de La Plata, La Plata, Argentina; STEADMAN, David, Florida Museum of Natural History, Gainesville, FL, USA; ALBERDI, Maria, Museo de Historia Natural, Madrid, Spain

We report a new vertebrate fossil locality, El Breal de Orocuál, 20 km northwest of Maturin, Monagas state, Venezuela. Thirty vertebrate taxa have been identified thus far in a small sample from a tar seep deposit in the Mesa Formation, which consists of fluvio-deltaic strata of the Early to Middle Pleistocene, based on thermoluminescence dates of 0.5 to 1.0 Ka. The presence of aquatic taxa, such as *Caiman* sp., Anateidae, aff. *Recurvirostridae*, *Tapirus* cf. *T. webbi* (first record for South America), and Hydrochaeridae, is consistent with a fluvio-deltaic environment. *Hippidion* sp., *Holmesina occidentalis*, *Pampatherium humboldtii*, *Glyptodon* sp., aff. *Hoplophorus* (first record for Venezuela), and *Paleolama* sp. suggest a savanna paleoenvironment at El Breal de Orocuál, whereas Erethizontidae and *Proechimys* sp. suggest an arboreal component. Taxa characteristic of a forest-savanna ecotone are *Eremotherium* sp., *Pachymatherium leiseyi* (first record for South America), *Tayassu* sp., *Propraopus sulcatus*, and *Mixotoxodon larenis*. We also report Testudines indet., aff. *Geochelone*, Colubridae, Cathartidae, Accipitridae, *Didelphis* sp., Megalonychidae, Mylodontidae, *Canis* sp., Machairodontinae-Homotheriini (confirmed new record for South America), *Platygonyx* sp. (first record for Venezuela), and Proboscidea indet. Preliminarily, the paleoenvironment of El Breal de Orocuál was similar to that of the Venezuelan llanos today, an extensive savanna with rivers and patches of gallery forest. Our future



research will feature comparisons of the material from El Breal de Orocuál with the recently recovered, very rich late Pleistocene vertebrate assemblage from tar seeps at Mene de Inciarte in northwestern Venezuela.

Poster Session IV (Saturday)

SKULL ALLOMETRY OF THE LATE TRIASSIC *PHYTOSAUR* GENUS *PARASUCHUS* AND ITS ONTOGENETIC AND PHYLOGENETIC IMPLICATIONS RINEHART, Larry, Albuquerque, NM, USA; LUCAS, Spencer, New Mexico Museum of Natural History, Albuquerque, NM, USA; HECKERT, Andrew, Appalachian State University, Boone, NC, USA

A preliminary allometric analysis of the skull of *Parasuchus* (= *Paleorhinus*), the most primitive phytosaur genus, demonstrates that, *contra* to the speculation of previous workers, the external nares do not migrate caudally during ontogeny. Our analysis thus supports the hypothesis that *Parasuchus* is a morphologically distinct, valid taxon. The data (10 skulls) show that as the skull length increased, the orbits grew relatively little (strong negative allometry; allometric constant,  $k = 0.4$ ), whereas preauricular length increased relatively more than skull length (weak positive allometry,  $k = 1.14$ ). Both preorbital and postorbital lengths increased in very slight positive allometry or, given sample size, possibly isometry ( $k = 1.06$  and  $k = 1.07$ , respectively). Skull width grew relatively less than length (negative allometry,  $k = 0.83$ ). Significantly, there was essentially no growth (extreme negative allometry,  $k \sim 0.06$ ) in the part of the rostrum between the antorbital fenestrae and external nares. Although these data show very wide scatter and the correlation coefficient,  $R^2$ , is extremely low (0.001), the data points definitely form a prolate grouping whose poles are essentially horizontal (zero growth). Additionally, the preantorbital fenestra length shows slight negative allometry ( $k = 0.95$ ) although most of its length is made up of the preauricular length, which shows positive allometry. The allometric difference between the preauricular length and preantorbital length definitely reinforces the idea that the sector between the nares and antorbital fenestra is one of extreme negative allometry. Obviously, at some point very early in ontogeny there must be growth in this region, but over the span of skull lengths in our database (275 mm to 775 mm) there is practically none. The fact that the area between the external nares and antorbital fenestra shows essentially no growth demonstrates that this key diagnostic character (nares anterior to antorbital fenestra) of *Parasuchus* is not ontogenetically variable. Retention of this defining character of *Parasuchus* throughout ontogeny helps show that it is a valid, diagnosable taxon and should not be considered a metataxon.

Technical Session III, Wednesday 3:45

CLIMATE RELATED NICHE SEGREGATION AND RESOURCE PARTITIONING OF THE UNGULATE FAUNAS FROM THE MIDDLE PLEISTOCENE SUCCESSION (OIS 14-12) AT THE CAUNE DE L'ARAGO CAVE (FRANCE) RIVALS, Florent, ICREA (Institució Catalana de Recerca i Estudis Avançats), Tarragona, Spain; SCHULZ, Ellen, University of Hamburg, Hamburg, Germany; KAISER, Thomas, University of Hamburg, Hamburg, Germany

Hypotheses related to climatic changes through time and habitat preferences for Middle Pleistocene ungulates were tested. Rather than studying a single species, we use a community-based approach to reflect the community structure of the biome, the interspecific competition, and the resource availability in the habitat. We selected the Caune de l'Arago assemblage that documents three main stratigraphic units corresponding either to cold and dry climate or to temperate and humid environments. Large samples of various herbivorous species (horse, reindeer, red deer, fallow deer, bison, musk ox, argali, and tahr) are available in all three units. We employ dental wear analyses as approach to infer the dietary niche of those ungulates. In comparing the three stratigraphic units, the interspecific variability in dental wear variables should reflect a climatic signal. The dental meso- and microwear signatures reflect a climatic signal according the changes in the three stratigraphic units, but also the interspecific variability. The importance of combined meso- and microwear analyses for the organisation and dynamics of ungulate communities during the Pleistocene is shown. A correlation between dietary habits and climatic changes is observed for horse, red deer, and bison. For all other ungulates, interspecific competition and resource partitioning may explain the diversity observed. Surprisingly, the more diverse is the community in term of species richness, the less diverse are the dietary traits. In all units, the overlap of the dietary signatures is very low, even if some share habitats or resources. This is interpreted as a coexistence of various strategies such as resource partitioning, grazing successions, or niche segregation.

Poster Session III (Friday)

NEW VERTEBRATE FOSSIL LOCALITIES FROM THE LATE CRETACEOUS OF NORTHERN COAHUILA, MEXICO

RIVERA-SYLVA, Hector, Museo del Desierto, Saltillo, Coahuila, Mexico; GUZMAN-GUTIERREZ, Jose Ruben, Secretaría de Turismo del Estado de Aguascalientes, Aguascalientes, Ags., Mexico; PALOMINO-SÁNCHEZ, Francisco Javier, Instituto Nacional de Geografía, Estadística e Informática, Aguascalientes, Ags., Mexico; LOPEZ-ESPINOSA, Jose, Museo del Desierto, Saltillo, Coahuila, Mexico; DE LA PEÑA-OVIEDO, Ileana, Museo del Desierto, Saltillo, Coahuila, Mexico

Previous workers have reported dinosaur remains from the Northwestern region of Coahuila State, Mexico, but additional material has been discovered in a new locality which we report here near a rural community called La Salada, Coahuila. The stratigraphic sequence of the continental Aguja Formation preserves a diverse biota, consisting of large tree trunks, belonging to a dicotyledonous tree: gar scales, turtles of the Family Trionychidae, crocodile remains that could be attributed to *Deinosuchus* sp. due to the size of its vertebrae and osteoderms, being the first report of this genus for Coahuila. Among the dinosaur families also represented are: Tyrannosauridae, Ceratopsidae and Hadrosauridae. In another new nearby locality called "Las Garzas", which also correlates to the Aguja Formation (Campanian), we also report for the first time the presence of the families Tyrannosauridae, Nodosauridae and Hadrosauridae. In a third locality called "El Bosque" of probable Maastrichtian age, have been found several tree trunks and stumps *in situ*, presumably belonging to the dicotyledonous tree *Javelinoxylon*, with scattered and very weathered dinosaur bones probably from an ornithomimid dinosaur. These remains from the three localities mentioned above provide further data on the geographical distribution of the Mexican Late Cretaceous vertebrate faunas, being the southernmost report for the crocodylian genus *Deinosuchus* and the dinosaur Family Nodosauridae respectively.

Poster Session I (Wednesday)

LIFE HISTORY PATTERNS OF MOSASAURS INFERRED FROM STABLE CARBON ISOTOPES

ROBBINS, John, Southern Methodist University, Dallas, TX, USA; FERGUSON, Kurt, Southern Methodist University, Dallas, TX, USA; POLCYN, Michael, Southern Methodist University, Dallas, TX, USA; JACOBS, Louis, Southern Methodist University, Dallas, TX, USA; RICK, Torben, Southern Methodist University, Dallas, TX, USA

$\delta^{13}\text{C}$  values obtained from teeth of multiple species of mosasaurs present a wide range (-2.0‰ to -10.5‰) that is likely not the result of trophic level variation alone, because an increase in trophic level is expected to produce a ~1‰ difference between predator and prey. Therefore, another mechanism(s) must dominate the  $\delta^{13}\text{C}$  values of mosasaurs. Modern marine turtles and mammals that remain more deeply submerged for long periods tend to have lower  $\delta^{13}\text{C}$  values as a result of the Bohr effect and the amount of respired  $\text{CO}_2$  in their blood. The smaller species in our sample set yield the highest isotopic values, with decreasing values roughly correlated with increasing body size. This correlation between body size and carbon isotope values may reflect the diving habits of a taxon, similar to the Bohr effect on modern marine turtles. Additionally, significant differences between juvenile (-5.2‰) and adult individuals (-10.5‰) of *Globidens* ( $\Delta\delta^{13}\text{C} = \sim 5\%$ ) are too great to be attributed to trophic level, requiring other factors for the explanation of this ontogenetic shift. *Globidens* dentitions vary ontogenetically from simple conical teeth in juveniles to round globular posterior teeth in adults. We suggest that this genus alters its foraging range as well as its primary food source between juvenile and adult stages, a change mirrored in isotopic and morphological ontogeny. The lower  $\delta^{13}\text{C}$  values of the *Globidens* adult may be the result of deeper foraging compared to its shallower foraging juvenile counterpart.

Poster Session I (Wednesday)

TAPHONOMY OF TWO CRETACEOUS DINOSAUR QUARRIES, TANZANIA, AFRICA: NEW INSIGHTS INTO REGIONAL PALEOCLIMATE, PALEOENVIRONMENTS AND PALEO GEOGRAPHY

ROBERTS, Eric, University of the Witwatersrand, Johannesburg, South Africa; O'CONNOR, Patrick, Ohio University, Athens, OH, USA; HIERONYMUS, Tobin, Ohio University, Athens, OH, USA; GOTTFRIED, Michael, Michigan State University, East Lansing, MI, USA; STEVENS, Nancy, Ohio University, Athens, OH, USA

Cretaceous vertebrate-bearing exposures of the Red Sandstone Group (RSG) crop out across the Rukwa Rift Basin in Tanzania. These exposures have been systematically prospected and studied, and here we present a taphonomic investigation of two of our most productive dinosaur quarries. The TZ-07 quarry is a confined bone accumulation (20 m<sup>2</sup>) situated near the top of the sequence, which contains a single, partially articulated titanosaurian sauropod. Elements are weakly aligned and sorted and show moderate bone weathering and extensive bone modification, including carnivore scavenging or predation (multiple tooth marked elements and shed theropod teeth) and insect-related bone borings suggesting post-mortem carcass utilization or incidental subsurface tunneling. The bones are preserved within a thin, lenticular, fine-grained muddy

sandstone bed containing semi-polygonal mudstone clasts (reworked desiccation cracks). The bed is preserved within a relatively homogeneous sequence of tabular and trough cross-stratified fluvial sandstones and paleosols. The locality is one of many similar deposits that are interpreted as abandoned channel-fill segments of a large, ephemeral braided river system. The second quarry, Galula-2, is depositonally similar to TZ-07, however it is a much larger (>50 m<sup>2</sup>) multi-taxon bone bed located near the base of the RSG. It contains multiple individuals of an undetermined titanosaurian sauropod, an unidentified theropod, and a possible ornithomimid. Elements are partially aligned and sorted and show moderate bone weathering. Adjacent channel sandstones preserve evidence of flashy-discharge, including armored mudballs, thick intraformational conglomerates, and meter-thick bar sets with mud and intraclast draped foresets. The characteristics displayed at both quarries, and in surrounding facies, are strikingly similar to observations from the putatively age-equivalent Dinosaur Beds of Malawi, suggesting a regionally extensive system of large, ephemeral rivers draining adjacent uplands (rift flanks) in a hot, semi-arid climate. This study provides a rare window into mid-Cretaceous paleoenvironments and paleoecology of sub-equatorial Africa.

#### Technical Session XV, Saturday

##### A MORPHOLOGICAL APPROACH TO UNRAVELLING THE RELATIONSHIPS OF RINGTAIL POSSUMS (PSEUDOCHEIRIDAE, MARSUPIALIA)

ROBERTS, Karen, University of New South Wales, Sydney, Australia; ARCHER, Michael, School of Biological, Earth and Environmental Sciences, Sydney, Australia

Molecular phylogenetics since the late 1970s has transformed understanding about the intrafamilial relationships of ringtail possums and greater gliders (Pseudocheiridae, Marsupialia). From their previous interpretation as relatives of the koala (Phascogasteridae) and referral of all species into two genera, there is now far stronger support for a sister relationship between pseudocheirids and petaurids (gliders and striped possums) and recognition of six monophyletic genera of living pseudocheirids inhabiting Australia and New Guinea. Unfortunately, extant intergeneric pseudocheirid relationships remain somewhat unresolved, and the rapidly accumulating fossil record, which extends back to the late Oligocene, has commonly been overlooked in phylogenetic overviews of this family because most recent analyses have focused on molecular rather than morphological diversity. Current research and systematic revision of Oligo-Miocene pseudocheirids has revealed at least two new genera and several new species. Generic identity and species diversity, relationships of the oldest pseudocheirids and a morphological hypothesis for the radiation of modern pseudocheirids has been investigated in this study using 89 craniodental characters of 41 fossil and extant pseudocheirids using six different diprotodontians as outgroups. Maximum parsimony analyses using PAUP 4.0 have led to the conclusions that the genus *Marlu* is paraphyletic, species of *Pildra* are more plesiomorphic than previously suggested and a third, new Oligo-Miocene genus should be recognised. Despite these advances, intergeneric relationships of modern pseudocheirids remain controversial.

#### Technical Session I, Wednesday 8:30

##### EARLY EOCENE PRIMATES FROM PENINSULAR INDIA

ROSE, Kenneth, Johns Hopkins University School of Medicine, Baltimore, MD, USA; SMITH, Thierry, Royal Belgian Institute of Natural Sciences, Brussels, Brunei; RANA, Rajendra, HNB Garhwal University, Srinagar, India; SINGH, Lachman, HNB Garhwal University, Srinagar, India; SAHNI, Ashok, Panjab University, Chandigarh, India

The early Eocene Cambay Formation, exposed at Vastan Lignite Mine, Gujarat, India, has produced the oldest known Cenozoic land mammals from India. The strata can be dated as late early Ypresian based on the foraminiferan *Nummulites b. burdigalensis*. The mammalian fauna includes a diverse assemblage of bats (the oldest known bats from Asia), insectivores, anthracobunids, a new ailuravine rodent, a hyaenodontid creodont, the basal artiodactyl *Diacodexis*, and at least 3 euprimates. The primates comprise at least one poorly known omomyid (*Vastanomys*) and two adapoids. Both adapoids are represented by jaws, isolated teeth, and a few postcrania, and appear to be closely related to European cercamoniine notharctids. Their trigonids lack the derived adapid condition. *Marcgodinotius indicus* is smaller and more primitive, retaining 4 lower premolars (p2 two-rooted; p3-4 simple, lacking any trace of a paraconid or metaconid). Some dental traits, such as a buccally shifted hypoconulid and an incipient notch between it and the entoconid, suggest possible relationship to basal adapoids. Larger specimens represent a more derived new genus and species with only 3 lower premolars, p2 one-rooted. As in *Marcgodinotius*, p3-4 lack a paraconid and metaconid. Its upper molars are more inflated than in *Marcgodinotius*. Postcrania include a small notharctid humerus and femur, probably referable to *Marcgodinotius*. Two sizes of euprimate calcanei have also been identified, probably belonging to the two adapoids. They are closer in proportions to calcanei of the notharctids *Cantius* and *Notharctus* than to *Adapis*. The adapoid postcrania show features typical of active arboreal primates. A third calcaneal morph has a shorter proximal arm, longer distal arm, and other minor details making it closely comparable to calcanei of the basal anthropoid *Eosimias*, but no eosimiid teeth have yet been found at Vastan.

#### Poster Session IV (Saturday)

##### *PELIGROTHERIUM TROPICALIS*: CRANIOMANDIBULAR MORPHOLOGY OF THE SOUTH AMERICAN DRYOLESTOIDS

ROUGIER, Guillermo, University of Louisville, Louisville, KY, USA; PÁEZ, Natalia, University of Louisville, Louisville, KY, USA

The dryolestoid *Peligrotherium tropicalis* comes from the "Banco Negro Inferior" (BNi), the basal section of the Danian Hansen Member of the Salamanca Formation, Patagonia Argentina. The associated fauna includes a unique assemblage of mammals representing the last survivors of Gondwanan lineages (gondwanatherians, dryolestoids, and monotremes) and Laurasian immigrants. With the exception of the incisors, all other dental elements of *Peligrotherium* are now known. Based on morphology and tooth wear the dental formula is reinterpreted as 4/?, 1/1, 3/3, 3/3. The gross dental morphology corresponds closely to that of mesungulatids and *Reigitherium*; it is likely that this dental formula is also present in these groups. The low number of molars is similar to that of paurodontids and unlike that of Dryolestidae. Upper and lower P2-P3 are highly complex. The skull is the first known for a dryolestoid; it retains primitive features present in *Vincelestes* but absent in Therians, such as a large septomaxilla, absence of nasal PMX contact, large dorsoventrally oriented prootic canal, and a broad facial sulcus. Other features are problematic. A fully coiled cochlear canal is present in therians, mesungulatids and likely also in *Peligrotherium*, however *Vincelestes*, putatively closer to therians than dryolestoids, has only a curved cochlea; therefore, either mesungulatids and *Peligrotherium* acquired a coiled cochlea independently from therians, or *Vincelestes* reverted to a more plesiomorphic condition. The skull and jaws of *Peligrotherium* are massively built and are distinct from those of non South American dryolestoids but reminiscent of those of mesungulatids. They show no indication of postdentary bones or of a Meckelian groove. A distinct mylohyoid groove is present. The Paleocene *Peligrotherium* with its highly specialized bunodont dentition represents the last known member of the radiation of dryolestoids. The skull however, and despite perhaps some 50 million years of independent evolution, can still be incorporated relatively easily into a broad phylogenetic framework of stem therians.

#### Technical Session III, Wednesday 2:15

##### PRENATAL TO EARLY JUVENILE WOOLLY MAMMOTH LIFE HISTORY AS REVEALED BY STRUCTURAL AND COMPOSITIONAL ANALYSES

ROUNTREY, Adam, University of Michigan, Ann Arbor, MI, USA; FISHER, Daniel, University of Michigan, Ann Arbor, MI, USA; MOL, Dick, CERPOLEX/Mammuthus and Natural History Museum Rotterdam, Rotterdam, Netherlands; LAZAREV, Petr, The Mammoth Museum of the Institute of Applied Ecology of the Academy of Sciences of The Sakha Republic (Yakutia), Yakutsk, Russia; BOESKOROV, Gennadiy, The Mammoth Museum of the Institute of Applied Ecology of the Academy of Sciences of The Sakha Republic (Yakutia), Yakutsk, Russia

Mammoth tusk dentin is continuously accreted during life, with temporally periodic structural features marking growth at daily, weekly, and annual scales. These features provide a means of precisely determining age, and they also allow samples for isotope analysis to be tied to specific times in life. Although an ever-growing structure like a mammoth tusk can, therefore, be a source of information on the complete life history of an individual, abrasion and breakage of the tusk tip often remove the record of the earliest years of life. This period can only be studied in tusks of individuals that died young. In this study, we analyze three mammoth tusks with estimated ages at death from eight months to two years. Through a combination of serial isotope (collagen  $\delta^{15}\text{N}$  and  $\delta^{13}\text{C}$ ) analyses and measurements of growth increment thicknesses, these juvenile tusks provide information on season of birth, nursing patterns, rate of tusk growth early in life, and season of death. The tusks originate from Yakutia, Russian Federation. Two were collected on Bolshoi Lyakhovskii Island (MMY 7916, dated to 24.7 ka, and an undated specimen acquired by DM), while the third (MMY 7911, dated to 41.3 ka) is from the Oimyakon region. All three tusks retain enamel, indicating that even the earliest pre-natal dentin is preserved, and MMY 7911 displays a well-defined neonatal line marking the time of birth. Increment analysis of MMY 7911 indicates that the permanent tusk began to form about six months prior to birth, and then increased its rate of growth until death ~32 weeks after birth. Prior to birth, which occurred in early spring, trends in  $\delta^{15}\text{N}$  and  $\delta^{13}\text{C}$  are consistent with expected seasonal patterns in maternal isotope composition. Following this, a post-natal trend toward more negative  $\delta^{13}\text{C}$  is likely the result of the calf's dependence on fat-rich milk. Forthcoming results from analyses of the two longer tusks will offer additional data on early life history, as those individuals appear to have lived through at least 1.5 post-natal years.

Technical Session XV, Saturday 10:45

FOSSIL EVIDENCE ON DIVERGENCE TIMING OF THE PLATYPUS AND ECHIDNA CLADES

ROWE, Timothy, University of Texas at Austin, Austin, TX, USA; RICH, Thomas, Museum Victoria, Melbourne, AZ, Australia; VICKERS-RICH, Patricia, Monash University, Victoria, Australia; SPRINGER, Mark, The University of California, Riverside, CA, USA; WOODBURNE, Michael, Museum of Northern Arizona, Flagstaff, AZ, Vanuatu

Monotremes have left a poor fossil record, and paleontology has been virtually mute during nearly two decades of discussion about molecular clock estimates of the timing of divergence between the platypus and echidna clades. Molecular clock estimates of the divergence between platypus and echidnas range from 17-80 Ma. New evidence from high-resolution X-ray computed tomography indicates that *Teinolophos*, an Early Cretaceous fossil from Australia's Flat Rocks locality (121-112.5 Ma), lies within the crown clade Monotremata, as a basal platypus. Divergence of the two monotreme clades therefore had occurred in or before the Early Cretaceous. *Teinolophos* is a platypus in both phylogenetic and ecological aspects, suggesting that monotremes have evolved at much slower rates than therian mammals. Only relaxed molecular clock estimates of divergence times have proven compatible with the fossil record.

Poster Session I (Wednesday)

GREGARIOUS BEHAVIOR RECORDED IN THE TRACKS OF A JURASSIC THERAPSID

ROWLAND, Stephen, University of Nevada, Las Vegas, Las Vegas, NV, USA; MERCADANTE, Jennifer, University of Nevada, Las Vegas, Las Vegas, NV, USA

Trackway research has revealed a great deal about the behavior of dinosaurs, revealing for example that most of the major groups of dinosaurs engaged in gregarious behavior. However, almost nothing is known about the behavior of Mesozoic mammals and therapsids. Here we report the occurrence of a series of twelve subparallel trackways, including approximately 100 individual tracks, on a single foreset surface of a dune within the early Middle Jurassic Aztec Sandstone in Valley of Fire State Park of Southern Nevada. The tracks belong to the ichnogenus *Brasilichnium*, which is well known from the Aztec Sandstone in the Mescal Range of eastern California, as well as from the correlative Navajo Sandstone of Utah. The Valley of Fire multiple-trackway site described here is the first known occurrence of this ichnogenus in the state of Nevada, and the first reported occurrence of multiple parallel trackways of this ichnogenus. The *Brasilichnium* trackmaker was certainly a synapsid; it was most probably a tritylodont therapsid. This site thus documents the occurrence of gregarious behavior in synapsids in the early Middle Jurassic and, so far as we know, the first known occurrence of gregarious behavior in any Mesozoic synapsid. The evolution of social behavior requires special ecological conditions in which the benefits of group living outweigh the costs. Therefore, the identification of social behavior in a particular fossil taxon, or ichnotaxon, contributes significant insights, not only into the autecology of an extinct species, but also into the structure of an ancient ecosystem.

Poster Session IV (Saturday)

STRATIGRAPHIC CHANGES IN THE LEPORIDS FROM HAGERMAN FOSSIL BEDS NATIONAL MONUMENT, IDAHO

RUEZ, Dennis, Auburn University, Auburn, AL, USA

The fossil leporid assemblage at Hagerman Fossil Beds National Monument (HAFO) is comprised of three extinct species that span about 100 m of exposed Glens Ferry Formation deposits. During this nearly one million-year interval there is evidence for a pronounced cooling period and subsequent warmth. Response of the leporids to these climatic events is reflected in their diversity, abundance, and dimensions of the lower third premolar (p3). None of the three leporids are present during the coolest interval at HAFO, but all reappear after a long hiatus. This reappearance coincides with a return to warm conditions at HAFO, and is additionally marked by a change in the relative abundance of the leporid taxa. All three species exhibit a longer p3 after the hiatus, which suggests that individuals returning to the HAFO area had a larger body size.

Technical Session XV, Saturday 12:00

CT SCANNING INVESTIGATION OF THE PETROSAL BONE AND THE INNER EAR OF *HENKELOTHERIUM GUIMAROTAE* (PAURODONTIDAE, DRYOLESTOIDEA)

RUF, Irina, Universität Bonn, Bonn, Germany; LUO, Zhe-Xi, Carnegie Museum of Natural History, Pittsburgh, PA, USA; MARTIN, Thomas, Universität Bonn, Bonn, Germany; WIBLE, John, Carnegie Museum of Natural History, Pittsburgh, PA, USA

The paurodontid *Henkelotherium guimarotae* from the Upper Jurassic Guimarota locality in Portugal represents the best preserved fossil of a stem cladotherian. In contrast to the almost complete postcranium, the skull is crushed and its petrosal had been misinterpreted as part of the occipital complex. High-resolution 3D computed tomography and imaging analysis have now allowed identification of the petrosal and detailed first-hand observations on the general features of the bony labyrinth. Almost the entire

petrosal is preserved, except for the part that would have housed the anterior semicircular canal. The preserved (although somewhat displaced) anterior petrosal lamina is extensive, and shows two foramina that can be interpreted as the foramina rotundum (V2) and ovale (V3) for the maxillary and mandibular branches of the trigeminal nerve. A reduced, narrow lateral trough and a small ventral opening of the cavum epiptericum are present lateral to the promontorium. The prootic canal and facial nerve openings are present lateral to the fenestra vestibuli. The cavum supracochleare is partially preserved and is positioned dorsolateral to the pars cochlearis. The canal for the inferior petrosal sinus is present along the medial margin of the pars cochlearis. Most of these petrosal features are also present in *Vincelestes*, albeit in slightly modified conditions. Pending the congruence with other synapomorphies, these petrosal features may represent the basal condition for the cladotherian clade. We tentatively interpret that the sulcus for the internal carotid artery is present on the promontorium in the *Henkelotherium* type specimen. CT scans reveal a primary bony lamina for the basilar membrane, and the computed 3D image model shows that *Henkelotherium* has a well developed cochlear canal coiled about 270°. Thus, we assume that the partially coiled cochlear canal (between 270° and 360°) and the primary bony lamina are apomorphies of the cladotherian clade including dryolestoids, in contrast to the un-coiled cochlear canal without a primary bony lamina in basal trechnotherians.

Technical Session II, Wednesday 9:00

CALIBRATED DIVERSITY, TREE TOPOLOGY AND THE MOTHER OF MASS EXTINCTIONS: THE LESSON OF TEMNOSPONDYL

RUTA, Marcello, University of Bristol, Bristol, United Kingdom; BENTON, Mike, University of Bristol, Bristol, United Kingdom

Three family-level cladistic analyses of temnospondyl amphibians are used to investigate the effect of taxonomic rank, tree topology, and sample size on diversity profiles, rates of originations and extinctions, and faunal turnover. Temnospondyls are used as a case study for investigating family replacement across the Permo-Triassic boundary and modality of recovery in the aftermath of the end-Permian mass extinction. Both observed and inferred (i.e. tree topology-dependent) values of family diversity have a negligible effect on the course of the diversity curve. However, inferred values produce a flattening of the curve throughout the Cisuralian as well as a less conspicuous increase in family diversity from Tatarian through to Induan than observed values do. Diversity curves based upon counts of genera and species display a clearer demarcation between peaks and troughs. When genera or species are rarefied within families, a recast profile of estimated family diversity during five time bins (Carboniferous; Cisuralian; Guadalupian-Lopingian; Early Triassic; Middle Triassic-Cretaceous) shows that the Cisuralian and Early Triassic diversity values are closer to one another than they are when observed families are used, and both are slightly higher than the Carboniferous estimated diversity. The Guadalupian-Lopingian value is lower than raw data indicate, reflecting in part the depauperate land vertebrate diversity from late Cisuralian to middle Guadalupian (Olson's gap). The time-calibrated origination and extinction rate trajectories plot out close to one another and show a peak in the Induan, regardless of the tree topology used to construct them. Origination and extinction trajectories appear disjunct in at least some Palaeozoic intervals, and background extinctions exert a significant role in shaping temnospondyl diversity during the lowermost Triassic.

Poster Session IV (Saturday)

TRANSLATING ORGANIC INFORMATION IN FOSSILS INTO PHYLOGENETICALLY INFORMATIVE DATA

RYAN, Michael, Cleveland Museum of Natural History, Cleveland, OH, USA; OSTROM, Peggy, Michigan State University, East Lansing, MI, USA; CAPPELLINI, Enrico, University of York, York, United Kingdom; BUCKLEY, Mike, University of York, York, United Kingdom; HUMPULA, James, Michigan State University, East Lansing, MI, USA

Recent protein sequence data from a Late Cretaceous fossil raises the possibility of probing phylogenetic relationships of the deep past. We address questions regarding ubiquity, indigeneity, and systematic information content of ancient protein residues by analyzing the organic composition of bison, equid and tyrannosaurid bones ranging in age from 10ka to 74 Ma, and present the first phylogenetic analysis based on ancient and modern protein sequences. Although protein yields, %C and %N obtained from fossils diverge from those typical of modern collagen, amino acid profiles and protein sequencing confirm survival of collagen in many fossils as old as 700ka, even with very low yields (<0.5%) of organic matter. However, 74 Ma tyrannosaurid bone shows very low amino acid content that does not resemble collagen. A preliminary phylogenetic analysis of amino acid substitution within the mineral-binding protein osteocalcin shows that it is amenable for recovering basal relationships of vertebrate groups. However, multiple homoplasies are present in more derived clades indicating that changes in osteocalcin are not consistent with established phylogenies of crown taxa and close relatives. Because many taxa have gone extinct within the known timescale of collagen survival, improved methods of analyzing collagen sequences from these organisms could allow further exploration of the phylogenetic potential of ancient protein sequences.

Technical Session VIII, Thursday 2:30  
MORPHOMETRIC ANALYSIS OF CROCODYLIAN CRANIAL ECCOMORPHOLOGY AND ONTOGENETIC SHAPE CHANGE  
SADLEIR, Rudyard, Field Museum & Univ. Chicago, Chicago, IL, USA

Crown group crocodylians exhibit a high degree of cranial variation and convergence throughout their 80 million-year fossil record. Repeated transitions among generalized, blunt and slender cranial ecomorphotypes may have misled crocodylian systematics by influencing phylogenetic character-state transitions. Investigation of ecomorph-character correlations is limited by the undetermined accuracy of current ecomorph definitions and unexplored ontogenetic relationships among existing ecomorphs. Using three-dimensional landmark-based geometric morphometric methods, the cranial shape variation of extant and fossil crocodylians is analyzed with respect to ontogeny to test the hypotheses that existing cranial ecomorph classifications accurately reflect quantified cranial shape variation, that like ecomorph taxa have identical ontogenetic shape-change trajectories, and that heterochronic shifts result in different ecomorphs. 120 landmarks summarizing crocodylian cranial shape in dorsal and ventral perspectives have been collected from over 200 specimens representing the ontogenies of 21 extant crocodylians and select fossil taxa. Cranial shape distributions within an empirical morphospace derived from principal component analysis reveal greater skull shape diversity than is currently recognized. Blunt cranial ecomorphs do not display the taxonomic divisions observed among slender and generalized taxa, and with systematic correlation results, suggest that blunt ecomorphs obfuscate phylogenetic resolution. Analysis of ontogenetic shape change shows that taxa with the same static cranial ecomorphotype can possess different ontogenetic trajectories. Differences in environmental conditions for *Alligator mississippiensis* (i.e. farmed vs. wild) can alter skull shape to a scale transcending species shape-boundaries. The ontogenetic shape relationships among the extant *A. mississippiensis* and the fossil *A. mefferdi* are analyzed to determine if observed environmentally-driven phenotypic plasticity is a potential source for cranial ecomorph transitions among the Alligatorinae.

Ernie Lundelius Symposium (Faunal Dynamics and Extinction), Wednesday 9:00  
THE LATE PLEISTOCENE VERTEBRATE FAUNA FROM ZESCH CAVE,  
MASON COUNTY, TEXAS

SAGEBIEL, James, San Bernardino County Museum, Redlands, CA, USA  
Zesch Cave, located 4 km west of Mason, Texas, contains the northwest-most Pleistocene fauna described from the Edwards Plateau. None of the few Pleistocene vertebrate localities described from the Llano Uplift of the Central Texas Edwards Plateau display the diversity seen in the Zesch Cave Fauna. At least seven extinct and thirteen extralimital taxa are reported from Zesch Cave. The fauna is composed of late Pleistocene - probably Rancholabrean Age - taxa, including *Canis dirus*, *Camelops hesternus*, *Hemiauchenia macrocephala* and *Synaptomys australis*. The Zesch Cave fossils accumulated through a combination of pitfall entrapment and collection by birds and carnivores. Although owls and raptors are frequently implicated as agents of bone accumulation for cave faunas, fossils of large scavenging and predatory birds are rare components of the avian fauna at Zesch Cave. Corvids, including the Raven (*Corvus corax*) and the Black-billed Magpie (*Pica pica*), are abundant and cathartid bones are also present. One would expect these diurnal species to give a different taphonomic overprint than cave faunas with heavy contributions from owl pellets. Fossils of the American Black Bear (*Ursus americanus*) and several canids are common, and these animals almost certainly used the cave as a den. Both mammalian and avian taxa paint a picture of the Llano Uplift during the Pleistocene as an environmental mosaic of woodland and grassland.

Poster Session I (Wednesday)  
THE OSTEOLOGY AND PHYLOGENETIC POSITION OF *ANOMOIODON LILIENSTERNI*, A PROCOLOPHONID REPTILE FROM THE MIDDLE TRIASSIC BUNDSANDSTEIN OF GERMANY  
SÄILÄ, Laura, Univ of Bristol, Bristol, United Kingdom

Procolophonoids are small to medium sized Permo-Triassic parareptiles that have been suggested as the sister group of turtles, and several taxa may have biostratigraphic potential. The detailed morphology of many procolophonoid taxa, however, is poorly understood, and this has led to a lack of consensus of the interrelationships of procolophonoids. The procolophonid reptile *Anomoiodon liliensterni*, from the Middle Triassic of Germany, is represented by a specimen that consists of two closely associated skeletons that are preserved as natural molds in a block of medium grained sandstone. These skeletons were described in 1939 from plaster casts, which revealed little detail and subsequently the original specimen was misplaced. This was unfortunate because interest in *Anomoiodon* has been renewed after suggestions that it is the senior synonym of *Kapes*. The latter genus is known from several specimens from the Triassic of both Russia and the United Kingdom, where it has been used as an informal index taxon. Fortunately, the original specimens of *Anomoiodon* recently resurfaced, allowing silicone rubber casts to be made. These reveal the anatomy of *Anomoiodon* in more detail and allow a comprehensive comparison with *Kapes*. The two specimens of *Anomoiodon*,

measuring about 150 mm from snout to tail, are found in association with their skulls overlapping slightly. The preservation is fine enough that several cranial sutures, together with details of the dentition and the postcranial skeleton, can be seen. *Anomoiodon* shares several features with *Kapes*, including the general shape of the skull, posteriorly increasing size and height of the marginal dentition and the shapes of the prefrontal bone, the interpterygoid vacuity and the dorsal vertebrae. *Anomoiodon* and *Kapes* form a sister-group relationship in my preliminary phylogenetic analysis of the procolophonoid clade Procolophonidae. Thus a close relationship, or indeed synonymy, is a real consideration, creating a stratigraphic link between the Middle Triassic localities in Germany, the UK and Russia where the taxa have been found.

Poster Session I (Wednesday)  
SCALING BITE FORCE IN PREDATORY TETRAPODS: BITE FORCE IS PROPORTIONAL TO BODY MASS<sup>2/3</sup>  
SAKAMOTO, Manabu, University of Bristol, Bristol, United Kingdom

Here I show that bite forces of terrestrial predators scale with increasing body size at a scaling factor of 2/3. This negative allometry indicates that bite force increases less-than-proportional to increase in body mass. This scaling factor of 2/3 can be observed in many instances of scaling: scaling of surface area to its volume in isometric bodies is one obvious example, but more relevant is that of muscle force with body mass. Since the contractile properties of muscle are generally agreed to be constant throughout vertebrates with varying scale, muscle force is most likely proportional to the physiological cross-sectional areas (PCSA) of muscles (length<sup>2.0</sup>) and since body mass is essentially volume (length<sup>3.0</sup>), muscle force is proportional to body mass<sup>2/3</sup>. This coincidence in identical scaling factors between the theoretical scaling of muscle force and the observed scaling in bite force suggests that muscle force, not the lengths of moment arms, is the determining factor of the overall scaling trend in bite force with increasing body size. This has great paleontological implications. In determining bite forces in extinct predators, PCSA of adductor muscles must be reconstructed with accuracy in order to obtain reliable values. Compared with this theoretical scaling in bite force, most bite force estimates in extinct predators are likely to be underestimates. Thus, a more robust method of reconstructing musculature and estimating PCSA is needed.

Poster Session IV (Saturday)  
A CRITICAL REASSESSMENT OF THE CRETACEOUS NON-AVIAN DINOSAUR FAUNAS OF AUSTRALIA AND NEW ZEALAND  
SALISBURY, Steven, The University of Queensland, Brisbane, Australia; AGNOLIN, Federico, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires, Argentina; EZCURRA, Martin, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires, Argentina; PIAS, Diago, Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires, Argentina

The traditional interpretation of Australasia's Cretaceous non-avian dinosaurian fauna is that it is distinct from those of other Gondwanan landmasses. Some Australasian dinosaurs are considered relics of clades that were more common in the Jurassic, while others are seen as early representatives of typically Laurasian clades. These interpretations are at odds with the pervading paleobiogeographic signal, which indicates that terrestrial vertebrate faunal interchange occurred between South America and Africa during the mid-Cretaceous, and South America, India and Madagascar during the Late Cretaceous. Given that some of this interchange must have taken place via the Antarctic-East Gondwanan corridor, there is an expectation that Australasia should also contain elements of this fauna. A reassessment of Australasia's non-avian Cretaceous dinosaurs indicates that several taxa traditionally interpreted as aberrant may share affinities with clades from other Gondwanan landmasses, and/or taxa already recognised within Australia. For instance, Australia's "hypsiphodontids" display features suggestive of basal iguanodontians - a grade of Ornithopoda that is already known from Australia (*Muttaborrasaurus*) and possibly New Zealand, and which is well represented in South America. Similarities between *Serendipaceratops* and basal ankylosaurians such as *Minmi* are also apparent, weakening the inclusion of the former within Neoceratopsia. Along with *Kukuru*, much of Australia's purported allosauroid theropod material may belong to abelisauroids, and oviraptorosauroid and ornithomimosauroid (*Timimus*) material from Victoria is assignable to Paraves, with *Timimus* additionally possessing features reminiscent of deinonychosaurian unenlagiines. An isolated theropod ulna from Victoria also compares favorably to that of the peculiar Argentinean tetanuran *Megaraptor*, while the enigmatic *Rapator* may represent a *Nqwebasaurus*-like basal coelurosaur. These observations indicate that, rather than being wholly endemic or relictual, at least some of Australasia's non-avian Cretaceous dinosaurs may have formed part of a more widely distributed Gondwanan fauna.

Romer Prize Session, Thursday 11:30  
ASSESSING CRANIOCERVICAL FUNCTIONAL MORPHOLOGY IN  
COELUROSAURIAN THEROPODS

SAMMAN, Tanya, University of Calgary, Calgary, AB, Canada

Assessing the biomechanics of feeding in theropod dinosaurs requires examination of craniocervical functional morphology, as the head and teeth are essentially welded by the neck. This study examined variation in vertebral shape and articulation from an osteological and arthrological perspective in order to provide a foundation for ongoing research into theropod feeding. Variation in vertebral shape and articulation as well as soft tissue structure were documented in selected North American coelurosaurian dinosaurs and extant birds with mensural, photographic, and dissection data. Extant bird necks in various poses were radiographed to assess similarities and differences in intervertebral articulation and range of motion. Analysis of these data revealed that cartilage on both zygapophyseal and central articular faces of cervical vertebrae in extant and extinct taxa is proportionally thin, and serves as a surface upon which the parts of the joint glide. These data also provided insight into the restrictions on mobility enforced by the synovial joint capsule, and the variation in degree of zygapophyseal overlap along the cervical series within individual specimens. Based on these results, all studied coelurosaurian taxa, extinct and extant, have sufficiently mobile necks to engage in inertial feeding. Of the extinct taxa, tyrannosaurid necks are the least flexible. Ornithomimid necks are the most flexible, with the neck of *Troodon* demonstrating a similar range of motion. The extremely beveled cervical centra of dromaeosaurids likely made them the least flexible of the small theropod taxa examined. An experimental model of *Tyrannosaurus rex* was created using an alpha version of the three-dimensional parametric software DinoMorph™ that is being developed by Dr. K.A. Stevens (University of Oregon). The experimental model demonstrated the utility of such software for craniocervical functional morphological analyses tailored to the specificities of theropod cervical vertebrae. Ongoing studies of osteology, arthrology, myology, and the use of parametric modeling techniques, will provide further insight into theropod foraging behavior.

Poster Session IV (Saturday)

SIRENIAN POSTCRANIA FROM NOSY MAHAKAMBY, NORTHWESTERN  
MADAGASCAR

SAMONDS, Karen, McGill University, Montreal, QB, Canada; ZALMOUT, Iyad, The University of Michigan, Ann Arbor, MI, USA; IRWIN, Mitchell, McGill University, Montreal, QB, Canada; RAHARIVONY, Lydia, Université d'Antananarivo, Antananarivo, Madagascar

The dearth of Tertiary terrestrial vertebrate fossils from Madagascar continues to inhibit direct testing of biogeographic hypothesis regarding the origin and evolution of many of its extant taxa. However, recent fossil discoveries within Madagascar's marine fossil record (e.g., an *Eotheroides* skull described from Ampazony) have started to elucidate this time period. Reconnaissance forays in 2005 have resulted in the discovery of new vertebrate fossils from the island of Nosy Mahakamby. This island was originally mapped as containing Miocene marine and Pliocene continental rocks, and is located 4 kilometers off the coast of northwestern Madagascar. It is renowned for previously producing the only mammal fossil from within the 65-million year "gap" in Madagascar's fossil record: a fragmentary and largely undiagnostic partial sirenian braincase, weakly attributed to the genus *Falitherium*. The lithology on Nosy Mahakamby contains much less carbonate than other known marine fossil-bearing localities, and is much sandier with more terrestrial input. We report here the discovery of the first associated sirenian postcranial material known from Madagascar. This specimen is represented by many associated ribs, vertebrae, and other elements that appear to be part of the pelvic girdle. Based on the size and shape of the ribs, which are long and slender like *Eosiren*, this specimen appears to represent a different species than the Malagasy *Eotheroides*, whose ribs possess the pachystotic, banana-shaped rib morphology. Well-preserved examples of other vertebrate fossils including bony fish, sharks, rays, and turtles were also collected, and will also aid in elucidating the evolutionary history of these groups. This discovery is potentially highly significant for reconstructing sirenian evolutionary and biogeographic history. While other marine localities have produced fragmentary or disassociated fossils, fossils from Nosy Mahakamby are more intact and frequently associated, more characteristic of a low-energy depositional environment. In addition, the sandy lithology suggests that Nosy Mahakamby has the potential to yield terrestrial vertebrate fossils.

Technical Session XVI, Saturday 1:30

SKELETAL PREDICTORS OF BODY MASS IN RODENTS

SAMUELS, Joshua, University of California, Los Angeles, Los Angeles, CA, USA

Body mass is closely linked to many ecological attributes and therefore estimation of mass is fundamental to understanding the ecology of extinct species. Rodents are well-represented and important components of modern and fossil ecosystems that have been largely overlooked in paleoecological reconstructions. Here, I use linear regressions to examine the correlation between body mass and 64 cranial, dental, and postcranial measurements of rodent species from 18 extant families. The ability of each measure to

predict mass was assessed, as were the influences of allometry, diet, and locomotor habits. Cranial and dental features were generally better predictors of body mass than postcranial features. Most skeletal measurements scale isometrically or weakly allometrically with respect to body size, but skull and rostrum length were both noticeably allometric as were some load bearing features of the postcranial skeleton. Molar breadths were better correlated with body mass than molar lengths or features of the incisors. Incisor structure and some other craniodental dimensions were strongly influenced by dietary and digging habits. Among postcranial skeletal features, diameters and articular dimensions of the limb bones were generally better predictors of body mass than lengths, which tend to reflect locomotor behaviors. Results highlight the importance of considering interspecific allometry and locomotor specializations when estimating mass. Regression equations based on locomotor categories more accurately predicted mass of some species than did equations based on phylogenetic relationships. Regression equations based on the extant sample were used to predict body mass for 19 extinct rodent species, including giant beaver, *Castoroides ohioensis*, and giant marmot, *Paenemarmota barbouri*. These estimates can be used to examine patterns of body size evolution over time and more accurately reconstruct extinct communities.

The Dissorophoidea - Early Amphibian Radiation Symposium, Friday 10:30  
LIFE-HISTORY TRAITS OF *APATEON* (LOWER PERMIAN OF EUROPE),  
A KEY-GENUS AMONG DISSOROPHOIDS, REVEALED BY  
BONE HISTOLOGY

SANCHEZ, Sophie, Muséum national d'Histoire naturelle, Paris, France; STEYER, J. Sébastien, Muséum national d'Histoire naturelle, Paris, France; DE RICQLÈS, Armand, Collège de France, Paris, France; SCHÖCH, Rainer, Staatliches Museum für Naturkunde, Stuttgart, Germany

Numerous growth series of the well-known dissorophoid *Apateon* Meyer have been discovered in the Permian of Europe, allowing detailed anatomical descriptions with interesting ontogenetic and phylogenetic implications on the group. However, the paleohistology of this key-genus remained enigmatic. A paleohistological and skeletochronological analysis has been therefore performed on the long bones of 22 individuals belonging to *Apateon caducus*, *A. pedestris*, and *Apateon* sp. from the Saar-Nahe Basin, Western Germany (Erdesbach, Odernheim/Pfalz and Niederkirchen/Pfalz, respectively). This study provides new data on the somatic age, growth rate and sexual maturity of the sampled specimens: bone histology of *A. caducus* and *A. pedestris* shows juvenile features such as a relatively high growth speed and a significant primary vascularization. *A. pedestris* shows also juvenile-like features: persistence of the Kastschenko's line and calcified cartilage, suggesting a (paedomorphic) condition via neoteny. Paleohistology of *Apateon* also provides new outcomes on its paleoecology: the histological pattern of the lines of arrested growth (LAGs), differently expressed in the three species, suggests different paleoenvironmental influences on the bone record during growth. *A. pedestris* shows a simple pattern of LAGs whereas *A. caducus* and *Apateon* sp. show a peculiar double-lines pattern. Compared with the living tetrapods, the latter pattern has only been described in high-elevation Portuguese populations of the extant newt, *Triturus marmoratus*, expressing yearly hibernating and aestivating arrests of growth. This suggests that *A. caducus* and *Apateon* sp. had also to hibernate and aestivate every year, probably because of relatively drastic seasonal climatic conditions. As the Saar-Nahe Basin was under the tropics at that time, seasonality could have only been enhanced at high altitudes. This therefore suggests that the aquatic tetrapods from Erdesbach and Niederkirchen may have lived at higher elevations than those of Odernheim.

Technical Session V, Wednesday 1:45

A NEW SHASTASAURID ICHTHYOSAUR FROM THE UPPER TRIASSIC  
OF GUIZHOU, CHINA, AND IMPLICATIONS FOR ICHTHYOSAUR  
ECOLOGICAL DIVERSITY

SANDER, P. Martin, University of Bonn, Bonn, Germany; CHEN, Xiaohong, Yichang Institute of Geology, Yichang City, China

The Triassic witnessed an unprecedented radiation of marine reptiles, possibly triggered by the Permian/Triassic extinction event or the dramatic decline of atmospheric oxygen content during this period. The most successful group in this radiation were the ichthyosaurs which during the Triassic reached their greatest ecological diversity, including durophagous forms, piscivores, possibly specialized suction feeders, and large marine predators. In this study, we describe a new species of large (~8 m) ichthyosaur, *Shastasaurus* nov. sp., from the early Carnian of Guizhou Province, southwestern China, that combines a small head and abbreviated snout with a very elongated body and apparently poorly ossified extremities. The material consist of two adults and one juvenile skeleton of half the adult size and comes from the Xiowa Formation of the Guanling area. The new material shares several derived characters with *Shastasaurus pacificus* from the Upper Triassic of California, but there are sufficient differences to warrant its description as a new species. Features of the skull anatomy suggest that both species of *Shastasaurus* shared the same special feeding adaptation. The remarkable diversity of ecomorphotypes in Triassic ichthyosaurs was lost at the end of the Triassic, and only generalized piscivorous ichthyosaurs seem to have survived into the Jurassic.

Technical Session XVI, Saturday 3:45

TAXONOMY, BIOCHRONOLOGY, AND PALEOECOLOGY OF LATE MIOCENE-EARLY PLIOCENE PROBOSCIDEANS FROM LANGEBAANWEG, SOUTH AFRICA

SANDERS, William, University of Michigan, Ann Arbor, MI, USA

The late Miocene-early Pliocene Varswater Formation at Langebaanweg, Western Cape Province, South Africa has produced a highly diverse and unique vertebrate assemblage that includes penguins, bears, saber-toothed cats, seals, and cetaceans. The site provides the best representation of animal life in southern Africa from this interval, which was a time of significant climatic and biotic change on the continent, featuring the spread of grasslands and establishment of more modern kinds of mammalian faunas. Also present in the Langebaanweg assemblage is an abundant but largely undescribed sample of proboscideans. Morphometric comparative study of the dental remains from this sample indicates the presence of an anancine gomphothere and two species of elephant. The gomphothere is assignable to a new species, *Anancus capensis*, differentiated from other African anancines by its novel mix of primitive (tetralophodonty) and advanced (prominent ananocoidy, complex occlusal morphology, and six-seven third molar loph(id)s) features. Strong regional endemism of African anancines is revealed by the study, as well. The most common elephant is identified as a primitive precursor to the *Loxodonta exoptata*-*L. africana* lineage, and is placed in a new species, *Loxodonta cookei*. It is characterized by low-crowned, thick-enamelled molars with few plates, low lamellar frequencies, strong loxodont sinuses, and retention of permanent premolars. The archaic mammoth species *Mammuthus subplanifrons* was previously recognized from the sample, and is readily diagnosed by its simpler occlusal morphology, longitudinally twisted tusks, and larger molar size. The elephants appear to have had a wider continental distribution than the gomphothere, and help to phylogenetically link basal and Recent members of their lineages. Biochronological correlation of these taxa indicates an age of ca. 5.0 Ma for the site. Based on analogy with related species, it may be inferred that open conditions and abundant grazing resources were present locally at Langebaanweg at that time.

Poster Session IV (Saturday)

PALEOENVIRONMENTS AND DINOSAUR HABITATS OF THE UPPER CRETACEOUS NEMEGT FORMATION IN THE SOUTHWESTERN GOBI DESERT, MONGOLIA

SANEYOSHI, Mototaka, Hayashibara Biochemical Laboratories, Inc., Okayama, Japan; WATABE, Mahito, Hayashibara Biochemical Laboratories, Inc., Okayama, Japan

The Nemegt Formation (Maastrichtian) is widely distributed in the southwestern Gobi Desert, Mongolia, known as dinosaur fossiliferous beds. This study reports the paleoenvironments and dinosaur habitats from the formation based on survey on the fossil localities such as: Khermeen Tsav, Bugin Tsav, Gurlin Tsav, Altan Ula II-IV, Tsagan Khushu and Ulan Khushu. The lithological transition from the underlying Barungoyot Formation (Campanian) to the Nemegt Formation was recognized in Khermeen Tsav. Sedimentary successions in this locality are subdivided, from lower to upper, into the lower white bed (age unknown), the middle red bed (Barungoyot Fm.) and the upper white bed (Nemegt Fm.) as proposed by Polish expedition in 1960s. We recognized wide development of fluvial environments with minor eolian and lacustrine conditions in these successions. The eolian deposits of the middle red bed are transitional eastward into the fluvial deposits of the upper white beds. This lateral facies change indicates that these formations are contemporaneous heterotopic facies, and humid condition had been adjacent to eolian environments in the early depositional phase of the Nemegt Formation. In the Bugin Tsav, the Nemegt Formation has widely distributed and yielded rich vertebrate remains including dinosaurs. This formation in this area mainly consists of fluvial deposits that are characterized by lateral accretion of channel deposits and fining-upward sequences. These fluvial deposits have been covered by widely developed, thick eolian sand dune deposits. The fluvial-eolian facies boundary is gradational, which indicate that eolian environments located nearby meandering river. The result of our study shows sand dunes were closely located and coexisted with fluvial environments during deposition time of Nemegt Formation. Eolian deposits of the Djadokhta (Campanian) and Barungoyot beds yield rich dinosaur remains. However, the eolian of the Nemegt Formation does very limited number of fossils such as bone fragments and dinosaur eggs. This difference suggests that the eolian environments of the Nemegt age had been no longer utilized as a constant habitat by the dinosaurs.

Technical Session XVII, Saturday 3:00

DINOSAURS AND DIRT: DINOSAUR PALEOECOLOGY, PALEOSOL STRATIGRAPHY, AND ISOTOPE GEOCHEMISTRY FROM THE UPPER AGUJA FORMATION (LATE CRETACEOUS: LATE CAMPANIAN - EARLY MAASTRICHTIAN), BIG BEND NATIONAL PARK, TEXAS

SANKEY, Julia, California State University, Stanislaus, Turlock, CA, USA; DRIESE, Steve, Baylor University, Waco, TX, USA; NORDT, Lee, Baylor University, Waco, TX, USA; DWORKIN, Steve, Baylor University, Waco, TX, USA

Big Bend National Park, Texas contains the southern-most Late Cretaceous through Paleocene vertebrates in the U.S. A high-resolution stratigraphic record has been analyzed for the Cretaceous through early Paleocene alluvial deposits exposed in Dawson Creek. Paleoclimatic and paleoenvironmental changes were documented from analyses of carbon and oxygen isotopes from paleosol carbonate nodules. In response to long-term sea level fall, mixed- to suspended-load fluvial paleoenvironments change from a coastal plain (late Campanian) to inland floodplain (early Maastrichtian to early Paleocene) setting. Although paleoclimate generally cooled during the Late Cretaceous and seasonality of temperature and precipitation in Big Bend increased, two short episodes of atmospheric warming occurred from 69.5 to 68.5 Ma and 65.5 to 65 Ma. Our study combines the paleoclimatic, paleoenvironmental, and vertebrate data to track changes during this time. Important late Campanian to Maastrichtian fossil sites occur in the upper Aguja Formation at Rattlesnake Mt., and were correlated to the Dawson Creek section via paleosol stratigraphy. Two paleosols are correlated to paleosols #42 and #43 in the Dawson Creek section based on similar features and trends in carbon and oxygen isotopes derived from pedogenic carbonate. At Rattlesnake Mt., these paleosols are directly above a bonebed that produced the most complete skull of the ceratopsian dinosaur, *Chasmosaurus mariscalensis*, and hundreds of fossils of fish, salamander, lizard, turtle, crocodylian, dinosaur (hadrosaur, ankylosaur, tyrannosaurid, cf. *Saurornitholestes*, ornithomimid, and other theropods), dinosaur eggshells, pterosaur, and mammal. Overlaying these paleosols are coarser-grained, more inland floodplain deposits of the uppermost Aguja (early Maastrichtian). A complete hadrosaur femur was collected from this unit. Based on the abundant soil nodules, seasonal aridity started at least as early as the late Campanian and became more intense and frequent in the Maastrichtian. Big Bend vertebrates were unique, adapted to drier environments during this time compared to their northern counterparts.

Romer Prize Session, Thursday 11:15

ORIGIN AND EARLY LOSS OF PAIRED FINS: THE PROBLEMS OF CHARACTER POLARITY IN STEM-GNATHOSTOMES

SANSOM, Robert, Bristol University, Bristol, United Kingdom

The evolutionary origin of gnathostomes represents a significant overhaul of the vertebrate body plan. A huge morphological gap exists between extant cyclostomes and gnathostomes; thus our only recourse is to the fossil taxa if we want to answer questions about this episode of increasing complexity and genome duplication. Stem-gnathostome groups such as galeaspid, osteostracans and placoderms show a step-wise addition of jawed vertebrate characters, yet our understanding of this important transition is limited by a lack of knowledge of the intrarelations and character polarity within each. This is especially true for the sister clade to jawed vertebrates - the Osteostraci - for which, controversy surrounds their ancestral morphotype, be it with developed pectoral and dorsal fins or entirely finless. The current situation therefore presents a difficulty in understanding the evolution and development of crucial characters. To address these problems, a comprehensive phylogenetic analysis of the Osteostraci was necessary, including numerous representatives of jawed and jawless taxa, both extant and extinct. The new phylogeny presented here allows reconstruction of key stages such as the hypothetical ancestors of Osteostraci and gnathostomes. The finned non-cornuates are confirmed as the basal-most Osteostraci and thus paired pectoral fins are homologous for jawed vertebrates and Osteostraci, having evolved once in their last common ancestor. Hypotheses of a finless osteostracan ancestor are firmly rejected, thus fin loss has occurred within the group i.e. in the tremataspids. The tremataspids can therefore now be added to the already well-characterized examples of pectoral fin/limb loss in vertebrates such as snakes, caecilians and eels. What makes the tremataspids exceptional however is that the loss occurs almost immediately after the initial evolution of this crucial character, both phylogenetically and temporally.

Ernie Lundelius Symposium (Faunal Dynamics and Extinction), Wednesday 10:45  
"A NEW LAND OF THE EYE": PARADIGMS AND PROBOSCIDEANS IN THE SOUTHERN GREAT LAKES REGION, USA

SAUNDERS, Jeffrey, Illinois State Museum, Springfield, IL, USA; CAMPBELL, G., Biological and Earth Science Department, Lincoln, IL, USA; MCCULLUM, Judd, Department of Biological and Earth Science, Lincoln, IL, USA; TREWORGY, Janis, Geology Department, Elsah, IL, USA

Four new AMS dates on *Mammuth americanum*, one on (presumptive) *Mammuth primigenius*, as well as OSL dates on *Mammuth* sp. are correlated with dated pollen records from northeastern (Nelson Lake) and central (Chatsworth Bog) Illinois. These localities and dates are Hawthorne Farm: 12,248±40 RC yr BP; Brewster Creek:

11,455±35 RC yr BP; Aurora 2: 11,320±50 RC yr BP; Aurora 1: 11,130±30 RC yr BP; Lincoln College: 11,635±45 RC yr BP; and Principia College: 20,600±2100 cal. yr BP (average of 2 OSL dates, calibrated to 17,300±1800 RC yr BP), respectively. Our data show *Mammuthus americanum* inhabiting spruce (*Picea*) and black ash (*Fraxinus nigra*) forest during the Bolling/Allerød (14,600–12,800 cal. yr BP) and early Younger Dryas (12,800–11,600 cal. yr BP) intervals. The Lincoln College (p) *Mammuthus primigenius* inhabited a forest of predominately black ash during the Allerød period. This vegetation suite has no modern analog, but black ash grows in swamps and poorly drained soils, and the high percentages of black ash pollen (>50%) prevailing at Chatsworth Bog at the time of (p) *Mammuthus primigenius* indicate a relatively warm, very wet climate. Although a pollen profile is not available for the interval of *Mammuthus* sp. at Principia College we infer spruce dominated an open wooded landscape including sage (*Artemisia*) and grasses. Hitherto, our paradigm of proboscidean succession during the full- to late-glacial period was based on the vegetation succession of tundra-like vegetation to spruce forest to spruce-deciduous forest. The presumed proboscidean succession was that of cold, dry steppe-adapted *Mammuthus primigenius* succeeded by more warmth- and mesic-tolerant *M. jeffersonii* that in turn was succeeded by wet forest adapted *Mammuthus americanum*. Our data do not support this view and indicate a need for reevaluation of other assumptions of proboscidean ecology and history, e.g., the environmental tolerances and habits of *M. primigenius* in the “Southern Refugium” and the timing of the immigration of this mammoth into regions south of 55 degrees N.

#### Poster Session I (Wednesday)

##### NEW EVIDENCES ABOUT THE EARLY EVOLUTION OF DERIVED MACROSTOMATANS (SQUAMATA, SERPENTES)

SCANFERLA, Agustin, Museo Argentino de Ciencias Naturales, Buenos Aires, Argentina

Tropidophiids are currently represented by two recent forms (*Tropidophis* Bibron and *Trachyboa* Peters), restricted to the Neotropical biogeographical realm. Except for some vertebral remains, no other evidence was available about extinct tropidophiids in tropical America. Here we report a new and indisputable member of this family clade, from Tiupampa fossil site, a highly productive early Late Paleocene locality in central Bolivia. This new snake (Museo de Historia Natural de Cochabamba MHNC 1321) constitutes the best-known South American Paleocene snake ever discovered, being represented by articulated cranial and postcranial material. Macrostromatan (“advanced snakes”) traits present in the new snake are: rostral portion of prefrontal bone covering the nasal gland as well as roofing the *aditus conchae*, and lateroventral portion of prefrontal (serving for articulation with the maxilla) is caudally positioned. Moreover, tropidophiid features include palatine with wide and plate-like vomerine process, lacrimal foramen piercing the maxilla/prefrontal contact, and proximal postorbital extremely bifurcated. The new snake exhibits a well-developed coronoid bone, in sharp contrast with living tropidophiids in which this bone is absent or fused to the compound bone. A remarkable postcranial trait of MHNC 1321 is the presence of a haemal keel in mid-posterior trunk vertebrae, in contrast with the “plate-like” morphology characterizing extant tropidophiids. The new discovery reinforces a South American origin for the Tropidophiidae, but most importantly it indicates that the diversification of derived macrostromatans was well underway during the early Late Paleocene, at least.

#### Poster Session IV (Saturday)

##### FIRST ASIAN *SINOPA* (PROVIVERRINAE, HYAENODONTIDAE, CREODONTA) FROM THE LATE MIDDLE EOCENE OF NORTHERN CHINA

SCHAAL, Stephan, Forschungsinstitut Senckenberg, Frankfurt am Main, Germany; MORLO, Michael, Forschungsinstitut Senckenberg, Frankfurt am Main, Germany; CHEN, Yuejun, Jilin University, Changchun, China; LI, Chuntian, Jilin University, Changchun, China

During recent field work by the Forschungsinstitut Senckenberg and the Research Center of Paleontology, Jilin University, the mandible fragment of a proviverrine hyaenodontid was discovered from the late middle Eocene locality Gonglangtuo in the oil shales of Huadian coal mines, Jilin Province, Northeast China. The previously known fossil assemblage consists of plants, gastropods, fishes, turtles, birds, and 5 genera of small mammals, including the omomyid *Asiomomys*. The lack of larger mammals (other than the new proviverrine) implies size biasing due to taphonomic processes. The proviverrine specimen is separated in two parts, one bearing p2-3 and the other bearing p4-roots and m1-3. It represents the most northern and one of the latest and most complete Asian proviverrines known so far. Representing a new species of *Sinopa* (characterized by m3 clearly smaller than m1, very strong and extended labial molar cingulids, backward leaning protoconids, cristid obliqua joining postvallid very labially), it is the first Asian creodont definitely belonging to a hitherto strictly North American genus. It also probably represents the youngest species of *Sinopa*, because the age of the Huadian formation is correlated to the later Uintan and no *Sinopa* specimens are yet reported from later than the lowest Uintan. Its occurrence in the Huadian Formation supports the idea of a faunal exchange between North America and Asia in the early middle Eocene, a hypothesis formerly based mainly on the presences of

*Asiomomys* in the Huadian Formation and of *Trogosus* and closely related tillodonts in East Asia, as well as on some perissodactyl genera shared between the middle Eocene of North America and the Irddimmanhan. As with the new *Sinopa* species, these taxa had their closest relatives in North America. Presence of *Sinopa* in Asia also opens the possibility that other Asian proviverrines root in North American taxa as well. Asian *Paratritemnodon*, *Yarshea*, and *Kyawdawia* resemble *Arfia* in several respects (e.g., morphology of m1, relative molar sizes), but it remains unclear whether North American or Asian *Arfia*, which is now known from the early Eocene of Mongolia and China, is closer.

#### Poster Session IV (Saturday)

##### A PRELIMINARY REPORT OF A NEW SPECIMEN OF *CHIROSTENOTES* (OVIRAPTOROSAURIA: THEROPODA) FROM THE HELL CREEK FORMATION OF NORTH DAKOTA

SCHACHNER, Emma, University of Pennsylvania, Philadelphia, PA, USA; LYSON, Tyler, Yale University, New Haven, CT, USA; ATTERHOLT, Jessie, University of Pennsylvania, Philadelphia, PA, USA; HANKS, Harold, Marmarth Research Foundation, Marmarth, ND, USA

*Chirostenotes* is a rare and poorly known, medium sized theropod dinosaur from the Late Cretaceous of North America. The genus is known mostly from cranial fragments, the vertebral column, and distal hindlimb and manual elements. Recent collections in channel sandstone deposits of the Hell Creek Formation (upper Maastrichtian) of southwestern North Dakota have resulted in the discovery a new specimen of *Chirostenotes* composed of multiple corresponding postcranial elements. Recovered elements include three cervical vertebrae, a complete scapulocoracoid, a radius, an ulna, and a single dorsal rib. The genus *Chirostenotes* encompasses two morphs that have been divided into distinct species, *C. pegraclis* and *C. elegans*, however there are no diagnostic features on the new specimen that allow for any conclusive species assignment. The vertebrae of the new specimen share the following features with previously described specimens: the centrum is long and narrow, there are pneumatic foramina in the centrum, the neural arch is low and broad, there are pedicular fossae on either side of the neural arch, the neural canal lies beneath a subtriangular recess associated with the attachment of interspinous ligaments, and the transverse processes are robust and subtriangular in transverse section. An unusual feature of the new specimen is the fusion of the cervical ribs to both the diapophyses and the parapophyses. The scapulocoracoid is a single fused element indicative of an adult individual. The radius and ulna are approximately equal in length, and the ulna is bowed as in other oviraptors. The scapula, radius, and ulna are all elements previously undescribed for the genus *Chirostenotes*, and provide new information on the skeletal morphology of this unusual theropod.

#### Poster Session II (Thursday)

##### HIGH-RESOLUTION VIRTUALIZATION OF DINOSAUR FOOTPRINTS AND ROCK ART IN THE FIELD USING A LOW-COST, HIGH-RESOLUTION LASER-SCANNER

SCHLADER, Robert, Idaho Virtualization Laboratory, Pocatello, ID, USA; BREITHAUPT, Brent, University of Wyoming, Laramie, WY, USA; CLEMENT, Nicholas, Idaho Virtualization Laboratory, Pocatello, ID, USA; CHAPMAN, Ralph, Idaho Virtualization Laboratory, Pocatello, ID, USA; PETERSEN, Christian, Idaho Virtualization Laboratory, Pocatello, ID, USA

Many of the fossils and archeological artifacts available to natural scientists can only be studied in the field because it is difficult, impossible, or undesirable to make the original specimens part of museum collections. Dinosaur footprints, for example, are notoriously difficult to remove from most outcrops without removing and storing large volumes of associated rock. Further, their geological context is an important component of their interpretation. Other paleontological and geological objects (e.g., other ichnofossils, sedimentary structures, items as parts of buildings, etc.) may be impossible to remove for either physical or economical reasons. Archaeological objects such as rock art often have an important geographical context that is essential for their interpretation so, consequently, removing them from the field can only be justified if their short-term existence is threatened, and only when allowed by the native people linked to the art. The optimal solution is to be able to study virtual models of these specimens in the laboratory while retaining the original fossils in the field in their original context. We have developed a system for virtualizing these objects by utilizing a new, low-cost surface laser-scanner and portable power units. These materials can be transported into the field and used on-site to capture high-resolution virtual models very rapidly. Further, once captured virtually, these models can be used to produce high-quality physical replicas at any scale for inclusion in museum collections, if desired. An additional bonus is that the resulting virtual models can show detail not apparent in the field because they allow viewing with greater flexibility in angle and lighting. The total cost of the technology for this work is less than \$5,000, an amount approachable for many research budgets, and the same technology also works perfectly within the laboratory, as well.

Poster Session III (Friday)

DIEL ACTIVITY PATTERN OF *ARCHAEOPTERYX*

SCHMITZ, Lars, University of California, Davis, Davis, CA, USA; MOTANI, Ryosuke, University of California, Davis, Davis, CA, USA; MILNER, Angela, Department of Palaeontology, London, United Kingdom

The quantitative inference of behavior in fossil amniotes is a major challenge in vertebrate paleontology. Here we present a new method to infer diel activity pattern in fossil Avialae and test a previously suggested hypothesis of diurnality in *Archaeopteryx*. Amniote eyes cope with highly variable light environments depending on their diel activity pattern. The maintenance of optimal image quality is especially difficult in low light conditions, because the photon number reaching the retina (retinal illumination, RI) sets a limit to potential visual performance. The bias can be partly compensated for by having either an optical system that maximizes RI or a sensory system that can react to the low availability of photons. Visual optics predicts several modifications to increase RI, e.g., the diameter of the fully dilated pupil (A) should be maximized for given eyeball diameter (D) and posterior nodal distance (PND). We tested this prediction by analyzing eyeball soft tissue dimensions of 53 extant amniote species, including mammals, birds, and squamates. It is known that PND is linearly correlated with eyeball axial length (l), and we demonstrate that A can be modelled by equatorial lens diameter (d). Results from multi- and bivariate analyses confirm our prediction and enable separation of nocturnal from diurnal species. Because eyeball soft tissues are not preserved in the fossil record they need to be estimated from osteology. We modelled d with internal diameter of sclerotic ring, D with orbit length, and l with orbit depth, and analyzed 157 extant bird species. Again, we were able to distinguish between nocturnal and diurnal species. We applied this method to *Archaeopteryx*, which is the only fossil avialan where skull distortion has been removed digitally thus far. Orbit depth was obtained from the retrodeformed skull of the London specimen and we scaled this dimension to fit the smaller Berlin and Eichstätt specimens. The Berlin specimen plotted within the range of diurnal birds, whereas the Eichstätt specimen fell outside. Considering error factors in our measurements, we conclude that the hypothesized diurnality in *Archaeopteryx* remains unproven.

Poster Session IV (Saturday)

VERTEBRATE PALEONTOLOGY AND GEOLOGICAL SETTING OF THE KEM KEM BEDS, MOROCCO

SCHOUTEN, Remmert, University of Bristol, Bristol, United Kingdom; DYKE, Gareth, University College Dublin, Dublin, Ireland; IBRAHIM, Nizar, University College Dublin, Dublin, Ireland; JALIL, Nour-Eddine, Cadi Ayyad University, Marrakech, Morocco; ZOUHRI, Samir, Université Hassan II, Casablanca, Morocco. The Kem Kem beds of Morocco form part of the 'Continental Intercalaire', a sediment package that extends across much of North Africa. Kem Kem sediments are exposed as a series of escarpments with fossils located at the base of large, cross-bedded sandstone units. Sedimentary features are consistent with a large-scale northward-trending river network; sediments comprising this package lie beneath late Cenomanian transgressive marine carbonates and are disconformable onto palaeozoic rocks of the middle Atlas. Similar deltaic environments have also been reported from Egypt and Tunisia. We have sampled fossil vertebrate remains along a 120km north-south transect of the Cenomanian Kem Kem beds in southern Morocco, confirming and adding elements to the known fauna. Fossils collected are placed into a detailed spatial and stratigraphic database, part of a comparative analysis across the whole of North Africa. The fossils include remains of crocodiles, turtles, dinosaurs, pterosaurs and birds. Mapping the results of our faunal survey onto the regional geological context of the middle Atlas for the first time demonstrates a range of preservation styles, contrasting bone taphonomy, surface diagenesis and articulation. We discuss the importance of the Kem Kem fauna and setting in the wider context of the North African late Cretaceous, biogeographically an important time in the evolution of a number of vertebrate groups, including turtles, pterosaurs, dinosaurs, snakes and birds.

Ernie Lundelius Symposium (Faunal Dynamics and Extinction), Wednesday 10:00  
AN UPDATE ON THE PALEOBIOLOGY OF GIANT SHORT-FACED BEARS, *ARCTODUS SIMUS*

SCHUBERT, Blaine, East Tennessee State University, Johnson City, TN, USA

Giant short-faced bear remains are known from over one hundred localities in North America, extending from coast to coast, and from Alaska to Mexico. One obvious gap in the geographic distribution of this species has been in the Southeast where two other tremarctines, *Arctodus pristinus* and *Tremarctos floridanus*, primarily occurred. New records of *Arctodus simus* reported here indicate it had a broader range than previously thought, extending deep into southeastern North America. The overlap in distribution of *Arctodus* species led to a re-examination of the temporal records of both taxa, as well as dental characters used to separate them. This analysis shows that metric proportions of molars are sufficient for distinguishing these species and that *Arctodus pristinus* is not known from post-Irvingtonian localities. *Arctodus simus* is primarily a Rancholabrean taxon, but one reported radiocarbon date suggests it survived the peak of the late Pleistocene extinction event, meeting its ultimate demise sometime in the early Holocene. If this is the case then *A. simus* coexisted with, and outlasted, the Clovis

archaeological complex. This temporal overlap may have had important implications for early humans on the continent, particularly if this bear preferred a diet of meat. Previously reported stable isotope analyses on *A. simus* specimens from northern portions of their range indicate a high percentage of animal protein in the diet. Reports on the ecomorphology of the species suggest it was not an active predator but may have been a specialized scavenger. Here, isotopic analyses from *A. simus* specimens across their range are reported and provide new insight into the diet and feeding behavior of these bears.

Technical Session IX, Friday 8:45

THE FIRST DINOSAUR TRACKSITE FROM THE ARABIAN PENINSULA

SCHULP, Anne, Natuurhistorisch Museum Maastricht, Maastricht, Netherlands; AL WOSABI, Mohammed, Sana'a University, Sana'a, Yemen

We report a multi-taxon dinosaur track assemblage near Madar village, Arhab area, 47 km north of Sana'a, Republic of Yemen. It is the first dinosaur tracksite on the Arabian Peninsula, and the only multi-taxon dinosaur ichnosite in the Middle East. Eleven parallel trackways represent a sauropod herd, with isolated tracks and trackways of sauropod and ornithopod dinosaurs nearby. The discovery is of temporal and geographic significance, given the very limited dinosaur record from the region. The Madar site is situated in a sub-horizontal outcrop of Amran Group yellow limestones. Ammonite fauna indicates a Callovian-Berriasian age for the Amran Group, whereas foraminiferal assemblages suggest a Bathonian-Berriasian age. The track horizon may correlate with the Oxfordian - Kimmeridgian *Alveosepta jaccardi* foraminiferal biozone. A bipedal tri-dactyl series spanning 14 m reveals 15 consecutive tracks; we refer these tracks to an ornithopod trackmaker. Eleven parallel quadrupedal trackways preserve evidence of large and small sauropods traveling together in a herd. The longest (16 m) of these trackways currently preserves 16 consecutive footprints. As with the bipedal trackway, potential exists for discovering additional tracks by further exposing the layer north of the site. The antero-posteriorly short manus, along with u-shaped manus impressions suggest an arc-shaped articulation of metacarpals, as seen in the Neosauropoda. The quadrupedal trackways at Madar are relatively narrow gauge, with the left and right pes tracks touching (but not overlapping) the trackway midline, unlike the wide-gauge trackways typically associated with titanosaurs. Given this narrow-gauge stance, together with a more derived, arc-shaped manus impression, the quadrupedal tracks were likely made by nontitanosauriform neosauropods. Preservation of both ornithopod and sauropod dinosaurs at Madar hints at global patterns in dinosaurian evolution that document a marked transition from sauropod- to ornithopod-dominated faunas at the Jurassic-Cretaceous boundary. It is only with intensified sampling effort that such patterns can be elucidated for Afro-Arabia.

Ernie Lundelius Symposium (Faunal Dynamics and Extinction), Wednesday 8:45  
PLEISTOCENE (IRVINGTONIAN, CUDAHYAN) VERTEBRATES FROM THE TEXAS PANHANDLE AND THEIR GEOGRAPHIC AND PALEOECOLOGIC SIGNIFICANCE

SCHULTZ, Gerald, West Texas A&M University, Canyon, TX, USA

The Cudahy fauna was named by C.W. Hibbard for a fossil assemblage recovered from silty clays beneath the "Pearlette" volcanic ash at the type Cudahy ash pit and other sites in Meade County, Kansas. The "Pearlette" ash comprises several variously dated Yellowstone ashes. The Cudahy (=Lava Creek B) ash is variably dated at 602-670 ka and is an important geochronologic marker in the Plains. The term Cudahy fauna is now restricted to that of the type locality although other Cudahy-type (Cudahyan) faunas have been described. From 1968 to 1971, 30 tons of silty clay and diatomite were collected from below outcrops of Lava Creek B ash at elevations of 3240 to 3500 feet in the High Plains of the Texas Panhandle. Screenwashing yielded about 30 mammal taxa and numerous small amphibians, reptiles, birds, and mollusks. Four local faunas (Woody Draw, Bull Draw, Mayfield Ranch, and Deadman's Creek) are recognized. These faunas, dominated by shrews and arvicoline rodents, are compositionally similar to each other and to the Cudahy and Sunbrite ash pit faunas of Meade County even though the Panhandle sites are 300 to 340 km southwest of the Kansas sites and are 700 to 950 feet higher in elevation. The Panhandle faunas include *Sorex cinereus*, *Sorex megapalustris*, *Cynomys*, *Spermophilus*, *Geomys tobinensis*, *Thomomys*, *Peromyscus cragini*, *Reithrodontomys moorei*, *Ondatra annectens*, *Mictomys meltoni*, *Microtus llanensis* (rare), *Microtus paroperarius*, and *Microtus (Pitymys) meadensis*. The large sample size of the latter two taxa permits statistical comparisons of teeth with those from Kansas. Local habitats consisted of ponds or playas with marshy areas suitable for shrews, muskrats, and bog lemmings. Moist grassy meadows nearby would have been inhabited by voles, mice, and some of the shrews; the less abundant gophers, ground squirrels, and prairie dog would have preferred drier, grassy uplands with well-drained soils. Several mammals (e.g. bog lemming) show affinities with extant boreal species that range through Canada and the northern U.S. The collective evidence suggests that the Texas Panhandle enjoyed cooler summers with more effective rainfall during Cudahy time.



Poster Session IV (Saturday)

REVISION OF *CETIOSAURISCUS GREPPINI*: THE REVIVAL OF A LATE JURASSIC SAUROPOD FROM SWITZERLAND

SCHWARZ, Daniela, Naturhistorisches Museum Basel, Basel, Switzerland; WINGS, Oliver, Universität Tübingen, Tübingen, Germany; MEYER, Christian, Naturhistorisches Museum Basel, Basel, Switzerland

*Cetiosauriscus greppini* represents the only skeletal find of a sauropod from Switzerland and ranks among the few well-preserved European sauropod skeletons. The remains originate from the Reuchenette Formation (Early Kimmeridgian *sensu gallico*) and were found in the 1870's near Moutier, canton of Bern, in a greenish lens of marls and limestone, indicating deposition in an ephemeral lake. The material represents at least three individuals of different size, of which the holotype is the most complete specimen. Preserved bones comprise skull fragments, a cervical vertebra, several caudal vertebrae, isolated neural spines, and many appendicular bones, such as scapulae, a coracoid, humeri, an ulna, femora, tibiae and a fibula. In the holotype, the distal extremity of the right humerus bears a well-preserved articular cartilage capsule, consisting of hyaline cartilage and fibrocartilage. In life, this cartilage is estimated to have been at least 3-5 cm thick between the humerus and antebrachium. Comparisons with extant archosaurs imply that the humerus length of *C. greppini* was 6 to 10% larger than previously thought. The material of *C. greppini* has received very little attention since the 1920s, being considered either a nomen dubium or completely ignored. Our revision of the taxon has revealed diagnostic characters, allowing a new taxonomic and systematic assignment. In comparison to *Cetiosauriscus stewarti*, the holotype specimen of *C. greppini* is remarkably smaller, but still appears to have been an adult, probably aged individual. Several characters clearly distinguish *C. greppini* from *C. stewarti*, such as vertical and wing-like caudal ribs, diapophyseal laminae at the anterior caudal transverse processes, coracoid with a notch ventrally to the glenoid articular surface, and more proximally positioned 4th trochanter. These characters certify that both taxa are distinctive at the generic level. Phylogenetically, *Cetiosauriscus greppini* is most probably a non-neosauropodan eusauropod closely related to *Turiasauria*.

Student Poster Session (Thursday)

MARINE REWORKING IN EASTERN NORTH AMERICA CAMOUFLAGED AN AFRICAN SPECIES OF *SQUALICORAX* (NEOSELACHII, LAMNIFORMES)

SCHWIMMER, David, Columbus State University, Columbus, GA, USA

*Squalicorax* lamniform shark species were global in distribution in the Late Cretaceous. Their presence in North America is amply documented by teeth from four species in approximate chronological appearance: *S. curvatus*, *S. falcatus*, *S. kaupi* and *S. pristodontus*. A fifth tooth form from eastern North America has only anecdotal support, and has been referred to either *Squalicorax bassanii*? or *Squalicorax sp.* However, I show that these Eastern continental representatives can be reliably assigned to *Squalicorax yangaensis*, a shark taxon known primarily in central Africa, Morocco and Syria. *Squalicorax yangaensis* is in fact fairly common in Gulf and Atlantic coastal sediments, but largely unrecognized because marine erosion and redeposition obscures the characteristic second-order serration, which is the only reliable characteristic separating the species from the ubiquitous, contemporary *S. kaupi*. To date, *S. yangaensis* teeth are found in Campanian-Maastrichtian marine deposits in Alabama, Georgia, North Carolina and New Jersey. Their occurrence coincides with another African marine fish, *Phacodus punctosus*, in the eastern USA Coastal Plains. The presence of these two "African" taxa suggests that drift currents existed in the Late Cretaceous between West Africa and southern-eastern North America, favoring marine faunal interchange

Ernie Lundelius Symposium (Faunal Dynamics and Extinction), Wednesday 12:15  
EXTINCTIONS, SCENARIOS, AND ASSUMPTIONS: CHANGES IN LATEST PLEISTOCENE LARGE HERBIVORE ABUNDANCE AND DISTRIBUTION IN WESTERN NORTH AMERICA

SCOTT, Eric, San Bernardino County Museum, Redlands, CA, USA

Proposed explanations for the terminal Pleistocene large mammal extinction event in North America include climate warming, overhunting by early humans, and disease. Climate change hypotheses have not fully explained why large mammals were the primary victims, or why earlier warming periods of similar intensity failed to cause significant extinctions. Overkill proponents face few confirmed kill sites, little or no evidence of any but a few extinct species having been hunted, unsupported assumptions about native prey naïveté, and uncertainty about the timing of the initial human occupation of North America. The "hyperdisease" scenario presently lacks hard supporting data. A key assumption common to all these scenarios is that large mammals present near the end of the Pleistocene were also present in similar abundance, with similar geographic distributions, during earlier, equally severe warming periods (e.g., ~130 ka). This assumption is challenged here. An important difference in the latest Pleistocene was the profusion and geographic extent of the genus *Bison*, particularly in the American West. Living bison are massive grazing ruminants that dramatically impact biological communities; their Pleistocene forebears were still larger. During the late Pleistocene, south of the glacial ice, the species *Bison antiquus* was more widely distributed and present in

greater profusion than earlier species such as the larger *B. latifrons* and the more northerly *B. priscus*. In the Great Plains, bison were virtually nonexistent prior to 50 ka, exceeding other large mammal taxa numerically only after 20 ka. In the southwest, fossils of *Bison* are relatively common at localities less than 40 ka in age, but less numerous or absent in earlier assemblages. The increased abundance of these large, aggressive, herd-dwelling ruminants in the late Pleistocene constitutes a critical difference between this time period and earlier, similarly intense interglacials. Extinction scenarios for Pleistocene North America should avoid assuming a relatively static long-term faunal component, and account for the impacts of nonhuman immigrant species on natives.

Technical Session X, Friday 12:00

A NEW CONTINENTAL RECORD OF WARMING DURING THE PALEO-CENE-EOCENE THERMAL MAXIMUM IN NORTH AMERICA

SECOND, Ross, University of Michigan, Ann Arbor, MI, USA; GINGERICH, Philip, University of Michigan, Ann Arbor, MI, USA

LOHMANN, Kyger, University of Michigan, Ann Arbor, MI, USA; The late Paleocene and earliest Eocene of North America are marked by several mammalian intercontinental dispersal events involving higher-order taxa. The largest of these occurred during the Paleocene-Eocene Thermal Maximum (PETM), which is associated with a negative carbon isotope excursion (CIE) that now defines the Paleocene-Eocene boundary. Facilitated by warming at high-latitudes during the PETM, Euprimates, Artiodactyla, and Perissodactyla dispersed across the Holarctic, permanently altering mammalian history. In spite of the importance of the PETM, the timing and magnitude of continental warming are poorly constrained. Here we present a proxy climate record, based on oxygen isotopes in *Phenacodus* tooth enamel, to better constrain PETM warming. Data are from the northern Bighorn Basin, Wyoming (paleolatitude 45°N). Our stable isotope record differs from previous records either in being of higher resolution or in controlling for seasonal variability by sampling only a single tooth position.  $\delta^{18}\text{O}$  in tooth enamel reflects the composition of surface water, which is strongly influenced by that of precipitation.  $\delta^{18}\text{O}$  in modern precipitation is strongly correlated with mean annual temperature (MAT), but the slope of this relationship may have been different in the Paleogene. Therefore, we calculate a  $\delta^{18}\text{O}/\text{MAT}$  slope that is specific to the Bighorn Basin, using published MAT estimates from leaf-margin analyses and new isotope data from early Eocene mammals. By this calculation temperature increased during the PETM by 9 to 10°C, which exceeds previous continental estimates. Warming occurred in two pulses. The first was in the 150 to 15 kyr interval preceding the CIE. The second was probably coincident with the release of greenhouse gases associated with the onset of the CIE. Immigrants do not appear until after the CIE onset, suggesting that the first pulse of warming was insufficient to open dispersal routes.

Technical Session XVI, Saturday 3:15

NEW RECORDS OF EOCENE AND OLIGOCENE AFROSORICIDA FROM THE FAYUM DEPRESSION, EGYPT

SEIFFERT, Erik, Stony Brook University, Stony Brook, NY, USA; SIMONS, Elwyn, Division of Fossil Primates, Duke Lemur Center, Durham, NC, USA; RYAN, Timothy, Pennsylvania State University, University Park, PA, USA; BOWN, Thomas, Erathem-Vanir Geological, Inc., Westminster, CO, USA

Afrosoricids (tenrecoids and chrysochlorids) differ from their afrotherian relatives in having zalambdodont molars - that is, their upper molar metacones and lower molar talonids are greatly reduced or absent, and their lower molars have capacious hypoflexids for occlusion of enlarged upper molar paracones. This molar occlusal pattern is generally assumed to be homologous in tenrecoids and chrysochlorids, but small metacones and relatively broad talonids are present in the extant tenrecoid *Potamogale* and early Miocene *Protenrec*, leaving open the possibility that zalambdodonty evolved convergently within Afrosoricida. On the basis of lower dental remains, late Eocene *Widanelfarasia*, from the Jebel Qatrani Formation in Egypt, has been interpreted as an incipiently zalambdodont stem afrosoricid or stem tenrecoid. Here we describe the upper dentition of *Widanelfarasia* and partial mandibles, maxillae, and isolated teeth of four additional taxa from the Fayum area that range in age from 37 to 32 Ma. *Widanelfarasia* exhibits a surprising suite of dental features in combining a dilambdodont M1, an incipiently zalambdodont M2, and an almost fully zalambdodont M3. Unique premolar features, such as the presence of a P4 ectocrista and ectostyle and an inset P3, are shared with certain living and extinct tenrecs to the exclusion of golden moles, and support *Widanelfarasia's* placement as a stem tenrecoid. A more primitive genus from the 37 Ma locality BQ-2 is similar in overall morphology to *Widanelfarasia* but retains a well-developed metacone on its moderately dilambdodont M3, suggesting that tenrecoid zalambdodonty may be derived from dilambdodonty. Additional evidence for convergent evolution of zalambdodonty within Afrosoricida is provided by two new genera from the ~33-32 Ma Quarry E, one of which is a relatively advanced stem tenrecoid, and the other of which is a tribosphenic stem chrysochlorid that differs markedly from Fayum tenrecoids in details of lower premolar and molar morphology.

“WHAT IF” TESTING IN DINOSAUR FUNCTIONAL ANATOMY USING EVOLUTIONARY ROBOTICS

SELLERS, William, University of Manchester, Manchester, United Kingdom; MAN-  
NING, Phillip, University of Manchester, Manchester, United Kingdom

It is a common occurrence in palaeontology that a particular anatomical structure is suggested to have a specific function. Ideally such a hypothesis should be tested by finding a modern analogue possessing the feature and then disabling or removing it and observing the effect on the animal. However such a testing regime is often impossible since either a suitable analogue does not exist or it is difficult to remove or disable the structure without harming the subject. Instead we can create computer simulations both with and without particular features and directly compare the simulated outcomes. If we are confident in the reliability of our model then this provides good evidence of function. In this paper we illustrate this approach by looking at the effect of elastic storage in bipedal dinosaurs. The locomotor capabilities of quadrupedal vertebrates are considerably enhanced by the storage of elastic energy in the back, providing energy recovery from step to step. However, elastic recoil in modern running bipeds is mostly restricted to legs and feet due to a vertical orientation of the torso. We hypothesize that the unique body shape of bipedal dinosaurs may have enabled them to store energy in their horizontally held torso and tail. To test this we developed a number of evolutionary robotic simulations that contained either a rigid or a passively sprung back. By tuning the resonant frequency of this spring we produced significant gains in top speed, coupled with a reduction in metabolic cost. This modelling approach is thus able to isolate the functional significance of a particular anatomical structure. Similarly we consider the functional value of serial and parallel elasticity in limb muscles and tendons by comparing simulations with and without these structures. Once again we demonstrate both considerable energy saving and power amplification illustrating the importance of optimising these parameters if we wish to estimate maximum running speeds in extinct animals.

Ernie Lundelius Symposium (Faunal Dynamics and Extinction), Wednesday 11:30  
AMS <sup>14</sup>C ANALYSIS OF LATE PLEISTOCENE NON-ANALOG (DISHARMONIOUS) FAUNAL COMPONENTS FROM CAVE DEPOSITS IN SOUTHEASTERN NORTH AMERICA

SEMKEN, JR., Holmes, Univ. of Iowa, Iowa City, IA, USA; GRAHAM, Russell, Penn State Univ., University Park, PA, USA

Late Wisconsinian cave faunas from the southeastern United States are characterized by substantially increased species density over that at present. It has been proposed that this richness was achieved by a paleoenvironment that permitted both the immigration and intermingling (co-habitation) of boreal and steppe taxa with the present-day deciduous forest community of southeastern North America. If these species are contemporaneous, they represent communities with no modern analogs. Analysis of 126 AMS <sup>14</sup>C dates from 21 caves proves that non-analog community structure frequently is responsible for this configuration. In fact, this pattern is especially apparent for the Appalachian, Allegheny and Ozark regions. Contemporary dates for 16 presently allopatric or marginally sympatric taxa micromammal taxa, frequently within one standard deviation (+/- 50-70 years), demonstrate both direct and regional association of non-analog taxa. These non-analog communities probably were a result of a unique last glacial environment that existed in southeastern North America at the end of the Pleistocene. These non-analog communities essentially disappeared after the last glacial and are rare in relatively species depauperate Holocene deposits. Contemporaneity of taxa can not be assumed without <sup>14</sup>C dating because time averaging and other mixing processes do occur. The question remains: What is a significant interval of time to assert a community versus a time averaging interpretation for fossil faunas?

Technical Session VI, Thursday 2:15

HYPSONDONT BROWSING: CAMEL AND PRONGHORN DIETARY RECONSTRUCTION THROUGH DEEP TIME

SEMPREBON, Gina, Bay Path College, Longmeadow, MA, USA; RIVALS, Florent, Institut Català de Paleoeologia Humana i Evolució Social, Area de Prehistòria-Universitat Rovira i Virgili, Tarragona, Spain

Dietary adaptations of both Tertiary and Quaternary representatives of North American Antilocapridae and Camelidae were examined through deep evolutionary time (via hypsodonty index), though ecological time (via mesowear analysis), and through the last few days of life (microwear). Fossil samples were from the Great Plains, Great Basin, and Florida and span from the early Miocene to the Recent. Mesowear patterns are strikingly similar in antilocaprids and camels and demonstrate a clear shift toward more abrasive diets beginning in the late Hemphillian (Late Miocene) and then a return to a less abrasive dietary regime beginning in the Pliocene and continuing into the recent. However, microwear patterns are strikingly dissimilar in antilocaprids versus camelids. In addition, hypsodonty indices fall short in terms of accurately predicting most probable modern and paleodiet. This study underscores the need to use an eclectic dietary approach to assess ancient diets and offers new insight into the origin of hypsodonty in these two groups.

PALEOZOIC AND MESOZOIC ANIMAL SOUNDS

SENER, Phil, Lamar State College-Orange, Orange, TX, USA

Acoustic signals are important for many extant arthropods and vertebrates, and the same was presumably true of their fossil predecessors. The fossil record includes no audio recordings but does provide clues to the nature of the animal sounds of the geological past. In some cases, sound-producing structures are preserved. For example, the presence of stridulatory structures in Triassic and later Orthoptera (crickets and kin) and their absence in Paleozoic Orthoptera indicates that orthopteran chirping began in the Triassic Period. In other cases, the time of origin of a clade constrains the time of origin of homologous acoustic behaviors in its members. For example, adult-attracting distress calls by juveniles and adult advertisement displays involving slapping the head on the water are behavioral symplesiomorphies of Alligatoridae and Crocodylidae. These behaviors were therefore present when the two families diverged in the Late Cretaceous. Auditory evolution constrains the time of origin of some acoustic behaviors. For example, terrestrial anti-predator vocalization was probably absent before the appearance of the earliest tympanic ears in terrestrial tetrapods of the Permian Period. By coupling biostratigraphy with the mapping of anatomical and behavioral homologies onto phylogeny, we can infer many details of pre-Cenozoic acoustic behavior by animals. Evidence from such a combination of data supports inferences that the following acoustic behaviors arose during the following geological times. Triassic Period: abdominal percussion by stoneflies and crackling sounds by barnacles. Upper Jurassic: anuran chorusing. Lower Cretaceous: cephalic percussion by termites, an upward shift in vocal frequencies in therian mammals, and avian vocalization. Patterns of skeletal pneumatization relevant to the syrinx do not support the hypothesis of a vocal organ in non-avian dinosaurs and non-ornithothoracine birds. However, this does not preclude acoustic displays such as hissing, stamping, and wing beating.

Technical Session XI, Friday 1:45

THE FIRST SKELETON OF A PLIOCENE CAT (FELIDAE) FROM NORTH AMERICA - A MISSING *LYNX*?

SEYMOUR, Kevin, Royal Ontario Museum, Toronto, ON, Canada

All North American Pliocene cat fossils are fragmentary, usually consisting of tooth-bearing elements only and the relationships of these cats are difficult to discern on this limited data set. Here I report on the first partial Pliocene cat skeleton, curiously from the marine San Diego Formation in California. The tooth-bearing elements suggest a species identification of “*Felis*” *longignathus*, which was known previously only from the type specimen, a partial mandible. This new skeleton includes parts of almost all limb bones, virtually complete front feet, partial hind feet, and hyoids and sternbrae. Morphometrically, the dental bearing elements suggest this species is most similar to living lynxes. However, the skeleton lacks the few osteological features that characterize the genus *Lynx*. Preliminary phylogenetic assessment of this taxon with a morphological dataset results in unresolved relationships to extant North and South American species. In addition, poor resolution of felid relationships conflicts with new, highly resolved DNA-based trees of the living species. Inspection of the data matrix shows few morphological characters support the DNA-based clades, and those that do are primarily postcranial characters. Since most cat morphological datasets to date are based on cranial data, this highlights the need for a better understanding of postcranial characters in living species before the systematic placement of fossil cat taxa can be identified.

Poster Session I (Wednesday)

BIOGEOCHEMICAL INDICATORS OF ECOLOGY AMONG AFRICAN CARNIVORANS: A TEST OF THE DUROPHAGE HYPOTHESIS OF THE ROBUST AUSTRALOPITHECINES (*PARANTHROPUS*)

SHABEL, Alan, University of California, Berkeley, Berkeley, CA, USA

Here I introduce a new biogeochemical proxy for distinguishing the broad ecological preferences of African carnivorans. In combination with independent empirical techniques, such as dental microfeature analysis and comparative anatomy, this new proxy will help us to answer problems in the paleoecology of mammals in general. African carnivorans are diverse both taxonomically and ecologically, and for this reason the Carnivora represents an important comparative context for testing problems in other clades, including primates and hominins. Most early hominin fossil localities in Africa are associated with ancient wetlands, however the extent to which early hominins used wetland habitats and resources is not known. I have argued previously that the craniodental anatomy of robust australopithecines (*Paranthropus*) can be explained as an adaptation to a diet that included hard-shelled invertebrates such as freshwater crabs and molluscs. Here I test this durophage model through an analysis of the trace element biogeochemistry of more than 38 species of extant African carnivorans, including aquatic, semi-aquatic, and terrestrial forms. The ratio of strontium to barium (Sr:Ba) is found to statistically distinguish taxa that forage in freshwater (*Hydrictis*) from those that forage amphibiously on land and in freshwater (*Aonyx*, *Atilax*) from those that forage terrestrially (the remaining species). Sr:Ba increases from freshwater aquatic to semi-aquatic to terrestrial ecologies. Coastal populations of carnivorans that consume marine prey have the highest Sr:Ba ratios because of the very low levels of barium in

seawater. These overall biogeochemical patterns are evident across sub-Saharan Africa. I compare these results with the published literature on fossil hominins, including *Australopithecus* and *Paranthropus*, and I conclude that the durophage model has not been falsified.

Preparators' Session, Thursday 10:30

WHO WANTS THE WHITE MEAT? PREPARATION, RESTORATION, MOLDING, AND CASTING OF AN EXCEPTIONALLY PRESERVED *TYRANNOSAURUS REX* CRANIUM USING A NEWLY-DEVELOPED APPARATUS

SHAW, Allen, Carnegie Museum of Natural History, Pittsburgh, PA, USA

In 2004, an exceptionally well-preserved but largely unprepared *Tyrannosaurus rex* skull and mandible was loaned to Carnegie Museum of Natural History (CMNH) for its full preparation, restoration, molding, and casting. This skull is remarkable in being nearly complete and exhibiting only minor distortion; it is therefore arguably the best-preserved *T. rex* skull yet discovered. Upon delivery to CMNH, the bulk of the skull was contained within a single large block, with several smaller blocks containing additional disarticulated skull elements, many teeth, and the lower jaws. Although the dorsal surface of the skull had been partially prepared prior to arrival at CMNH, many months were still required to remove all matrix from the palate and the numerous cranial fenestrae and foramina. The final preparation of the skull entailed the use of an air abrasive over its entire surface, as well as on the numerous disarticulated skull elements and teeth. Restoration of the skull involved using an epoxy resin to fill in numerous cracks and reconstruct missing pieces. The preparation of the new *Tyrannosaurus* skull required that it be rotated and ultimately inverted. Also, due to spatial issues, we needed a device that could be rotated in place, allowed maximum accessibility, and added structural and load support. Even though similar problems have already been resolved during the preparation of other large theropod skulls, with satisfactory results, we developed a novel and very effective apparatus. Two large wooden wheels connected by six metal struts and resting on electric tube rollers became known as the "*Tyrannosaurus* rotisserie." This device allowed us not only to fully prepare and restore the skull, but to also mold and cast it as well. Here I provide an overview of this exceptionally preserved *T. rex* cranium, and reveal the surprises and problems we encountered in preparing and restoring this exceedingly large and fragile specimen.

Student Poster Session (Thursday)

PARTIAL SKULL OF LATE CRETACEOUS DUROPHAGOUS SHARK, *PTYCHODUS ANONYMUS* (PTYCHODONTIDAE), FROM NEBRASKA

SHIMADA, Kenshu, DePaul University, Chicago, IL, USA; KIM, Sun, DePaul University, Chicago, IL, USA; RIGSBY, Cynthia, Children's Memorial Hospital, Chicago, IL, USA

*Ptychodus* (Ptychodontidae) is an extinct durophagous shark genus known from Late Cretaceous marine deposits nearly worldwide based primarily on isolated crushing-type teeth. The University of Nebraska State Museum, Lincoln, houses a previously undescribed *Ptychodus* specimen (UNSM 123607) found from the Greenhorn Limestone in Nebraska. The specimen, tentatively identified as *P. anonymus* Williston, is significant because it preserves partial upper and lower dental plates along with calcified cartilage pieces including fragments of neurocranium and paired Meckel's cartilages, vertebrae, and placoid scales. The use of computed tomography imaging technique reveals that there are at least 267 teeth preserved in the specimen and that the two dental plates are anteroposteriorly elongate. The largest teeth in the mouth are the symmetrical lower medial teeth, measuring 7.0 mm in crown height. Although the palatocranial sutures are not discernable in the specimen, the partial paired Meckel's cartilages show elongate fused jaw symphysis and elongate jaw rami posterior to the symphysis. The outline of the neurocranium is not clear in the specimen. However, calcified cartilage pieces of the neurocranium significantly extend anteriorly and laterally with respect to the position of the dental plates, suggesting that the head of the taxon was laterally broad and had a subterminal mouth. The vertebrae, which likely represent anteriormost ones in the vertebral column, are weakly calcified and taphonomically compressed, but their diameter was likely about 11.5 mm. Placoid scales generally measure up to 0.5 mm in height and are characterized by a massive crown and a bulbous root, that are nearly equal in size and are well separated by a constriction. The apex of the scale crown is generally flat or gently rounded, some of which exhibit multiple blunt longitudinal keels weakly extending from a rounded anterior crown edge. Although the exact body form of the species remains enigmatic, the cartilaginous remains in the specimen at least suggests that the shark had a broad head with a narrow mouth, and its weakly keeled scale indicates that the shark was a sluggish swimmer.

Student Poster Session (Thursday)

BITE FORCE ANALYSIS OF THE PTYCTODONT PLACODERMS, THE EARLIEST VERTEBRATE DUROPHAGE

SHIN, Ji-Yeon, University of California, Davis, Davis, CA, USA; MOTANI, Ryosuke, University of California, Davis, Davis, CA, USA

Durophagy, the ability to crush hard prey, has convergently evolved multiple times among both bony and cartilaginous fishes. Devonian ptyctodont placoderms are considered to be one of the earliest durophagous vertebrates based on their beak-like tooth plates. However, it is usually impossible to establish durophagy in fossil vertebrates based only on their tooth morphology. The goal of this study is to understand the mechanical basis of ptyctodont feeding to test whether durophagy was possible. The range of potential hard prey that durophagous species eat can be defined by identifying maximum bite force. A four-bar linkage model, which focuses on lower jaw depression associated with opening and closing of mouth, was used to estimate the bite force of ptyctodonts. Morphometric data for bite force analysis were collected from the skulls of two ptyctodont species, *Campbellodus decipiens* and *Austroptyctodus gardineri* from Gogo Formation, Western Australia. The preliminary theoretical bite force analysis of these ptyctodonts revealed a range of 8.04-24.02 N in estimated body size of 13-30 cm. Published data show that bite force ranges from 12-87 N in extant holocephalan, *Hydrolaguscolleii*, in body size of 21-44 cm while for horn shark, *Heterodontus francisci*, it ranges from 95-133 N in body size of 63-73 cm. Shell strength per area of invertebrate shell materials varies depending on the species (e.g. bivalve, *Scrobicularia plana* ranges from 2.7-3.6 Ncm<sup>2</sup>). Estimated bite force of ptyctodonts is not only comparable with the bite force of cartilaginous fishes considering scaling effects, but also with the shell strength of potential invertebrate prey. The result supports the hypothesis that ptyctodont placoderms were durophagous, and that durophagous vertebrates were already present as early as Mid Devonian.

Poster Session II (Thursday)

PYRITE OXIDATION: REVIEW AND PREVENTION PRACTICES

SHINYA, Akiko, The Field Museum, Chicago, IL, USA; BERGWALL, Lisa, The Field Museum, Chicago, IL, USA

Pyrite (FeS<sub>2</sub>) is a common mineral found in sedimentary rock and fossils and its decay is a major problem in the conservation of fossil specimens. Pyrite oxidation, also referred to as pyrite disease or pyrite decay, is identified by a sulphuric acid odor, white crystalline powder, yellow sulphide powder, and/or gray to yellowish microcrystalline mass in and out of specimens. Its presence can be devastating to a geological collection. In the presence of oxygen, pyrite breaks down to ferrous sulphate (FeSO<sub>4</sub>) and sulphur dioxide (SO<sub>2</sub>). If water is present, sulphuric acid (H<sub>2</sub>SO<sub>4</sub>) is also produced and can cause damage to labeling and storage containers. The most effective method to preventing rapid pyrite oxidation decay is to store specimens within a moisture and oxygen barrier containing an oxygen absorber/scavenger. Further oxidation can be reduced or eliminated by storing specimens in an environment with a humidity level below 30%. Additionally, ammonium gas and ethanalamine thioglycolate treatments neutralize sulphuric acid and remove ferrous sulphate, and are reportedly effective in partly or completely removing oxidation reaction products. Specimens that contain large amounts of pyrite and are in danger of losing morphological information through pyrite oxidation should be molded and cast. Because latex rubber contains ammonium, its use as a molding material can have the added benefit of neutralizing sulphuric acid and ferrous sulphate. Although not tested in a controlled scientific experiment, it has been reported that this method was successful in halting the oxidation process in some specimens.

Technical Session III, Wednesday 3:00

PLEISTOCENE CAVE FAUNAS FROM THE ANDES OF CENTRAL PERU: A GLIMPS OF ANDEAN LIFE OF THE GREAT AMERICAN BIOTIC INTERCHANGE

SHOCKEY, Bruce, American Museum of Natural History, New York, NY, USA; SALAS, Rodolfo, Museo de Historia Natural/UNMSM, Lima, Perú; PUJOS, Francois, Institut français études andines, Lima, Perú; GUYOT, Jean-Loup, Institut de Recherche pour Développement, Lima, Perú; BABY, Patrice, Institut de Recherche pour Développement, Lima, Perú

Recent fieldwork in caves of the Central Andes of Peru reveals rich Pleistocene faunas. Taxa discovered include foxes (cf. *Pseudalopex* spp.), cats (*Puma*, *Smilodon*), extinct sloths (*Megatherium*, mylodontid indet., and the newly recognized megalonychid, *Diabolotherium*), Lama, caviomorph rodents, bats, and some specimens of horse (*Onohippidium*). The caves under study include Jatun Uchco (located within cliffs above the Huallaga River near Ambo in the Departamento de Huánuco), Trigo Jirka (in a cliff overlooking the Río Marañón, near Huacaybamba, Depto. de Huánuco) and Mantero Cave (located on land owned by a mining interest near Huancayo, Depto. de Junín). The quality and quantity of the fossils has inspired various studies. For example, the numerous canid fossils are providing data regarding the variation within the population. Trigo Jirka has preserved organic material (i.e., keratin claw and quantities of dung, apparently from sloths), which has initiated attempts to recover DNA to be

included in phylogenetic analyses. Collagen has been recovered from specimens of two caves was were submitted for accelerated mass spectrometry radiocarbon dating. A sample of the sloth, *Diabolotheerium*, from Trigo Jirka, yielded a <sup>14</sup>C age estimate of 29,140 ± 260 year BP and that of *Onohippidium*, from Mantero Cave, an age estimate of 23,340 ± 120 years BP. Preliminary study suggests that these low latitude faunas have potential for resolving questions regarding some migrations from South America to North America and the West Indies. For example, though megalonychid sloths are common in the Plio-Pleistocene of North America and the West Indies, they are uncommon in South America. The excellent material of *Diabolotheerium*, a megalonychid having a relatively generalized dentition, may serve as a model sister taxon to North American and West Indian megalonychids. The cave faunas may also enlighten the evolutionary history of immigrants from North America. Life history studies combined with molecular, and palynology analyses have the potential to illuminate the paleoecological context into which these North American taxa immigrated.

#### Poster Session II (Thursday)

THERE'S A WHOLE LOTTA SHAKIN' GOIN' ON - PALEONTOLOGICAL RESOURCE MANAGEMENT IMPLICATIONS FOR 3-D GEOPHYSICAL EXPLORATION: CASE STUDY FROM THE WIND RIVER BASIN, FREMONT COUNTY, WYOMING

SHOUP, Ben, ARCADIS U.S., Inc., Buffalo, WY, USA

The Madden North 3-D geophysical exploration project, using primarily vibroseis technology, was conducted by Burlington Resources Oil & Gas Company in the northern Wind River Basin, Fremont County, Wyoming on public lands administered by the Bureau of Land Management. Vibroseis operations utilize a metal plate that is lowered from a large all-terrain vehicle to create energy source points by intensely vibrating the plate. The project area included approximately 29,500 acres and encompassed extensive bedrock exposures of several formations known to contain significant paleontological resources, including the Eocene Wind River Formation and the Jurassic Morrison and Sundance Formations. A two-phase assessment was conducted to evaluate impacts to paleontological resources. In the first phase, prior to exploration activities, an investigation was conducted for the project area, including background research and a pedestrian field survey to identify localities within the area of potential effects (APE). Background research uncovered numerous localities, including type localities for the informally named Lysitean and Lostcabinian subages of the Wasatchian North American Land Mammal Age. The field survey resulted in twenty-seven new paleontological localities discovered in the Wind River Formation and one new locality discovered in the Sundance Formation. As the effects of this type of vibroseis activity have not been previously analyzed, a post project impact assessment was conducted following completion of the geophysical exploratory operations to evaluate the direct and indirect impacts of vibroseis activities on paleontological resources. The results of this post-project assessment indicated very little direct impact to paleontological resources. It is suggested from this study that the best management practices for vibroseis-type geophysical exploration projects should be completion of a field survey prior to the activity, avoidance of identified localities, and that no concurrent or post-activity monitoring is warranted.

#### Technical Session XIV, Saturday 10:15

THE BIOMECHANICS OF SCALE: A PHYLOGENETIC AND ONTOGENETIC INVESTIGATION OF TYRANNOSAUROID DINOSAURS USING GEOMETRIC MORPHOMETRICS AND THE FINITE ELEMENT METHOD

SHYCHOSKI, Lara, Saskatoon, SK, Canada; RAYFIELD, Emily, University of Bristol, Bristol, United Kingdom; SAKAMOTO, Manabu, University of Bristol, Bristol, United Kingdom

Scale has profound consequences on biological structure and function. As a structural tissue, bone has evolved the ability to remodel and adapt in response to changing biomechanical stress. This occurs throughout the history of many vertebrate lineages as well as throughout the lifetime of an individual animal. Like any material, bone has limiting properties that constrain its shape while it attempts to avoid mechanical failure with increasing scale. Therefore, the goal of this project was to record skeletal modifications that may have occurred due to significant changes in size. Tyrannosauroids were chosen to study since they exhibit a seven-fold increase in cranial dimensions during phylogeny and ontogeny. Twenty-six juvenile and adult tyrannosauroid crania were analyzed using geometric morphometrics to determine morphotypic distribution. A generalized Procrustes method of superimposition allowed comparisons while removing the influence of scale. Load cases simulating regressed bite forces were determined for each specimen using the Subtemporal Fenestral (STF) method of bite force estimation and bite force was calculated for three points along the alveolar margin. Ten specimens representing theoretical phylogenetic and ontogenetic stages were analyzed using the finite element method. Each cranium was scaled to similar lengths of 500mm and subjected to 500 N (newton) bite forces to facilitate comparative observations. Peak stress was recorded at four highly deformed regions in the lateral crania within the rostrum-braincase junction; (1) the lacrimal-postorbital; (2) the maxilla-nasal-lacrimal; (3) the jugal-postorbital; and (4) the jugal-maxillary region. This allowed the investigation of cranial design and suture morphology. Results show that with increasing scale tyrannosauroid crania adapted to biomechanical stress by developing (1) robusticity and (2) suture complexity in specific areas of the cranium. It is hoped that future research will provide further insight into the biomechanics of scale, contributing to debates surrounding the ultimate size limits in functional vertebrate design.

Technical Session II, Wednesday 8:45  
NEW TEMNOSPONDYLS FROM THE TRIASSIC OF ANTARCTICA

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Antarctic rocks are the premier source of paleontological data for high-latitude regions of Gondwana during the Triassic. Exposures of the Fremouw Formation in the central Transantarctic Mountains record Lower and Middle Triassic ecosystems inhabiting the Polar Circle, with locally abundant vertebrate, invertebrate, and plant fossils. The vertebrate fauna has long been recognized as very similar to that of South Africa's Karoo Basin, with an inferred *Lystrosaurus* and *Cynognathus* biozone equivalency. Although known since the 1960s, lower Fremouw temnospondyls are poorly understood taxonomically; recent systematic revisions fail to recognize valid temnospondyl genera from Antarctica, despite the common perception that at least four families are present (viz. Brachyopidae, Lydekkerinidae, Mastodontosauridae, Rhytidosteidae). Upper Fremouw temnospondyls were first noted in the 1980s, but only recently described. Notably, the recognition that *Parotosuchus* was present in the Antarctic portion of Gondwana suggests an extremely broad distribution for this genus (it also known from Germany, Kazakhstan, Russia, and South Africa). A new giant temnospondyl is represented by a large snout fragment characterized by greatly enlarged transvomerine and parachoanal tooth rows, as well as a distinct process on the palatal surface of the premaxilla. Although it does not preserve anatomy permitting its higher-level taxonomic position to be understood at this time, the recognition of an endemic genus is surprising, given that Triassic vertebrates from Antarctica are typically considered a subset of coeval taxa from the Karoo. The new genus also provides evidence that high latitude Triassic tetrapods might have had a more restricted geographic distribution than previously considered. Biostratigraphically, the fauna of the upper Fremouw Formation is best correlated with the *Cynognathus* Assemblage Zone of South Africa's Beaufort Group, although the lack of species-level identifications for many of the Antarctic fossils precludes a more refined correlation.

#### Evolutionary History of Bats Symposium, Thursday 10:15

THE PRIMITIVE CONDITION OF LOWER MOLARS AMONG BATS

SIGÉ, Bernard, Université Claude Bernard, Villeurbanne, France; MAITRE, Elodie, UMR CNRS 5125, Villeurbanne, France; HAND, Suzanne, School of Biological Science, Sydney, Australia

Among various tooth characters found in insectivorous bats, two distinctive patterns in lower molars (particularly m1 & m2) are recognized. The most common pattern is nyctalodonty, in which the posterior crest (postcristid) extends from the labial hypoconid cusp to the disto-lingual hypoconulid cusp and then to the entoconid. The other, less common pattern is myotodonty, in which the postcristid (which is taller and sharper than in nyctalodont forms) directly connects the hypoconid to the entoconid, isolating the reduced hypoconulid on the posterior face of the entoconid. Transitional conditions between these patterns are rare, but occur in a number of extinct and extant species. These two major dental morphotypes correspond to two different evolutionary steps. Myotodonty is more specialized, the taller, sharper postcristid enhancing its cutting function against the anterior face of the metacone of the upper molar. Some bats reported from Early Eocene strata on some continents (e.g. Europe, North America), mainly archeonycteridids *s.l.*, display typical nyctalodonty. However, other early Paleogene bats from various areas (e.g. *Ageina*, *Honrovits*, *Necromantis*, *Palaeophyllophora*, *Australonycteris* as well as unnamed or undescribed bat material) are characterized by large hypoconulids in a median or sub-median position. This feature, being found in diverse, ancient lineages, most likely represents the primitive condition among bats, characterizing also the (as yet unknown) earliest bats. Here we name this dental morphotype necromantodonty. Necromantodonty, and to a large extent the general tooth morphology in these latter bat taxa, is shared by various insect-feeding arboreal fossil eutherians (e.g. early leptictids, nyctitherians, adapsoriculids, euprimates), including those that are probably closely related to bats.

#### The Dissorophoidea - Early Amphibian Radiation Symposium, Friday 11:30

THE BRAINCASE AND OTIC REGION OF THE AMPHIBAMID *DOLESERPETON* (TEMNOSPONDYLI), AND ITS IMPLICATIONS FOR THE ORIGIN OF FROGS

SIGURDSEN, Trond, Redpath Museum, McGill University, Montreal, QB, Canada

There is at present no consensus as to the evolutionary origins of lissamphibians. However, the Lower Permian amphibamid *Doleserpeton* has been suggested as a close relative of salientians (frogs and proanurans). As frogs alone among lissamphibians possess a tympanic auditory system, it is possible to argue for a strong link between this

group and temnospondyls, since the latter appear to have had a similar hearing system. I have restudied the available material of *Doleserpeton*, with focus on the braincase and otic regions of the skull. A pair of lateral ridges on the paroccipital process have previously defied interpretation, but a close comparison of these to similar processes found in frogs leads to the assumption that the tympanic annulus was attached to the otic capsule as seen in modern anurans. Furthermore, the opisthotic has a pronounced bulbous pseudobasal process, giving it a very anuran appearance in posterior view. In anurans, this area of the otic capsule is filled with the perilymphatic cistern. This part of the perilymphatic system is connected to both the stapes and the operculum, but the expanded posterior cavity is particularly closely associated with the latter. The pseudobasal process may thus be connected to the evolution of an operculum, although this (usually cartilaginous) element has not been found in the *Doleserpeton* material. Several specimens reveal the osseous labyrinth of *Doleserpeton* in some detail. The configuration of this system compares closely to anurans in most respects, and it also reveals hints as to the configuration of the perilymphatic system. Features of the osseous labyrinth strongly suggest that *Doleserpeton* had a posteriorly located perilymphatic duct, as in modern lissamphibians, but unlike amniotes. Although the distribution of many of these traits among Paleozoic forms is unknown, the otic region of *Doleserpeton* seems to share more features with salientians than does any of the other fossil groups.

Technical Session I, Wednesday 9:00

#### CRANIAL ANATOMY OF *LABIDOLEMUR KAYI* AND THE RELATIONSHIPS OF THE APATEMYIDAE

SILCOX, Mary, University of Winnipeg, Winnipeg, MB, Canada; BLOCH, Jonathan, Florida Museum of Natural History, Gainesville, FL, USA; BOYER, Doug, SUNY Stony Brook, Stony Brook, NY, USA; HOUDE, Peter, New Mexico State University, Las Cruces, NM, USA

The relationships of apatemyids have been considered enigmatic, with most authors favoring possible primate or "insectivoran" affinities. Apatemyids are well known from fairly complete Eocene-age skeletons from both the Messel and Green River Formations; however, these specimens are flattened, obscuring many details of cranial anatomy. Here we describe three new crania of *Labidolemur kayi* from the late Paleocene (Clarkforkian) and early Eocene (Wasatchian) of North America using ultra high resolution computed tomography data. These specimens permit the first descriptions for an apatemyid of critical components of cranial anatomy, such as the make-up of the tympanic roof and the pathways of the internal carotid artery and facial nerve. The relevance of these new data to apatemyid relationships is assessed in a cladistic analysis, which is the first to include the family with a broad sample of eutherians. *Labidolemur* differs from Primates (except microsopids) in having no evidence for a fully ossified bulla; rather the tympanic cavity is circled by a rim of tympanic processes formed by the basisphenoid, alisphenoid, and petrosal, which surround an atrophic or slightly semiphaneic, narrow ectotympanic ring. *Labidolemur* additionally differs from non-microsopid primates in retaining an inferior ramus of the stapedia artery, and having a facial nerve that passes through the tympanic cavity in an open sulcus, rather than being contained in a closed tube. Although *Labidolemur* possesses a basisphenoid tympanic process, which is seen in many eulipotyphlans, it lacks other suggested "insectivoran" traits such as an expansion of the maxilla into the orbit, a reduced jugal, and an absent postglenoid process. Cladistic analysis of cranial and postcranial traits fails to group apatemyids with Primates, Euarchonta, or Eulipotyphla, and instead suggests that they were basal members of Laurasiatheria, a view in keeping with their relatively primitive basicranial anatomy. These results indicate that by the Paleocene a Laurasiatheria had already filled the same highly specialized niche filled by the aye-aye in Madagascar today.

Poster Session IV (Saturday)

#### ARTHUR LAKES WAS ALSO A DINOSAUR TRACKER: ARCHIVAL EVIDENCE EMERGES OF A 1902, CRETACEOUS DAKOTA GROUP DISCOVERY IN COLORADO

SIMMONS, Beth, Bowling Green State U., Denver, CO, USA; VEATCH, Steven, Emporia State U., Florissant, CO, USA; LOCKLEY, Martin, U. Birmingham, England, Denver, CO, USA

In 1902, Arthur Lakes, the famous 19th century dinosaur hunter, and Henry Byron Slater, a mining engineer, were assessing the oil-bearing potential of the Merit Ranch, on the border of El Paso and Pueblo Counties in Colorado, when they discovered dinosaur tracks in the Dakota Group. This find, evidently the first reported in the Cretaceous of Colorado, marked a crucial step in the discovery and collecting of large 18 x 19" (= 45 x 48 cm) dinosaur (ornithomimid) tracks from what has become the best-known 'mid' Cretaceous track-bearing stratigraphic unit in North America (now dubbed the Dinosaur Freeway). This find culminated a lifetime of fossil hunting for Arthur Lakes. Beginning in 1872 he collected plant fossils for the U.S. Geological Survey and Jarvis Hall (now the Colorado School of Mines) and for Leo Lesquereux who named 15 species in his honor. In 1874, Lakes and Captain E. L. Berthoud discovered the first *Tyrannosaurus rex* tooth, which they sent to O.C. Marsh at Yale where it remained unrecognized until identified by Ken Carpenter in 2002. Famously, in

1877, Lakes and Captain Horace C. Beckwith discovered the first large Jurassic dinosaurs in the west near Morrison, Colorado, and played important roles in the "bone wars" between Cope and Marsh. Lakes was evidently well aware of the existence of dinosaur tracks, which he discussed in his teachings as early as 1877. The Merit Ranch discovery marked the 25th anniversary of Lakes' famous Morrison discoveries, and extends the historic record of his dinosaur tracking into the 20th century. The find, reported 1902 indicates that a large slab (4 x 16'/10.6 X 40.6 cm) was excavated with remarkable speed and efficiency and taken to Colorado College (Colorado Springs) with the intent of preserving the trackway, with a stride of 5'7" (1.7m). However, the source of the footprints and the name of its famous discoverer remained unknown until the newspaper archives were 're-discovered' in 2007. Although the large slab is no longer preserved, a single track has survived in the Colorado College Geology Department.

Evolutionary History of Bats Symposium, Thursday 12:00

#### A NEW PRIMITIVE BAT FROM THE EARLY EOCENE OF WYOMING: FOSSILS, PHYLOGENETICS, AND THE EVOLUTION OF ECHOLOCAATION AND FLIGHT

SIMMONS, Nancy, American Museum of Natural History, New York, NY, USA; SEYMOUR, Kevin, Royal Ontario Museum, Toronto, ON, Canada; GUNNELL, Gregg, Museum of Paleontology, Ann Arbor, MI, USA

Bats (Chiroptera) represent one of the largest and most diverse radiations of mammals, accounting for one fifth of extant species. Although recent studies unambiguously support bat monophyly and a consensus is rapidly emerging regarding phylogenetic relationships among extant lineages, early evolution of the group remains poorly understood. An undescribed bat from the Early Eocene Green River Formation of Wyoming (ca 52.5 Ma) provides a new view of the earliest stages of bat evolution. Known from two nearly complete skeletons, this animal exhibits several features that are more primitive than seen in any previously known bat. Phylogenetic analyses, including those using a molecular scaffold, unambiguously indicate that the new bat represents the most basal known branch of Chiroptera, with *Icaronycteris* (also from the Green River Formation) occupying the next most basal branch. The evolutionary pathways that led to flapping flight and echolocation in bats have been in dispute, and Eocene fossils, though remarkably well preserved, have been of limited use in documenting transitions involved in this dramatic change in lifestyle. Comparisons of the new taxon to other bats and non-volant mammals demonstrate that critical morphological and functional changes evolved in an incremental fashion. Forelimb anatomy indicates that the new bat was capable of powered flight like other Eocene bats, but basicranial morphology suggests that it lacked their echolocation abilities, supporting a "flight first" hypothesis for chiropteran evolution. Shape of the wings suggests that an undulating gliding-fluttering flight style may be primitive for bats. Presence of a long calcar in the new bat indicates that a broad tail membrane evolved early in Chiroptera contra previous hypotheses, probably functioning as an additional airfoil rather than a prey-capture device. Limb proportions and the retention of claws on all digits suggest that the new bat may have been an agile climber that employed quadrupedal locomotion and under-branch hanging behavior in its locomotory repertoire.

Romer Prize Session, Thursday 8:45

#### THE SEMICIRCULAR CANALS OF BIRDS AND NON-AVIAN THEROPOD DINOSAURS.

SIPLA, Justin, University of Texas at El Paso, El Paso, TX, USA

The invasion of aerial habits by primitive birds involved massive reorganization of neurological and sensory systems, many of which are coordinated in the brain by vestibular cues from the semicircular canals. These organs sense angular accelerations experienced by the head and body with every movement. Canal signals are combined with visual and somatosensory inputs and are used to generate a wide-range of reflexive behaviors necessary for stabilizing gaze, maintaining posture, and coordinating body movements. This study focuses on understanding the relationship between locomotor behavior and vestibular function in birds and non-avian theropod dinosaurs, both from a comparative and functional perspective. Widespread use of noninvasive computed tomography (CT) has opened great possibilities for visualizing canal structures, which are often preserved in fossil specimens. The otic capsules of 178 species of extant birds and 15 species of non-avian theropods were CT scanned and the vestibular structures reconstructed and measured from digitally prepared volumes. The morphology of the semicircular canals in non-avian theropods and many flightless birds is shown to reflect their status as bipedal cursors, while the pattern seen in volant avians is found to correlate strongly with different flying behaviors. Independent measures of aerobatic maneuverability, such as wing loading and wing aspect ratio, also correlate with canal morphology, indicating conclusively that, at least in flying birds, larger and thus more sensitive canals are possessed by agile species flying at slower speeds. Freed in air from the need for intermittent contact with a surface substrate, birds can employ a wider repertoire of body movements during locomotion, including forms of rotation that would be improbable on land. In the absence of somatosensory cues from postural interactions with the ground, these movements place increased demands on the vestibular system of avian fliers. Investigation into the size and shape of avian semicircular canals

permits evaluation of the mode of flight employed by primitive avialians, like *Archaeopteryx*, shedding light on some of the broader neurophysiological adaptations to flight behavior that characterize bird evolution.

Carnivora: Phylogeny, Form and Function Symposium, Saturday 11:45  
IMPLICATIONS OF CRANIOFACIAL FORM FOR PERFORMANCE OF THE  
CANID SKULL DURING PREY KILLING AND FEEDING

SLATER, Graham, UCLA, Los Angeles, CA, USA; DUMONT, Elizabeth, University of Massachusetts, Amherst, MA, USA; VAN VALKENBURGH, Blaire, UCLA, Los Angeles, CA, USA

To reconstruct trophic relationships in fossil faunas paleobiologists must rely on demonstrated links between morphology and diet in extant taxa. Although teeth are highly informative about diet, the morphology of the craniofacial skeleton is likely to play an important role in the mechanics of prey capture. Short, broad jaws are associated with large bite forces and long, narrow jaws with rapid closure. Theoretical analyses suggest that, all things being equal, long narrow jaws will be weaker under torsion. Until recently, techniques for assessing performance of such complex structures were not available. Here we use Finite Element (FE) Analysis to test hypotheses relating carnivoran craniofacial form to performance under different loading or biting regimes. Three-dimensional FE models were constructed from CT slices of skulls from three extant African canids that exhibit different hunting preferences and skull morphologies: African wild dog, *Lycan pictus* (broad-faced large mammal specialist), Ethiopian wolf, *Canis simensis* (narrow-faced small mammal specialist), and black-backed jackal, *Canis mesomelas* (generalized predator). Our FE experiments simulated loading schemes experienced during hunting, such as bilateral canine or unilateral canine biting. Within taxa, preliminary results generally match predictions; bilateral canine loads resulted in lower and more evenly distributed stresses, and unilateral canine loads resulted in higher peak stresses and steeper gradients. However, craniofacial form appears to affect relative performance under loading schemes other than pure bending. Using these findings, we discuss the relationship between craniofacial morphology and fundamental niche breadth in carnivorans.

Poster Session IV (Saturday)  
FUNCTIONAL INTERPRETATION OF THE PROXIMAL FEMUR IN  
EOCENE *RODHOCTETUS* (MAMMALIA, ARCHAEOCETI)

SLIVENSKY, Katherine, SUNY Stony Brook, Okemos, MI, USA; GINGERICH, Philip, University of Michigan, Ann Arbor, MI, USA

Whales are aquatic mammals, but their evolutionary transition to life in the water is not fully understood. Eocene *Rodhocetus* is a semi-aquatic protocetid with associated postcranial remains that was in or near the ancestry of later whales. Here we analyze the proximal femur of *Rodhocetus* in relation to femora of a selected set of six hind-limb dominated semi-aquatic mammals and six more closely related artiodactyls, including the hippo. Principal components analysis of 14 femoral measurements yields all-positive loadings on PC-I. On PC-II, greater angle between the neck and femoral shaft contrasts with greater femur length. Finally, greater projection of the lesser trochanter contrasts with greater width of the proximal femur on PC-III. Neck-to-shaft angles of all semi-aquatic mammals sampled, including *Rodhocetus*, were nearly 20 degrees larger than those of artiodactyls. The lesser trochanter is the insertion point for the extensor muscles psoas major and iliacus. River otters, aquatic rodents, artiodactyls, and *Rodhocetus* have large and projecting lesser trochanters, while pinnipeds have small lesser trochanters. River otters, aquatic rodents, and artiodactyls require powerful extension for swimming in water or running on land. Pinnipeds do not bring their legs forward during swimming, and hence do not require powerful extension to return them back. We interpret PC-I as a size axis. PC-II is an index of aquatic adaptation, as a high neck angle is associated with maneuverability in mammals that do not place much weight on their hind limbs. *Rodhocetus* has a large angle, and thus shows this aquatic adaptation for high maneuverability. PC-III is an index of power of hind limb extension, whether aquatic or terrestrial. The enlarged lesser trochanter of *Rodhocetus* and powerful hind limb extension can be interpreted as an exaptation inherited from its common ancestry with artiodactyls. *Rodhocetus* was evidently a highly maneuverable swimmer, bearing little weight on its hind limbs, with powerful hind limb extension in swimming.

Poster Session III (Friday)  
EARLY PERMIAN *ICHTHOTHERIUM*-DOMINATED FOOTPRINT  
ASSEMBLAGES FROM THE MAROON FORMATION, COLORADO

SMALL, Bryan, Denver Museum of Nature and Science, Denver, CO, USA;  
SANDERS, Frank, Denver Museum of Nature and Science, Denver, CO, USA

The Maroon Formation of central Colorado is a massive nonmarine red bed unit (4,600m thick) deposited in a subsiding cratonic basin. Conglomerates, coarse-grain sandstones and a few thin limestones dominate the lower half of the Maroon Formation. Siltstones and fine-grain sandstone units dominate the upper half of the Maroon Formation. The entire formation is tentatively dated as Pennsylvanian/Permian, with no good age constraint at the top. Formation outcrops

produce non-vertebrate traces and a few plants (mostly walcchian conifers) of little chronostratigraphic value. Conspicuously absent from the Maroon Formation are vertebrate body fossils. Two recent vertebrate footprint assemblage discoveries are shedding light on the poorly known vertebrate communities in the upper half of the Maroon Formation. The Gast Footprint locality in the Aspen sub basin is dominated by *Ichniotherium*, comprising over 95% of the footprints observed, with *Dimetropus*, *Tambachichnium*, and *Varanopus* comprising the remaining 5%. *Ichniotherium* also dominates new vertebrate track localities in the Eagle Basin in the northern part of the Maroon Formation, with minor components consisting of the cosmopolitan ichnotaxa *Dromopus*, *Batrachichnus*, and *Varanopus*. There have been other reports of tetrapod tracks in the Maroon Formation. Two parallel trackways from near Glenwood Springs (Eagle Basin) have been attributed to *Ichniotherium*. Tracks from the southern part of the Maroon Formation have been tentatively identified as cf. *Dimetropus*. The dominance of *Ichniotherium* in the upper half of the Maroon Formation mirrors the dominance of *Ichniotherium* in the Early Permian Tambach Formation of Germany. In fact, the assemblage of the Gast locality in the Aspen sub basin is exactly that which is found in the Tambach Formation. The track maker of *Ichniotherium* has been attributed to an herbivorous diadectid. Fossil evidence from the Tambach and Maroon Formations documents the earliest herbivore dominated tetrapod assemblages. The observed biostratigraphic correlation between the Tambach and Upper Maroon ichnotaxa constrains the upper Maroon Formation to Early Permian age.

Poster Session I (Wednesday)  
FIRST EVIDENCE FOR A THERAPSID IN THE UPPER PERMIAN MORADI  
FORMATION OF NIGER

SMILEY, Tara, University of Washington, Seattle, WA, USA; SIDOR, Christian, University of Washington, Seattle, WA, USA; STEYER, J. Sébastien, CNRS, Paris, France; TABOR, Neil, Southern Methodist University, Dallas, TX, USA

Recent discoveries from the Upper Permian Moradi Formation of Niger provide evidence for an endemic tetrapod fauna climatically isolated from the therapsid dominated faunas prevalent in the high latitude portions of Pangea. The Moradi fauna consists of two reptiles, the giant captorhinid, *Moradisaurus*, and the pareiasaur, *Bunostegos*, as well as two edopoid temnospondyls, *Nigerpeton* and *Saharastega*. A second, smaller captorhinid remains undescribed. The apparent lack of therapsids upsets the long held view that Upper Permian tetrapods were broadly distributed across Pangea. The most recent expedition to the Moradi Formation in December 2006 has recovered a fragmentary upper jaw, which is exceptional in its possession of a large, caniniform tooth. Exposed along the ventral margin of the specimen, the tooth is oval in cross-section, with a major axis diameter of approximately 5.5 cm and minor axis diameter of approximately 3.5 cm. The lateral surface of the maxilla is rugose and rises from its ventral edge to reveal the root of the caniniform along its broken dorsal margin. In ventral view, a portion of the choana is preserved. Its lateral margin is formed by the maxilla, which bulges medially in the vicinity of the caniniform. More medially a small portion of the vomer is present in addition to other palatal bones. The features of this fossil do not correspond to any taxon previously known from the Moradi Formation, but instead most closely conform to those of the therapsid clade Gorgonopsia. This find represents the first record of a therapsid in the Upper Permian of equatorial Pangea and the first evidence for a large-bodied amniote carnivore. The recognition of a therapsid carnivore does not refute the uniqueness of the Moradi fauna, but rather adds a layer of complexity to its interpretation. The present material does not permit a generic identification to be made, although its size is suggestive of the Rubidgininae. As one of only two basins preserving nonmarine Permian rocks deposited at low latitude in central Pangea, the Izegeouandane Group presents a rare window on the relationship between climate and biogeography at the close of the Paleozoic Era.

Poster Session III (Friday)  
TAXONOMIC REVISION OF GENUS *ALCA* (AVES, ALCIDAE):  
AND A NOVEL MORPHOMETRIC AND PHYLOGENETIC APPROACH  
FOR ASSESSING DIVERSITY AMONG TAXA KNOWN FROM ISOLATED  
SPECIMENS

SMITH, Adam, North Carolina State University, Raleigh, NC, USA

Alcidae is a monophyletic clade of pelagic wing-propelled divers with a fossil record including auks, auklets, puffins, guillemots, murres and murrelets. Knowledge of extinct alcid diversity has potential to clarify our presently poor understanding of alcid paleobiogeography and may help answer questions such as whether alcids originated in the Pacific or Atlantic, and whether radiations and extinctions of alcids were driven by paleoclimatic events such as changes in oceanic circulation patterns. Correlations between alcid evolutionary history and paleoclimatic events also holds potential to inform our interpretations of present-day shifts in avian population ranges due to the current global warming trend. Despite the many thousands of Pliocene fossils referred to the Atlantic alcid genus *Alca* (auks), species diversity among this taxon has remained unresolved due to the paucity of associated specimens, and the fragmentary preservation of the vast majority of specimens (~97%). In addition to the identification of diagnostic morphological features, measurements of multiple variables from >3000 *Alca* fossils were categorized by hierarchical cluster analysis, and resulted in the recognition

of six "species clusters". Statistical support for these clusters was assessed by means of discriminant function analysis. The reliability of this method was tested using the exact same measurements taken from 13 extant species of alcids, and was found to be extremely robust with regard to the accurate recovery of distinct species groups. Clustered groups of fossils were then re-evaluated to identify diagnostic morphological features. The holotype specimens of all known *Alca* species were recovered in separate, statistically supported clusters. Both statistical and morphological assessment of all material referred to extinct Atlantic alcids support *Alca grandis*, *Alca stewarti*, and *Alca tarda* as valid Pliocene species. Identification of the first remains of the puffin genus *Cerorhinca* (Aves, Alcidae) from the Atlantic increases to our knowledge of Pliocene alcid diversity, and constrains inferences about alcid vicariance events.

Poster Session III (Friday)

THE ENDOCRANIUM AND ASSOCIATED STRUCTURES OF THE CERATOPSIDAN *ZUNICERATOPS CHRISTOPHERI* (TURONIAN, NEW MEXICO)

SMITH, David, Northland Pioneer College, Show Low, AZ, USA; WOLFE, Douglas, New Mexico Museum of Natural History and Science, Albuquerque, NM, USA; SANDERS, R., University of Utah, Salt Lake City, UT, USA

Ceratopsian dinosaurs are a long-known, diverse group of ornithischian dinosaurs from the Cretaceous of North America and Asia. *Zuniceratops christopheri* is the oldest known North American taxon possessing well-developed brow horns. It is represented by many elements from several individuals from the Turonian Moreno Hill Formation of western New Mexico. The *Zuniceratops* skeleton, including a well-preserved braincase, exhibits a suite of primitive and derived characters relative to derived neoceratopsians. In order to extract the endocranium and associated structures, the braincase was ct-scanned at the University of Utah Hospital using a five-millimeter slice thickness for a total of 85 coronal slices. We obtained good separation between the bone and the matrix, so recovered the endocranial cavity, the ear, and the previously undescribed basiocranial sinus. Surfdriver was used to stack and register the slices. This region of *Zuniceratops* was then compared with *Protoceratops*, *Anchiceratops*, and *Triceratops* endocrania described in the literature. The brain of ceratopsian probably did not fill the endocranial cavity. *Zuniceratops* possessed low pontine and cephalic flexures, more similar to *Anchiceratops* and *Triceratops* than the similar-sized *Protoceratops*. Details of the foramina accommodating the cranial nerves are also typically more similar to *Anchiceratops* and *Triceratops* than *Protoceratops*. The sinus is well-defined posteriorly, but becomes indistinct anteriorly as it becomes surrounded by spongy bone. It extends into the basipterygoid processes, but not the occipital condyle. The semicircular canals are well-preserved on the left side. *Zuniceratops* possessed a short cochlea that has been correlated in the past with poor high frequency sound discrimination.

Poster Session I (Wednesday)

SEXUAL DIMORPHISM IN TUSKS OF GREAT LAKES-REGION AMERICAN MASTODONS (*MAMMUT AMERICANUM*)

SMITH, Kathlyn, University of Michigan, Ann Arbor, MI, USA; FISHER, Daniel, University of Michigan, Ann Arbor, MI, USA

Sexual dimorphism is evident in tusks of American mastodons (*Mammuth americanum*), but few studies have evaluated this dimorphism quantitatively. One difficulty of documenting tusk dimorphism in mastodons of the Great Lakes region is the relatively small number of female mastodons recovered in this area. This study addresses the issue of sexual dimorphism in Great Lakes-region mastodons by measuring aspects of tusk morphology to discriminate between males and females. Tusk dimorphism is evaluated using: 1) tusk circumference measured at a succession of locations relative to the tip, 2) maximum tusk circumference, and 3) axial depth of the pulp cavity. Previously compiled measurements of tusk morphology are compared to measurements of eight tusks from the Bothwell site in northwestern Indiana in order to determine the sex of the Bothwell mastodons and enlarge the sample of individuals for which sexual dimorphism is evaluated. Tusk circumference profiles for adult mastodons show that circumference increases from the tip toward an intermediate position, beyond which it retains a relatively stable value until it decreases near the proximal end. Circumference stabilization for adult male tusks occurs at a greater distance from the tip than for adult female tusks. The maximum tusk circumference is also higher for adult male mastodons than for adult females, and the axial depth of the pulp cavity is greater for males than for females of the same ontogenetic stage. Maximum tusk circumference differentiates between adult male and adult female mastodons, with no overlapping values. Axial depth of the pulp cavity strongly differentiates between male and female mastodons of the same ontogenetic stage, with no overlapping values. The results of this study indicate that the tusks from the Bothwell site are all from female mastodons. A site with multiple female mastodons is extremely rare, and additional work is needed to understand the lives and circumstances surrounding the deaths of these females.

Poster Session IV (Saturday)

*PSEUDOTRIMYLUS* (SORICOMORPHA: HETEROSORICIDAE) FROM THE EASTGATE FAUNA, NEVADA

SMITH, Kent, Oklahoma State University Center for Health Sciences, Tulsa, OK, USA; CIFELLI, Richard, Sam Noble Oklahoma Museum of Natural History, Norman, OK, USA; CZAPLWESKI, Nicholas, Sam Noble Oklahoma Museum of Natural History, Norman, OK, USA

In the late 1960s, D. I. Axelrod discovered vertebrate fossils of Miocene age near the town of Eastgate in Churchill County, Nevada. These fossils were collected from a volcanic tuff in the basalmost section of the Monarch Mill Formation. The Eastgate local fauna, as it is now known, is an assemblage of fishes, amphibians, reptiles, birds, and mammals. The mammalian fauna comprises 25 families and 60 species (18 insectivores, one chiropteran, seven lagomorphs, 33 rodents, five carnivores, three artiodactyls, and three perissodactyls). The mammalian fauna includes a new species of insectivore and two new genera of rodents and several new species of rodents. At present, the age of the fauna is not well defined: it is either late Hemingfordian or early Barstovian. Fossil mammals of the Eastgate fauna have been collected from 21 sites within the Monarch Mill Formation; of these, four yielded remains of a heterosoricid shrew referable to the genus *Pseudotrimylus* (Soricomorpha: Heterosoricidae). Several mandibles and isolated teeth of heterosoricids have been collected at Eastgate. These elements represent a range of wear stages from juvenile to adult, and are sufficient to confirm a new species of *Pseudotrimylus*. In addition, the sample size is large enough for a study of morphological variation within the genus.

Romer Prize Session, Thursday 9:45

LIZARD BIOGEOGRAPHY DURING THE WARMEST PART OF THE CENOZOIC: A DIACHRONIC PERSPECTIVE ON MODERN PATTERNS OF SPECIES DIVERSITY

SMITH, Krister, Vertebrate Paleontology Lab, Austin, TX, USA

There has been a recent convergence of interest on the part of ecologists in historical influences on modern patterns of biodiversity. The warm early Tertiary in particular is relevant to the question of high modern tropical diversity because megathermal regimes are not only older than temperate ones but were also once more areally extensive. The early Eocene of Wyoming witnessed significant excursions in temperature and affords an opportunity to evaluate related questions of diversity and climate change. What is the response of local species richness to change in temperature? By what means does richness change? What is the relation of mid-latitude Eocene forms to tropical clades today? To address these questions, I studied a series of Eocene lizard faunas from Wyoming which sample a mean annual temperature range of ~10°C. The 1369 identified elements represent at least 37 species (at least half new). Local diversity and regional temperature estimates are positively related even when taphonomic factors are taken into consideration. New species appear largely by immigration. Because phylogeny links the biogeographic and evolutionary histories of clades, I also examined the relationships of the fossil taxa, especially of the problematic clade Iguania. A comprehensive new analysis shows that the early Eocene iguanids are close relatives of the modern Central or South American clades *Anolis*, *Polychrus*, and *Corytophaninae*. Shifts in species ranges are the proximate mechanism driving fluctuations in diversity. In Iguanidae and other taxa, migration during warming appears to occur from the south. The broad-scale biogeographic shifts implied by these results highlight the direct contribution that mid-latitude Tertiary species may have made to tropical regions today and also the importance of decoupling the two components of species richness—inventory and differential diversity—in developing an accurate diachronic perspective. I finally present new numerical approaches to the differential component.

Preparators' Session, Thursday 10:15

VERTEBRATE MICROFOSSIL STORAGE, THE BASICS, AND A NEW TECHNIQUE

SMITH, Matthew, Kimberly, OR, USA

Historically, vertebrate microfossils have been curated in a wide variety of ways within individual paleontological collections. While some systems are well thought out and standardized, it is important to review policies on occasion to ensure that standardized storage techniques are keeping pace with the needs of scientific research methods. John Day Fossil Beds staff have recently reviewed several available storage practices for micro-vertebrate material and modified our standard techniques to accommodate possible future research initiatives. Our new preferred method utilizes polyethylene/poly-styrene cassettes into which a polyethylene foam rod containing the vertebrate microfossil is placed. This methodology has been determined to be best practice based on cost considerations and the minimal introduction of foreign chemicals to the specimen. The major benefit of this curatorial technique over more typical pin and cork type techniques is the lack of introduced chemicals. This allows stable isotope analysis through laser ablation techniques to be performed with a minimum of processing. This technique should also increase the feasibility for DNA or protein analysis of these small fossils.

Technical Session XIV, Saturday 10:30  
EARLY THEROPOD EVOLUTION AND PARAPHYLY OF THE  
COELOPHYSOIDEA

SMITH, Nathan, University of Chicago, Chicago, IL, USA; MAKOVICKY, Peter, Field Museum of Natural History, Chicago, IL, USA

A recent morphological description of *Cryolophosaurus ellioti* and phylogenetic analysis of basal theropod dinosaurs including 347 characters and 56 taxa suggests that the Coelophysoidea *sensu lato* is non-monophyletic, and that *Cryolophosaurus* forms a clade with the other crested, Early Jurassic theropods, including *Dilophosaurus wetherilli*, *Dracovenator*, and '*Dilophosaurus sinensis*'. Several features supporting this group include: contribution of the premaxilla to a nasal crest, antorbital fossa extends onto nasal in lateral view, nasolacrimal crests, and tab-like dorsal processes on the articulators. These medium-bodied theropods are more closely related to a (Ceratosauria + Tetanurae) clade than to remaining 'coelophysoids' (*Liliensternus* + Coelophysidae). Although support for relationships in this part of the tree is not robust, the mosaic of morphological features present in these poorly known Early Jurassic taxa appears to be driving phylogenetic signal. Many of these taxa possess classic 'coelophysoid' features (low angle between alveolar and anterior premaxillary margins, subnasal gap, antorbital fossa ventral margin raised), but also share traits with tetanurans and/or ceratosaurs (keyhole-shaped orbit, anteriorly positioned maxillary tooth row, expanded anterior end of jugal, lacrimal fenestra). The recovery of a paraphyletic 'Coelophysoidea' is also due to our observation of a broader distribution for many traditional 'coelophysoid' synapomorphies (reduced axial parapophyses/diapophyses, 'kinked' pubic peduncle) among basal theropods and outgroups. Our results provide additional support for hypotheses of global homogeneity between Early Jurassic continental biotas, as well as for body-size mediated resource partitioning among Early Jurassic theropods. Additional results of our phylogenetic analysis that merit further attention include the recovery of: (1) a sister-taxon relationship between *Piatnitzkysaurus* and *Condorraptor*, (2) the enigmatic taxon *Megaraptor* as a carcharodontosaurid, and (3) a sister-taxon relationship between *Monolophosaurus* and (Allosauroidae + Coelurosauria).

Technical Session II, Wednesday 10:30  
VERTEBRATE TAPHONOMY OF A PERMIAN "WET DESERT" IN  
CENTRAL PANGAEA

SMITH, Roger, Iziko: South African Museum, Cape Town, South Africa; SIDOR, Christian, USA, University of Washington, Seattle, WA, USA; TABOR, Neil, Southern Methodist University, Dallas, TX, USA; STEYER, J. Sébastien, CNRS-MNHN, Paris, France; CHANEY, Dan, Smithsonian Institution, Washington DC, MD, USA

Paleogeographic models position the vertebrate fauna of the Upper Permian Moradi Formation, northern Niger, approximately 20°S of the paleoequator in central Pangaea. This basin lies east of the Tethys Sea within a 5000 km wide "corridor" between Gondwana and Laurasia. Recent field investigations have confirmed that climate was warm, arid with seasonal monsoonal rainfall and, possibly as a result of these unique physio-climatic conditions, the tetrapod fauna shows a high degree of endemism. The Moradi sediments accumulated on a flat semi-arid to arid alluvial plain with large, low angle gravelly alluvial fans prograding from the tectonically active Air Massif to the east, which at times impinged on a large stable meandering channel system flowing generally northwards along the axis of the basin. Fossil rich intervals are characterized by wide shallow anastomosing channels conformably filled with a conglomerate of reworked pedogenic carbonate nodules, rhizocretions, and claystone clods overlain by massive sandy siltstone. At Ibadanane, 20km west of Arlit, an area measuring 280 x 50 m was found to contain at least 15 concentrations of scattered bones comprising ribs, vertebrae and long bones of pareiasaurians. Preliminary quarrying revealed scattered, but still associated, skeletons of *Bunostegus* as well as amphibians such as *Nigerpeton* and the captorhinid *Moradisaurus*. These "bone on bone" occurrences dip gently towards the channel axis. The preliminary interpretation of the depositional setting of the pareiasaur "cemetery" site is of a distal alluvial fan where ephemeral flash-flood streams swept across a silt-dominated loessic plain, scouring through the sparsely vegetated soils to the more resistant calcrete horizons, reworking previously buried bones and burying desiccated drought-stricken cadavers. Localized depressions filled with brecciated limestone overlain by finely-laminated calcic siltstone are interpreted as end-point playa deposits. They clearly demonstrate that this "wet desert" hosted standing water bodies and preserve a range of insect, arthropod, amphibian and reptile tracks not previously recorded from the Moradi Formation.

Technical Session X, Friday 11:30  
RAPID MAMMALIAN FAUNAL TURNOVER AT THE ONSET OF THE  
PALEOCENE-EOCENE CARBON ISOTOPE EXCURSION (CIE) IN THE  
BIGHORN BASIN, WYOMING

SMITH, Thierry, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; GINGERICH, Philip, University of Michigan, Ann Arbor, MI, USA

Five field campaigns have been organized by an American-Belgian team in the northern Bighorn Basin, Wyoming since 2001 to locate paleosol intervals with mammal concentrate levels near the Paleocene/Eocene boundary. Here we describe mammals from three wash sites in a 5-meter thick interval of brown paleosols at the south end of Polecat bench. The sites lie within the lower part of the Paleocene-Eocene carbon isotope excursion (CIE) and are intermediate stratigraphically between beds yielding late Clarkforkian and early Wasatchian mammals known previously. The first site, the SC-435 Shell Bed, is the lowest stratigraphically. The Shell Bed site yielded a mammalian fauna including the diagnostically-Clarkforkian species *Apheliscus nitidus*, *Haplomylys simpsoni*, and *Aletodon gunnelli*. The second site, the SC-434 gar scale Channel, is two meters or so above the shell bed site. The gar scale Channel site yielded a fauna including the diagnostically-Wasatchian genera *Macrocranium*, *Meniscotherium*, and cf. *Reithroparamys*. A new lepticid insectivore genus and species, *Amphigyion straitae*, and a new very small hyposodontid condylarth species, *Haplomylys zalmouti*, are described from the gar scale Channel site. The third site, the SC-434 brown mudstone, is a meter or so above the gar scale Channel. This yielded specimens representing species identical to those known from the larger gar scale Channel fauna. *Meniscotherium priscum* Granger, 1915, is now known from 10 specimens in addition to the holotype. These come from the northern, western, and southern Bighorn Basin. There are no verifiable records of *Meniscotherium* from the Paleocene anywhere, and all Bighorn Basin specimens come from the earliest Wasatchian *Meniscotherium* zone (Wa-M). *Meniscotherium priscum* and *Haplomylys zalmouti* both appear to be diagnostic of this zone, corresponding to the warmest period of the Cenozoic. These are situated a few meters below the Wa-0 interval that records the first occurrences of most of the modern orders in North America.

Student Poster Session (Thursday)  
ONTOGENY OF BITE STRESS IN *DUNKLEOSTEUS*

SNIVELY, Eric, University of Alberta, Edmonton, AB, Canada; RYAN, Michael, Cleveland Museum of Natural History, Cleveland, OH, USA

Adults of the arthrodire *Dunkleosteus* exerted among the highest bite forces of any vertebrate, with respectively efficient rapid and low-gear kinematics. Multiple specimens from the Cleveland Shale record a growth series of *Dunkleosteus*, ideal for investigating the ontogeny of bite stresses and feeding function in this taxon. In finite-element stress analyses of variably-sized *Dunkleosteus* mandibles, we scaled food-reaction and adductor forces from estimates by Anderson and Westneat, and used dynamics equations to estimate force at the fang-like anterodorsal cusps of the infragnathals. Results for juvenile and adult *Dunkleosteus* indicate formidable biting capability at all ontogenetic stages. Scaling of hydrodynamic drag influenced the balance of anterior impact and posterior shearing forces applied to prey. Despite their higher bite forces, mandibles of adult *Dunkleosteus* experienced post-gnathal stresses similar to those of juveniles. Anterodorsal cusps of *Dunkleosteus* infragnathals, and those of the equally large arthrodire *Gorgonichthys*, potentially resisted forces from high-velocity impacts at the front of the jaws.

Poster Session III (Friday)  
THE TALE OF THE LOST *STEGOSAURUS LONGISPINUS* TAIL

SOUTHWELL, Elizabeth, University of Wyoming, Laramie, WY, USA; BREITHAAPT, Brent, University of Wyoming, Laramie, WY, USA

W.H. Reed is well known for his important dinosaur discoveries at Como Bluff in Wyoming, and his years of loyal collecting for O.C. Marsh (Peabody Museum) in the late 1800s. He continued finding and collecting a variety of new taxa of prehistoric animals after leaving Marsh's employment, working with the Carnegie Museum, the American Museum of Natural History, and finally, the University of Wyoming. In July, 1908, Reed (while curator of the University of Wyoming museum), accompanied by UW professor of geology, A.C. Dart, made the final major dinosaur discovery of his life-long career: a new species of *Stegosaurus*. Reed and Dart were investigating a Morrison Formation outcrop near the hot springs resort of Alcova in Natrona County, Wyoming. Reed was well acquainted with the genus, after excavating significant stegosaur fossils from Como Bluff years earlier. He recognized that this new specimen was similar in size to *S. stenops*, but had several unique characteristics. Because the University of Wyoming had no research paleontologist on staff at that time, Reed lent the specimen to C.W. Gilmore (a former UW graduate employed by the U.S. National Museum) for identification and description. Gilmore named this specimen a new species, *Stegosaurus longispinus*, specifically because of its extraordinarily long tail spikes. As the longest spike measured 860 mm with its tip missing, Gilmore estimated its total length to be 985 mm. In addition to the 4 tail spikes, Reed collected 42 vertebrae, a partial sacrum, 2 ischia, a right femur, several ribs, and a partial pubis from a single,



isolated individual. Several, historic, field photographs show the active quarry during a visit by Wyoming schoolteachers. Eventually, Reed would creatively display these bones in UW's geology museum. Some years after Reed's death, the museum's overhead water pipes burst, with disastrous consequences for the vulnerable fossils and many specimens were lost. Fortunately, photos, casts, and figures of many of the bones allow the locality and specimen (suggested by some to represent a unique form of North American *Kentrosaurus*) to continue to be analyzed.

Technical Session XI, Friday 3:00

#### THE IMPACT OF POSTCRANIAL CHARACTERS ON RECONSTRUCTING THE PHYLOGENY OF CARNIVORAMORPHA

SPAULDING, Michelle, American Museum of Natural History, New York, NY, USA

When reconstructing the evolutionary history of the Carnivoramorpha (crown clade Carnivora, plus their nearest fossil relatives) character sampling has been limited primarily to dental and cranial character systems. Little attention has been paid to the utility of postcranial characters, with some authors going so far as to say the postcranial skeleton has little to no importance for reconstructing phylogeny, due to a perceived higher level of homoplasy among this character system than in craniodental anatomy. This view has been especially held for basal carnivoramorphans - the monophyletic Viverravidae and an array of taxa previously grouped in the paraphyletic "Miacidae". Among these groups, perceived problems, such as "a paucity" of postcranial material and an overall lack of phylogenetically informative variation in the skeleton, have led to a lack of study of the postcranial skeleton. This perception has led to the inability to include a large number of postcranial specimens of basal carnivoramorphans in prior analyses, as the lack of a well-preserved skull would tend to preclude reliable placement of these taxa within phylogenies based principally on craniodental characters. This study presents the first phylogenetic analysis based on a comprehensive sampling of the entire skeleton, integrating over 100 postcranial skeleton characters into a pre-existing craniodental character matrix. This has allowed the inclusion of a wider array of taxa, including specimens of basal carnivoramorphans with well-preserved postcranial skeletons, but that lack much craniodental material. The incorporation of these characters allows for a better reconstruction of the evolutionary transformations that occurred in basal carnivoramorphans, including locomotor specializations. Within basal carnivoramorphans the monophyly of some problematic genera can now be tested due to increased character sampling. Additionally these characters provide another level of testing on the placement of 'problematic' taxa relative to the crown-clade Carnivora, such as the Nimravidae and Amphicyonidae.

Poster Session I (Wednesday)

#### FOSSIL FISH FROM THE EARLY JURASSIC (HETTANGIAN) MOENAVE FORMATION IN SOUTHWESTERN UTAH

SPEARS, Sarah, St. George Dinosaur Discovery Site at Johnson Farm, St. George, UT, USA; MILNER, Andrew, St. George Dinosaur Discovery Site at Johnson Farm, St. George, UT, USA; KIRKLAND, James, Utah Geological Survey, Salt Lake City, UT, USA

Since the discovery of dinosaur tracks in 2000 by Dr. Sheldon Johnson, the St. George Dinosaur Discovery Site at Johnson Farm (SGDS) has yielded thousands of unique and scientifically significant fossils, including several new plant species, dinosaur remains, and at least five types of identified dinosaur ichnogenes. These fossils are found within the basal Lower Jurassic (lower Hettangian) Whitmore Point Member of the Moenave Formation, which is representative of a large freshwater lake known as Lake Dixie. Fossil fish remains are abundant in the Whitmore Point Member and have recently yielded two new species, *Lissodus johnsonorum* (freshwater hybodont shark, represented by jaw, teeth and fin spines) and *Ceratodus stewarti* (represented by a lung-fish tooth plate fused to the prearticular found in nearby Warner Valley). Other recent discoveries include the first known palaeoniscoid fish from the Moenave Formation, being a small and nearly complete specimen that displays unique features representing a new taxon. Additional taxon includes a large (~2 m) *Chinlea*-like coelacanth represented by common skull material, the first reported from the Lower Jurassic in western North America. Abundant and often large specimens of semionotid fishes are the main component of the Lake Dixie assemblage. Until now, semionotids were the only fish reported from the Moenave Formation, including the taxa *Semionotus kanabensis*, *S. gigas*, and *Lepidotes walcotti*. However, based on the material on which these identifications were based, it is unlikely that *S. gigas* and *L. walcotti* are valid named taxa for the abundant semionotid fossils preserved in these strata. Preparation on the extensive collections is ongoing and will result in a revision of the semionotids in the Moenave Formation. Comparison of the diverse fish fauna found at and around the SGDS in the Moenave Formation to those of the Late Triassic Chinle Formation in southeastern Utah and correlative fauna from the Early Jurassic Newark Supergroup in the eastern United States has led to great insight as to the speciation of this Lake Dixie fish fauna found in St. George and elsewhere, particularly within the semionotids.

Poster Session I (Wednesday)

#### A REVISION OF THE TRILOPHOSAURIDAE (ARCHOSAURAMORPHA) FROM THE LATE TRIASSIC OF WESTERN NORTH AMERICA

SPIELMANN, Justin, New Mexico Museum of Natural History and Science, Albuquerque, NM, USA; LUCAS, Spencer, New Mexico Museum of Natural History and Science, Albuquerque, NM, USA; HUNT, Adrian, New Mexico Museum of Natural History and Science, Albuquerque, NM, USA; HECKERT, Andrew, Appalachian State University, Boone, NC, USA

Trilophosaurids are a family of archosauromorphs from the Upper Triassic Chinle Group of West Texas, New Mexico and Arizona. Here, we revise the taxonomy of the Trilophosauridae, which has not seen major modification since the 1950s. We recognize two genera (*Spinosuchus* and *Trilophosaurus*) and three species (*S. caseanus* von Huene, *T. buettneri* Case and *T. jacobsi* Murry [= *T. dornorum* Mueller and Parker]) within the family Trilophosauridae. The two species of *Trilophosaurus* can be distinguished from each other by tooth, vertebral, humeral, femoral and astragalar morphology. *Spinosuchus* is included in the Trilophosauridae based on similarities to *Trilophosaurus* in the morphology of its centra and pre- and postzygapophyses, while the tall, rod-like neural spines readily distinguish *Spinosuchus* from *Trilophosaurus*. *Spinosuchus* is known from three localities in West Texas: the Spur-Crosbyton mail road locality (the type locality) in the Tecovas Formation, Rotten Hill also in the Tecovas Formation and the Kahle *Trilophosaurus* quarry (NMMNH locality 3775) stratigraphically low in the Trujillo Formation. Trilophosaurids have a biostratigraphic range from the middle Otischalkian to middle Revueltian, with *T. buettneri* extending from the middle Otischalkian through the late Adamanian, *T. jacobsi* extending from early Adamanian to middle Revueltian and *S. caseanus* being present only in the Adamanian, so it is an index taxon of that faunachron.

#### Ernie Lundelius Symposium (Faunal Dynamics and Extinction), Wednesday 11:00 THE DIAMOND VALLEY LAKE LOCAL FAUNA: LATE PLEISTOCENE VERTEBRATES FROM INLAND SOUTHERN CALIFORNIA

SPRINGER, Kathleen, San Bernardino County Museum, Redlands, CA, USA; SCOTT, Eric, San Bernardino County Museum, Redlands, CA, USA; SAGEBIEL, James, San Bernardino County Museum, Redlands, CA, USA; MURRAY, Lyndon, University of Texas at Austin, Austin, TX, USA

The Diamond Valley Lake local fauna is the largest open, non-asphaltic late Pleistocene assemblage known from the American southwest. A classic suite of Rancholabrean vertebrates characterizes the fauna, which includes nearly 100,000 identifiable fossils of vertebrates, invertebrates and plants representing more than 100 animal and plant taxa from 2,581 localities. Because of the volume, diversity, and excellent preservation of fossils recovered, this assemblage is designated a local fauna, named here for the reservoir now filling the valleys where the fauna originated. Located within the northern Peninsular Range physiographic province of southern California, the Diamond and Domenigoni Valleys form a contiguous east-west drained trough, 9 km long and 2.5 km wide. The alluvium-filled valleys are bounded by bedrock highlands. Bedded silts and clay intercalated with coarse-grained stream channels represent a braided stream environment, which yielded AMS dates from ~22 ka to ~13 ka. These fluvial sediments overlie silts, clays and an organic black clay at depth, interpreted as lacustrine in origin, with AMS dates from ~46 ka to ~41 ka. These distinct sediment packages yielded abundant vertebrate remains, with the lower clays producing an unexpected and rare flora. The attritional vertebrate assemblage exhibits a substantial taphonomic overprint, resulting in few pedal bones or caudal vertebrae. Large mammal fossils generally occur as isolated elements, but some partial skeletons were recovered. Apparent concentration of fossil remains in the west end of the Domenigoni Valley likely occurred in response to a hydraulic bottleneck. Spatial and temporal changes in faunal diversity can be assessed due to the large geographic study area and the dated stratigraphy. Remains of *Mammot americanum* are abundant in the fauna, particularly in the west, including representatives of very large individuals with respect to the size of other mastodons in the American West. Fossils of *Bison* are more common to the east and in younger sediments. Large carnivorans are very rare relative to the abundant herbivore fossils, suggesting a normal distribution for the sample population.

Technical Session VIII, Thursday 3:00

#### OXYGEN AND CARBON ISOTOPES FROM EXTANT CROCODYLIAN AND RATITE BIRD BIOMINERALS: AN INTERPRETIVE MODEL FOR FOSSIL DINOSAUR ISOTOPIC DATA?

STANTON, Kathryn, Sacramento City College, Sacramento, CA, USA; CARLSON, Sandra, University of California, Davis, Davis, CA, USA

What is the range of variation in  $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$  in extant archosaurs? Improving our understanding of these groups will be invaluable when interpreting similar fossil archosaur data, yet our isotopic knowledge of them is far from adequate. We developed a dataset ( $\delta^{18}\text{O}$  and  $\delta^{13}\text{C}$ ) from extant archosaur enamel, bone, and dentine and evaluated its potential as an interpretive tool for fossil archosaur bioapatite data. We analyzed 10 extant wild-caught crocodylian species and five extant ratite bird species and interpreted the data in terms of diet, thermoregulatory strategy, behavior, climatic

influences, biomineral type, and potential for use in assessment of diagenesis. The  $\delta^{18}\text{O}_p:\delta^{18}\text{O}_c$  relationship in extant archosaurs is statistically significant, but with much greater scatter about the best-fit line than that previously determined in mammals. Ratites and crocodylians display isotopic ratios suggestive of increased water vapor loss at higher temperatures and/or lower humidity. Crocodylians show decreased water vapor loss during cooler and/or wetter conditions. Most crocodylian species show  $\delta^{13}\text{C}$  values indicating consumption of prey with mixed C3/C4 diets. Crocodylians with the greatest  $\delta^{13}\text{C}$  range have known cosmopolitan diets; those with the narrowest range have documented narrow diets. Ratites fall within a C3 plant-based diet  $\delta^{13}\text{C}$  range; arid-environment species have the most positive values and forest-dwelling species the most negative. Crocodylian  $\delta^{18}\text{O}_p$  is explained primarily by three non-exclusive variables: local precipitation, dietary sources, and behavior, to varying species-dependent degrees. Ratite  $\delta^{18}\text{O}_p$  primarily reflects water usage and habitat. Absolute ranges of  $\delta^{18}\text{O}_p$  and  $\delta^{13}\text{C}$  are greater for crocodylians than ratites, likely due to differences in thermoregulatory strategy, dietary preferences, and behavioral patterns. The  $\delta^{18}\text{O}_p:\delta^{18}\text{O}_c$  relationships documented here could be useful in evaluating thermoregulatory strategies in extinct archosaurs, which should display a relationship more similar to ratites if homeothermic, or crocodylians if heterothermic.

Preparators' Session, Thursday 11:45

#### THE RESTORATION AND RECONSTRUCTION OF MULTIPLE ORNITHISCHIAN DINOSAUR SKELETONS AT THE CARNEGIE MUSEUM OF NATURAL HISTORY: TECHNIQUES, SURPRISES, PROBLEMS, AND RESOLUTIONS

STEVENS, Lauren, Carnegie Museum of Natural History, Pittsburgh, PA, USA; SHAW, Allen, Carnegie Museum of Natural History, Pittsburgh, USA; PICKERING, Daniel, Carnegie Museum of Natural History, Pittsburgh, PA, USA; WUERTHELE, Norman, Carnegie Museum of Natural History, Pittsburgh, PA, USA

Carnegie Museum of Natural History (CMNH) is well-known for its extensive dinosaur exhibits that consist largely of original fossil skeletons. Nevertheless, most of CMNH's exhibited dinosaur specimens were originally mounted in the early 20th Century. More recent discoveries have greatly increased the sample size for many of these taxa, thus contributing to a more accurate understanding of their morphology and significantly altering initial interpretations of skeletal anatomy, stance, and posture. CMNH is currently remounting all of its mounted dinosaur skeletons for their display in the upcoming exhibition *Dinosaurs in Their World*. All skeletal elements are being cleaned, restored, reconstructed, and remounted according to current scientific understanding to ensure that they are as anatomically accurate as possible. Much of this work is being carried out in the museum's publicly accessible fossil preparation laboratory (*PaleoLab*). Work completed in *PaleoLab* to date includes converting three wall-mounted ornithomimid skeletons (*Dryosaurus*, *Camptosaurus*, and *Corythosaurus*) into three-dimensional freestanding mounts, and preparing CMNH's *Stegosaurus* to be remounted. Here we provide an overview of the techniques we applied to dismantling, cleaning, preparing, restoring, and reconstructing these four ornithischian dinosaurs, as well as revealing the surprises and problems we encountered in refurbishing mounted skeletons that stood for nearly a century.

Poster Session IV (Saturday)

#### A HYRACOID FROM THE RUKWA RIFT BASIN OF SOUTHWESTERN TANZANIA

STEVENS, Nancy, Ohio University, Athens, OH, USA; O'CONNOR, Patrick, Ohio University, Athens, OH, USA; GOTTFRIED, Michael, Michigan State University, East Lansing, MI, USA; ROBERTS, Eric, University of the Witwatersrand, Johannesburg, South Africa;

NGASALA, Sifa, Michigan State University, East Lansing, MI, USA

A striking array of fossil hyracoids has been described from northern Africa and the Arabian Peninsula, with several taxa recognized from Paleogene strata not only in the Fayum Depression of Egypt, but also in Morocco, Algeria, Tunisia, Libya and Oman. Hyracoids appear to have reached their apex in diversity during the Paleogene, at which time the group dominated the small-medium sized herbivorous niches in known Afro-Arabian faunas, and spanned a range of body sizes and locomotor and dietary morphologies. Faunal exchange beginning in the Miocene introduced a number of immigrant ungulates to the African continent, with a dramatic decline in hyracoid diversity occurring shortly thereafter. Today, only three hyrax genera remain. The hyracoid record in sub-equatorial Africa has been relatively undocumented prior to the Neogene faunas of Kenya, Namibia, and South Africa. Based in southwestern Tanzania, the Rukwa Rift Basin Project addresses critical gaps in the continental African Paleogene fossil record. Recent work in Unit II of the Red Sandstone Group reveals a diverse mid-late Oligocene microfauna preserving invertebrates, lungfish, anurans, crocodylians, and mammals. Here we describe the earliest hyracoid evidence from the region, represented by a comb-like right lower first incisor bearing four individual tines, each less than 1mm across and approximately 2mm in length. The tooth is labiolingually narrow and mesiodistally elongate, measuring approximately 4.5mm at its widest point. It exhibits a mild concavity along its lingual aspect, and an elongate and

tapering root centered directly beneath tines two through four. The mesial placement of tine one results in an asymmetric morphology reminiscent of hyracoids that exhibit a triangular wedge of alveolar bone between the central incisors. The specimen is distinctive among Paleogene hyracoids in preserving four separate tines on the central lower incisor. Taxa such as *Thyrohyrax* exhibit only three tines whereas the hyperpericinate *Antilohyrax* preserves up to 10 individual tines. Rukwa Rift Basin localities provide a rare window into hyracoid evolutionary history prior to the Neogene faunal transition, helping to expand our knowledge of Paleogene vertebrate diversity on the African continent.

Technical Session II, Wednesday 10:45

#### THE FIRST TETRAPOD TRACKWAYS FROM THE PALEOZOIC OF WEST AFRICA: ONE STEP TOWARDS RECONSTRUCTING THE LANDSCAPE OF CENTRAL PANGAEA

STEYER, J. Sébastien, CNRS-MNH, Paris, France; GAND, Georges, University of Burgundy, Dijon, France; SMITH, Roger, Iziko, South African Museum, Cape Town, South Africa; SIDOR, Christian, University of Washington, Seattle, WA, USA; TABOR, Neil, Southern Methodist University, Dallas, TX, USA

The Moradi Formation of northern Niger has yielded the only substantial tetrapod fauna from the Upper Permian of central Pangea. The body fossil record presently consists of two large temnospondyls (*Nigerpeton* and *Saharastega*), the pareiasaur *Bunostegos*, the captorhinid *Moradisaurus*, and a possible therapsid. This endemic fauna, which is strikingly different in composition from others of the Upper Permian, suggests that reliance on high-latitude southern African and Russian faunas has yielded an oversimplified picture of the distribution of terrestrial faunas. Recent fieldwork in December 2006 has led to unexpected discoveries such as the first macroflora (including silicified logs and carbonized plant remains), freshwater bivalves, coprolites, paleosols characterized by accumulation of calcium carbonate, gypsum, and silica, and trackway horizons. The trackway horizons contain an exquisite tetrapod ichnofauna that is preserved within a local, 1.2 to 1.5 m deposit of thinly bedded calcisiltite, with polygonal desiccation cracks upon the upper surfaces, in the upper Moradi Formation. Importantly, the ichnofauna documents small-bodied tetrapods unlikely to be recovered from the Moradi Formation as body fossils because of preservational biases. The ichnofauna consists of beautifully preserved trackways and isolated footprints authored by at least three types of amphibians and reptiles, which can be distinguished by their digit number and shape, as well as attributes of their trackways. The footprints and trackways are preliminary referred to the ichnotaxa *Fylopus herminatus* or *Fyloidichnus* (ascribed to captorhinomorphs or bolosaurs), *Dromopus* or *Rhynchosauroides* (lacertoids in shape), and *Paradoxichnium* (with parallel digits). Interestingly, all of these records suggest Euramerican rather than Gondwanan affinity, as is the case of the associated body fossils outlined above. This ichnofauna and its accompanying sedimentological context will allow us to better reconstruct the landscape of central Pangea towards the end of the Permian.

Technical Session XIII, Friday 3:00

#### A UNIQUE DERIVED POSSIBLY ZYGODACTYL BIRD SKELETON FROM THE PALEOCEAN (TORREJONIAN) OF NEW MEXICO

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The discovery of a locality (NMMNH L-6898) in the late Torrejonian (To3), *Mixodectes pungens* zone of the Nacimiento Formation, San Juan Basin, New Mexico has yielded the partial skeletons of small mammals (multituberculates, a plesiadapiform, and others), glyptosaurine lizards, and a neoavian bird. This specimen is the first bird reported from the Torrejonian of North America. A mix of articulated and disarticulated bones were recovered from a 2-3 cm thick layer of massive muddy siltstone collected primarily through surface collecting, quarrying and underwater screening of a small (<1m<sup>2</sup>) area. Partial articulation and concentration suggests minimal transport prior to burial. Some bones were partially encased in calcitic and/or gypsiferous nodules or crusts. Fragments of humeri, scapulae, coracoids, thoracic vertebrae, tibiotarsi, tarsometatarsi, ulnae, the jaw, and the pygostyle are preserved. This skeleton of a single adult individual bird exhibits many highly derived characters within crown group birds. The jaw articulation exhibits the derived condition found within Neoaves of 3 quadrate mandibular condyles. One of the unique features of the skeleton is a tarsometatarsus that appears to have been able to reverse the 4th pedal digit. It is not as derived as later Paleogene zygodactyl morphologies, but may represent an early stage in the evolution of a zygodactyl foot. The coracoid has a procoracoid foramen, the scapular cotyla is shallow and subtriangular in outline, and the supracoracoideus fossa is relatively deep. The scapula has a short acromion and a subcircular glenoid. The characters found in the skeleton occur individually in many extant clades including owls, mousebirds, parrots, and others. This specimen does not appear to fit into the crown clade of any extant ordinal level clade, but may be sister to one of more of the derived neoavian clades. The unique Torrejonian age and geographic location of this bird taxon in New Mexico place this partial skeleton in a unique position of the debate over the diversification of birds in the early Paleogene.

Technical Session XIV, Saturday 8:00

REEXAMINATION OF AN AETOSAUR FROM THE TECOVAS FORMATION (DOCKUM GROUP) OF TEXAS: IMPLICATIONS FOR AETOSAUR DIVERSITY, ONTOGENY, BIOCHRONOLOGY, AND BIOSTRATIGRAPHY  
STOCKER, Michelle, University of Iowa, Iowa City, IA, USA; PARKER, William, Petrified Forest National Park, Petrified Forest, AZ, USA; IRMIS, Randall, University of California, Berkeley, CA, USA

Aetosaur alpha taxonomy is largely based on characters from the paramedian and lateral osteoderms. Though some fragments are diagnostic to genus or species, associated specimens of more than one complete plate allow a more accurate taxonomic assignment. Furthermore, most studies do not address whether differences in aetosaur osteoderm ornamentation could represent different ontogenetic stages. Investigation of a partial aetosaur skeleton from the Dockum Group of Texas (UMMP V60817) suggests that it is a new taxon. This specimen was previously considered to be a juvenile *Desmatosuchus*, though its morphology differs significantly from known *Desmatosuchus* specimens. Histological investigation of osteoderms, comparison with a growth series of *Typhorax*, and the use of size-independent growth indicators (e.g., neurocentral suture closures) indicate that this specimen is at least a sub-adult. Thus, the characters differentiating UMMP V60817 from *Desmatosuchus* likely diagnose it as a new taxon. This conclusion is further supported by the results of a phylogenetic analysis of aetosaurs including the new specimen. This study demonstrates that the use of suchian osteoderm morphology for phylogenetic characters is a robust practice, independent of any ontogenetic changes. This taxon also adds to the known diversity of aetosaurs, and indicates that some referred specimens of previously known taxa may actually represent new species of aetosaurs. Finally, this "hidden" diversity of aetosaurs means that voucher specimens for biochronologic and biogeographic analyses should be carefully investigated before being used in these studies.

Preparators' Session, Thursday 11:15

DUPLICATION, THREE-DIMENSIONAL RECONSTRUCTION, AND MOUNTING OF THE SKELETONS OF THREE TRIASSIC TETRAPODS USING EPOXY-RESIN AND ACRYLIC GLASS

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In the course of construction of a new large-scale exhibition at the State Museum of Natural History Stuttgart, Germany, the following three Triassic tetrapods were reconstructed and mounted three-dimensionally: *Lystrosaurus hedini*, a herbivorous therapsid from the Lower Triassic of Xinjiang, China; *Belesodon magnificus*, a carnivorous therapsid from the Upper Triassic of Brazil; *Plagiosuchus pustuliferus*, a marine temnospondyl amphibian from the Upper Triassic of Germany. For all three reconstructions and mountings, casts of the bones were made using epoxy-resin, and acrylic glass was used as hidden support. All preserved bones were completely casted, and missing elements were replaced either by reconstructions of similar elements (e.g. in the case of vertebrae) or by completely new models. A scientifically accurate but also aesthetically pleasing result was thereby achieved by combining both original and supplemental material. The original specimen of *Lystrosaurus hedini* is considered to be the most complete skeleton of a juvenile dicynodont currently known. The skull is broken into several parts, thus exposing the internal structure of the braincase, while the postcranial area of the specimen is strongly compressed with the elements of the thorax region being fused during fossilization, requiring the exclusive use of replicas in order to achieve an anatomically correct skeleton. *Belesodon magnificus* was first mounted in 1930 by Friedrich von Huene, using the original material. Because the remarkably complete skull is strongly compressed, anatomical details could not be rectified without damaging the original fossil, and therefore the extensive use of newly modelled bone reconstructions was necessary. *Plagiosuchus pustuliferus* has never been mounted before, and the reconstruction was based on material from different individuals from multiple localities of eastern and southern Germany. Acrylic glass was used extensively in this case especially, as it must be considered that the precise orientation of several points of articulation was not known due to the lack of preserved cartilage, the shape and size of which being crucial for an accurate mounting.

Poster Session I (Wednesday)

THE PROMISE OF LOW COST 3D LASER SCANNERS

STRAIT, Suzanne, Marshall University, Huntington, WV, USA; SMITH, Nicholas, Marshall University, Huntington, WV, USA; PENKROT, Tonya, Marshall University, Huntington, WV, USA

Three dimensional laser scanning effectively visualizes and quantifies complex morphology; however, the widespread use of this technology has been restricted by high equipment costs (\$25-100K). This year a substantially lower cost (\$2.3K) laser scanner was introduced to the market. This study's goal was to evaluate the potential of this scanner for paleontological research. NextEngine has marketed their Desktop 3D Scanner as having a maximal accuracy and resolution of 0.127 mm. To evaluate this claim, an accuracy study was performed on a certified scale bar (100 x 10 x 1 mm). The scale bar was coated with ammonium chloride and scanned at ten different orientations

that were aligned to form a single 3D model. Six replicants were modeled. The models were processed in the proprietary ScanStudio, exported to Geomagic Studio to transfer the created mesh into a solid, and finally into AutoCAD for measurement. The length of each scale bar model was measured and the results indicated a system accuracy of + 1.00 mm (1% error rate). As a comparison, the Laser Design Inc. Surveyor RPS-120 scanner (~\$55K system) has a linear accuracy of + 0.001 mm. These data indicate that, although this scanner is less accurate than existing higher priced, higher resolution scanners now available, it does have potential for paleontological research. While this system is not appropriate for small teeth and skulls, it would be useful for medium to large sized skulls and dentitions, and excellent for a variety of postcrania with typically less detailed and complex morphology. The maximum field size for a single scan is 34 x 25 cm (larger objects can be scanned, but need to be composite-captured and merged). A benefit of this scanner over more costly systems is that it is small and light enough for museum travel. Additionally, the scanner and associated software are relatively user-friendly for this level of technology. In summary, these results indicate that although this scanner's accuracy is inadequate for small topographically complex specimens, it still has potential paleontological applications.

Student Poster Session (Thursday)

A TAXONOMIC REVIEW OF LATE CRETACEOUS CIMOLESTIDS

STRAUSS, Justin, San Diego State University, Valencia, CA, USA

Cimolestids, Late Cretaceous mammals known primarily from western North America, are hypothesized to include the origins of Carnivora as well as the extinct creodonts, palaeoryctids, and taeniodonts. This relationship is based on their biostratigraphic position, within Late Cretaceous and early Paleocene (70-64 Mya) sediments, as well as the carnassial-like occlusion of their dentition. Current taxonomic relationships of cimolestids are based almost entirely on tooth morphology, and remain largely unresolved. The last major taxonomic study of cimolestids was done in 1973, and our knowledge of early eutherians and the number of specimens collected has more than doubled since then. The methods utilized for analyzing the phylogenetic relationships between taxa have also advanced dramatically. Even in recent studies of early eutherians, cimolestids are often referred to as a single taxon, providing no detail as to how the known species are related to one another and little detail as to how they are related to other eutherians. This study is examining the known Late Cretaceous cimolestids using modern techniques to interpret their phylogenetic relationships amongst themselves and to earlier eutherians. One cimolestid in particular, *Procerberus*, is of special interest because of its uncertain relationship to *Cimolestes*. Preliminary morphological analyses suggest that it groups within *Cimolestes*, and further that *Cimolestes* is paraphyletic.

Poster Session I (Wednesday)

DESCRIPTION OF THE PLESIOSAUR *TATENECTES LARAMIENSIS* FROM THE SUNDANCE FORMATION (WYOMING, USA) AND ITS POSITION IN THE CRYPTOCLEIDOID LINEAGE

STREET, Hallie, Arlington, VA, USA; O'KEEFE, F. Robin, Marshall University, Huntington, WV, USA; LOCKWOOD, Rowan, College of William and Mary, Williamsburg, VA, USA

The majority of cryptocleidoid plesiosaurs have been recovered from Upper Jurassic units in the United Kingdom, but *Tatenectes laramiensis* is one of two cryptocleidoids documented from the Sundance Formation (Wyoming, USA). The purpose of this research is to describe new fossil material of *Tatenectes* and to reevaluate the phylogenetic position of this genus within the cryptocleidoid lineage based on this new material. The Sundance Formation was deposited in the Sundance Seaway, a shallow isolated epicontinental seaway, which inundated the northern Rocky Mountain states in several pulses during the Jurassic. The fossils were collected during fieldwork in the Bighorn Basin in North-central Wyoming from "Redwater Shale member" sediments, near Shell, Wyoming. This new material includes a partial skull, a humerus missing part of the shaft, and a partial pectoral girdle, among other elements. Nine new phylogenetic characters based on morphological features of the humerus and pectoral girdle were integrated into previously existing character matrices for cryptocleidoids to generate new phylogenetic trees using parsimony criteria. The pectoral girdle is very short anteriorly and most closely resembles that of *Tricleidus seeleyi*. Two most parsimonious trees were obtained, and the consensus tree solidifies the phylogenetic position of *Tatenectes* as being most closely related to the Oxford Clay cimoliasaurid *Kimmerosaurus*. The relationship between the highly derived plesiosauriform Polycotylidae and the cimoliasaurid plesiosaurs is also strengthened.

Poster Session III (Friday)

PALEOGENE TERRESTRIAL MAMMALS IN THE TIETON RIVER AREA, SOUTH-CENTRAL WASHINGTON

STRGANAC, Christopher, Southern Methodist University, Dallas, TX, USA

Volcaniclastic sediments in the Tieton River area, 30 miles southeast of Mount Rainier, preserve Paleogene terrestrial mammals in two stratigraphic units. A perissodactyl tooth fragment from the Milk Creek tuff, zircon fission track dated at 34 Ma, is the oldest non-marine vertebrate record from Washington. The upper portion of the overlying

Wildcat Creek beds preserves isolated elements of *Cormocyon copei*, *Daphoenus*, a cricetid rodent, *Miohippus equinanus*, *Diceratherium annectens*, *Promerycochoerus superbus*, *Eporeodon major*, *Hypertragulus*, and cf. *Thinohyus*. These taxa show a northwest extension of the "middle" John Day "Fauna" from eastern Oregon and suggest an early Arikarean (26-28 Ma) correlation. This fauna lived in a moist seasonal environment, indicated by a Goshen-type paleoflora of the Ohanapocosh Formation and supported by the presence of argillaceous and protosols.

Poster Session I (Wednesday)

#### FISH OTOLITHS FROM THE EOCENE CLINCHFIELD FORMATION OF GEORGIA WITH NOTE OF A HAEMULID (GRUNT) OF GIGANTIC PROPORTIONS

STRINGER, Gary, University of Louisiana at Monroe, Monroe, LA, USA;  
CICIMURRI, David, Clemson University, Clemson, SC, USA

Fish otoliths (earstones) have proven to be invaluable in the identification of fossil actinopterygians (bony fishes) in the Cenozoic deposits of the United States Gulf Coastal Plain, Central America, and Caribbean. Preliminary investigations of the Clinchfield Formation (late Eocene; 34.2 to 36.0 million years old) from the Hardie Kaolin Mine northwest of Gordon, Wilkinson County, central Georgia, yielded skeletal remains representing only five taxa of actinopterygians. The number of bony fishes is unusual considering that 30 chondrichthyan taxa (sharks, rays, and a holoccephalian) have been identified from the site. To better interpret actinopterygian diversity at the site, surface and bulk collecting techniques were utilized to obtain otoliths. Identification of the otoliths nearly tripled the number of teleosts known from the vertebrate assemblage based exclusively on skeletal elements. The fossil fish assemblage based on otoliths is dominated numerically and taxonomically by sciaenids (drums), which are represented by five taxa. The otoliths also indicate the presence of albulids (bonefishes), heterenchelyids (marine eels), congrid (conger eels), ariids (sea catfishes), ophiidiids (cusk-eels), and haemulids (grunts). The fish assemblage provides important data for the interpretation of the paleoecology of the Clinchfield Formation and verifies a nearshore, marine environment as indicated by earlier studies on chondrichthyans and invertebrates. One otolith specimen is of special interest because of its tremendous size. Although worn, the left sagitta measures 3.48 cm in length. The specimen appears to belong to the genus *Anisotremus* in the family Haemulidae (the grunts) and compares favorably with *Anisotremus virginicus*, which is found in the present Gulf of Mexico. Fossil otoliths of this length are extremely rare and are seldomly preserved in the paleontological record. Furthermore, comparison of the fossil otolith to otoliths from modern haemulids indicates that fossil specimen would represent a grunt of gigantic proportions.

Technical Session XII, Friday 2:15

#### TOWARDS CALIBRATING THE LATE MIOCENE C<sub>3</sub>/C<sub>4</sub> SHIFT IN THE GREAT PLAINS, NORTH AMERICA: A COMBINED RECORD OF PHYTOLITH ASSEMBLAGE COMPOSITION AND STABLE CARBON ISOTOPES

STRÖMBERG, Caroline, NMNH, Smithsonian Institution, Washington, DC, USA;  
SMITH, Francesca, Northwestern University, Evanston, IL, USA

During the late Miocene, ungulate faunas of the Great Plains experienced a decline in taxonomic richness, despite overall higher numbers of grazing taxa. The change has in part been attributed to the rise to ecological dominance of grasses using C<sub>4</sub> photosynthesis at ca. 8-5 Ma. This vegetation shift has been recognized in the stable carbon isotope record of paleosols, ungulate tooth enamel, and phytoliths, but as of yet, no direct evidence for floral composition has been available. We use the same phytolith assemblages from late Miocene sites in Nebraska and Kansas to extract information about phytolith assemblage composition and stable carbon isotopes of phytoliths. The dual record spans the critical interval (~12-3 Ma), allowing us to, for the first time, examine how isotopic shifts correlate with floral change. The phytolith data are broadly concordant with isotopic data, in showing a marked increase of grass short cells typical of chloridoid and other potentially C<sub>4</sub> PACCAD grasses between 8 and 5 Ma. However, in several cases, phytolith analysis indicates lower relative abundance of potential C<sub>4</sub> grasses than do the carbon isotopes from the same phytolith assemblages. The discrepancy may relate to several factors, including differential production of non-diagnostic phytoliths by C<sub>3</sub> and C<sub>4</sub> grasses, volcanic ash contamination of phytolith assemblages used in isotopic analysis, and the possibility that evolutionary changes in phytolith morphology prevent us from correctly identifying C<sub>4</sub> grasses in Miocene phytolith assemblages. The latter hypothesis remains to be tested through detailed work on modern phytolith reference material.

Technical Session X, Friday 9:30

#### MULTITUBERCULATES AND OTHER MAMMALS FROM WA4 (EARLY LYSITEAN, EARLY EOCENE) OF THE WIND RIVER FORMATION, HELLS HALF ACRE, WYOMING.

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KRISHNALKA, Leonard, Biodiversity Institute, Lawrence, KS, USA

The vertebrate fauna from the Cole Locality in Hell's Half Acre, Natrona County, Wyoming, preserves the oldest known assemblage from the Wind River Formation. Based on the co-occurrence of *Apheliscus* sp. and *Heptodon* sp. and the "primitive" species of other taxa, the site is considered to be from Wasatchian 4 and the earliest Lysitean Land Mammal Subage (Early Eocene). Fossils come from two horizons - a variegated mudstone of overbank origin, and a channel sandstone. Fossils from the upper mudstone unit consist primarily of lower jaws of *Hyopsodus* sp. The faunas from the lower sandstone consist of very abundant isolated teeth and a few jaw fragments. Much of the material was recovered from screen washing of anthills. The Cole Locality sandstone horizon contains the first record of multituberculates from the Lysitean of the Wind River Formation. The fauna consists of at least the following: *Palaoryctes* sp., *Didelphodus* sp., *Macrocranium* sp., *Centetodon* sp., *Palaictops* sp., *Hyopsodus* spp., *Apheliscus* sp., cf. *Thryptacodon* sp., *Phenacodus* spp., *Heptodon* sp., *Hyracotherium* spp., *Diacodexis* sp., *Bunophorus* sp., *Absarokius abbotti*, *Microsops* sp., *Cantius* sp., and at least five rodents, four carnivores and creodonts, and additional insectivorous mammals, primates and minimally two multituberculates. The fauna is more diverse than that from the type area of the Lysitean and Lysite Member of the Wind River Formation and differs in the presence of *Apheliscus*, the multituberculates, additional primate taxa, and the conspicuous lack of *Hyopsodus powellianus*, which represents more than 50% of the genus in the Lysite Member.

Poster Session I (Wednesday)

#### LAM-ICP-MS ANALYSIS OF FOSSIL BONE: SOME UNEXPECTED RESULTS AND IMPLICATIONS FOR INTERPRETATION OF RARE EARTH ELEMENTS IN FOSSIL BONE

SUAREZ, Celina, University of Kansas, Lawrence, KS, USA; MACPHERSON, G., University of Kansas, Lawrence, KS, USA; WOLFE, Melissa, University of Kansas, Lawrence, KS, USA; GONZALEZ, Luis, University of Kansas, Lawrence, KS, USA; GRANDSTAFF, David, Temple University, Philadelphia, PA, USA

Laser ablation microprobe inductively coupled mass spectroscopy (LAM-ICP-MS) uses a laser to directly sample ~10-5 µm<sup>3</sup> of material. Solution ICP-MS requires dissolution of a minimum of 10-2 cm<sup>3</sup> of material, usually from a larger homogenized powdered sample. Thus, LAM-ICP-MS technique provides detailed information on spatial variability that solution ICP-MS cannot. This study uses LAM-ICP-MS to investigate variability of rare earth element (REE) concentrations throughout the cortex of two bone pieces from the Crystal Geyser Dinosaur Quarry, Utah. One bone piece, representing 25-30% of the bone circumference, has consistent REE patterns (CGDQ-44). CGDQ-3, with > 60% of the bone circumference represented, has variable REE patterns. Variability is interpreted as two end-member patterns with a small transitional boundary between them. To date, no such variable REE patterns using LAM-ICP-MS on fossil bone have been reported. These results offer significant insight into how fossil bone acquires REEs. Possible explanations may include fossilization at a geochemical boundary or "partially closed system" conditions. A "partially closed system" could allow partial fossilization in one environment and further fossilization in another environment. Partially closed systems could also result in differential rates of fossilization for different parts of the bone resulting in variable REE patterns. As researchers have suggested use of bone REE patterns as a tool for provenance, taphonomy, and paleoenvironmental reconstruction, it is important that variations in REE patterns be explained. Although our results seem to call into question the use of bone REEs for taphonomic purposes, they may simply suggest LAM-ICP-MS analysis be used to ascertain homogeneity particularly for sites in terrestrial environments where high variability in bone REE patterns can occur. In addition, bones with variable REE patterns provide more information about taphonomic alteration history. Therefore, we suggest that REE geochemistry is still a valuable tool, but should be used with caution. Fossil bone should be characterized carefully by use of LAM-ICP-MS, solution ICP-MS and petrography to unravel a potentially complex diagenetic history.

Technical Session IX, Friday 11:30

#### DOMING, HETEROCHRONY, AND PAEDOMORPHOSIS IN THE PACHYCEPHALOSAURIDAE (ORNITHISCHIA: DINOSAURIA): TAXONOMIC AND PHYLOGENETIC IMPLICATIONS

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Fully-developed frontoparietal domes versus "flat-headed" skulls has been a convenient way to divide the Pachycephalosauridae into neat phenetic types. However, fully-domed small pachycephalosaurids abruptly appear in North America ~85 ma (late Santonian), and flat-headed pachycephalosaurids are more frequently encountered in younger (Judithian-Lancian [and equivalent] age) strata, thus offering a clue that, in part, undermines the thesis that "flat-headedness" is truly primitive. The ubiquitous

prevalence of smaller-domed pachycephalosaurids in older strata, and the more common occurrence of "flat-headed" pachycephalosaurids in younger Upper Cretaceous strata, suggests that the "flat-headed" morphology may represent an earlier ontogenetic stage that is delayed in larger and more mature individuals and thus is heterochronic in its expression. Paedomorphosis, the retention of ancestral juvenile characters in later ontogenetic stages, is evident among some younger "end" members of the family. Paedomorphic pachycephalosaurids would include all those taxa that have "flat-headed" skulls, incipient developed domes, and/or retain open supratemporal fenestrae. The taxon *Stegoceras validum* is the earliest pachycephalosaurid to exhibit this trend, as it has flat frontoparietals in juveniles, and incipiently domed frontoparietals and partly opened supratemporal fenestrae in (presumably) adult specimens. The taxonomic and phylogenetic implications of recognizing paedomorphic trends in the Pachycephalosauridae are tremendous, especially if doming occurs late in ontogeny. The validity of many of the Asia taxa (*Goyocephale*, *Homalocephale*, *Tylocephale* and *Wannanosaurus*) would be in doubt, as would the newly described *Dracorex*, and *Stygmoloch*, from North America. The clade "Pachycephalosaurinae" would need to be abandoned, as it has been defined by the acquisition of a fully developed dome. Consequently, the accepted phylogeny of the Pachycephalosauria and Pachycephalosauridae would be equivocal and unresolved.

Technical Session II, Wednesday 9:15

A NEW GENUS AND SPECIES OF CAPTORHINID REPTILE FROM THE LOWER PERMIAN OF NORTH-CENTRAL TEXAS ILLUSTRATING THE COMPLEXITY OF SIZE AND CRANIODENTAL EVOLUTION IN THE CAPTORHINIDAE

SUMIDA, Stuart, California State University, San Bernardino, CA, USA; DODICK, Jeff, Hebrew University of Jerusalem, Givat Ram, Jerusalem, Israel

The cranial anatomy of a new genus and species of captorhinid reptile with a single row of dentary and maxillary marginal teeth is described on the basis of two well-preserved specimens from the Lower Permian Waggoner Ranch Formation of north-central Texas. The holotypic specimen consisting of a partial skull and lower jaws was misidentified by Williston as *Labidosaurus hamatus*, and is here distinguished from other captorhinid genera, with the exception of *Labidosaurus hamatus*, based on its large size compared to all other single-tooth-rowed captorhinids, while lacking the marked cheek expansion normally found in *Labidosaurus* and other larger captorhinids. Unique features of the new taxon include recurved teeth and the possession of an extremely large Meckelian foramen on the inner surface of the lower jaw. A phylogenetic analysis was performed including taxa traditionally assigned to the Captorhinidae, the new taxon, *Protorothyris*, and the intermediate German form *Thuringothyris* resulting in the following topology: [*Protorothyris* [*Thuringothyris* [*Concordia* [*Romeria* [New Taxon [*Protocaptorhinus* [*Rhiodenticulatus* [*Saurorictus* [*Captorhinus laticeps* [*Captorhinus aguti*] [*Labidosaurus* [*Labidosaurikos*]]]]]]]]]]]. The new genus is the most basal of described captorhinid genera with the exceptions of *Romeria* and *Concordia*. This description of the new, large, single-tooth-rowed form suggests that, in addition to multiple tooth rows, relatively larger size may have evolved more than once in the basal reptilian family Captorhinidae. Furthermore, the family exhibits at least three different tooth morphologies. Early studies of the captorhinid family frequently characterized it as a homogenous, conservative group, but this study again indicates that evolution within the family is more complex than previously suggested.

Poster Session I (Wednesday)

NEW SUBHOLOSTEANS FROM THE MIDDLE TRIASSIC OF WESTERN GUIZHOU, SOUTHWESTERN CHINA

SUN, Zuo-yu, Peking University, Beijing, China; TINTORI, Andrea, Università degli Studi di Milano, Milano, Italy; JIANG, Da-yong, Peking University, Beijing, China; HAO, Wei-cheng, Peking University, Beijing, China; LOMBARDO, Cristina, Università degli Studi di Milano, Milano, Italy

The fossil-bearing layer in the Upper Member of the Guanling Formation near Yangjuan Village, (Xinmin District, Panxian County, Guizhou Province, southwestern China), has yielded many well preserved specimens of fossil reptiles which have been already extensively studied, but also a remarkable number of fossil fishes, which have been totally ignored by palaeontologists. The site age is early Pelsonian (Anisian, Middle Triassic) because it lies inside the conodont *Nicoraella kockeli* Zone. The rocks of this fossiliferous layer consist of dark, often laminated, slightly marly limestones, with bentonitic intercalations: at least four of these intercalated horizons can be used as markers at local scale. The first studies on this ichthyofauna have concerned some big-sized subholosteans (about 40 cm in s.l.) which are considered as Perleidiformes: they are characterized, in fact, by a wide preoperculum (which is slightly forward bent and sutured with the expanded posterior region of the maxilla), by a large and forked tail (which, having at least 10 epaxial rays, becomes nearly symmetrical) and by heavily ornamented scales on the whole body. The genus that mostly resembles these new specimens is *Colobodus*: it is very common in the Western Tethys, especially from the Anisian to the early Ladinian. Like the European specimens, these Chinese fishes show a remarkable variability, which is, on the other hand, peculiar of many other subholosteans. They can be tentatively gathered in two different species. These new find-

ings further confirm the resemblance between the marine vertebrate faunas coming from the two extreme points of the Tethys. Furthermore, the Panxian fish fauna shows that as early as in the early Pelsonian subholosteans had started the radiation that gave them the absolute supremacy in the Middle Triassic seas.

Preparators' Session, Thursday 8:15

UNSTABLE MATRIX: EXAMPLES OF FIELD AND LAB TECHNIQUES FOR FOSSILS IN A WET, ORGANIC-RICH CLAY FROM THE LATE MIOCENE GRAY FOSSIL SITE IN NORTHEAST TENNESSEE

SUPPLEE, Jeffrey, East Tennessee State University, Johnson City, TN, USA

A wet clay matrix requires field and lab techniques that permit a controlled transition from wet to dry conditions. The Gray Fossil Site vertebrate fossils are slightly mineralized and often badly fractured and displaced due to the weight and movement of the wet clay matrix. After the bedded organic-rich clay dries, it still expands or contracts as relative humidity changes, often separating along bedding planes. Iron concretions tend to be localized around some skulls and vertebral columns. Finely disseminated pyrite occurs rarely in some of the fossils; to date, the pyrite appears to be stable. In the field, roofed structures cover the dig areas to prevent rapid drying and excessive heat. All fossils are quickly removed to the lab to prevent them from wicking moisture from the matrix, which would result in the deposition of salts. Fossils are uncovered only enough for the paleontologist to identify, photograph, and survey. They are then pedestaled and completely jacketed with a plastic or tinfoil vapor barrier between the clay and the plaster jacket. Any matrix removed during excavation is bagged with location information and is wet-screened for microvertebrate and plant fossils. Isolated elements that are not fractured can be bagged for cleaning and consolidation in the lab. All efforts are made to clean and consolidate the fossils prior to each new field season so they do not dry out before preparation. Bagged fossils are washed in water and allowed to dry slowly in cleaned, opened field bags. When field jackets are opened, any mold or mildew is sprayed with isopropyl alcohol. While wet, the clay matrix is easily removed. When iron concretion encases the fossil bone, air scribes and/or rotary grinding tools are used. As jacketed fossils are uncovered, they are allowed to dry enough to be cleaned with isopropyl alcohol and treated with Butvar-98 consolidant, and then they are photographed. A lab bedding jacket with vapor barrier is applied to permit working on the fossils from the other side. Once the remaining clay matrix is removed, the fossils are cleaned and consolidated. Some get immediate archival bedding jackets while others are reassembled using Butvar-76 adhesive prior to collections storage.

Poster Session III (Friday)

DISCOVERY OF MAMMALIAN FOOTPRINTS FROM THE MIDDLE EOCENE OF MONGOLIA

SUZUKI, Shigeru, Hayashibara Biochemical Laboratories, Inc., Okayama, Japan; WATABE, Mahito, Hayashibara Biochemical Laboratories, Inc., Okayama, Japan; TSUBAMOTO, Takehisa, Hayashibara Biochemical Laboratories, Inc., Okayama, Japan; SANEYOSHI, Mototaka, Hayashibara Biochemical Laboratories, Inc., Okayama, Japan; TSOGTBAATAR, Khishigjav, Mongolian Paleontological Center, Ulaanbaatar, Mongolia

We report mammalian foot prints from the lower Middle Eocene Khaychin Ula III locality of southern Mongolia discovered by the Hayashibara Museum of Natural Sciences and Mongolian Paleontological Center Joint Paleontological Expedition in 2006. This is the first discovery of mammalian footprints in the Cenozoic of Mongolia. In the Khaychin Ula III, there are several beds with footprints probably of large-sized mammals, which overlie bone beds. The sedimentary environment of the footprint-bearing beds is a flood plain with shallow fluvial channels. The flood plain deposits underlie lacustrine deposits, indicating that the fluvial system was located near marginal part of the lacustrine environments. The footprints were preserved in horizontally stratified sandstone layers. The vertical profile (section) of the footprints is appropriate sample for close observation of preservation condition of the footprints and for relationships among their size, physical properties of substrates, and development of ghost print. The inside of the footprints formed in stratified sandstone layers was filled by massive sands without lamination. Two morphotypes of footprints were recognized: (1) footprint hollows that were filled by massive sands supplied from surrounding substrates; and (2) ghost prints formed under the true footprint—in this case, main parts of the footprint including the impact surface by the animal's foot were eroded by succeeding depositional process of overlying layers. The lower Middle Eocene of the Khaichin Ula locality (Khaychin Ula II, III, V) yields many large-sized mammals: a mesonychid *Mongolonyx*, a pantodont cf. *Eudinoceras*, and perissodactyls such as brontheriids, amynodontids, hyracodontids, lophialetids, and deperetellids. These mammals are candidates of the footprint makers.

Technical Session II, Wednesday 10:00

PALEOCLIMATIC INDICATORS FROM THE MORADI FORMATION OF NIGER INDICATE PROGRESSIVE ARIDIFICATION OF CENTRAL PANGAEA DURING THE PERMIAN

TABOR, Neil, SMU, Dallas, TX, USA; THOMAS, Stephanie, Southern Methodist University, Dallas, TX, USA; SIDOR, Christian, University of Washington, Seattle, WA, USA; LOOY, Cindy, National Museum of Natural History, Washington, DC, USA; STEYER, J. Sébastien, Muséum National d'Histoire Naturelle, Paris, France

The Late Paleozoic is characterized by extreme physiographic, climatic and life changes brought about by the formation of Pangea and isolation of the Tethys sea. Climate sensitive lithologies (e.g., coals, laterites, calcretes, evaporites) paint a clear picture for Carboniferous-Permian (C-P) climates in (1) low latitude (~5°S to 15°N) Euramerican tropical basins around the Central Pangean Mountains, (2) high latitude (~45 to 70°) basins of southern Gondwana and Russia and (3) eastern (para)tropical latitude (~0-30°) basins of Mongolia, China, and southeast Asia. These lithologies indicate C-P climate changes from (1) warm and humid (nearly ever-wet) to hot and arid at low latitude (a transgressive aridification from west to east), (2) cold to cool and humid at high latitude, and (3) persistence of humid conditions at eastern (para)tropical latitudes. This is reflected in terrestrial vertebrate faunas by (1) depauperate Upper Permian faunas of Euramerica, (2) persistence of faunas across the P-T boundary in the Karoo Basins and (3) abundant faunas in the Late Permian of Asia. There is a large blank spot in our knowledge of C-P paleoclimate between ~15° and ~45°. We present here newly documented climate-sensitive lithologies from the Izegouandane Group (C-P of Niger), which spanned from ~28°S to 18°S during this interval of time.

Description and analysis of sediments and paleosol profiles delineate numerous sedimentological and pedological processes, including periodic shrink-swell of soil profiles and accumulation of soil carbonate, gypsum and silica. Considering the occurrence of these processes on modern landscapes, the Moradi Formation was deposited in a continental basin on wide alluvial plains under a warm, arid climate characterized by strongly seasonal precipitation (< 9.5) surface waters. Under these harsh climatic conditions, a unique, endemic vertebrate fauna persisted across the Moradi landscape.

Poster Session I (Wednesday)

SOMETHING LOST, SOMETHING GAINED: EFFECTS OF 14,000+ YEARS OF EROSION ON DINOSAUR FOSSIL RESOURCES, DINOSAUR PROVINCIAL PARK, ALBERTA, CANADA

TANKE, Darren, Royal Tyrrell Museum, Drumheller, AB, Canada; HENDERSON, Donald, Royal Tyrrell Museum, Drumheller, AB, Canada

The 80 km<sup>2</sup> badlands of Dinosaur Provincial Park (DPP) have yielded a diverse Late Cretaceous dinosaur fauna. At present, some 353 isolated skulls and partial to complete skeletons have been found in roughly 100 years. The DPP badlands began forming approximately 14,000 years ago when melt waters from retreating glaciers cut down into the soft strata. With high annual erosion rates of 2 - 4 mm/year, new specimens are continually being exposed. But how many skeletons have been lost? Within the boundaries of DPP, a volume of rock 145m thick between the level of the down-cutting Red Deer River and capping prairie was subdivided into 5m thick slabs. The exposed surface area of each slab was calculated using digital elevation data with an average horizontal spatial resolution of 19m and a vertical resolution of 1m. The number of dinosaurs collected from the surface of a 5m slab was divided by the product of the exposed area and a thickness of 75cm to give a volume density of dinosaur fossils. Knowing the volumes of rock lost from each layer, and the dinosaur density for a layer, the numbers of skeletons lost could be calculated. Of the original volume of DPP, 6.58 km<sup>3</sup> (59.7%) has eroded away, taking with it 39,335 dinosaurs (20,984 hadrosaurs; 7,485 ceratopsians; 3,310 ankylosaurs; and 7,556 theropods). The remaining 4.44 km<sup>3</sup> (40.3%) of sediments remaining in DPP can be expected to produce 31,744 more dinosaurs of similar quality (17,269 hadrosaurs; 6,265 ceratopsians; 2,843 ankylosaurs; and 5,367 theropods). These estimates are minimums as the estimation process excluded bone beds and the countless numbers of isolated bones littering DPP. Barnum Brown was certainly correct when in 1919 he predicted: "In a few years the same territory can be explored with similar results, and for all time to come the Red Deer River will be a classic locality for collecting prehistoric treasures".

Poster Session III (Friday)

MANDIBULAR ANATOMY IN BASAL CERATOPSIANS

TANOUE, Kyo, University of Pennsylvania, Philadelphia, PA, USA; YOU, Hailu, Chinese Academy of Geological Sciences, Beijing, China; DODSON, Peter, University of Pennsylvania, Philadelphia, PA, USA

The Ceratopsia has been known for its unique form of mastication. Although basal ceratopsians lack dental batteries, with teeth merely erupting in a line, derived ceratopsians have jaws with large numbers of teeth, compressed for close packing in dental batteries. These dental batteries have vertical cutting planes. To grasp the evolution of ceratopsian jaw structure, detailed observation of basal ceratopsian skulls is necessary. Until recently, however, evolutionary transformation of their jaw structure has not been fully understood since there were few basal ceratopsian genera with relatively abundant

skulls. Numerous discoveries of new taxa with superb skulls in the past ten years now make it possible to document the evolution of ceratopsian jaw structure. Moreover, further preparation of the specimens after the initial descriptions, especially involving detachment and removal of mandibles from skulls, has revealed new information that was not accessible in previous studies. In this study, the anatomy of mandibles in basal ceratopsians has been examined. Two Jurassic ceratopsians, *Yinlong* and *Chaoyangsaurus*, and psittacosaurids have a relatively longer portion of mandible caudal to coronoid process than in Cretaceous basal neoceratopsians. This morphological difference is due to a smaller contribution of surangular and angular to lateral surface of mandible in the latter. There also is transverse thickening of mandible in Cretaceous basal neoceratopsians associated with medial displacement of the tooth row. As a result, their mandibular fossa is wide and short in dorsal view, whereas that of other basal ceratopsians is long and narrow. Tooth row of Cretaceous basal neoceratopsians along the medial border of mandible is more convex and relatively longer than that of other basal ceratopsians in dorsal view. Unlike ceratopsids, however, the tooth row does not extend caudal to the apex of coronoid process in any of the basal ceratopsians observed. Relatively shorter distance between coronoid process and jaw joint of Cretaceous basal neoceratopsian mandibles compared to psittacosaurids indicates different feeding adaptations in the two groups.

Evolutionary History of Bats Symposium, Thursday 8:30

MOLECULAR PHYLOGENETICS INVESTIGATES THE BAT FOSSIL RECORD

TEELING, Emma, University College Dublin, Dublin, Ireland; MILLER-BUTTERWORTH, Cassandra, University of Pittsburgh, Pittsburgh, PA, USA

The evolutionary history and biogeographic origin of the order Chiroptera (bats) is rife with conflicting hypotheses due to competing phylogenetic trees and a poor fossil record. However, recent large molecular data sets (exons, introns and mitochondrial data) have provided conclusive, congruent support for the paraphyly of Microchiroptera and for the phylogenetic position of most families. Currently, the phylogenetic positions of Miniopteridae, Craseonycteridae and Myzopodidae are still in dispute due to inadequate data and conflicting results. To resolve the phylogenetic positions for these families a combined nuclear supermatrix (~15kb, nuclear introns and exons) was generated, collected and analysed using traditional phylogenetic techniques. This new phylogeny was used to: (1) elucidate the biogeographic origin of bats and the resulting four superfamilial microbat clades; (2) investigate the extent of missing fossil data in light of molecular divergence dates. Both the 'Out-of-Africa' and Laurasiatherian hypotheses for the origin of bats were assessed using evolutionary biogeographic reconstruction methods. These theories were further investigated in light of recent fossil evidence.

Poster Session I (Wednesday)

THE LATE PLEISTOCENE LOCALITY LUGOVSKOE (WESTERN SIBERIA, RUSSIA)

TELEGINA, Svetlana, The State Museum of Nature and Man, Khanty-Mansiysk, Russia; GORELIK, Vasily, The State Museum of Nature and Man, Khanty-Mansiysk, Russia; NAROCHNYI, Viktor, The State Museum of Nature and Man, Khanty-Mansiysk, Russia; GLAZUNOVA, Valentina A., The State Museum of Nature and Man, Khanty-Mansiysk, Russia; REZVYI, Anton, The State Museum of Nature and Man, Khanty-Mansiysk, Russia;

The Lugovskoye locality is situated about 25 km west of Khanty-Mansiysk City and is associated with the marginal part of the first erosive-accumulative fluvial terrace of the Maramka River, a channel of the Ob-Irtys river system. The bone bed occurs at a depth of 0 to 1.5 m below the modern surface within the muddy clay deposits of a small stream that flows into the Maramka River. Results of <sup>14</sup>C dating of the 16 samples from Lugovskoe show that bones accumulated at the site over a long period of time, during the Late Sartan- Early Holocene (16,500 BP to about 9,600 BP). The bone bed is represented by two layers. The bottom layer is composed of sandy-argillaceous sediments with lenses and layers of proto-peat with a thickness of more than 1 m. Most remains recovered from this layer are well preserved but all of them were subjected to lateral displacement during the Sartan epoch. The modern/ Holocene top layer of brownish-gray silty sediment has a thickness of up to 0.2 m. Numerous bone fragments and teeth found in this layer indicate intensive destruction of fossiliferous horizons during modern/Holocene time. More than 3,000 bones and teeth mainly of mammoths were found. The vertebrate fauna includes three vole species, hare (*Lepus* sp.), ground squirrel (*Spermophilus* sp.), woolly mammoth (*Mammuthus primigenius*), Arctic fox (*Alopex lagopus*), gray wolf (*Canis lupus*), cave lion (*Panthera spelaea*), woolly rhinoceros (*Coelodonta antiquitatis*), Pleistocene horse (*Equus* sp.), reindeer (*Rangifer tarandus*), moose (*Alces* sp.), steppe bison (*Bison* sp.), and an unidentified bird. The destruction of bones in the top layer may have been the result of animals foraging for various minerals in the viscous clay sediments. In addition to the animal remains, traces of human activity were found. Some 271 Paleolithic artifacts and mammoth vertebrae showing marks from lithic spear or javelin points were collected from the bottom bone bed. These vertebrae are the first direct evidence of the mammoth hunting in Asia.

Romer Prize Session, Thursday 8:00

HOLOCENE SMALL MAMMALS OF THE GREAT BASIN: RECENT RICHNESS DECLINES AND LIVE-DEAD ANALYSIS OF ECOLOGICAL FIDELITY  
TERRY, Rebecca, University of Chicago, Chicago, IL, USA

Forecasting long-term biotic responses to anthropogenically-driven environmental change necessitates unlocking the wealth of pre-settlement baseline information contained in the recent fossil record. Homestead Cave and Two-ledges Chamber, long-term owl roosts in the Great Basin of the western United States, contain stratified deposits of regurgitated raptor pellets rich in small-mammal skeletal remains. These stratified deposits record shifts in local faunal composition through the Holocene. To successfully interpret the ecological information archived in these death-assemblages, however, the accuracy with which they record community composition must first be quantified, thus testing the strength of the biological signals captured by such deposits. Here I compare modern trapping surveys, modern "pellet rain", and Holocene deposits from both caves to assess fidelity of the Holocene small mammal fossil record. Preliminary results indicate high rank-order correspondence among modern and fossil death-assemblages and the living community, which weakens as the amount of summed time and elapsed time between samples increases (Spearman rho  $-0.9-0.3$ ). Additionally, modern and fossil death-assemblages are richer than snapshot trapping surveys, with 60-100% more taxa. In contrast to Two-ledges Chamber, the Homestead Cave record reveals a striking decline in species richness and live-dead correspondence over the past century, suggesting a community in transition. In an effort to identify the cause(s) behind this recent loss in biodiversity, analyses are underway to differentiate the effects of trap bias and predator selectivity as potential confounding factors. In summary, by highlighting taxa with unexpected live-dead offsets, taphonomic analyses can reveal modern ecosystem transitions over decadal to centennial timescales and highlight particularly sensitive taxa. Since many ecological processes operate at timescales beyond those of direct human observation, this type of information provides a critical window into understanding long-term biotic responses to fluctuating conditions, which in turn can better guide and inform long-term conservation efforts.

Technical Session VI, Thursday 3:15

THE EAR REGION OF CAINOTHERES AND THEIR RELATIONSHIP TO TYLOPODA

THEODOR, Jessica, University of Calgary, Calgary, AB, Canada

Most recent phylogenetic analyses place the Cainotheriidae within the Tylopoda, but doubts about this placement within Tylopoda have been persistent. The Cainotheriidae are well known from numerous specimens and their cranial anatomy is well documented from complete, partial and disarticulated cranial material. In spite of the detailed descriptions, high resolution CT scans can provide additional data to resolve problems in the interpretation of the auditory region, and allow comparison with other tylopod and ruminant taxa. Cainotheriids share an enlarged mastoid fossa with camelids. In camelids, *Bunomeryx*, and *Merycoiododon*, a large medial flange extends from the promontorium of the periotic, enclosing the petrosular canal. In the most detailed cranial descriptions of the Cainotheriidae, a large flange of the periotic is noted as overlapping the dorsolateral margin of the basioccipital. The petrosular canal has been reconstructed as running in a sulcus along the medial part of this flange. However, subsequent workers have been unable to locate this sulcus, and have suggested that the specimen figured may have been broken, because the figure showed a discontinuity in the periotic. A MicroCT scan of *Cainotherium*, YPM 25037 shows the morphology is more complex. Anteriorly, the periotic has a small projection over the basioccipital. In this region, the periotic bears a shallow sulcus with a slight ridge along the lateral margin, and no medial flange or ridge. The lateral ridge becomes more pronounced posteriorly, and the medial edge of the periotic becomes depressed, forming a deep sulcus in the periotic and restricting the contact between the basioccipital and the periotic to the ventral portion. The periotic does not completely roof over the petrosular canal at any point. Thus, the basioccipital encloses the petrosular canal only on the medial side, unlike the condition seen in camelids, *Bunomeryx*, and *Merycoiododon*. Additional comparisons using CT will help characterize the anatomy of this region of tylopods and the position of cainotheriids within Artiodactyla.

Poster Session IV (Saturday)

NEW NEST OF A MANIRAPTORAN THEROPOD FROM THE UPPER CRETACEOUS TWO MEDICINE FORMATION OF MONTANA

THERRIEN, Francois, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; ZELENIITSKY, Darla, University of Calgary, Calgary, AB, Canada

Until now, the only reported theropod egg clutches from North America had been ascribed to the Late Cretaceous maniraptoran *Troodon formosus*. Here we report a new maniraptoran egg clutch and nest trace from the Upper Cretaceous (Campanian) Two Medicine Formation of Montana. The partial clutch consists of the impressions and eggshell fragments of at least five eggs preserved in a bioturbated sandstone nest trace. The eggs are 120 x 65 mm in diameter, and the eggshell thickness varies between 0.70 mm and 0.85 mm. The outer surface eggshell ornamentation is a fine reticulate pattern

of ridges that parallel the long axis of the eggs. The contact between the mammillary zone and the overlying squamate zone is gradational, and the squamate zone-to-mammillary zone thickness ratio is approximately 2:1. The nest trace is 420 mm in diameter and has a flattened, circular, central high (160 mm in diameter), with sides that slope away from the centre at an angle of 150-200. The elongate, asymmetrical eggs are paired and positioned radially in a ring configuration on the slope surrounding the central high. A phylogenetic analysis of dinosaur oological and reproductive characters places the egg-layer of this clutch as the sister taxon to the clade formed by troodontids and birds, which we infer is likely a dromaeosaurid.

Technical Session XVIII, Saturday 1:45

EVOLUTION OF THE SENSORY LANDSCAPE IN EOCENE CETACEANS

THEWISSEN, J. G. M., Northeastern Ohio Universities College of Medicine, Rootstown, OH, USA; BAJPAI, Sunil, Indian Institute of Technology, Roorkee, India

Eocene cetacean evolution is documented by a series of fossils that show the transition from four-footed land mammals to obligate marine swimmers. Complete skulls are known for many Eocene cetaceans and this makes it possible to study the evolution of the sense organs in some detail. Olfaction, vision, hearing, balance, and mechanoreception can be studied in nearly all families of archaeocetes. All sense organs underwent significant changes during the land-to-water transition, making this a fertile ground for studying evolutionary patterns caused by the interaction of the different senses with each other. Olfaction was reduced in cetaceans, as documented by the loss of olfactory turbinates, which are present in early cetaceans such as *Remingtonocetus*, but absent in later ones such as *Basilosaurus*. The presence of a vomeronasal organ cannot be established unambiguously, but its absence in, for instance, *Remingtonocetus*, is indicated by the absence of the anterior palatine foramina. These foramina are present in pakicetids. The importance of vision as a sense can be inferred based on the relative size of the orbits. The orbits of *Remingtonocetus* are reduced with respect to those of pakicetids, whereas those of protocetids are enlarged. Many aspects of the organs of hearing and balance are preserved in fossil record and have been published in some detail. These findings allow inferences about the origin of underwater directional hearing and loss of precise land locomotion. Mechanoreception is difficult to study in fossils, but the surface texture of the bones of the rostrum in some early cetaceans resembles that of crocodylians and shorebirds, which have sophisticated mechanoreceptors in their snout. The sensory landscape of an animal is the sum of all sensory information available to an animal, as filtered through its sensory organs. The contribution of different sense organs to the sensory landscape varies greatly among different groups of Eocene cetaceans, suggesting a period of experimentation in the sense organs during the Eocene.

Student Poster Session (Thursday)

A DESCRIPTION OF NEW PLIESTOCENE BAT SPECIMENS FROM SOUTHERN AFRICA

THIES, Monte, Sam Houston State University, Huntsville, TX, USA; LEWIS, Patrick, Sam Houston State University, Huntsville, TX, USA

The evolutionary history of bats in southern Africa is poorly known. Recent excavations in deposits from two cave localities in southern Africa, however, are providing a better understanding of Plio-Pleistocene bats in the region. A nearly complete cranium from Plovers Lake, Gauteng Province, South Africa, is dated to approximately 70,000 BP, while a partial mandible and a complete femur have been recovered from a cave in the Koanaka (!Ncumsta) Hills, western Ngamiland Province, Botswana. The Koanaka Hills specimens are conservatively dated to 390,000 BP. A morphological comparison of the fossil bat material from both sites with modern species from southern Africa is currently under way. Preliminary analysis has placed the Plovers Lake cranium in the genus *Rhinolophus*, with species determination to follow. Characters on the lateral margin of the horizontal process of the palatine show affinities with two modern Rhinolophid species, *R. capensis* and *R. clivus*. The Botswanan mandible preserves a partially complete ramus and third molar, as well as the alveoli for m2 and m1. Morphology of these features also places the mandible within the Rhinolophidae. Rhinolophid bats have been reported at earlier dating sites in South Africa, such as Makapansgat, Sterkfontein, and Swartkrans. Likewise, Rhinolophid bats were reported in deposits dating to 2 million BP in the Koanaka Hills, and at the terminal Pleistocene locality of Drotsky's Cave. Several species of Rhinolophid bat are widespread in both Botswana and South Africa today. The new specimens from Plovers Lake and the Koanaka Hills suggest that the bat fauna from southern Africa has been stable during the Plio-Pleistocene, unlike much of the other mammalian fauna from the region. More specimens from the Koanaka Hills will allow the bats from this site to be identified to a lower taxonomic level and for a better understanding of the distribution of Rhinolophid species through the past 2 million years.

Preparators' Session, Thursday 8:00

FROM SALVAGE OPERATION TO *IN SITU* PRESERVATION: TECHNIQUES USED IN CONSERVATION AT THE MAMMOTH SITE OF HOT SPRINGS, SOUTH DAKOTA

THOMPSON, Kristine, The Mammoth Site of Hot Springs SD, Inc, Hot Springs, SD, USA; AGENBROAD, Larry, The Mammoth Site of Hot Springs SD, Inc, Hot Springs, SD, USA; POTAPOVA, Olga, The Mammoth Site of Hot Springs SD, Inc, Hot Springs, SD, USA; HOLTE, Sharon, SD School of Mines and Technology, Rapid City, SD, USA

The Mammoth Site of Hot Springs, South Dakota is the largest primary accumulation of mammoth remains in the new world. The accumulation and preservation of mammoth remains was accomplished in the form of a karst depression containing a spring fed pond. Fossil remains discovered on the southern city limits of Hot Springs, South Dakota, in 1974 and additional field season proved the site to be paleontologically significant. The sinkhole fill consists of laminated fine-grained materials ranging from clay to coarse sand. The environment of the deposits and the nature of the sediments being deposited have preserved even the most delicate bones, such as mammoth hyoid elements. The bones of vertebrates and invertebrates at the Mammoth Site are not mineralized. The warm spring waters that infiltrated the sinkhole likely leached out the collagen in the bones. Skeletal evidence from 30 years of excavation has revealed 55 mammoths and 81 other species yielding several radiocarbon dates with a mean of 26,000 b.p. Over 2,200 sub-fossil bones remain on display *in-situ* in an 18,000 square foot building. This presents a unique challenge for long-range conservation. Conservation techniques have evolved over the course of the years as new materials and methods are recognized. Current conservation methods practiced at the Mammoth Site include examination, documentation, treatment, and preventive care, supported by research and education. We present a description on sub-fossil *in situ* stabilization procedures and conservation techniques in use at the Mammoth Site.

Poster Session IV (Saturday)

FIRST DESCRIPTION OF CERVICAL VERTEBRAE FOR AN EARLY CRETACEOUS TITANOSAUR FROM NORTH AMERICA

TIDWELL, Virginia, Denver Museum of Nature and Science, Denver, CO, USA; CARPENTER, Kenneth, Denver Museum of Natural History, Denver, CO, USA

In recent years, several Early Cretaceous sauropods have been reported from North America, including brachiosaurs (*Cedarosaurus*), and basal titanosaurs (*Venenosaurus* and undescribed specimens). Unfortunately, none of the skeletons described to date include cervical vertebrae. In 1997 the Denver Museum of Nature and Science recovered a series of four articulated cervical vertebrae from the Yellow Cat Member of the Cedar Mountain Formation belonging to a large sauropod dinosaur. Although suffering somewhat from erosion, this specimen provides important and previously unavailable information on cervical morphology in North American titanosaurs. The neural arches represent three posterior cervicals and an anterior dorsal based on comparisons with other Cretaceous titanosaurs including *Malawisaurus* and *Rapetosaurus*. The first in the series is elongate, as measured by the length between the pre- and postzygapophyses, whereas the remaining arches are remarkably shortened antero-posteriorly. Two well-preserved prezygapophyses are large and circular, widely spaced and dorsally directed. The postzygapophyses are similarly widely divergent from the midline. Neural spines on the first 3 cervicals are extremely diminished, failing to rise above the level of the postzygapophyses, and are only discernible by a prominent prespinal rugosity. All neural spines are single, as is common to titanosaurs. On the anterior dorsal the neural spine rises a short distance above the level of the postzygapophysis. It is transversely expanded but antero-posteriorly compressed. A prominent prespinal lamina is evident, as is a less prominent postspinal lamina. Titanosaur characters include a single, low neural spine, prespinal lamina, and short posterior cervical length.

Technical Session VII, Thursday 2:15

EVOLUTION OF MODULAR MORPHOLOGY IN ACTINOPTERYGIAN PECTORAL FINS

TISSANDIER, Sylvie, Redpath Museum, McGill University, Montreal, QB, Canada; LARSSON, Hans, Redpath Museum, McGill University, Montreal, QB, Canada

With a generally conserved function for locomotion, paired fins have an extensive evolutionary history that has resulted in highly disparate morphologies in a wide diversity of taxa. Two-dimensional geometric morphometrics offers a means to quantitatively describe disparity and changes in the shape of pectoral fins. Actinopterygians lend themselves well to a study of this nature due to their prolific diversity and prevalence in the fossil record. As a result of changes in skeletal fin structures and the lack of homologous elements throughout the group, three morphological modules are used as the unit of comparison rather than individual elements of the fin. Ordination plots from thin plate spline analyses, including fossil and extant taxa, show correspondence with the actinopterygian phylogeny as trends become apparent through the group. Basal actinopterygians and basal teleosts tend to have a narrow, elongate fin shape. Following a shift in morphospace, derived teleosts have a wider fin base, with an elongate anterior margin of the fin relative to the posterior trailing edge. Linear and squared-change par-

simony reconstructions of continuous data allow the phylogeny to be traced through morphospace to approximate the path of pectoral fin evolution. The shift in morphospace occurs at Acanthomorpha, and is correlated with the evolution of a physoclistous swim bladder and a change in the position and orientation of pectoral fins. As a result of these changes, new swimming modes are made available, and the expansion of locomotory modes of Acanthomorpha is here hypothesized to be associated with a sharp increase in pectoral fin disparity.

Poster Session IV (Saturday)

EXTANT AFRICAN LEPORIDS, *CAPROLAGUS* AND *PENTALAGUS* REVISITED: PALEONTOLOGICAL VIEWS ON DENTAL AND CRANIAL CHARACTERS

TOMIDA, Yukimitsu, National Museum of Nature and Science, Tokyo, Japan; JIN, Changzhu, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

Although the fossil record of *Pentalagus furnessi* (Japan, extant) is very rare, the ancestral forms (*Pliopentalagus* spp., extinct) from China clearly display the phylogenetic relationship between these two genera and also with *Aztlanolagus agilis* (extinct) known from North America. In addition to these three genera, there are five additional leporid groups that have p3 with 5 reentrant angles. They are *Trischizolagus* (Eurasia, extinct), *Caprolagus* (Asia, extant) and *Pronolagus*, *Poelagus* and *Bunolagus* (Africa, extant). We present a paleontological analysis of all five extant genera in order to clarify the phylogenetic relationships and dispersal events of these genera. All the characters observed on the skull (13), mandible (8), posterointernal reentrant angle of p3, complexity of enamel crenulations on cheek teeth, and morphology of the first upper incisor (including presence/absence of cement in the groove) strongly suggest that: (1) *Pronolagus* and *Bunolagus* (both in Africa) are closely related; (2) *Poelagus* (Africa) and *Caprolagus* (southern Asia) are very closely aligned and also closely related to *Pentalagus*; (3) *Pronolagus* and *Bunolagus* probably originated from *Trischizolagus*; (4) *Poelagus* and *Caprolagus* probably derived from the *Pliopentalagus* - *Pentalagus* lineage; and (5) *Poelagus* entered Africa at a different time than *Pronolagus* and *Bunolagus*. Nevertheless, recent molecular phylogenetic study of *Leporidae* suggests that: (i) *Pronolagus* and *Poelagus* are closely related; (ii) *Bunolagus* and *Pentalagus* and then *Caprolagus* are closely aligned; and (iii) *Pronolagus* and *Poelagus* are not closely related to the latter 3 genera, and even farther than *Sylvilagus* and *Lepus* both of which have only 4 reentrant angles. This is a good example of diverging interpretations between paleontology and molecular phylogeny. Further studies are definitely needed because only one phylogeny is actually true.

Technical Session III, Wednesday 3:30

PALEOECOLOGY OF LATE PLEISTOCENE MAMMALS FROM PACHECO, CALIFORNIA, AND IMPLICATIONS FOR THE STABILITY OF SMALL MAMMAL COMMUNITIES

TOMIYIA, Susumu, University of California, Berkeley, Berkeley, CA, USA

Taxonomic composition of mammal assemblages from two late Pleistocene localities in Pacheco, Contra Costa County, California, was compared with the composition of the present-day mammalian community of the East San Francisco Bay region. The two Pleistocene localities, which are in close proximity to each other and together yielded more than 6000 vertebrate specimens, are represented by at least 18 genera of mammals. Remarkably, all of the small (body mass < 10 kg), non-volant mammalian species, of which there are at least 14 species, are extant and are known to occur in the region today. In contrast, all but one (*Ursus americanus*) of the 7 large (body mass  $\geq$  10 kg) mammals from Pacheco are extinct. The compositional stability of the small mammal assemblage despite major climatic fluctuations of the late Pleistocene and the loss of potential keystone species such as *Mammuthus* sp. and *Mammot americanum* from the ecosystem suggests considerable resilience and a certain degree of ecological autonomy of the community, which may have been structured around middens of packrats (*Neotoma fuscipes*). The emerging pattern of compositional conservatism of small mammal communities has implications for differential stabilities of parts of a food web and ecological connectivity among distinct communities within an ecosystem over geologic time.

Poster Session III (Friday)

MIDDLE EOCENE MAMMALIAN ECOLOGICAL DIVERSITY IN THE UINTA FORMATION, UINTA BASIN, UTAH.

TOWNSEND, Beth, Case Western Reserve University, Cleveland, OH, USA

One of the hallmarks of the middle intervals of the Eocene epoch is a significant shift in the composition of mammalian faunas. The early Eocene is characterized by a higher diversity of smaller arboreal forms, while the middle Eocene is distinguished by a greater diversity of larger terrestrial forms. This transition is first marked on the North American continent during the Uintan North American Land Mammal Age (NALMA). Recent stratigraphically controlled fossil mammal collections from the Uinta Formation, the type formation of the Uintan NALMA, offer the opportunity to evaluate the timing of changes in mammalian ecological diversity. Here the ecological diversity of the fossil mammal fauna from the Uinta Formation is evaluated collectively



using three stratigraphically controlled faunal assemblages: Uinta Faunal Assemblage Zone (UFAZ) 1, UFAZ 2, and UFAZ 3. These three UFAZ were based upon the stratigraphic placement of the most abundant localities in the Uinta Formation. Ecological profiles were generated for all taxa in each UFAZ using estimates of diet, body mass, and locomotor strategy. These profiles were then used to compare the ecological diversity among the three UFAZ. The ecological profiles of each of the UFAZ indicate that a notable increase in medium to larger-bodied, terrestrial herbivores occurred during UFAZ 3, the youngest Uintan faunal assemblage. Artiodactyls, perissodactyls, and rodents are the dominant taxa of UFAZ 3. The beginning of UFAZ 3 has been approximated at 42.5 Ma, suggesting that a significant shift in the ecological composition of mammalian faunas occurred during this time.

Technical Session IV, Wednesday 2:45

EXPLAINING THE GAPS IN BODY MASS DISTRIBUTIONS (CENOGRAMS): STATISTICAL VISUALIZATION OF THE ECOLOGICAL IMPACT OF INTRODUCED SPECIES

TRAVOUILLO, Kenny, University of New South Wales, NSW, Sydney, Australia; LEGENDRE, Serge, Université Lyon 1, Villeurbanne cedex, France; ARCHER, Michael, University of New South Wales, Sydney, Australia; HAND, Suzanne, University of New South Wales, Sydney, Australia

Body size distribution and cenogram analyses both use body weight distributions of mammalian species to describe structural patterns within communities. Using these methods it has been possible to correlate modern mammalian community structure and habitat. In turn these correlations have been used to infer palaeohabitat from analysis of the structure of extinct mammal communities. Continuous body size distributions indicate closed environments, and discontinuous distributions, with a gap between 500 g and 8 kg, indicate open environments. Some quantitative studies have suggested that the gaps present in open environments are not always statistically significant. However, qualitative studies continue to show that the gap in body mass distribution and cenograms does reliably reflect environment type and is more efficient at doing so than use of more traditional methods such as analyses of diet or locomotion. Very few studies have tried to explain the gaps in open environments or question the results of the quantitative analyses. Considering all other potential explanations for the gap, we suggest that introduction by Europeans of non-indigenous herbivorous and carnivorous mammals into Australian ecosystems has caused extinction of medium-sized native mammals in the body weight range of 35 g to 5500 g. We used the cenogram method to construct the body size distribution of both contemporary and pre-European invasion lists of mammal taxa from 53 Australian national parks spanning all major environments. All modern Australian open environments showed a gap in body mass distribution. Historical open environments showed no distinct gap in body mass distribution but had significantly less medium-sized species than closed environments. Large, introduced Australian mammalian predators have been shown to prefer medium-sized prey over large or small prey and to contribute significantly to the extinction of medium-sized species in open environments. We suggest that the observed gaps in open environment mammal communities are at least in part the result of non-indigenous species, particularly carnivores, following the European colonization of Australia.

Romer Prize Session, Thursday 12:15

PHYLOGENETICS, ORIGIN AND EVOLUTIONARY HISTORY OF EXTINCT AND EXTANT PENGUINS (AVES, SPHENISCIFORMES)

TRICHE, Nina, The University of Texas at Austin, Austin, TX, USA

The penguin fossil record is temporally long (61mya), geographically widespread, taxonomically diverse, and reasonably complete. The group is therefore ideal for use in examinations of the timing and pattern of evolution in modern birds during the Cenozoic. Previously, phylogenetic analyses of penguins that could support such evolutionary exploration were drastically hindered by the fact that most reported penguin fossils are isolated, dissociated elements from discrete, widely separated, localities. Here, I present a new hypothesis of penguin phylogeny for use in investigations of the links between penguin origination and evolution and Southern Hemisphere tectonic and climatic events. I based my phylogeny on examination of all living and all diagnostic extinct penguin species, numerous proposed outgroups, all skeletal elements, and a new matrix of 503 osteological, myological, integumentary, and behavioral characters. I recover a well-resolved phylogeny that includes two extinct clades (Palaeudyptidae and Paraptenodytidae) and a monophyletic crown-group (Spheniscidae). Further analysis shows both ingroup and outgroup choice to be integral to topology. Extinct species, even mostly incomplete taxa, are more variable than extant species and are indispensable to hypotheses of penguin phylogeny and evolution. The highest resolution is achieved by using the most data from the maximum number of sources. I conclude that initial phylogenetic analyses, especially of extinct taxa, should attempt to include all known species, many outgroups, and large datasets to circumscribe all potential character variation and provide maximum recovery of informative synapomorphies. After time-calibration using fossil dates, correlation of this phylogeny with geologic history suggests that penguins originated in relatively warm climates, diversified concurrently with the late Eocene onset of Antarctic glaciation and global cooling, and

decreased in diversity when climate warmed. Because penguins are highly derived within modern birds, their probable late Cretaceous origin implies that numerous modern bird lineages may also date their origins, if not their radiations, to the Cretaceous.

Poster Session IV (Saturday)

MORPHOLOGICAL VARIATION IN TITANOSAURIAN SCAPULAE (DINOSAURIA, SAUROPODA) FROM THE LATE CRETACEOUS OF MINAS GERAIS, BRAZIL

TROTТА, Marcelo, Museu Nacional/Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil; CAMPOS, Diogenes, Museu de Ciencias da Terra/Departamento Nacional de Producao Mineral - RJ, Rio de Janeiro, Brazil; KELLNER, Alexander, Museu Nacional/ Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

The most important dinosaur collection of Brazil was made by L. Price, who collected many specimens from sites near the city of Peirópolis (State of Minas Gerais) between the years of 1947 and 1974. All come from the Marília Formation, Late Cretaceous of the Bauru Basin and are housed at the Museu de Ciências da Terra (DNPM/RJ). Most specimens consist of isolated elements that have not been studied so far. Among those are nine scapulae that can be separated into four morphotypes. Morphotype 1 (e.g., MCT 1680-R) is the most common and can be distinguished by the presence of a well-marked ridge-like medial process on the internal surface of the scapular blade, and a comparatively more constricted scapular blade. Morphotype 2 (MCT 1642-R; MCT 1703-R) is similar to morphotype 1 but shows the scapular blade less constricted and lacks the medial process. Morphotype 3 (MCT 1691-R) is distinguished by having the dorsal border of the scapular plate straight and anteroposteriorly long, with squared anterodorsal corner; the scapular blade short in respect to total length; and the medial process blunt (similar to morphotype 4). Morphotype 4 (MCT 1708-R; MCT 1709-R) comprises the largest scapulae, and is distinguished by the overall heavy construction. It further differs by having the scapular blades L-shaped in cross-section; medial process blunt (similar to morphotype 3); dorsal border of scapular plate anteroposteriorly short; distal half of scapular blade dorsally expanded. At present it is not clear if those features are due to individual variation, ontogeny, sexual dimorphism or indicative of different species. The presence of a medial prominence in the internal surface of the scapular blade has been regarded as a synapomorphy of a clade uniting *Aeolosaurus*, *Alamosaurus* and saltasaurines. The presence of this feature in morphotypes 1, 3 and 4 suggest that they might be closely related to those taxa, but it is clear that the process displays some morphological variation deserving further investigation before it can be used as a valid taxonomic character.

Poster Session IV (Saturday)

THE REX PIPELINE DINOSAURS: PARTNERSHIPS FOR SCIENCE

TRUJILLO, Kelli, Uinta Paleontological Associates, Inc., Laramie, WY, USA; DEMAR, David, Uinta Paleontological Associates, Inc., Laramie, WY, USA; BREITHAUPT, Brent, University of Wyoming Geological Museum, Laramie, WY, USA; HALL, Dee, Uinta Paleontological Associates, Inc., Vernal, UT, USA; BILBEY, Sue Ann, Uinta Paleontological Associates, Inc., Vernal, UT, USA

The current boom in oil and gas across the West is creating unique opportunities for paleontologists. Because of both regulations and scientifically responsible petroleum companies, paleontologists are finding and collecting fossils from areas that were previously inaccessible. Recent examples of this are the dinosaurian and other vertebrate fossils found in a natural gas pipeline trench near Laramie, WY in the Fall of 2006. Construction on segment 2 of Kinder Morgan's Rockies Express-Entrega (REX) pipeline began in July 2006. Paleontologists with Uinta Paleontological Associates, Inc. (UPAI) were on hand to monitor grading and trenching activities in paleontologically sensitive areas along the route. On Sept. 20, 2006, sauropod caudal vertebrae were found in both the spoils pile and the ditch wall itself just south of Laramie on private land in the Upper Jurassic Morrison Fm. Excavation of the area began on Sept. 21, 2006, and continued for 5 weeks. Overall, the excavation did not slow down construction of the pipeline, and workers were able to observe the excavation as they moved around it. An estimated 10 tons of material was removed from the site, including many large plaster jackets. The excavation was aided greatly by a backhoe and operator supplied by Associated Pipeline, Inc. In Dec. 2006 an agreement was reached between UPAI and the University of Wyoming to prepare the fossils in the UW Geological Museum. An existing prep. station was expanded, and full-time work on the fossils began in January 2007. So far, taxa include adult and juvenile *Camarasaurus*, juvenile *Allosaurus*, turtle, and crocodile. The preparation of the pipeline fossils in the museum has had many benefits for all involved parties. One of the most unique opportunities has been the involvement of student interns of UWTV who shot and produced weekly segments on the progress of the preparation. These segments were aired on Wyoming Public TV, YouTube, and as podcasts on the UW website. The students' work has not only allowed the public to see the preparation of fossils, but it has also helped educate them in how the largest industry in Wyoming can be beneficial to science.

Technical Session XI, Friday 2:00

**TOUGH NEW WORLD: DISCOVERY OF AN UNUSUAL IMMIGRANT MUSTELID WITH CRUSHING DENTITION FROM THE MIDDLE MIOCENE OF COASTAL CALIFORNIA**

TSENG, Zhijie, University of Southern California, Los Angeles, CA, USA; WANG, Xiaoming, Natural History Museum of Los Angeles County, Los Angeles, CA, USA; STEWART, J.D., LACM, Los Angeles, CA, USA

The North American Pliocene mustelids *Trigonictis* and *Sminthosinis* have been interpreted as relatives of the otter-like *Mionictis* and *Lutravus*, with a common Old World origin. Here we describe a new specimen from a terrestrial facies of the Temblor Formation in California, closely related to these taxa. A combination of basal and derived dental characteristics puts the new form at an evolutionary stage intermediate between the European early Miocene *Dehmictis* and its North American relatives. A highly autapomorphic trait of this new form is its prominent P4 with hypertrophied paracone and a bulbous crown. The robust upper carnassial and very strong development of the sagittal crest both suggest capability for durophagy. Although the cusp morphology is reminiscent of otters, a suite of craniodental characteristics differentiates this taxon from the contemporaneous *Mionictis*. Cladistic analysis of craniodental characters suggests a clade including *Mionictis*, *Lutravus* and *Lutra*; the new genus has a position basal to this clade, among some other North American and European forms. The results indicate that the new form may be a Eurasian immigrant postdating an Old World divergence from lutrines. The robust cusp morphology shared between lutrines and the new mustelid indicates a more complicated, perhaps highly convergent, history of morphological evolution towards durophagy in Mustelidae.

Technical Session XI, Friday 1:30

**VERY SMALL *HYAENODON* AND HYAENODONTID CREODONT FAUNA FROM THE UPPER EOCENE ERGILIN DZO FORMATION OF MONGOLIA**

TSUBAMOTO, Takehisa, Hayashibara Biochemical Laboratories, Inc., Okayama, Japan; WATABE, Mahito, Hayashibara Biochemical Laboratories, Inc., Okayama, Japan; TSOGTBAATAR, Khishigjav, Mongolian Paleontological Center, Ulaanbaatar, Mongolia

We report a mandible of a very small species of *Hyaenodon* (Mammalia, Creodonta, Hyaenodontidae) from the upper Eocene Ergilin Dzo Formation at the Khoer Dzan locality of southeastern Mongolia and briefly review the hyaenodontid fauna of the formation to clarify its current status. The specimen reported here was discovered by the Hayashibara Museum of Natural Sciences and Mongolian Paleontological Center Joint Paleontological Expedition in 2004. It is assigned to *Hyaenodon chunkhtensis*, one of the smallest species of *Hyaenodon*. This is the first discovery of the smallest species of *Hyaenodon* in the formation, adding one more species to its hyaenodontid fauna. The hyaenodontid fauna of the Ergilin Dzo Formation currently consists of eight species: six species of *Hyaenodon* (*H. chunkhtensis*, *H. eminus*, *H. pervagus*, *H. incertus*, *H. mongoliensis*, and *H. gigas*), *Macroprodon zelenovi*, and an indeterminate proviverrine. There is a possibility that *M. zelenovi* is synonymous with *H. gigas*. If this synonymy is accepted, its hyaenodontid fauna consists of seven species. Existence of many and multiple-sized species of *Hyaenodon* in the Ergilin Dzo Formation indicates that the fauna of *Hyaenodon* from the formation is analogous to that of the North American Chadronian (late Eocene) faunas and of the lower Oligocene Hsanda Gol Formation of Mongolia.

Technical Session XIV, Saturday 9:45

**A JUVENILE SKELETON OF *TARBOSAURUS* WITH A NEARLY COMPLETE SKULL AND ITS IMPLICATIONS FOR ONTOGENETIC CHANGE IN TYRANNOSAURIDS**

TSUIHJI, Takanobu, Ohio University, Athens, OH, USA; WATABE, Mahito, Hayashibara Center for Paleobiological Research, Okayama, Japan; WITMER, Lawrence, Ohio University, Athens, OH, USA; TSUBAMOTO, Takehisa, Hayashibara Center for Paleobiological Research, Okayama, Japan; TSOGTBAATAR, Khishigjav, Mongolian Paleontological Center, Ulaanbaatar, Mongolia

An articulated juvenile skeleton of the tyrannosaurid *Tarbosaurus bataar* was found from the Nemegt Svita of the Bugin Tsav locality in South Gobi, Mongolia, by a field party of the Hayashibara Museum of Natural Sciences - Mongolian Paleontological Center Joint Expedition. It is nearly complete and even has such elements as articulated gastralia preserved in situ, lacking only the neck, anterior one third of the dorsal series, and posterior two-thirds of the tail. With a femoral length of 300 mm, it is the smallest articulated specimen ever reported that is confidently referable to *Tarbosaurus*, significantly extending the known size range and providing new ontogenetic information in this large-bodied taxon. Observed postcranial ontogenetic changes include: the first metacarpal is shorter than the third metacarpal in this juvenile whereas the opposite has been considered diagnostic of *Tarbosaurus*; distal limb elements (epipodials and metapodials) of both the fore- and hindlimbs are proportionally longer relative to propodials than in adults (e.g., the length of the third metatarsal is about 83% of femoral length in this juvenile); the first metatarsal articulates with the second metatarsal on its medial side, rather than on the posterior/ventral side as in adults.

Most remarkably, a skull of about 290 mm in length is preserved in superb condition. Not surprisingly, it shows various characteristics common to juvenile tyrannosaurids, such as the anterior margin of the maxillary fenestra not reaching that of the antorbital fossa and a smooth dorsal surface of the lacrimal (no cornual process present). However, the right and left nasals, which bear a small lacrimal process unlike in adults, are already coossified. Tooth-position counts in the maxilla (13) and dentary (14 and 15) are the same as those for adults, suggesting that they do not change ontogenetically. CT scanning reveals new details about the ontogeny of the cephalic pneumatic system, brain cavity, and inner ear.

Technical Session II, Wednesday 9:45

**MIDDLE EAR EVOLUTION AND IMPEDANCE-MATCHING HEARING IN PARAREPTILIA**

TSUJI, Linda, Humboldt-Universität zu Berlin, Museum für Naturkunde, Berlin, Germany; MUELLER, Johannes, Humboldt-Universität zu Berlin, Museum für Naturkunde, Berlin, Germany

The origin and evolution of the impedance-matching (tympanic) middle ear in amniotes was considered a key innovation of basal tetrapods, which was only later modified during amniote diversification. More recent investigations, however, have shown that the otic region of the earliest known amniotes lacks any indication of impedance matching, indicating that the tympanic middle ear seen in modern taxa must have evolved independently in multiple amniote lineages, most notably Synapsida and Eureptilia, in the Mesozoic. In order to explicitly infer the presence of an impedance matching middle ear in fossil amniotes, several functional requirements must be reflected in the anatomy, including: a modified temporal region indicating the presence of a tympanum; firm contact between the skull roof and paroccipital process freeing the stapes from a strictly bracing function; a slender stapes, an indication of the mediation of airborne sounds via vibrations from the tympanum to the inner ear; and differentiation of the posterolateral braincase wall into oval and pressure-relief windows, along with ossification of the medial wall to separate the inner ear from the other part of the braincase. Until recently a true tympanic middle ear had not been positively identified in the third major amniote lineage, the Parareptilia. However, we present here evidence that within derived parareptiles, a poorly known group found primarily in the Middle Permian of Russia possesses all the above characteristics typical of an impedance-matching middle ear. This study also undertook the first phylogenetic analysis to include each of *Macroleter*, *Tokosaurus*, *Emeroleter*, *Bashkyroleter* and *Nycteroleter*, and confirmed the monophyly of the group, which was also demonstrated to be sister-taxon to pareiasaurs. The discovery of a tympanic ear in this little researched clade represents the first true unequivocal evidence of this feature in parareptiles, and the earliest yet found in amniotes.

Student Poster Session (Thursday)

**TAPHONOMIC INFLUENCES ON SHARK FAUNAL ASSEMBLAGES FROM THE JUDITH RIVER FORMATION (CAMPANIAN) OF MONTANA**

TULU, Yasemin, Michigan State University, East Lansing, MI, USA

Two Judith River Formation (JRF) sites in north-central Montana, the Woodhawk bonebed (WH) and the Power Plant Ferry bonebed (PPF), have been the focus of recent research on Campanian chondrichthyan faunas. The two localities are approximately 3 km apart and from the same stratigraphic horizon in shoreface deposits, and they preserve comparable fossil assemblages. The matrix at each site consists of very well-sorted, moderately rounded, medium to fine-grained, yellow-tan quartz sandstone, with an assortment of fossils including shark and ray teeth, dermal denticles, and centra, chimaerid fragments, teleost teeth, and archosaur material. When examined on a finer scale, these sites reveal subtle differences relating to the mode of formation of their respective fossil assemblages, which differ in abundance, diversity, and preservation. The WH has ca. 16 identifiable species (collected directly from the weathered sediment). The PPF fauna, which consists of material collected both *in situ* and from weathered sediments, is currently composed of ca. eight identifiable species, with far fewer identifiable specimens but many bone fragments. The chondrichthyan fauna from WH displays a wide range of preservation, from near pristine to worn and broken teeth, whereas teeth in the PPF fauna are largely pristine (with teeth still sharp to the touch), with relatively few broken and worn teeth. The disparity in abundance and diversity of the fossils between the sites, and the range in preservation, indicates the likelihood of local paleoenvironmental variation. The WH site is north and west of PPF, and appears to represent a higher energy environment that brought in material from farther offshore and mixed it with local material, abrading them to a greater degree than the specimens preserved at PPF, where the material reflects a more autochthonous origin.

Technical Session XIV, Saturday 11:30

THE BASAL-MOST DROMAEOSAURID: A NEW SPECIES FROM TUGRUGYIN SHIREH, MONGOLIA

TURNER, Alan, American Museum of Natural History, New York, NY, USA; POL, Diego, CONICET, Trelew, Argentina; CLARKE, Julia, North Carolina State University, Raleigh, NC, USA; NORELL, Mark, American Museum of Natural History, New York, NY, USA

Although small theropod dinosaurs are generally extremely rare, they are common in the Upper Cretaceous rocks of the Djadokhta Formation of Mongolia and North China. Here we report on a new element of this fauna, a fairly complete skeleton of a dromaeosaurid theropod dinosaur. A well-preserved braincase, quadrate and frontals are preserved in addition to a largely complete postcranial skeleton. The new species offers new character data to explore the phylogenetic relationships of dromaeosaurid theropods and bears important information on understanding the ancestral conditions of Paraves (the clade containing dromaeosaurids, troodontids, and avialans). Phylogenetic analysis identifies IGM 100/1033 as the most basal dromaeosaurid and supports paravian monophyly with Avialae as the sister group to a monophyletic Deinonychosauria (Dromaeosauridae+Troodontidae). Characters uniting IGM 100/1033 with other dromaeosaurids include the absence of an accessory tympanic recess dorsal to the crista interfenestralis, elongate paroccipital processes with parallel dorsal and ventral edges that twist rostrocaudally distally, and the presence of a distinct ginglymus on the distal end of metatarsal II. Unlike all other dromaeosaurids except *Buitreraptor*, IGM 100/1033 lacks the characteristic elongate prezygapophyses on the caudal vertebrae. The basal position of IGM 100/1033 produces a number of topological and character state optimization changes that modify our understanding of the early history of deinonychosaurians. First, unenlagiine dromaeosaurids are monophyletic but not reproduced as holophyletic given that *Shanag* from the Early Cretaceous of Mongolia nests within the Gondwanan dromaeosaurids. Second, these dinosaurs are united with Jehol microraptorines (*Microaptor*, *Graciliraptor*, *Sinornithosaurus*) to form the sister group to derived dromaeosaurids from Laurasia (velociraptorines and allied forms). Third, the purported Jehol avialan *Jinfengopteryx* is recovered as a basal troodontid.

Poster Session III (Friday)

AVIAN REMAINS AND OTHER VERTEBRATES FROM A NEW LOCALITY IN THE WOODBINE FORMATION (MIDDLE CENOMANIAN) OF NORTH-CENTRAL TEXAS

TYKOSKI, Ronald, Museum of Nature & Science, Dallas, TX, USA; FIORILLO, Anthony, Museum of Nature & Science, Dallas, TX, USA

The Woodbine Formation (middle Cenomanian) in north-central Texas is a fluvio-deltaic unit that has produced a limited number of terrestrial vertebrate fossils. We report on a new locality in the Woodbine near Lake Grapevine, Dallas County, Texas. The site has produced the remains of the semionotid fish *Leptidotes*, abundant turtle shell fragments likely belonging to a baenid, crocodylian remains referable to *Woodbinesuchus*, and isolated dinosaur elements that include both theropods and the iguanodontian *Protophadros*. A partial turtle mandible from the site has a broad trituran surface similar to that in *Euclastes* from younger Cretaceous and Tertiary deposits. Thus this fauna represents a mixed assemblage of terrestrial and coastal vertebrates. The most notable specimens from the site are avian bones, the first reported from the Woodbine Formation and the first from Cenomanian terrestrial deposits in North America. The avian bones come from an area of approximately one square meter and we consider them parts of a single individual. The avian remains include a scapula, manual phalanx II-1, the end of a long bone, and additional pieces. The phalanx and long bone piece are thin-walled and hollow, but the preservation quality of the specimens makes determination of finer details difficult. There are not enough apomorphies preserved in the material to confidently assign the specimen to more specific avian clades at this time. The discovery of avian skeletal elements in the Woodbine Formation reestablishes the presence of birds in this non-marine Cenomanian setting.

Technical Session XVIII, Saturday 2:30

THE EARLIEST TOOTHLESS MYSTICETE: A CHAEOMYSTICETAN FROM THE EARLY OLIGOCENE ALSEA FORMATION, TOLEDO, OREGON

UHEN, Mark, Smithsonian Institution, Washington, DC, USA

Modern whales (Neoceti) evolved from fully aquatic archaeocetes in the late Eocene. Archaeocetes persisted through the Oligocene alongside large-toothed mysticetes (Llanocetidae and others), small-toothed mysticetes (Aetiocetidae), toothless, baleen-bearing mysticetes (*Mauicetus*, Cetotheriopsidae, Eomysticetidae), as well as early odontocetes. Evolution of baleen has been suggested to occur in toothed mysticetes as shown by the presence of foramina and vascular grooves on the palate homologous to those that house blood vessels feeding gums that support the bases of baleen plates in living mysticetes. The earliest toothless mysticetes described thus far are late Oligocene in age. An early mysticete lacking teeth from the early Oligocene Alsea Formation, was collected by Douglas Emlong near Toledo, Oregon in 1977 and is housed at the USNM. This specimen includes the skull (including both bullae and periotics),

mandibles, hyoid apparatus, much of the vertebral column and most of both forelimbs. The skull is characterized by a broad, slightly convex, toothless palate, along with a deep excavation of the posterior palate ventral to the internal choanae. The bullae are small compared to the skull, a characteristic of modern mysticetes. The mandible is also toothless, is laterally bowed, lacks a bony symphysis, and has a distinctive mysticete groove on the medial side of the anterior end. The forelimbs bear humeri that are as long as the radius and ulna, a feature shared with basilosaurids. Unlike basilosaurids, the radius and ulna are locked in place by separate articular facets on the distal end of the humerus, preventing anything by slight passive motion at the elbow. This skull is intermediate in morphology between members of the Basilosauridae and members of the Eomysticetidae, but bears no teeth. Grooves are present in the palate appear to be homologous with those that house blood vessels that supply the baleen-bearing gums in modern mysticetes. Comparisons of this highly plesiomorphic yet baleen-bearing animal with other toothed mysticetes and other early baleen-bearing mysticetes will be necessary to determine how these animals are related, and whether toothlessness arose once or multiple times within Mysticeti.

Evolutionary History of Bats Symposium, Thursday 9:45

ANCIENT DNA SHEDS LIGHT ON THE HISTORY OF MOUSE-EARED BATS (MYOTIS) IN EUROPE

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Nietoperzowa Cave in southern Poland has more than 33 fossils of mouse-eared bats of known age (ca. 800 years BP) that if DNA was preserved in a useable fashion could provide unique opportunities for studying historic population genetics of these animals. We successfully isolated DNA and sequenced the entire cytochrome b gene (1,140 bp) from 7 fossilized specimens of mouse-eared bats. Fossil haplotypes were either identical with contemporary haplotypes, or differed from the latter by one or two substitutions. To provide a better understanding of levels of genetic variation at this locality, we included fossil specimens in a phylogenetic study of mouse-eared bats from Europe and Asia Minor. Our results document that two sibling species were present at Nietoperzowa Cave for at least the past 800 years (about 400 generations) and that they diverged in allopatry relatively recently (560,000 years BP), corresponding with the Donau II stage of glaciation. We also found that these volant mammals followed the general "bear-paradigm" characteristic of post-glacial dispersal of several terrestrial mammals in Europe. Finally, inclusion of nuclear RAG2 sequence data from contemporary individuals and their consideration in context of the cytochrome b tree revealed possible interspecific hybridization events of ancient and recent origins.

Poster Session II (Thursday)

CREATING A SEARCHABLE GEOGRAPHIC INFORMATION SYSTEMS (GIS) DATABASE OF FOSSIL LOCALITIES AND SPECIMENS: AN EXAMPLE FROM THE EOCENE OF SOUTHWESTERN WYOMING

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Geographic Information Systems (GIS) allow paleontologists to analyze spatial components of data in new and exciting ways through the use of geospatially referenced maps detailing the geographic distribution of fossils and rock units. When attempting to create a database of fossil localities and associated specimens for use with GIS software, however, multiple difficulties can arise. In particular, importing all records of individual specimens from each locality can cause problems in the analysis and display of these data when attempting to query the database. In order to circumvent some of these problems, a new approach was developed involving a searchable database for use with ESRI's ArcGIS software. Separate tables were designed for locality and taxonomic data fields (e.g., family, genus, and species) consisting of unique records for each fossil taxon represented at a locality. This approach leads to a more streamlined database structure that eliminates repetition of individual records (e.g., multiple examples of a single fossil taxon or element represented at an individual locality) while still retaining the associated locality information for each record. This was accomplished using a series of unique primary keys for each table. The result is a searchable database allowing the user to search by locality, family, genus, or species. This database was developed for the early Eocene fossil mammal collections at Western Michigan University's Department of Anthropology based on 10 seasons of fieldwork in the Great Divide Basin of southwestern Wyoming. In this poster we present the results for the Steamboat Mountain-Freighter Gap area in the northern part of the basin, involving 2100 mammalian specimens from 40 localities. In conjunction with detailed stratigraphic mapping and exhaustive fossil collecting in the field, the use of GIS techniques and analytical approaches shows great potential for investigations in vertebrate paleontology and biostratigraphy.

Technical Session IX, Friday 9:45

BURROWING BEHAVIOR IN A NEW ORNITHOPOD DINOSAUR FROM THE MID CRETACEOUS OF MONTANA

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A new specimen from the upper (Cenomanian) portion of the Blackleaf Formation of southwest Montana represents the first trace and body fossil evidence of burrowing behavior in a dinosaur. Skeletal remains of the new hypsilophodont, *Oryctodromeus cubicularis*, occurred in the expanded terminal chamber of a 2.1 m-long, S-shaped burrow. The densely packed and jumbled bone assemblage consisted of adult and juvenile material representing cranial, axial and appendicular skeletons. With one exception, bones were complete prior to fossilization and assignable to the new dinosaur. Absence of hydraulic sorting, bone breakage and bite marks precludes hydraulic transport or scavengers as agents of collection. Further, burrow dimensions (diameter, cross-sectional area, and length between turns) correspond closely to the adult body size. Although *Oryctodromeus* retains typical cursorial hind limb proportions, it also bears modifications of the snout, fore limb and pelvis consistent with digging habits. *Oryctodromeus* may have shared a similar ecology with the extant Patagonian cavy, *Dolichotis patagonum*, a modern herbivorous cursor that burrows. Two varieties of small side burrows extend off the main *Oryctodromeus* tunnel and indicate the presence of commensal burrowers such as insects and mammals. Implications of fossorial behavior in dinosaurs include: 1) Burrowing expands the known range of dinosaur behaviors and emphasizes that the cursorial ancestry of dinosaurs did not fully restrict the evolution of different functional regimes such as fossoriality or arboreality. 2) The association of an adult and two medium-sized juveniles within a burrow argues for extensive parental care in this dinosaur and adds to the growing evidence for parental care of eggs and young in the Dinosauria. 3) Burrowing provides a mechanism by which animals can avoid harsh environmental conditions. Potentially, small dinosaurs may have exploited extreme environments like polar latitudes, deserts, and high mountain areas by burrowing. The ability among dinosaurs to find or make shelter may contradict some scenarios of the end-Cretaceous impact event.

Poster Session III (Friday)

LATE CRETACEOUS MAMMAL FAUNA FROM THE DECCAN VOLCANO-SEDIMENTARY SEQUENCES OF CENTRAL INDIA

VERMA, Omkar, University of Jammu, Jammu, India; PRASAD, Guntupalli, University of Jammu, Jammu, India

Cretaceous mammals are poorly known from the Indian subcontinent. Until now, the fossil record of these mammals is confined to two localities (Naskal and Rangapur) on the southern margin of the Deccan volcanic province. Here we report a fairly rich assemblage of mammals from the Deccan intertrappean beds exposed along the right bank of Kharmer river about 1.2 km southwest of Kisalpur village, Dindori district, Madhya Pradesh (state) in Central India. The new site is located approximately 700 km north of Naskal and Rangapur mammal yielding intertrappean sections and lie on the northeastern fringe of the Deccan volcanic province. The mammal-bearing Kisalpur intertrappean section consists of a 4 m thick sequence of clays, brownish-green siltstone, and pebbly green mudstone. Virtually, all the micromammals from this site have been recovered from a distinctive 70 cm thick brownish-green siltstone horizon. About 3000 kg of samples from this horizon were screen-washed in the field and sorted under the microscope for micromammals. So far, 50 specimens representing incisors, canines, premolars and molars of upper and lower dentitions and postcranial bones of eutherian mammals, and a couple of hypsodont teeth were recovered. Preliminary study of this fauna indicated the presence of at least three new eutherian taxa and one gondwananther mammal. The eutherian mammals exhibit close morphological affinities to the Laurasian boreosphenidan taxa, whereas the gondwananther mammal is closely related to the Late Cretaceous *Lavanify miolaka* of Madagascar. The associated microvertebrate fauna includes fishes: *Igdabatis indicus*, *Rhombodus* sp., *Lepisosteus* cf. *L. indicus*, Pycnodontidae gen. et sp. indet., Osteoglossidae gen. et sp. indet., Siluriformes indet.; amphibians: ?Leptodactylidae gen. et sp. indet.; reptiles: Lacertilia indet., Bothremyidae turtles, neosuchian crocodiles, and dinosaur egg shell fragments.

Carnivora: Phylogeny, Form and Function Symposium, Saturday 8:15  
PHYLOGENY OF THE VIVERRIDAE AND THE VIVERRID-LIKE FELIFORMS

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Recent molecular studies have shed some lights on the phylogeny of the Feliformia and have particularly clarified the systematic position of some debated taxa that were previously placed in the Viverridae. The African palm civet (*Nandinia*), the Malagasy carnivores (*Cryptoprocta*, *Eupleres*, *Fossa* and *Galidiinae* sp.) and the Asian linsangs (*Prionodon*) are now no more included in the Viverridae. The Viverridae family now consists of three subfamilies, the Hemigalinae (banded palm civets), the Paradoxurinae

(palm civets) and the Viverrinae (civets and genets). Using these findings, we have confirmed several morphological convergences and shown which reliable morphological characters can be used in phylogenetic reconstruction or as diagnostic criterion for recognition of the Viverridae in fossil records. Contrary to previous studies, we found that the structure of the tympanic bullae could not be used as a reliable criterion for Viverridae systematics, that dental characters can provide structuring signal at lower intrafamilial level in the Viverridae, and that some soft anatomy characters can provide good synapomorphies.

Poster Session I (Wednesday)

A NEW EUCRYPTODIRAN TURTLE FROM THE EARLY CRETACEOUS GLEN ROSE FORMATION OF TEXAS

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Four complete and two partial skulls from the Early Cretaceous (Albian) Glen Rose Formation, Texas, show a combination of primitive and derived characters not previously described for turtles, including a reduced temporal emargination, prominent and elongate otic trochlea, and presence of an epipterygoid. The maxilla is large and extended with a prominent triturating surface. Phylogenetic analysis indicates this taxon is a basal Eucryptodira, near *Thalassemys* based on the presence of a medial contact of the prefrontals and the posterior entrance to the carotids situated completely within the pterygoids. The Glen Rose taxon shares characters with *Sandownia harrisi* from the Aptian of the British Isles, including a well-developed secondary palate, extensive skull roof with a large lateral contact of the parietal and postorbital, and medial contribution of the prefrontals to the orbit. The Glen Rose taxon is more primitive than *Sandownia* having presence of paired nasal bones situated along the dorsal rim of the external nares, and lack of jugal contribution to the orbit.

Poster Session I (Wednesday)

THE MOST COMPLETE PLESIOSAUR FROM THE SUNDANCE FORMATION (JURASSIC), HOT SPRINGS COUNTY, WYOMING

WAHL, William, Wyoming Dinosaur Center, Thermopolis, WY, USA

The discovery of an articulated plesiosaur from the Redwater Shale Member of the Sundance Formation of Hot Springs CO, Wyoming, may represent the most complete cryptocleidid ever found from the Sundance. The specimen is partially preserved in concretion but extends into the surrounding shale. The specimen comprises portions of the trunk region, sacral vertebrae and the first complete pelvic region ever found for a Sundance plesiosaur including both articulated hind flippers and a complete tail. The specimen (WDC-SS01) is a juvenile as indicated by the un-fused neural arches on the vertebrae and a lack of facets on the epipodials. The specimen has concentrated gastric contents consisting of a mass of coleoid hooklets. This mass appears intact as opposed to the scattered hooklets found in other Sundance plesiosaurs. The placement of gastric contents mass was posterior to the gastralia and anterior to the pelvic girdle. This find provides further evidence of the importance of cephalopods in the diets of Sundance marine reptiles.

Technical Session XI, Friday 2:45

FIRST MANDIBLE AND LOWER DENTITION OF *PRISTINAİLURUS BRISTOLI* WITH COMMENTS ON LIFE HISTORY AND PHYLOGENY

WALLACE, Steven, East Tennessee State University, Johnson City, TN, USA; WANG, Xiaoming, Natural History Museum of Los Angeles County, Los Angeles, CA, USA

Recent fossil discoveries coupled with genetic studies among the Carnivora have clouded the systematics and life history of the Ailurinae (red or lesser panda and its relatives). Aside from a few isolated records, the fossil history is represented by one genus, the Pliocene *Parailurus* of North America and Eurasia, which occupies too high a position in the clade to be of much phylogenetic value. In addition, most of the Eurasian material is fragmentary, and the North American sample consists of a single tooth. The recently described *PristinaİLurus bristoli* from the Late Miocene Gray site of eastern Tennessee however, sits low on the clade, continues to be recovered, and therefore may offer insight into this unique group. Here we describe the first lower jaw (with c1, p4, m1, & m2) of *P. bristoli* and address its significance to understanding the Ailurinae. Overall the dentary is strikingly similar to that of *Ailurus* (living Red Panda). Though broken, the angular process was enlarged, but it is unclear if it extended past the mandibular condyle as in *Ailurus*. The anterior border of the coronoid process is more procumbent than *Simocyon* (sister taxon to the Ailurinae), but not quite as extreme as in *Ailurus*. The lower dentition exhibits a combination of primitive and derived characters. Though missing, there were three small incisors. The canine exhibits a deep lateral groove as seen in other ailurines and some procyonids. Alveoli show that all premolars except p1 are double rooted as in *Ailurus*; however p1-p3 are small and likely exhibited a single cusp as in *Simocyon*. The p4 is also small, but does contain several cusps; however, like *Simocyon* but unlike *Ailurus*, it lacks a paraconid. Molars are nearly identical to *Ailurus*, including all accessory cusps and the enlarged talonids. There is a slight labial cingulum on m1 that is more developed than on *Ailurus*. Wear obscures its presence or absence on m2. *PristinaİLurus* clearly represents a transitional form within the

Ailurinae. Although the molars are equivalent to the living *Ailurus*, which specializes in eating bamboo, *P. bristoli* retains the typical carnivorous premolars suggesting a less specialized diet.

Technical Session X, Friday 11:00

DOCUMENTING THE UINTAN/DUCHESNEAN TRANSITION IN THE DUCHESNE RIVER FORMATION, UTAH

WALSH, Stephen, San Diego Natural History Museum, San Diego, CA, USA; MURPHEY, Paul, San Diego Natural History Museum, San Diego, CA, USA

The Duchesne River Formation (Tdr) of northeastern Utah is the nominal stratotype of the Duchesnean NALMA, but is sparsely fossiliferous. The base of the lowest member (Brennan Basin Member, Tdr-bb) has yielded the Randlett Point local fauna, generally regarded as late Uintan in age. The upper part of the Tdr-bb and the overlying Dry Gulch Creek Member (Tdr-dgc) are of uncertain age, while the overlying Lapoint Member is of undoubted Duchesnean age. Therefore, the Uintan/Duchesnean transition may occur in the upper part of the Tdr-bb and/or the Tdr-dgc. In order to better document this transition, a project was initiated in 2006 to prospect and screenwash all levels of the Tdr. In particular, the only published mammal specimens definitely collected from the Tdr-dgc are a hyracodontid? femur and astragalus and the holotype of *Duchesnehippus intermedius*. Undaunted, we focused our initial test sampling on this member. Encouragingly, six out of 12 blind samples of "promising" matrix yielded fossil bone and/or tooth fragments, and one site proved rich enough to warrant further screenwashing. SDSNH Loc. 5939 ("Halfway Hollow One") is situated roughly in the stratigraphic middle of the Tdr-dgc, at about the same level as the type locality of *D. intermedius*. The fossiliferous bed is a 1 m thick, pale reddish brown, calcareous, very fine-grained sandstone, grading upward to sandy siltstone. 440 kg of matrix washed through 30 mesh screens yielded 67 identifiable mammal teeth. Taxa include *Nanodelphys* sp., *Insectivora* indet., *Pareumys* cf. *P. guensburgi*, cf. *Janimus* sp., *Metanoiamys* sp., *Protadajidamo typus*, *Protadajidamo* sp. (large), Eomyiidae, unidentified gen. and sp., Eomyiidae? new gen. and sp., Geomorpha, new gen. and sp., cf. *Griphomys* sp., cf. *Passaliscomys* sp., *Mytonolagus* sp., and *Artiodactyla* indet. Thus, the number of identifiable mammal specimens from the Tdr-dgc has been increased dramatically. Fourteen additional mammal taxa are now known from this member, nine of which are new records for the Tdr as a whole. Importantly, *Pareumys* cf. *P. guensburgi*, *Protadajidamo typus*, and cf. *Passaliscomys* sp. suggest a Duchesnean age for most or all of the Tdr-dgc.

Technical Session XI, Friday 2:15

A BASAL HOG-NOSED SKUNK, *CONEPATUS* (MEPHITIDAE, CARNIVORA), FROM LATE MIOCENE TO EARLY PLIOCENE OF CENTRAL MEXICO AND ORIGIN OF SOUTH AMERICAN SKUNKS

WANG, Xiaoming, Natural History Museum of Los Angeles County, Los Angeles, CA, USA; CARRANZA-CASTAÑEDA, Óscar, Universidad Nacional Autónoma de México, Juriquilla, Qerrétaro, Mexico

The hog-nosed skunk, *Conepatus* Gray, 1837, is one of the most widespread carnivores in the New World, and one of the first to arrive in South America during the Great American Biotic Interchange (GABI). We report a basal hog-nosed skunk from the early Pliocene San Miguel de Allende Basin, State of Guanajuato, central Mexico. The new Mexican species greatly extends the first appearance of *Conepatus* from Irvingtonian to early Blancan in North America, more than doubling the time period of previously known appearances. The new species of *Conepatus* is also geographically closer to the Panamanian land bridge than previous records from the United States and northern Mexico, and permits a better sense of the faunal exchange during the early phase of the GABI. A new phylogeny suggests that Central and South American *Conepatus* form a sister group to the North American clade, and as such, must have equally ancient divergence time that dates back to at least 4-5 Ma. As a result, *C. altiramus* from coastal marine cliffs of Argentina should be seriously reconsidered to be from the Chapadmalal Formation in the early Pliocene, a notion dismissed by some recent authors. If this is correct, South American *Conepatus* represents the first carnivore immigrant during the first wave of the GABI.

Technical Session X, Friday 9:00

EARLY EOCENE BUMBANIAN FAUNA FROM THE ERLIAN BASIN, INNER MONGOLIA, CHINA AND ITS BIOCHRONOLOGICAL IMPLICATIONS

WANG, Yuan-Qing, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; MENG, Jin, American Museum of Natural History, New York, NY, USA; NI, Xi-Jun, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; BEARD, K. Christopher, Carnegie Museum of Natural History, Pittsburgh, PA, USA

Fossil mammals from the Bumbanian Asian Land Mammal Age are critical in understanding mammalian faunal turnover across the Paleocene-Eocene (P-E) transition in Asia. The Bumbanian fauna from the Mongolian Plateau was previously documented only by fossils from the Bumban Member of the Naran Bulak Formation and its equivalent in Mongolia, until its recent discovery in the Huheboerhe (Camp Margetts) area

of the Erlian Basin, Inner Mongolia, China. Our recent field investigations indicate that the lower Paleogene in the Huheboerhe area consists of three lithologic units: the Nomogen Fm., the Arshanto Fm., and the Irdin Manha Fm., in ascending order, which clarifies problems with the stratigraphic sequences in the area. The Nomogen Fm. produces two different mammalian faunas: a lower Gashatan fauna and an upper Bumbanian fauna. Bumbanian fossils were collected from the upper part of the Nomogen Formation in the working area. They include *Gomphos elkema* (gliroid), *Baataromys ulaanus* (euprimate), *Anatolostylops* sp. nov. (arctostylopid), *Pataecops parvus?*, *Homogalax* sp. (perissodactyls), *Dissacus* sp. (mesonychid), several species of rodents, a lagomorph, a creodont and a possible artiodactyl. Most fossils, except the euprimate, the lagomorph, the arctostylopid, and *Pataecops*, are either typical Bumbanian elements or similar to those from the Bumban beds in Mongolia. Paleomagnetic results show that the Bumbanian equivalent beds at Huheboerhe occur within Chron C24r of the Geomagnetic Polarity Timescale, which, plus comparison of the mammalian fossils with those from different levels and areas, suggests that the fossil-bearing beds are most likely early Eocene, probably basal Eocene, in age. The first appearances of rodents, lagomorphs, perissodactyls and euprimates at the P-E boundary in the Erlian Basin represent a distinctive change from those of the late Paleocene Gashatan fauna and bear importantly on the origins and dispersals of several modern mammalian orders.

Poster Session III (Friday)

MASS BURIAL EVENT OF *PINACOSAURUS* (ANKYLOSAURIA, DINOSAURIA) IN ALAG TEG, A FLUVIAL FACIES OF THE DJADOKHTA FORMATION (LATE CRETACEOUS), GOBI DESERT, MONGOLIA

WATABE, Mahito, Hayashibara Biochemical Laboratories, Inc., Okayama, Japan; FASTOVSKY, David, University of Rhode Island, Kingston, RI, USA

Hayashibara Museum of Natural Sciences and Mongolian Paleontological Center Joint Paleontological Expedition found a mass-burial site of *Pinacosaurus* in 1995. The locality is called Alag Teg, about 3km north of Tugurikin Shire in central Gobi desert. More than 30 individuals were found together in one mudstone layer at the site. Among those skeletons, some show good articulation with a skull and a tail. Others are disarticulated and bones are scattered. All skeletons are set in normal posture. All skeletons shows very similar body size, with same ontogenetic stages. The bed including those skeletons is red-colored mudstone. The geology in Alag Teg is considered as fluvial facies, and the facies were overlain by eolian facies that forms main lithology of Tugurikin Shire in the south. The eolian sediments in Tugurikin Shire and fluvial ones in Alag Teg are in heteropic facies relationships. Geological age of the bed is correlated with Campanian. This synchronous sedimentation of eolian and fluvial facies is observed in other Djadokhta vertebrate localities, such as Bayn Dzak. Hypotheses on the process of this mass burial phenomenon are: drought; mudflow; and mud-trap. There is no evidence of existence of drought, then, desiccation cracks are shown in the bed with those skeleton, and overlying and underlying beds. There are no other vertebrate fossils with those pinacosaurus, especially aquatic ones such as turtles and crocodiles. Mudflow sediments cannot be recognized in the bed. Those skeletons are preserved a thin mudstone layer. Occurrence of isolated and dispersed bones suggests no quick burial process. Mud trap hypothesis seems the best adequate. A hadrosaurid pes (articulated metatarsals and other digits) that is vertically positioned was found in a mudstone layer, similar in lithology and horizon to those of the death site. This suggests that these animals were killed in the mud trap. However, there is no other vertebrate fossil, except for one tooth of theropod. A tooth of theropod (carnivorous dinosaur) was found from the same bed with *Pinacosaurus*, close to a skeleton. This occurrence of *Pinacosaurus* suggests they were gregarious animals.

Technical Session XV, Saturday 9:00

DIETARY INFERENCES FROM DENTAL MICROWEAR IN MULTITUBERCULATE MAMMALS FROM THE HELL CREEK AND TULLOCK FORMATIONS OF EASTERN MONTANA

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We analyzed dental microwear on molars of multituberculate mammals from the Hell Creek and Tullock Formations of Garfield and McCone Counties in Montana. This section preserves abundant multituberculate fossils in age-constrained assemblages, and it includes the K/T boundary at 65.5 MYA. We were able to compare microwear within species surviving the end-Cretaceous extinction event, and also among Late Cretaceous species from the Hell Creek Formation. Dental microwear can indicate the physical properties of foods masticated by an individual animal in the period antecedent to death. Thus it is a direct indicator of diet, but there may be considerable seasonal and individual variation within species, and a large sample size may be necessary to recognize significant differences among samples. To study microwear across the K/T boundary, we photomicrographed a consistent wear facet on upper first molars of *Mesodma* and *Cimexomys*, and analyzed both descriptive and measurement data. The most common patterns of wear within each taxon vary between Cretaceous and Paleocene individuals. Microwear on Cretaceous individuals often consists of short scratches and frequent pits; the leading edge of cusps is chipped to form a ragged edge.

Microwear in Paleocene individuals is characterized by longer, parallel scratches, most of which extend beyond the edges of single cusps; the cusp edges are sharp. Many fine, parallel scratches are also present. In the species *Mesodma thompsoni*, for which we have the largest sample, differences in feature length and orientation are significant at  $p < .05$ . These results suggest that multituberculate diets changed across the K/T boundary, possibly to include tougher foods. Some of the difference may be also be attributable to increased ingestion of fine grit. Our comparison of microwear among the Late Cretaceous species has not yet reached statistical significance in the measurement data, but qualitative comparison suggests that, as one might expect from diverse tooth morphologies, Late Cretaceous multituberculates of the Hell Creek Formation effectively partitioned food resources.

Technical Session XV, Saturday 11:30

#### POSTCRANIAL SEQUENCE HETEROCHRONY AND THE MARSUPIAL-PLACENTAL DICHOTOMY

WEISBECKER, Vera, UNSW, Sydney, Australia; GOSWAMI, Anjali, University of Cambridge, Cambridge, United Kingdom; SÁNCHEZ-VILLAGRA, Marcelo, Universität Zürich, Zürich, Switzerland; WROE, Stephen, University of New South Wales, UNSW/Sydney, Australia

It has long been recognized that there is a deep dichotomy between marsupials and placentals in terms of taxonomic and ecological diversity. Marsupial species known today comprise a small percentage of the number of placental species, and have no extremely specialized (e.g. aerial or fully aquatic) representatives. The comparative lack of marsupial diversity is particularly evident in the marsupial forelimb, which is much less diverse compared to that of placentals. Marsupials are born in an extremely altricial state, and in most species, the neonate actively crawls into the pouch using its forelimbs. Current consensus holds that the crawl to the pouch is related to heterochronic acceleration of the marsupial forelimb. However, this hypothesis has only experienced limited formal testing. We analysed postcranial ontogeny in a new dataset of ossification sequences of 13 placentals, 11 marsupials, and three outgroup taxa, considering 25 events. Data were obtained from clear-staining and/or micro-computed tomography of ontogenetic series, and in some cases from the literature. The ossification sequence data were analyzed using the event-pair based Parsimov analysis. To examine their potential phylogenetic signal, a parsimony analysis of the event-pair data was conducted. This did not retrieve any of the recognized mammalian clades except for monophyletic marsupials (except *Petaurus*) nested within placentals. This suggests that postcranial ossification sequences carry some limited phylogenetic signal for marsupials, although not sufficient to separate them from placentals. Event distributions within species suggest that a larger amount of events occurs in younger animals compared to older specimens, a pattern particularly obvious in marsupials. We expect that this is due to fast appearance of the forelimb long bones, shoulder girdle, cervical and thoracic elements in the youngest marsupials. Parsimov analysis reports that ossification events in the hindlimb of marsupials are *decelerated* with respect to forelimb long bone ossification events. This novel hypothesis challenges the long-held tenet of an ontogenetic "bottleneck" on marsupial forelimb diversity.

Technical Session IX, Friday 10:15

#### VIRTUAL HADROSAUROID MASTICATION

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Pleurokinesis is one of several masticatory models suggested for at least iguanodontian ornithomorphs and it remains one of the best tested. Originally coined by Norman, pleurokinesis consists principally of laterally mobile maxillae and sequelae cranial mobility to produce a transverse power stroke. Mastication in these ornithomorphs, based on the probability that these animals were isognathous with commensurate bilateral occlusion, was originally tested using a numbers-in - numbers-out kinematic algorithm, with no imaging available at that time. We constructed a 3-D virtual model of pleurokinesis on the basis of a new hadrosauroid collected in 1994 at Bayshin Tsav by the Joint Hayashibara Museum of Natural Sciences and Mongolian Academy of Sciences Expeditions. This specimen is a full postcranial skeleton and a complete, disarticulated, and relatively undeformed skull. We laser-scanned all of the skull elements and attempted to assemble them using joint surfaces as constraints on inter-element position. This proved to be inexact, since only minor deformation produced considerable inaccuracies in reconstruction. As a result, we took the best fit regions of the skull and mirror-imaged them to get a realistic reconstruction. We did not include palatal elements because the vomers and ectopterygoids were missing and the palatines and pterygoids were distorted. Pleurokinesis accords well with the virtual hadrosauroid model in producing transverse tooth wear. Using the adductor mandibulae musculature, single bite points continuously pass down the dentition on both sides at the same time as the jaws go through their power stroke. The virtual model will make possible the fine tuning of joint constraints, the insertion of palatal elements and musculature, and the expansion from kinematics to dynamics to investigate stress-strain relations in ornithomorph skulls.

Carnivora: Phylogeny, Form and Function Symposium, Saturday 10:15

#### THE GEOGRAPHY OF CARNIVORAN DISPARITY

WERDELIN, Lars, Swedish Museum of Natural History, Stockholm, Sweden; WESLEY-HUNT, Gina, National Museum of Natural History, Washington, DC, USA

To capture the pattern of morphological and ecological structure within modern Carnivora we compiled a database of 17 characters for 217 fissiped carnivorans. Characters used capture the variety of functional units found within the carnivoran tooth row. The taxa were plotted in morphospace using non-linear multidimensional scaling to visualize the pattern of distribution. Phylogenetic patterns predominate with genera within families overall clustered together. The first axis describes a continuum from hyper- to hypocarnivorous forms. Felidae are extreme in the first direction, accompanied by hyenas and *Cryptoprocta*, a very "cat-like" Malagasy carnivore. Procyonidae lies at the hypocarnivorous end of this axis, together with some Mustelidae and Viverridae. The second axis is a complex vector contrasting taxa with hypocarnivorous upper carnassials (Ursidae, Lutrinae) against taxa with unreduced premolar tooth rows (Canidae, some Viverridae, Herpestidae, Mustelidae). Hyaenidae has the highest average disparity due to its occupation of both hypercarnivorous and insectivorous ecologies, and low diversity. Viverridae, which occupies a range of ecologies and dietary types, also has high disparity. Felidae has the lowest average disparity as the family is restricted to hypercarnivory and is taxonomically diverse within its narrow envelope of morphospace. More surprising is that Canidae, even with the inclusion of the insectivorous *Otocyon*, has low disparity. Disparity distributions in Africa and the Americas were compared. The African Carnivora are distributed in a broad belt along axis 1, with only a small gap (caused by recent extinctions) among the Hyaenidae. By contrast, the pattern for the Americas shows large gaps between hypo-, meso-, and hypercarnivores. Comparison shows that these gaps lie where Africa has Viverridae and Hyaenidae. We suggest that the pattern is due to historical patterns of taxon distribution coupled with constraints on intra-familial disparity. Continental disparity patterns are very similar in all cases, despite the differences in distributions. We suggest that this is due to guild structuring in evolutionary time.

The Dissorophoida - Early Amphibian Radiation Symposium, Friday 10:15

#### "MILNERPETON" FROM THE LATE PENNSYLVANIAN OF NEW MEXICO IS THE FIRST TRULY "EUROPEAN BRANCHIOSAURID" FROM NORTH AMERICA

WERNEBURG, Ralf, Schleusingen, Germany; LUCAS, Spencer, New Mexico Museum of Natural History and Science, Albuquerque, Albuquerque, NM, USA

The new-like dissorophoid "*Milnerpeton huberi*" from the Pine Shadow Member of the Atrasado Formation (Late Pennsylvanian, middle Virgilian) at the Kinney Brick Company quarry in the Manzanita Mountains of New Mexico was described by Hunt, Lucas and Berman as a new amphibamid temnospondyl in 1996. A second, newly-prepared specimen and the revision of the first one extend the knowledge of this taxon. "*Milnerpeton huberi*" belongs clearly to the dissorophoid family Branchiosauridae for the following reasons: (1) the narrow ectopterygoid and narrow posterior palatine indicate no contact to the maxilla and therefore an elongated subtemporal fossa; (2) carotid foramina are present on ventral parasphenoid; (3) branchial denticles are supplied with ball-like base (no plate) and multiple tooth-like peaks. It is very probable that "*Milnerpeton*" is a junior synonym of *Branchiosaurus* Fritsch from the Late Pennsylvanian of Europe. "*Milnerpeton huberi*" is similar in most features with *Branchiosaurus salamandroides* from the Moskovian (Westphalian D) of N\_rany and Tremo\_na (Plzen Basin, Czech Republic). Characteristic is the early, high degree of ossification of the skeleton, especially of the jugal, quadratojugal, sclerotic ring elements, branchial denticles, neural arches and ventral scales. The New Mexico branchiosaurid was an "ostracod eater" in a probable lacustrine environment. Some ostracod shells are clearly preserved as stomach contents. All other records of American branchiosaurids are uncertain. The holotype specimen of "*Branchiosaurus darahii*" seems to be a branchiosaurid specimen from the Autun Basin in France. Most of the very tiny, larval temnospondyls from the Francis Creek Shale (Mazon Creek) belong to *Amphibamus* and perhaps to saurerpetontids or to branchiosaurids, but no diagnostic features are preserved in them.

Technical Session XVII, Saturday 1:45

#### "TEENAGE PREGNANCY" IN NON-AVIAN DINOSAURS AND ITS RELEVANCE TO GROWTH

WERNING, Sarah, UC Museum of Paleontology, Berkeley, CA, USA; LEE, Andrew, UC Museum of Paleontology, Berkeley, CA, USA

From viruses to whales, the delay until reproductive maturity increases with body mass in extant species. Whether that scaling relationship also applies to non-avian dinosaurs has not been tested, because direct evidence of reproductive maturity in non-avian dinosaurs is rare. In living female birds, reproductive maturity is signaled histologically by the deposition of endosteal medullary bone, a labile tissue associated with egg production. Recent reports of this tissue in the non-avian theropods *Tyrannosaurus* and *Allosaurus* and in the ornithomorph *Tenontosaurus* provide a new proxy for reproductive maturity in non-avian dinosaurs. Using skeletochronology and bootstrapped confi-

dence intervals, we estimate that female *Tenontosaurus*, *Allosaurus*, and *Tyrannosaurus* likely reached reproductive maturity by 8, 13, and 18 years, respectively. These ages are not only consistent with the virus-to-whale scaling relationship between reproductive maturity and body mass, but they are also decades younger than predictions from recent models of dinosaur growth and maturity based on data from living reptiles scaled to equivalent size. These data also permit us to test whether growth curve inflection points can be used as an accurate estimate of reproductive maturity. Additionally, histology and skeletochronology indicate that these dinosaurs reached reproductive maturity well in advance of skeletal maturity. This contrasts starkly with the pattern observed in almost all extant birds, which reach skeletal maturity within a few months of hatching but delay reproduction until a year or more later.

Technical Session XVIII, Saturday 3:15

#### DO ODONTOCETES MASTICATE? INVESTIGATING EVIDENCE FROM TOOTH WEAR, HOMODONTY, AND ENAMEL MICROSTRUCTURE

WERTH, Alexander, Hampden-Sydney College, Hampden-Sydney, VA, USA; BEATTY, Brian, New York College of Osteopathic Medicine, Old Westbury, NY, USA; PYENSON, Nicholas, University of California, Berkeley, Berkeley, CA, USA

Odontocete dentition is derived from a normal mammalian dentition with relatively complex enamel microstructure and regular use in mastication of food items, resulting in wear. However, odontocete dentitions are often characterized as having simplified enamel microstructure, simplified occlusion (non-occlusal, only interdigitating), and simplified tooth morphology (peg-like and homodont). These features are all interpreted as plesiomorphic modification from mastication to raptorial prey-capture and/or suction feeding, but these interpretations are not supported by comparative data. To better characterize dentition and tooth wear of odontocetes, we studied gross dental wear, dental microwear, and occlusal geometry of several representatives of most clades of modern and fossil odontocetes, with several archaeocetes as outgroups. Results indicate a positive, yet complex relationship between the degree of heterodonty (apomorphic in some taxa), enamel microstructure, and dental wear (not simply breakage), with modern "river dolphins" providing the best exemplars (e.g., *Inia*). Several characters of enamel microstructure, including thickness, presence and type of prisms, and absence of Hunter-Schreger bands, correlate with loss of occlusal function. Additionally, breakage is most evident among taxa that have significantly reduced the development of enamel, such as *Physeter* and *Delphinapterus*, but have subsequently returned to more potentially damaging diets. Ultimately, the generalizations of odontocetes as homodont and non-masticating are not applicable to the whole of the clade. Rather, a continuum of dental features exists in which some members continue some primitive dental function to the present day, whereas others apomorphically lose masticatory ability. To better understand this transition, we need to incorporate more fossils of archaeocetes and stem Neoceti in the context of modern comparative data to clarify the polarity of these changes.

#### Carnivora: Phylogeny, Form and Function Symposium, Saturday 10:30 COMPARATIVE ECOMORPHOLOGY AND BIOGEOGRAPHY OF THE HERPESTIDAE AND VIVERRIDAE

WESLEY-HUNT, Gina, National Museum of Natural History, Smithsonian, Washington, DC, USA; DEHGhani, Reihaneh, Swedish Museum of Natural History, Stockholm, Sweden; WERDELIN, Lars, Swedish Museum of Natural History, Stockholm, Sweden;

Ecomorphology is a useful tool for investigating the patterns and processes of evolution. In this paper we use ecomorphology to clarify the comparative biogeography of Viverridae and Herpestidae (Carnivora). Their current range is Africa and Eurasia, but the evolutionary history of these two families is not well known, due in part to a poor fossil record. The African fossil record of both families is sparse. There are a few occurrences of Viverridae in the latest Miocene of Asia, but to our knowledge, there is no definitive record of pre-Pliocene Herpestidae. Thus, we use ecomorphology to estimate the pattern of geographic diversification. We compiled a database of 17 characters for 217 extant fissioned carnivorans. The characters include 16 from the dentition, of functional significance, and one of body size. A dissimilarity matrix was calculated and the data was plotted in morphospace using principal-coordinates analysis. All 217 taxa were included in the analysis. However, this paper incorporates only members of Viverridae and Herpestidae. Although there is overlap in the ecological morphospace (ecospace) of the two families, each continent by itself shows little overlap. In Africa the carnivorous ecospace is dominated by viverrids, which occupy a similar part of the ecospace as the Asian carnivorous herpestids. In contrast, in Asia the carnivorous viverrids occupy a distinct part of ecospace, separate from the carnivorous herpestids sharing the continent. The only generalists in Asia are viverrids, while in Africa this part of the ecospace is dominated by herpestids. In general, in Africa the herpestids are generalists and the viverrids are carnivores. In Asia the viverrids are generalists, as well as carnivores but functionally distinct from the carnivorous herpestids. The pattern of ecological morphospace occupation supports competitive exclusion and an ecological structure in which an "occupant" group cannot be dislodged by an immigrant group.

Technical Session I, Wednesday 12:00

#### BRAIN SIZE AND INSULAR DWARFISM: A CASE STUDY OF THE EXTINCT DWARF HIPPOPOTAMUSES FROM MADAGASCAR

WESTON, Eleanor, Natural History Museum, London, United Kingdom; LISTER, Adrian, Natural History Museum, London, United Kingdom

The effect of insular dwarfism on the brain size of island mammal species relative to that of their mainland ancestors is a matter of debate. Although it is generally accepted that a reduction in body size within a mammalian species is usually associated with relatively little brain size reduction, reflecting the early completion of brain development, it remains unclear whether the insular dwarfing process follows this trend. Most dwarfed island mammals are extinct and incompletely preserved, accounting for the dearth of empirical data until now. However, the exceptional preservation of the recently extinct dwarf hippopotami from the Holocene of Madagascar are an exception. Measures of cranial capacity have been taken from up to 50 well preserved crania of two dwarf subfossil hippopotami, *Hippopotamus lemerlei* and *Hippopotamus madagascariensis* and from a complete postnatal ontogenetic series of dry skulls of the probable ancestor, the extant mainland *H. amphibius*. Results from a comparative morphometric analysis of growth in the larger mainland *Hippopotamus* and the two dwarf species are presented. A hypothesis of ontogenetic scaling is evaluated in the context of the reduction in both brain and overall skull size of these dwarf species. In light of the current controversy over brain size reduction in the putative dwarf hominin *Homo floresiensis*, studies of other mammalian analogues such as the hippos, with larger samples and ontogenetic series, are likely to be informative on mechanisms of dwarfing in mammals.

Technical Session VIII, Thursday 3:15

#### EVOLUTION OF SALT-WATER TOLERANCE IN CROWN CLADE CROCODYLIANS

WHEATLEY, Patrick, University of California, Santa Cruz, Santa Cruz, CA, USA; KOCH, Paul, University of California, Santa Cruz, Santa Cruz, CA, USA

Crown clade crocodylians exhibit a variety of responses to saline environments. Alligatorids cannot drink saline water, but occasionally spend time foraging in brackish, estuarine, and even marine waters. Crocodylids are better adapted to saline habitats; several species spend a substantial amount of time in marine environments. Even the crocodylids that do not exploit marine ecosystems have special lingual salt glands for excreting excess salt and they can drink salt water if necessary. The narrow-snouted taxa, the tomistomines and gavialoids, are more problematic. Both are currently restricted to freshwater, however, they have lingual salt glands and biogeographic distributions that suggest at least some salt tolerance. We have used stable isotopes of carbon and oxygen as proxies for marine resource use in modern reptiles; here we extend this approach to study fossil individuals found in near shore marine environments. Testing fossil members of Alligatoroidea, Tomistominae, and Gavialoidea, we find evidence of marine resource use. We interpret the results in the context of paleobiogeography, and possible past oceanic crossings. Additionally, the isotopic data help to pinpoint the time of origin of salt-water tolerance in clade Crocodylia, and provide independent constraints for phylogenetic debates concerning crocodylians.

Student Poster Session (Thursday)

#### DIETARY INFERENCES FROM STUDIES OF SKULL SHAPE AND ENAMEL MICROWEAR IN DIPLODOCOID SAUROPODS

WHITLOCK, John, University of Michigan, Ann Arbor, MI, USA

Diplodocoid sauropods are notable not only for their large average size but also for their remarkable skulls, the use of which in gathering food has long been a source of confusion. Particularly noteworthy is the shape of the snout, which is commonly described as broad and blunted. Snout shape has been correlated with feeding behavior in mammals, both living and extinct. Blunt snouts are most often found in grazers and low-croppers, whereas rounded or pointed snouts are associated with more selective browsers: in some instances relatively small absolute differences in shape correlate with highly distinct diets. This relationship may have important consequences for determining the habits of diplodocoid sauropods. Prior work has shown that snout shape differs between adults and juveniles within at least one genus, *Diplodocus*; it also appears likely that this is true for other diplodocoid taxa as well. Snout shape also varies between taxa, both drastically, as in the disparate shapes of *Nigersaurus* and *Diplodocus*, as well as subtly, such as between *Diplodocus*, *Apatosaurus* and *Dicraeosaurus*. Snout shape can be quantified by a metric that is here termed the premaxilla-maxilla index (PMI). Comparisons of PMI and enamel microwear (an indicator of diet) in a sample of diplodocoids allow for the relationship of shape and diet to be tested. Adult skulls with blunt snouts (e.g. *Diplodocus*) typically have teeth with unidirectional scratch patterns and increased pitting, both indicators of low-height grazing behavior. Preliminary investigations of skulls with rounded snouts indicate an association with less regular wear patterns, which may be related to browsing rather than grazing behavior. Shape and wear data from some diplodocoid and dicraeosaurid sauropods are examined in the

context of an ongoing phylogenetic analysis, building towards the development of a comprehensive hypothesis of the evolution of variability in feeding behavior in diplodocoid sauropods.

Student Poster Session (Thursday)  
DEFORMATION OF DINOSAUR BONES: DIAGENETIC AND TECTONIC EFFECTS

WILBORN, Brooke, University of Oklahoma, Norman, OK, USA

Skeletal elements of vertebrates may be subject to tectonic stresses after burial. Researchers have conducted analyses of observed deformation in order to estimate tectonic-induced strain. Deformation studies typically assume that bilaterally symmetric skeletal elements are actually bilaterally symmetric, or that paired elements from the appendicular skeleton are true mirror images of each other. These assumptions may be invalid due to numerous obvious causes such as breakage/repair, "handedness," and disease during the life of the animal, in addition to tectonic stress and strain. However, even skeletal elements found in tectonically undeformed sediments may show deformation. Elements are subjected to many different stresses during the biostratigraphy and diagenetic stages of taphonomy, such as differential compaction. Thus the assumption of initial symmetry may not be valid even if the elements entered the sedimentary record meeting that assumption. I test the validity of this assumption by analyzing the vertebrae and paired limb elements from an ontogenetic series of sauropod dinosaur bones from the University of Oklahoma Kenton Quarries in the Morrison Formation. Determining how symmetrical bones actually are from a tectonically "undeformed" sample provides a baseline for comparison of deformed bones from a tectonically active area. The Morrison Formation Nickopod Quarry, worked by the Virginia Museum of Natural History, is in a tectonically deformed area. The strata containing the quarry are part of an imbricate thrust fault system. The dinosaur bones from the quarry are visibly deformed. By utilizing the baseline data from the Kenton Quarry, I will quantify the strain evident in the bones and the stress orientation of the thrust faulting in the Nickopod Quarry.

Poster Session IV (Saturday)  
MORPHOLOGICAL INDICATORS OF STANCE AND GATE IN SAUROPODS  
WILHITE, Ray, Louisiana State University School of Veterinary Medicine, Denham Springs, LA, USA

More than 600 individual sauropod appendicular elements were examined for keys to morphological characters that may have a bearing on stance and gate. The humerus, ulna, and femur were all found to be useful in determining relative stance and gate width. In those sauropods thought to produce wide gauge trackways, such as titanosaurs and brachiosaurs, the humeral head is located more medially; the distal condyles of the humerus are noticeably asymmetrical; the proximal ulna is L-shaped; the posterior process of the ulna projects caudolaterally; the femoral head is offset medially; and the femoral condyles are either coequal in length or the fibular condyle is longer. Conversely, in those sauropods thought to produce narrow gauge trackways, such as diplodocids, the humeral head is centered on the proximal end of the humerus; the distal condyles are nearly symmetrical; the proximal ulna is V-shaped; the posterior process of the ulna projects caudally; the femoral head is not offset; and the tibial condyle is longer than the fibular condyle. These differences in morphology between taxa with different locomotor strategies may allow for interpretation of stance in taxa for which only partial appendicular material is known. Finally, this study demonstrates that the Upper Jurassic sauropod *Camarasaurus* would have produced relatively wide gauge trackways. This interpretation may help explain the presence of wide gauge trackways in the Morrison Formation previously suspected of having been made by titanosaurs.

Student Poster Session (Thursday)  
AVIAN TAPHONOMY IN NATURAL TRAP CAVE (LATE PLEISTOCENE-HOLOCENE), WYOMING

WILLIAMS, Daniel, University of Kansas, Lawrence, KS, USA

Natural Trap Cave is a large sinkhole (26 m deep) located in the Big Horn Mountains of Big Horn County, Wyoming at an elevation of approximately 1,600 meters. The cave acted as a pitfall trap for large mammals since at least the Sangamonian. Although the nearest modern aquatic habitat is 4 km west of the cave, Anseriformes, Gruiformes, Podicipediformes, and Charadriiformes are present in the cave's fossil fauna. Therefore, avian predators probably accounted for some portion of the small fossil vertebrates in Natural Trap Cave. *Neotoma*, which currently nest in the cave, may have introduced the birds from predator roosts exterior to the cave. Alternatively, the avian predator may have nested in the cave. In this study I will address this issue by describing the extent and type of weathering found on avian fossils. Elements that were introduced directly into the cave should primarily show cave-related weathering, similar to that already documented in the large mammals, while elements brought in from the outside should have varying degrees of weathering due to causes exterior to the cave.

Poster Session II (Thursday)  
FOSSIL PREPARATION TECHNIQUES FOR SMALL PERMIAN TETRAPODS FROM RICHARD'S SPUR, OKLAHOMA

WILLIAMS, Scott, Burpee Museum of Natural History, Rockford, IL, USA; HENDERSON, Michael, Burpee Museum of Natural History, Rockford, IL, USA; MAY, William, Sam Noble Oklahoma Museum of Natural History, Norman, OK, USA; REISZ, Robert, University of Toronto, Mississauga, ON, Canada

In 2006, the Burpee Museum of Natural History in Rockford, IL initiated a vertebrate fossil collecting program from the famous Lower Permian fissure fill deposits, in the Dolese Brothers Quarry, near Richard's Spur, Oklahoma. The Dolese Quarry has been yielding the remains of Early Permian tetrapods for more than 70 years, and the known vertebrate assemblage is entirely restricted to fully terrestrial tetrapods. Although much of the recent quarry operation has produced few vertebrate remains, because the active quarry has been operating below the depth of the fossil producing layers, a newly excavated site has started to yield many important, articulated specimens. The Burpee specimens were collected from spoil piles within the quarry and occur in several lithologies including: soft clay that is greenish when first exposed or wet, calcite cemented conglomerate, and flowstone. These deposits accumulated during the lower Permian as cave and fissure fills within a fossilized karst developed in Ordovician-aged carbonates. The tetrapods range from partially articulated to completely disarticulated and show little evidence of transport. Although hundreds of bones and several skulls and partially articulated skeletal elements of the captorhinid reptile *Captorhinus aguti* were collected, other components of the fauna including varanoid synapsids, microsaur, and dissorophid amphibians have been recovered. The current discoveries are unusual in preserving a disproportionately large percentage of articulated or partially articulated skeletons. Each of these specimens presents unique challenges for preparation. Once at the museum, specimens were prepared using a variety of techniques including: use of pneumatic micro-jacks on hard calcified matrix, screen washing of fossiliferous clay deposits, alternating soaking of specimens in low-grade acetic acid (vinegar) and distilled water, and in some cases light air abrading specimens with sodium bicarbonate.

Technical Session X, Friday 8:30  
EXCEPTIONAL PRESERVATION OF MAMMALS, A BIRD, AND LIZARDS FROM THE LOWER PALEOCENE OF NEW MEXICO

WILLIAMSON, Thomas, New Mexico Museum of Natural History, Albuquerque, NM, USA

Partial skeletons of several small mammals, a bird, and lizards were collected from a locality (NMMNH L-6898) of the late Torrejonian (To3), *Mixodectes pungens* zone of the Nacimiento Formation, San Juan Basin, New Mexico. Fossils were recovered from a thin (2-3 cm thick) massive muddy siltstone using a combination of surface collecting, quarrying, and underwater screening of a small (1m<sup>2</sup>) area. Some bones were partially articulated and some were associated with carbonate nodules and/or partially encased in gypsiferous crusts. Locality L-6898 is atypical of most reported microfossil sites of the Nacimiento Formation because of minimal transport of bones prior to burial. This site may represent a shallow, ephemeral pond. Taxa collected from L-6898 include the basal euarchontan? *Mixodectes pungens*, the "palaechthonid" plesiadapiform *Torrejonina wilsoni*, the palaeoryctid *Acmeodon* sp., at least three multituberculate taxa, a marsupial, a nyctitherid, a neavian bird, and at least two lizards. *M. pungens*, represented by a nearly complete skeleton, is significantly larger than other mammals from the site. Thus there is no ambiguity regarding the referral of its bones. *T. wilsoni* and *Acmeodon* sp. are each represented by partial skeletons, but because they are similar in size, referral of some bones is problematic. Bird bones from L-6898 probably represent the partial skeleton of a single individual. Lizards include a partial skull and skeleton of a glyptosaur. Locality L-6898 provides an exceptional array of Torrejonian specimens. The specimen of *M. pungens* is the oldest nearly complete skeleton of a euarchontan. The partial skeleton of *T. wilsoni* is the first reported for a "palaechthonid" and the oldest for an undisputed plesiadapiform Primate. The partial skeleton of *Acmeodon* sp. is the oldest for a palaeoryctid. The partial bird skeleton is the first bird reported from the Torrejonian of North America. Specimens from L-6898 thus reveal abundant new information, especially regarding the early Paleocene diversification of euarchontans and birds.

Technical Session XV, Saturday 8:30  
ENDEMIC, RELICTS, AND DISPERSALISTS: NEW MAMMALS FROM THE LATE CRETACEOUS OF INDIA

WILSON, Gregory, Denver Museum of Nature & Science, Denver, CO, USA; DAS SARMA, Dilipchandra, Geological Survey of India, Hyderabad, India; ANANTHARAMAN, S., Geological Survey of India, Hyderabad, India

Paleontologists hypothesize that the geographic separation of Laurasia and Gondwana during the Late Jurassic and Cretaceous led to the independent evolution of their respective terrestrial biotas. Cretaceous vertebrate fossils from Gondwana, though relatively sparse, largely uphold this hypothesis. Cretaceous mammal faunas from Laurasia are characterized by multituberculates and boreosphenidans, whereas those from



Gondwana are characterized by australosphenidans and non-tribosphenic endemics and relicts. An exception to this hypothesis is the mammal fauna from the Late Cretaceous of India. Over 90% of mammal specimens known from the Maastrichtian of India are eutherians. These taxa, which have phylogenetic affinities to Laurasian taxa, pose unresolved questions: Did eutherians from Laurasia reach India directly via island arcs or indirectly via other Gondwanan landmasses? Or did eutherians originate in Gondwana? Other Late Cretaceous vertebrates from India (abelisaurid theropods, gondwanatherian mammals) share closest ancestry with taxa from other Gondwanan landmasses (South America, Madagascar). These phylogenetic relationships shed light on the sequence of geographic separation of Gondwanan landmasses. Yet, sampling is uneven across Gondwanan landmasses and the fragmentary nature of most recovered fossils limits phylogenetic analyses. Continued fieldwork in India aims to address these issues. A new collection of specimens from the Late Cretaceous of India includes new eutherians, a haramiyidan, and gondwanatherians. Whereas the eutherians likely represent dispersalists from Laurasia and the haramiyidan represents a relictual distribution on Gondwana, the gondwanatherians are part of an endemic Gondwanan radiation. Derived features of the Indian gondwanatherian suggest phylogenetic affinities with *Lavanify* from the Maastrichtian of Madagascar and to a lesser extent with *Sudamerica* from the Paleocene of Argentina. The haramiyidan molariform shows greatest affinities with *Allostaffia* from the Late Jurassic of Tanzania. The phylogenetic affinities of the Indian eutherians are presently unclear but dentulous jaw fragments hold promise for future resolution.

Technical Session XVII, Saturday 1:15

#### GROWTH AND LIFE HISTORY OF ASIA'S LARGEST DINOSAUR

WINGS, Oliver, University of Tübingen, Tübingen, Germany; SANDER, P. Martin, University of Bonn, Bonn, Germany; TÛTKEN, Thomas, University of Mainz, Mainz, Germany; FOWLER, Denver, Museum of the Rockies, Bozeman, MT, USA; SUN, Ge, Ancient Biology Research Institute, Changchun, China

A new extensive dinosaur locality was discovered during fieldwork of the Sino-German Project in April 2006. The site is located 24 km NNE of Jiangjunmiao (Junggar Basin, NW China), in the upper Shishugou Formation (Upper Jurassic). Despite exploration of this site being cancelled prematurely due to permit problems, we excavated and studied several important specimens including associated and partly articulated sauropod and theropod remains. Among these finds is an enormous mamenchisaurid (Sauropoda) ulna (preserved length: 96 cm), representing the largest dinosaur known from Asia. Using current methods for sauropod mass estimation, and comparison to published *Mamenchisaurus* data, we calculated a mass estimate of 30,868 kg (assuming a specific density of 0.8 g/cm<sup>3</sup>). Sectioning of the ulna revealed a very thick primary cortex with very little bone remodeling and a small medullary cavity, allowing a detailed study of bone histology and isotope geochemistry. The primary cortex consists of laminar fibrolamellar bone, as in other sauropods. However, the specimen differs in the early onset of cyclical growth, at 40% final size. Growth cycles are delimited by lines of arrested growth (LAGs), and a total of 27 were counted. By calculating body mass increase from cortical thickness increase, we derived the first growth curve for a sauropod. Maximum mass gain occurs between cycles 13 and 14 and is 2006 kg. The last three LAGs are very closely spaced, indicating that the individual was fully grown. A cross-section of the cortex was serially sampled at mm-resolution for analysis of carbon and oxygen stable isotopes in bone apatite.  $\delta^{13}\text{C}$  values ( $-7.3 \pm 0.4$  VPDB,  $n=29$ ) indicate that the mamenchisaurid fed on C3 plants.  $\delta^{18}\text{O}$  values ( $-12.5 \pm 0.5$  VPDB,  $n=29$ ) reflect apatite formation from bodyfluids with low  $\delta^{18}\text{O}$  values. The cortex displays cyclic intra-bone variation of the  $\delta^{18}\text{O}$  values which is unlikely to result from diagenesis and thus probably reflects an in vivo signal. However, the number of  $\delta^{18}\text{O}$  cycles ( $n=11$ ) does not correspond to that of LAGs observed ( $n=27$ ). Relation between annual growth marks and  $\delta^{18}\text{O}$  seasonality will be further tested with a higher spatial resolution.

Technical Session XVI, Saturday 2:15

#### THE FOSSIL RECORD OF LAGOMORPHS FROM NORTHERN PAKISTAN

WINKLER, Alisa, Southern Methodist University, Dallas, TX, USA; TOMIDA, Yukimitsu, National Museum of Nature and Science, Tokyo, Japan; FLYNN, Lawrence, Harvard University, Cambridge, MA, USA

Thousands of fossil small mammal specimens have been recovered from the early Miocene-early Pleistocene sediments of the Potwar Plateau, northern Pakistan (ca. 18-2 Ma), in particular, from the Miocene-late Pliocene Siwalik Group. In spite of this incredible record, lagomorphs are extremely rare. Only one ochotonid (pika) is known: a single molar from the base of the Siwalik Group (ca. 18 Ma). All other dental remains from Pakistan are from leporids. From the entire Miocene-earliest Pleistocene, this includes only 13 cranial specimens (most isolated teeth) from six localities, dating from 7.2 Ma to 1.6 Ma. One locality has dental and postcranial remains that may be referable to a single individual. Six postcranial bones referable to Lagomorpha are from three additional localities (7.8 Ma to 7.0 Ma). Most of the material is not specifically identifiable. However, p3s from two sites (7.2 Ma and 6.3 Ma) represent *Alilepus*, and are diagnostic of a new species, albeit with high individual variation. An isolated

incomplete cheektooth that is 1.6 Ma is referable to either *Caprolagus* (extant, but not found in Pakistan) or *Pliopentalagus* (extinct). The older Siwalik leporids are likely sister taxa to the earliest African leporids (from Kenya; 6.57-6.54 Ma and 6.2-5.6 Ma), suggesting a southern Asian origin for African *Alilepus*. The appearance of leporids in the Pakistani Siwalik record is congruent with the expansion of C4 grasses on the Potwar Plateau after ca. 8.1 Ma. Their appearance correlates also with a period of elevated faunal turnover at 7.8 Ma of both large and small mammalian taxa.

Technical Session XVII, Saturday 2:45

#### PRESERVATION OF A VERTEBRATE MICROFAUNA AT ULAN KHUSHU, NEMEGT FORMATION (LATE CRETACEOUS), MONGOLIA

WINKLER, Dale, Southern Methodist University, Dallas, TX, USA; LEE, Yuong-Nam, Korea Institute of Geoscience and Mineral Resources, Daejeon, Korea, South; LÜ, Jun-Chang, Chinese Academy of Geological Sciences, Beijing, China; KOBAYASHI, Yoshitsugu, Hokkaido University, Sapporo, Japan

The Nemegt Formation of Mongolia is locally the uppermost Cretaceous unit in the Gobi Desert of Mongolia and is best known for its abundant and diverse dinosaur fauna. *Tarbosaurus*, *Oviraptor*, *Gallimimus*, and *Sauroplophus* are characteristic among the dinosaurs. Vertebrate micro-fossils, such as the lizards and mammals which are spectacularly preserved in the underlying Djadokhta and Baruungoyot formations, are virtually unknown. Depositional environments in the Nemegt Formation have been interpreted as lacustrine and fluvial, in contrast to the more eolian sediments of the underlying beds. A locality at Ulan Khushu allows investigation of the rare preservation of micro-vertebrate remains in the Nemegt Formation. At Ulan Khushu abundant small bones are preserved in a tabular fine to medium grained muddy sand. Isolated fragmentary bones occur scattered in a 12 centimeter thick unit cropping out over more than 100 square meters. The bone-bed is densely calcite-cemented and contains abundant small calcareous nodules and granule-size mud rip-up clasts. Most bone fragments are less than five centimeters in diameter. Fish and turtle remains dominate, but teeth and tooth fragments are not uncommon, including those of crocodylomorphs, as well as dinosaurs. Isolated teeth are otherwise rare in the Nemegt Formation. Fish vertebrae and turtle shell fragments vary in concentration across the outcrop. Mudstones underlie the bone-bed and trough-cross bedded sands occur above. Small bones in such abundance represent an attritional concentration. Mud clasts and occasional rounded bone fragments indicate that the remains were transported before burial. However, the unsorted matrix and sharp fragmented edges on many bones suggest minimal transport and little sorting during final emplacement at Ulan Khushu. A recurrent mode of micro-vertebrate preservation in the Nemegt Formation is suggested by reports of similar concentrations dominated by fish and turtles. Sites similar to that at Ulan Khushu contain rare vertebrates including birds.

The Dissorophoidea - Early Amphibian Radiation Symposium, Friday 8:15

#### THE ORIGIN OF THE DISSOROPHOIDEA - AN ALTERNATIVE PERSPECTIVE

WITZMANN, Florian, Museum fuer Naturkunde, Berlin, Germany; SCHOCH, Rainer, Staatliches Museum fuer Naturkunde, Stuttgart, Germany; MILNER, Andrew, The Natural History Museum, London, United Kingdom

The monophyly of the Dissorophoidea is well-established, but there are two current theories of its phylogenetic position within the Temnospondyli. In the 'Eryopoidea' concept of Boy, the Dissorophoidea forms a clade that is the sister group to the basal Stereospondylomorpha including Eryopidae+Zatracheidae. In the 'Euskelia' concept of Yates and Warren, Eryopidae+Zatracheidae are the sister group to the Dissorophoidea, forming a wider terrestrial group, the Euskelia. The monophyly of the Euskelia is supported by two characters, the proportionally short dermal pectoral girdle and the abbreviated skull table. Morphological and ontogenetic assessment of the taxa that comprise the Euskelia creates questions concerning the unity of this group. The abbreviated skull table does not constitute a synapomorphy, since the Micromelerpetontidae and plesiomorphic representatives of the Amphibamidae show that a proportionally long skull table is primitive for Dissorophoidea. The apomorphic miniaturization of the otic notch of the Eryopidae is shared with all except the basal representatives of the Stereospondylomorpha, but not with the Dissorophoidea or the Zatracheidae. The dermal pectoral girdle in the eryopid *Onchiodon* is proportionally larger in larvae and juveniles, as in the Stereospondylomorpha, and attains its compact morphology later in ontogeny. This suggests that this morphology evolved independently to the Dissorophoidea+Zatracheidae, in which the pectoral girdle is proportionally small in both larvae and adults. These features indicate a position of the Eryopidae near the base of the Stereospondylomorpha. The Zatracheidae remain as the potential sister-group to the Dissorophoidea based on the compact dermal pectoral girdle present throughout ontogeny. If this interpretation is correct, then the common ancestor of the Dissorophoidea and Zatracheidae may have been relatively similar to forms such as *Dendropteron* and *Balanerpeton*.

Student Poster Session (Thursday)  
ORAL PATHOLOGY OF THE ARCHOSAURIA: BONY ABNORMALITIES  
AND PHYLOGENETIC INFERENCE

WOLFF, Ewan, Montana State University, Bozeman, MT, USA

This project proposed that a broad survey of oral pathology in archosaurs would reveal unique disease relationships. The approach created to pursue this study was termed *zoological paleopathology*. The justification of this approach lies in the differences between the immune response in mammals and archosaurs. This response governs the majority of disease progression within the body and the morphology of associated lesions. 2,443 skulls were examined for abnormalities from four major groups of archosaurs; the crocodiles, pterosaurs, dinosaurs and birds. Skulls of iguanids, monotremes and marsupials provided outgroup comparisons for the study. Lesions were analyzed, photographed and interpreted for 123 total cases. The majority of cases related to either traumatic or inflammatory diseases. The disease patterns within the study were examined using cladograms and addition reports from the veterinary literature. When these patterns were compared between archosaurs and the outgroups, the influence of anatomy, behavior and immunology, or phylogenetic constraint, was evident in the disease categories of trauma, inflammatory diseases, congenital/developmental diseases, neoplasia and certain unknown diseases. In fact, 77.7% of the diseases found could only be explained adequately with reference to archosaur pathology. The paleopathology approach currently in use was able to explain fracture and metabolic bone diseases through cross-vertebrate comparison, but was only relevant for a fraction of the cases. The results demonstrate a division of work between the phylogenetic comparisons of zoological paleopathology and the general comparisons of current methods. In addition to establishing the domain of a new paleopathology approach, this project also delved into the nature of dinosaur immunity and contributed methods for the naming of unknown diseases in the fossil record. The construction of phylogenetic comparisons in ancient disease research, the elucidation of disease development and progression, and the exploration of undiscovered diseases in the fossil record will provide new fronts in paleopathology.

Carnivora: Phylogeny, Form and Function Symposium, Saturday 8:00  
PINNIPED AND RED PANDA AFFINITIES ELUCIDATED USING EXON  
NUCLEOTIDE SEQUENCES OF FIVE NUCLEAR GENES

WOLSAN, Mieczyslaw, Polish Academy of Sciences, Warszawa, Poland; SATO, Jun, Fukuyama University, Fukuyama, Japan

Considerable long-standing controversy surrounds the phylogenetic affinities of seals, walrus, and sea lions (Pinnipedia) and red or lesser panda (*Ailurus fulgens*). Although the arctoid nature of the pinnipeds and red panda has convincingly been demonstrated on both morphologic and genetic grounds, there remains uncertainty about the phylogenetic positions of both taxa relative to the other arctoid Carnivora. Until most recently, the two major competing hypotheses of pinniped relationships were that the pinnipeds have a monophyletic origin from a bear-like ancestor or that they have a diphyletic origin, with sea lions (Otariidae) deriving from a bear-like ancestor and seals (Phocidae) deriving from an otter-, mustelid-, or musteloid-like ancestor. Red panda has previously been classified with bears (Ursidae) or raccoons (Procyonidae), grouped with giant panda in their own family, or considered a separate lineage of uncertain affinities. Recent molecular studies have recovered red panda as a musteloid, placing it basally to a clade containing Procyonidae and Mustelidae (weasels, otters, zorillas, martens, badgers, and allies), but have failed to unambiguously resolve the position of this species relative to Mephitidae (skunks). We examined phylogenetic relationships among 42 species of Arctoidea (Ursidae, Pinnipedia, Musteloidea) using a concatenated sequence of 5497 exon nucleotides from five nuclear genes (APOB, BRCA1, RAG1, RBP3 [IRBP], VWF). Maximum parsimony, maximum likelihood, and Bayesian analyses of separate and combined data sets produced trees with largely congruent topologies. The analyses of the combined data set resulted in well-resolved and -supported phylogeny reconstruction. Evidence from nuclear DNA evolution presented here contradicts the two major hypotheses of pinniped relationships and strongly suggests a monophyletic origin of the pinnipeds from an arctoid ancestor shared with Musteloidea to the exclusion of Ursidae. This evidence also provides the first robust support for the phylogenetic placement of red panda, identifying the species as the closest extant relative of the procyonid-mustelid clade, with the skunks as most basal musteloids.

Technical Session X, Friday 9:45  
MEASURING DENTAL WEAR AND TOOTH SHAPE: CONTRASTING  
MULTIVARIATE RESULTS FROM TWO SPECIES OF THE EARLY EOCENE  
EQUID *HYRACOTHERIUM*

WOOD, Aaron, University of Michigan, Ann Arbor, MI, USA; ZELDITCH, Miriam, University of Michigan, Ann Arbor, MI, USA

Dental wear reflects the dynamic relationship between dental morphology and function. Consequently, differences in how tooth shape responds to increased wear among taxa should indicate differences in how teeth are used during mastication. In a previous geometric morphometric study of the early Eocene equid *Hyracotherium*, pristine lower

third molars exhibited no differences in shape among putative chronospecies despite changes in size. Here we investigate the response of tooth shape to wear. *Hyracotherium* has a brachydont dentition, which ought to degrade with wear because the amount of enamel is limited. Thus, shape should change significantly with increasing wear. We compare dental wear shape in two *Hyracotherium* chronospecies, *H. grangeri* and *H. aemulor*, with samples sizes of 84 and 58, respectively. Lower third molars with different degrees of wear were digitized in buccal and lingual views, using a combination of landmarks and semi-landmarks. A multivariate wear index was constructed by measuring several traits (e.g., cusp heights, complexity, buccal/lingual asymmetry, etc.), extracting principal components (PC) from these correlated measures, and regressing PC scores on the area of exposed dentin. The suites of correlated measurements related to wear differed between the species. To determine the response of dental shape to wear, Procrustes superimposed shape coordinates were then regressed onto the multivariate wear index. *H. grangeri* shows a significant relationship between wear and shape; wear explains 20.4% and 10.6% of the variance in buccal and lingual shape, respectively. However, *H. aemulor* does not show any significant relationship between shape and wear; only 1.9% and 2.6% of variance in buccal and lingual shape, respectively, are explained by wear. *H. grangeri* fits the expectations for brachydont dentitions, but *H. aemulor* dentition appears to maintain its shape despite wear. This unexpected result suggests that *H. aemulor* may have either employed a chewing motion that symmetrically wore crown surfaces without degrading precise occlusion or eaten different foods than *H. grangeri*, leading to differences in wear patterns.

Technical Session XV, Saturday 9:45  
FITS OVER FITS: HOW CAN CORRESPONDENCE IN SHAPE BETWEEN  
UPPER AND LOWER TRIBOSPHEMIC MOLARS BE QUANTIFIED, AND  
WHY WOULD WE WANT TO KNOW?

WOOD, C.B., Providence College, Providence, RI, USA; MOYER, Benjamin, Providence College, Providence, RI, USA; MOYER, Benjamin, Providence College, Providence, RI, USA

Description of two new upper molars referred to one of the rarest North American (Lancian) species of eutherian mammals (*Batodon tenuis*) six years ago raised two obvious questions. (1) An anonymous reviewer said (correctly) that there is no established test of conspecificity based on degree of similarity or dissimilarity of shape between upper and lower molars in occlusal or functional association - therefore, how can a hypothesis of conspecificity be tested for the new molars compared to lower molars already referred to the species? Furthermore (2), can correspondence in shape be quantified such that a hypothesis of conspecificity can be falsified? An excellent study two years ago adapted a relatively simple Procrustes method to these questions. Procrustes units are dimensionless; a value of zero indicates perfect superimposition of corresponding landmarks on upper and lower teeth, and larger numbers indicate increasing differences. With a database from extant bats, that study showed an average of 0.091 units for upper and lower teeth from one individual, and 0.171 units as a limit for teeth compared from different individuals from the same species. Given these values, the new molars should not be referable to a single species, and diversity for Late Cretaceous eutherian mammals could be underestimated - probably an important issue when considering trends across the K/T boundary. We extended the method to seven extant and one Cretaceous didelphimorph (plus one Paleogene, eutherian) species. Very preliminary results indicate limits for conspecificity in bats may be too demanding to test conspecificity in the other taxa. Chiropterans may not be the best model (functionally?) for more generalized tribosphenic molars like those of Cretaceous therians. Obviously more data are required from an expanded study. Finally, a question of broader interest to evolutionary biology is how selection operates upon molar fit, and to what degree quantifiable patterns can be observed across related or unrelated clades.

Technical Session VII, Thursday 2:45  
TAXONOMY, PALEOECOLOGY, AND EVOLUTION OF THE  
OTOLITH-BASED FISHES OF THE UPPER CRETACEOUS KEMP CLAY,  
HUNT COUNTY, TEXAS

WOODWARD, A., North Dakota Geological Survey, Bismarck, ND, USA; STRINGER, Gary, The University of Louisiana at Monroe, Monroe, LA, USA

A study of approximately 1,200 teleost otoliths (earstones) from the Upper Cretaceous Kemp Clay near Commerce in Hunt County, Texas reveals a large fauna of 15 families and 27 species. The fauna is dominated by six groups that comprise 85.9 percent of the total number of otoliths. These dominant groups consist of *Pterothrissus* sp., congrid, ophidiids, "genus *Trachichthydarum*" *stringeri*, and two species of ariids. As in other studies from the Cretaceous and Cenozoic assemblages, otoliths provide a much stronger picture of teleost diversity. The present study documents 27 otolith-based species compared to only seven skeletal-based species from several formations in the Sulphur River section. This study is only the fifth major otolith-based teleost fish fauna study from the Late Cretaceous in the United States. Paleocological evaluations indicate a shallow marine environment of normal salinity, muddy substrate, and tropical climate. The high abundance of pterothrissid otoliths suggests that during the Cretaceous, these teleosts survived in much shallower marine settings than do their Recent descendants. Recent and fossil otolith specimens of heterenchelyids, congrid,

and ophidiids also agree with the paleoecological assessment. Especially significant is the evolutionary data obtained from the otolith assemblage. Maastrichtian otoliths indicate the dramatic radiation of perciforms began in the Late Cretaceous rather than the Early Tertiary as previously reported. This study is the first report of the range extension of the taxon "genus *Tiachichthydarum*" *stringeri* into the Cretaceous Period and also reveals many taxa that belong to Recent families in the Order Perciformes (several species of apogonids, percoids, and caristiids). This study provides further evolutionary evidence of perciforms in the Cretaceous and allows for perhaps 40-50 million years for the modern genera to evolve rather than the 20 million years allowed by an Early Tertiary development.

Carnivora: Phylogeny, Form and Function Symposium, Saturday 12:00  
FINITE ELEMENT MODELING OF FEEDING BEHAVIOR IN THE  
THYLACINE AND WOLF: A NOVEL TEST FOR CONVERGENCE

WROE, Stephen, University of New South Wales, Sydney, Australia; CLAUSEN, Philip, University of Newcastle, Newcastle, Australia; MCHENRY, Colin, University of Newcastle, Newcastle, Australia; MORENO, Karen, University of New South Wales, Sydney, Australia; NIL, Brunei

There is perhaps no more iconic example of phenotypic convergence than that of the marsupial thylacine (*Thylacinus cynocephalus*) and placental gray wolf (*Canis lupus*). However, form-function analyses of various character systems have led to conflicting conclusions, suggesting specialization in the thylacine toward either relatively small or large prey, and the degree to which resemblance between the marsupial and placental was superficial has remained uncertain. Here we apply three dimensional finite element analysis to examine convergence in mechanical behavior between skulls of the thylacine and wolf subspecies widely implicated in its extinction from mainland Australia, the dingo (*C. l. dingo*). Our modeling protocols represent a number of advances over previous simulations of the vertebrate skull in that they 1, incorporate multiple material properties for bone, 2, treat the mandible and skull as a single articulated unit and, 3, describe the 3-D architecture of jaw adducting musculature. Analysis of stress distributions reveals considerable similarity between the two taxa, but also informative differences. The thylacine's mandible performs relatively poorly where only the actions of the jaw muscles (intrinsic) are considered and stresses are comparatively high in the posterior of the cranium under loads simulating forces generated by the prey itself (extrinsic). Previous FE analyses, considering intrinsic forces only, have concluded that much of the mammalian skull is not optimized for feeding. Consideration of extrinsic forces suggests that this may not be so, at least for predatory species. We find that relative prey size in the thylacine and dingo may have been comparable where both species acted as solitary hunters, but the dingo is better adapted to withstand the higher extrinsic loads likely to accompany social hunting of large prey. When differences in body mass are considered it is probable that there was considerable ecological overlap.

Technical Session VII, Thursday 2:30  
EARLY TRIASSIC FRESHWATER FISHES FROM NORTHERN GANSU  
PROVINCE, CHINA, AND THE AGE OF THE BEISHAN BEDS

XU, Guang-Hui, Peking University, Beijing, China; GAO, Ke-Qin, Peking University, Beijing, China

Along with well-preserved tetrapod fossils, the Lower Triassic deposits exposed in Beishan area, Gansu Province, China yielded several thousand specimens representing a taxonomically diverse fish assemblage, including a new hybodont, five actinopterygians (*Eochondrosteus*, *Boresomus*, *Perleidus* and two new palaeonisciforms), and a coelacanth. The coexistent amphibians, reptiles and plants indicate a fresh water depositional environment and the Triassic age of the fossil beds. The hybodont material shows exceptional preservation of whisker-like nostril and mouth barbells, large liver, digestive tract, and numerous dermal denticles; and another specimen even preserved claspers, indicating a male individual. The actinopterygian *Eochondrosteus*, similar to *Birgeria* from the Lower Triassic of East Greenland, Spitzbergen, Madagascar, and North America, bears a largely naked body with remnant rhomboidal scales in the upper lobe of the caudal fin. *Boresomus* is for the first time found in freshwater deposits. *Perleidus* has derived characters of the upright preopercle and the strongly abbreviated heterocercal tail (with presence of one or two epaxial rays). Of the two new palaeonisciforms, one closely resembles the Triassic genus *Pteromisculus*, referring to the Palaeoniscidae, and the other is referable to the Scanilepididae with a great extension of the dorsal fin and unforked dorsal fin rays. Most these fossil fish taxa and their close relatives are found in the Triassic. Of them, *Boresomus* and *Perleidus* are only known from the Triassic worldwide, and *Boresomus* strictly exists in the Early Triassic. Thus, the study of the fish assemblage supports the age assessment of the fossil beds being Triassic as derived from other vertebrate fossils.

Technical Session XIV, Saturday 11:00  
COELUROSAURIAN PHYLOGENY REVISITED: RECOVERING PHYLOGENETIC SIGNALS FROM SUBTLE MORPHOLOGICAL VARIATIONS

XU, Xing, Beijing, China; ZHAO, Qi, Institute of Vertebrate Paleontology & Paleoanthropology, Beijing, China

Significant advancements have been made on coelurosaurian phylogeny recently by the Theropod Working Group (TwiG). Interestingly two most recent analyses on TwiG's dataset produced some results significantly different from those of previous analyses in which some basal birds were shifted outside the Aves. In one analysis, the monophyly of the Aves was challenged with *Confuciusornis* posited within the Dromaeosauridae and in the other analysis *Rahonavis* was united with *Buitreraptor* and *Unenlagia* within a Gondwanan lineage of dromaeosaurids, both indicating separate origins of flight. These results have profound effect on the reconstruction of the evolution of the major avian characters. Such radical changes are probably caused by close morphological resemblances of basal taxa from three major paravian groups and insufficient appreciation of morphological variations among the paravians as well. Detailed comparisons revealed abundant subtle morphological variations unemployed in these analyses. Many of these variations are related to the evolution of avian locomotor system. Running analysis on TwiG's dataset with inclusion of new characters extracted from these subtle variations recovered conventional results in which *Archaeopteryx*, *Rahonavis*, and *Confuciusornis* lie at the base of the Aves and thus resulted in a relatively simple morphological evolutionary pattern along the line to birds. While subtle morphological variations are informative and could play a key role in reconstructing coelurosaurian phylogeny particularly in case of fine scaled analyses with dense taxonomical sampling, it is relatively subjective to define character states from these subtle and often continuous morphological variations and thus attention should be paid to this issue.

Technical Session IX, Friday 11:45

A NEW DIVERSE DINOSAUR ASSEMBLAGE FROM THE EARLY JURASSIC OF SOUTH AFRICA

YATES, Adam, University of the Witwatersrand, Johannesburg, South Africa; BONNAN, Matthew, Western Illinois University, Macomb, IL, USA; NEVELING, Johann, Council for Geoscience, Pretoria, South Africa

The Early Jurassic upper Elliot Formation (UEF) of South Africa has a well-known fauna dominated by the basal sauropodomorph *Massospondylus*. Its depositional environment was an arid floodplain crossed by small, ephemeral streams. Calcareous paleosols are common. An outcrop of the UEF at Spioenkop, Senekal District, is sedimentologically atypical. Paleosols are absent from the middle of the section and the bulk of the unit is formed by stacked channel sands, some from deeper, possibly permanent streams. Excavations over the past four years reveal that the fauna is also atypical. *Massospondylus* is apparently absent. Instead there is a diverse sauropodomorph fauna with three new taxa: a basal sauropodomorph; a basal sauropod similar to *Jingshanosaurus* (sauropod A); and a more advanced sauropod (sauropod B). The basal sauropodomorph differs from *Massospondylus* by its extensively denticulated teeth and the absence of a buccal emargination. It is diagnosed by a unique dorsal process on the postorbital. Sauropod A retains bipedal limb proportions but does show sauropod-like lateral plates and rugose tooth enamel. It can be diagnosed by: five premaxillary teeth; a straight posterior margin of the postorbital; and particularly stout pedal elements. Sauropod B is closer to Eusauropoda and shares with it the following derived character states: lingual concavities on the tooth crowns; very tall dorsal neural spines; and transversely compressed and laterally canted pedal unguals. It can be diagnosed by the anteroventral inclination of the anterior cervical centrum face. Also present are an *Allosaurus*-sized theropod, known from teeth and a possible thryophoran known from osteoderms including stegosaur-like plates. The only typical UEF taxa found at Spioenkop are the small carnivores *Protosuchus* and *Coelophys* (= *Syntarus*). The unusual assemblage, with its diverse large herbivores, is interpreted as occupying a well-vegetated microenvironment on the UEF floodplain. The absence of the typical paleosols and the dominance of channel sands suggest that this environment was a riparian forest alongside one of the larger, more permanent streams crossing the floodplain.

Carnivora: Phylogeny, Form and Function Symposium, Saturday 10:45  
MODERN, HISTORICAL, AND FUTURE CARNIVORE COMMUNITIES IN  
SUB-SAHARAN AFRICA: IMPLICATIONS FOR CONSERVATION AND  
CLIMATE CHANGE

YEAKEL, Justin, University of California, Santa Cruz, Santa Cruz, CA, USA; KOCH, Paul, University of California, Santa Cruz, Santa Cruz, CA, USA; DOMINY, Nathaniel, University of California, Santa Cruz, Santa Cruz, CA, USA

Sub-Saharan African ecosystems are distinguished by relatively large numbers of co-occurring carnivores. Traditional observational techniques, although vital for a detailed understanding of carnivore ecology, are typically expensive, fraught with observer bias, and site-specific, and they do not allow for quantitative temporal and spatial comparisons. Stable isotope analysis is poised to elucidate aspects of large-scale carnivore community structure through space and time, thereby allowing comparative relationships between species to be analyzed quantitatively. We aim to elucidate carnivore communi-

ty interactions in modern and historical ecosystems in an effort to establish a baseline for understanding the flexibility of carnivore communities, and if they change predictably to specific climatic forcings. Here we investigate resource partitioning by carnivores within a number of Sub-Saharan African sites. Our initial stable isotope results reveal top-level carnivore foraging strategies that fluctuate in response to Wild Dog (*Lycan pictus*) presence/absence in the Mpala Game Reserve, Kenya between 1985 and 2005. These data are then compared to a comprehensive isotopic examination of predators and co-occurring fauna collected by the 1909 Roosevelt/Rainey British East Africa Expedition. Differences in foraging strategies will likely be a function of environment shifts due to escalating human pressures and urbanization during the twentieth century. Finally, the effects of ongoing climate change are predicted to further desiccate many open environments in Africa, undoubtedly affecting carnivore populations. Further investigations will be directed to compare modern East African communities to those in xeric southern African regions to assess - and in turn predict - the effects of climate change-induced aridification on modern top-level carnivore community interactions.

Student Poster Session (Thursday)

#### EVOLUTION OF LOCOMOTION IN ODOBENIDAE

YONAS, Joshua, San Diego State University, San Diego, CA, USA; DEMÉRÉ, Thomas, San Diego Natural History Museum, San Diego, CA, USA; BERTA, Annalisa, San Diego State University, San Diego, CA, USA

Molecular and morphological phylogenetic analyses conflict on the placement of the Arctic walrus (*Odobenus rosmarus*; Odobenidae) within pinnipeds. Molecular phylogenies place Odobenidae as sister to Otariidae (sea lions and fur seals) and morphological phylogenies find Odobenidae as sister to Phocidae (true seals). These competing phylogenetic hypotheses provide two models by which to evaluate the evolution of modes of locomotion exhibited by modern odobenids and predicted for fossil odobenids. The modern walrus is a hindlimb swimmer (seal-like) and a forelimb walker (sea lion-like) and is the sole survivor of a more diverse group of fossil odobenids. The correlation of extant walrus osteology and musculature with the observed modes of terrestrial and aquatic locomotion of *O. rosmarus* provides a useful model for investigating the modes of locomotion in extinct walruses. *Valenictus chulavistensis* from the Pliocene of California is the sister taxon to *O. rosmarus* in the crown clade Odobenini. Both taxa possess similar forelimb anatomy relative to the earlier diverging dusignathine walruses. However, an important difference is seen in the more robust humerus (with an enlarged entepicondyle) of *V. chulavistensis* the significance of which appears to be related to flexion of the manus. The most obvious differences in the hindlimbs of *O. rosmarus* and *V. chulavistensis* occur in the upper, middle, and lower ankle joints (i.e., between the tibia and astragalus, the astragalus and calcaneum, and the calcaneum and pes respectively). Biomechanical implications of these differences suggest that *V. chulavistensis* had a greater range of motion at the upper and lower ankle joints relative to *O. rosmarus* and that *O. rosmarus* has a greater range of motion in the middle ankle joint relative to *V. chulavistensis*. Future work will include dissection of walrus forelimbs and osteological comparisons with other earlier diverging walruses (*Dusignathus*, *Imagoteria*, *Proneotherium*) to determine the evolution of walrus locomotion.

Student Poster Session (Thursday)

#### THE EVOLUTION AND INTERRELATIONSHIPS OF METRIORHYNCHIDAE (CROCODYLIFORMES, THALATTOSUCHIA)

YOUNG, Mark, University of Bristol, Bristol, United Kingdom

The evolution and interrelationships of the most marine-adapted crocodyliforms, the Metriorhynchidae are investigated using cladistics. Metriorhynchids represent the only group of archosaurs to adapt and radiate in the marine realm, and unlike other groups of Mesozoic marine reptiles very little work has been done to determine their interrelationships, or the monophyly of the genera attributed to the family. In order to rectify this, a phylogenetic analysis was undertaken using 120 osteological characters and 46 taxa, of which 37 have been attributed to Metriorhynchidae at some point. Metriorhynchidae was found to be monophyletic, though *Pelagosaurus* is here found to be the sister taxon to Teleosauridae. The genera *Teleidosaurus* and *Metriorhynchus* are paraphyletic, with the European brevirostrine forms of *Metriorhynchus* being attributable to *Suchodus*, and the South American species to *Purranisaurus*. *Geosaurus* is polyphyletic, with the type species nesting with *Dakosaurus*, as does one species of *Cricosaurus*, making *Dakosaurus* a junior synonym of *Geosaurus*. However, all the other species currently within *Geosaurus* are monophyletic, with the type species of *Enaliosuchus*, *Cricosaurus*, and *Neustosaurus* nesting within this clade. As *Neustosaurus* is the oldest name, all species are transferred to that genus, with the exception of *Geosaurus gracilis*, as it lacks the hindlimb synapomorphies of *Neustosaurus*, therefore the name *Rhacheosaurus* is resurrected for this species. *Metriorhynchus*, *Rhacheosaurus*, and *Neustosaurus* form a monophyletic clade that is characterized by becoming successively more marine adapted (such as posterodorsal displacement of the external nares with a medial septum). Its sister group is a clade formed by *Suchodus*, *Purranisaurus* and *Geosaurus*, which became successively adapted to high-order carnivory (i.e. larger supratemporal fenestra, serrated teeth).

Technical Session XI, Friday 1:15

#### NEW MATERIAL OF *GALECYON*, A RARE EARLY EOCENE HYAENODONTID (MAMMALIA: CREODONTA)

ZACK, Shawn, Marshall University, Huntington, WV, USA; ROSE, Kenneth, The Johns Hopkins University, Baltimore, MD, USA

*Galecyon* is a rare hyaenodontid creodont known from the early Eocene of North America and Europe. Published material consists of a few incomplete lower dentitions and isolated upper and lower teeth. The scrappy nature of known material limits potential insights into the functional morphology and evolution of the genus. New material extends the stratigraphic and geographic range of North American *Galecyon*, documenting a temporal range from Wa-0 to Wa-6, which includes most of the Wasatchian. The record from Wa-0 is particularly significant, as it demonstrates that the genus was among the immigrants to North America at the Paleocene-Eocene boundary (during the PETM). Over the course of this period, *Galecyon* became substantially larger and more robust. A newly recognized specimen from the San Juan Basin (New Mexico) represents the first North American record of the genus outside of Wyoming. In addition to extending the range of the genus, new material greatly improves knowledge of the morphology of *Galecyon*. New specimens include relatively complete lower dentitions, as well as the first specimen of the genus preserving the upper and lower dentition in association. Dental morphology reveals a curious mixture of derived features including some suggestive of hypocarnivory (short prevallid and postvallum, small but well-developed talonid basins), and massive premolars consistent with durophagy. New specimens also document the petrosal and much of the postcranial skeleton of *Galecyon*, which had been unknown. The postcranium indicates that the genus was relatively terrestrial for an early Eocene hyaenodontid. In particular, features of the humerus, including a tall, anteriorly positioned greater tuberosity, reduced lesser tuberosity, sharp trochlea, reduced supinator crest, and perforate or near-perforate olecranon fossa are consistent with terrestrial locomotion and contrast with the more scansorial/arborescent morphology seen in some contemporary taxa (e.g. *Prolimnocyon*).

Technical Session XVIII, Saturday 1:15

#### CRANIAL AND SKELETAL CHARACTERISTICS OF *EOTHEROIDES* (MAMMALIA, SIRENIA) FROM THE EOCENE OF EGYPT

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The dugongine sirenian *Eotheroides* was previously best known from Eocene Tethyan sediments from Egypt. Detailed description of the type species, from early last century, was based on a collection from the Lutetian nummulitic limestone beds of the Mokattam Hills near Cairo that included isolated postcrania, blocks of ribs and vertebrae missing fore and hind limbs, and crania lacking rostra and accompanying lower jaws. Several new skeletons of *Eotheroides* from the Priabonian Birket Qarun Formation in Wadi Al Hitan (Valley of Whales) are exceptionally well preserved and provide a more complete picture of the genus. They show *Eotheroides* to have been medium to large dugongs, ranging in length from 1.5 to 2.5 m, with a stout, heavy skull that has a deflected rostrum bearing medium to small sized tusks. The trunk is widest between the ninth and eleventh thoracics; the end of the tail was fluked; and hindlimbs are reduced to a vestigial innominate that has a club-like ilium and shallow acetabulum, with a short and slender femur. There cannot have been any substantial lower leg or foot. Variable expression of the extensively pachyosteosclerotic anterior ribs and club-like ilia plays a central role in diagnosis of the genus and its species. Morphology and structure of the skeletal elements of Lutetian and Priabonian *Eotheroides* are characteristic of a fully aquatic marine mammal.

Poster Session IV (Saturday)

#### A NEW TROODONTID THEROPOD FROM THE LATE CAMPANIAN KAIPAROWITS FORMATION, SOUTHERN UTAH

ZANNO, Lindsay, University of Utah, Salt Lake City, UT, USA

Recently, the Utah Museum of Natural History and the University of Utah launched a collaborative effort-known as the Kaiparowits Basin Project (KBP)-aimed at surveying and recovering macrovertebrate remains of the poorly understood fauna of the upper Cretaceous (late Campanian) Kaiparowits Formation. Thus far, the KBP has met with notable success, revealing a unique dinosaur fauna distinct from those of contemporaneous formations in the WIB. Currently, with only a single exception, every dinosaur taxon recovered from this previously under-sampled unit appears to represent a new genus and/or species-including three ceratopsids, a "hypsilophodontid" grade ornithomimid, a hadrosaurid, and a tyrannosaurid. Unfortunately, macrofossil remains of Kaiparowits maniraptorans are relatively rare in the formation. Prior to 2000, our understanding of the maniraptoran fauna was based almost entirely on isolated teeth, which are generally considered undiagnostic at the genus level. As a result, the taxonomic distinction of the Kaiparowits maniraptoran fauna has long been unrecognized. Although only a small sample of maniraptoran macrofossils has thus far been recovered by the KBP, the distinctiveness of these specimens has led to the identification of new taxa, such as the recently described oviraptorosaur *Hagryphus giganteus*. Here we report

on the discovery of an isolated left frontal (UMNH VP 16303), which compares closely with that of *Troodon formosus* (CMN 12340) from the penecontemporaneous Dinosaur Park Formation in Alberta. Both taxa share elongate and subtriangular frontals, characterized by an extensive orbital rim, a prominent ridge defining the rostral limit of the supratemporal fenestra, and a large, laterally extensive postorbital process. The Kaiparowits specimen can be distinguished from *Troodon* on the basis of several diagnostic features including: absence of medial frontal depression caudal to nasal contact; presence of weakly excavated lacrimal suture on frontal; and lack of ventral overlap of lacrimal onto frontal. As such, this discovery represents the first evidence of a new troodontid species from the Kaiparowits Formation.

Poster Session IV (Saturday)

LATE CRETACEOUS MAMMALIAN FAUNA FROM THE HELL CREEK FORMATION, SOUTHEASTERN MONTANA

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The richest known Late Cretaceous mammalian fauna from the Hell Creek Formation was discovered in southeastern Montana in the 1980's. Although a faunal list was included in a paleobiogeographic study, the taxa have never been described. This study describes and compares this important fauna to other Late Cretaceous mammalian faunas. There are some 20 mammal producing localities, but the richest are the four localities composing Claw Butte Anthills local fauna and the single richest locality composing the Spigot-Bottle local fauna. Over 1000 mammal specimens have been recovered by screen washed from an *in situ* channel fill composed of silty sand. The Hell Creek Formation is quite thick in this area, reaching 150m, with the two local faunas ranging from 65 to 61 m below the formational contact. Based on faunal content the two local faunas are not different. Spigot-Bottle local fauna includes the multi-tuberculates *Mesodma formosa*, *M. hensleighi*, *M. thompsoni*, *Cimolodon nitidus*, *Cimolomys gracilis*, *Meniscoessus robustus*; the metatherians *Protalphadon lulli*, *Alphadon marshi*, *A. wilsoni*, *Pediomys cooki*, *P. elegans*, *P. florencae*, *P. hatcheri*, *P. krejci*, *Turgidodon rhaister*, *Didelphodon vorax*; and the eutherians, *Batodon tenuis*, *Cimolestes incisus*, *C. propalaeoryctes*, *C. stirtoni*, *Gypsonictops* sp., cf. *Paranyctoides* sp. In addition, from the Claw Butte local fauna the multituberculate *Essonodon browni*, the metatherian *Glasbius twitchelli*, and the eutherian *Gypsonictops hypoconus* have been recovered. The eutherian *Cimolestes magnus* also has been reported elsewhere from the Hell Creek Formation in southeastern Montana.

Poster Session III (Friday)

ENDOCRANIAL MORPHOLOGY OF A BASAL CERATOPSIAN, *PSITTACOSAURUS*

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Psittacosurs, small basal ceratopsians with a parrot-like beak from the East Asian Early Cretaceous, are among the most abundant dinosaurs. Although psittacosaur general morphology is well understood, endocranial anatomy is undescribed. We examined psittacosaur endocranial morphology by Computed Tomography scans of well-preserved skulls from the Liaoning beds of northeastern China, the first such study of a basal ceratopsian. The cranial endocast is high and long, proportions intermediate between those of *Protoceratops* (high and short) and *Triceratops* (low and long); well-developed olfactory bulbs imply a keen sense of smell. A steep slope marks the transition from the fore- and midbrain to the medulla oblongata, as in *Protoceratops*. The optic foramen is confluent, as in *Protoceratops*, unlike the bilateral foramen in *Anchiceratops* and *Triceratops*. The pituitary fossa is dorsal in position, a *Psittacosaurus* apomorphy, and extends anteroventrally, as in other ceratopsians except *Protoceratops*, in which it extends ventrally. The carotid canals converge at the tip of the pituitary fossa, as in *Triceratops*, but unlike *Protoceratops* and *Anchiceratops*, in which the canals open into the fossa walls. The posterior semicircular canal is nearer the posterior margin of the medulla oblongata than in *Triceratops*, implying a short medulla as in *Protoceratops*. The apomorphic size and configuration of the semicircular canals agree with limb proportions to suggest that psittacosurs were uniquely agile ceratopsians, while lateral semicircular canal orientation implies a head posture lowered 20° from the horizontal. In a cladogram showing ceratopsian relationships, endocranial features reported here show no clear phylogenetic pattern, suggesting adaptive aspects override phylogenetic signal in ceratopsian endocranial morphology.

Poster Session I (Wednesday)

THE STRUCTURE OF TRABECULAR BONE IN SELECTED HAND ELEMENTS IN A LATE MIOCENE HOMINOID, *DRYOPITHECUS BRANCOI*

ZYLSTRA, Myriam, Midwestern University, Glendale, AZ, USA; BEGUN, David, University of Toronto, Toronto, ON, Canada; KETCHAM, Richard, University of Texas at Austin, Austin, TX, USA

*Dryopithecus brancoi* is a large-bodied hominoid from the late Miocene deposits of Rudabánya, Hungary. These deposits are dated to about 10 Ma and likely consisted of subtropical seasonal forest conditions, as well as some form of swamp vegetation.

Functional morphology of *Dryopithecus* postcranial remains indicates that the forelimb possesses characters associated with quadrupedal and suspensory behaviors. Features of external joint geometry provide information about overall joint mobility, however quantification of subchondral cancellous bone structure is useful for reconstructing forelimb loading patterns associated with locomotion. The purpose of the current study is to investigate trabecular architecture within the scaphoid and distal metacarpal of *Dryopithecus brancoi* using high resolution X-ray computed tomography (HRXCT). Assessment of cancellous tissue is accomplished by quantification of the three dimensional fabric anisotropy using the star volume distribution (SVD) method, as well as visual inspection of 3D rose diagrams depicting structural differences of trabecular distributions. A sample of extant primates including apes, monkeys and humans, is used for comparative purposes. Results of the investigation show that quadrupeds can be distinguished from more suspensory primates (and humans) with respect to degree of anisotropy (DA) of trabecular architecture within the metacarpal head, and that *Dryopithecus* values are consistent with those of quadrupeds. *Dryopithecus* has a DA which is less than *Gorilla* and *Papio*, but greater than *Pan*. DA values for the scaphoid vary across locomotor groups, however in terms of overall SVD shape, *Dryopithecus* is most similar to *Pan* and *Nasalis*. Results of the current study suggest that arboreal quadrupedalism was an integral part of the overall positional repertoire of *Dryopithecus*, in conjunction with suspensory behaviors inferred from other forelimb elements like the proximal phalanges.

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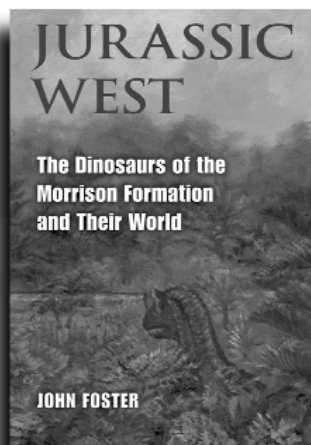
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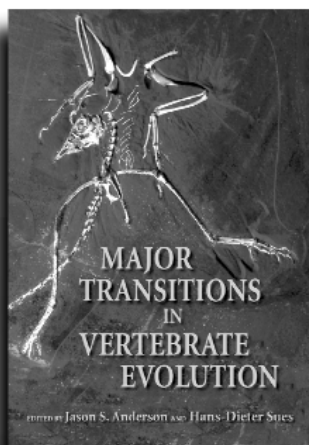


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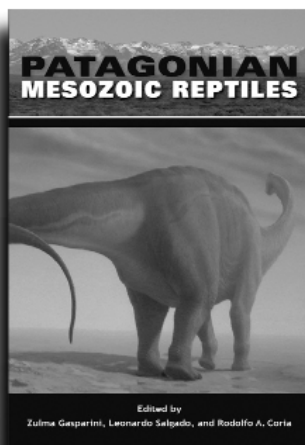
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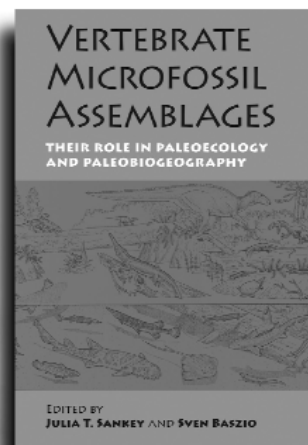
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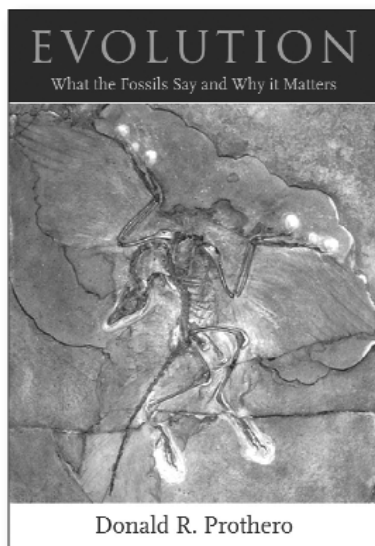
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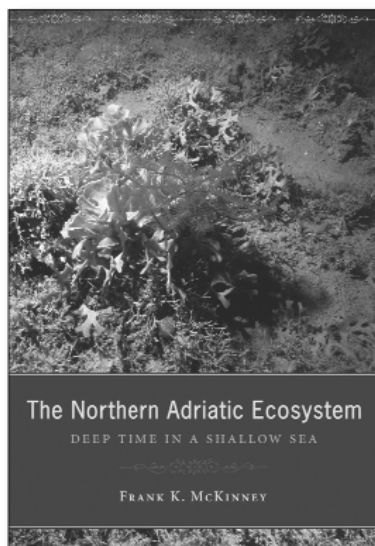
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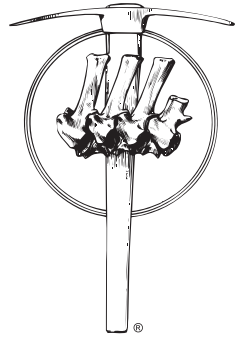
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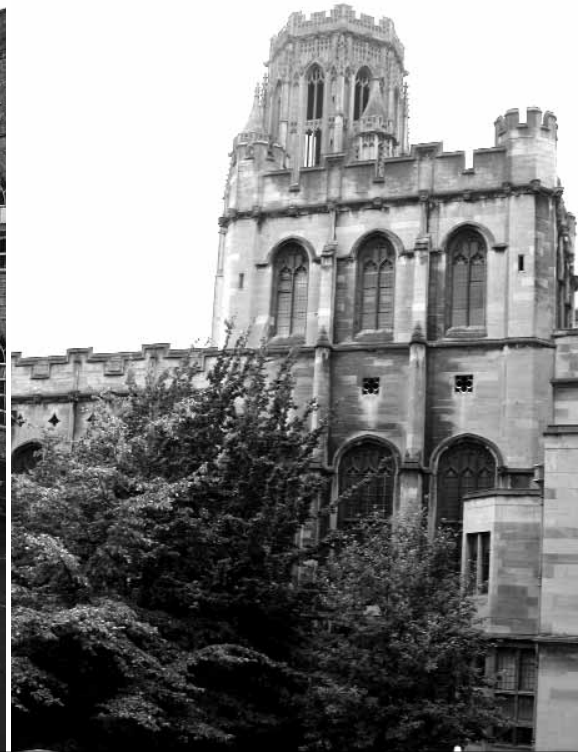
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