Acrocanthosaurus

Terror of the South

Educator Activity Guide
Student Activities for Grades K-12

Revised August 2003

NORTH CAROLINA
MUSEUM of NATURAL SCIENCES

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Acrocanthosaurus Student Activities

Contents

Introduction

One hundred ten million years ago, *Acrocanthosaurus* roamed the area we now call home. At the Museum of Natural Sciences your students may view the only real *Acrocanthosaurus* fossil on display anywhere in the world. The Terror of the South exhibit recreates the moments before *Acrocanthosaurus* attacks *Pleurocoelus*, a plant-eating sauropod. Awaiting the outcome of the attack is a pack of scavenging *Deinonychus*. As the drama unfolds, three pterosaurs soar overhead on their way to fish in the ancient ocean.

The information and activities contained in this activity guide can be used to complement a unit on dinosaurs and/or to enhance a visit to the Museum's *Acrocanthosaurus* exhibit. There are two types of activities in this guide: exhibit hall activities and classroom activities. Exhibit hall activities are based on the Museum's *Acrocanthosaurus* exhibit and encourage your students to use their critical thinking skills while examining the displays. Classroom activities do not require a visit to the Museum but can be used to prepare your students for a visit to the Museum's *Acrocanthosaurus* exhibit or to extend your students' experience after a visit.

Acro Facts

Scientific name

Acrocanthosaurus atokensis. Acrocanthosaurus is Greek for "high-spined lizard," after the extremely long spines along the top of the vertebrae of this dinosaur's back, hips, and tail. The species name, *atokensis,* comes from Atoka County, Okla., where the dinosaur was found. Named by J. Willis Stovall and Wann Langston, Jr. in 1950, paleontologists often refer to the animal as "Acro."

Time

Early Cretaceous period, about 110 million years ago. (45 million years earlier than *Tyrannosaurus rex*.)

Group

Allosauroids: members are three-fingered, two-legged meat-eaters.

Size

The largest predator of its time: 40 feet long, 13 feet tall (measuring from the ground to the top of the pelvis), weighing 5,280 pounds (2.6 tons). Comparable in size to *T. rex*.

Physical details

Unusually prominent vertebral spines run from back to tail. Head measures 4 $^{1}/_{2}$ feet long, 3 feet high and 2 feet wide. Its jaw houses 68 thin, knife-like teeth. Eyes face to the side, meaning Acro cocked its head on one side to examine its prey. Each 3-foot arm ends in three sharp, wickedly curved claws used to tear flesh from bones.

Rarity

Known from only four specimens. The Museum's specimen is by far the most complete, with 54 percent of the bones represented. Not until discovery of this specimen were scientists able to determine the general appearance of this dinosaur. Sediments containing its remains are not well exposed, making it likely that Acro will remain rare.

Feeding

The only giant carnivore of its time, Acro preyed on dinosaurs larger than itself. Fossilized footprints show that it ran alongside its prey and then lunged, using its strong forelimbs to grip its prey.

Range and Habitat

Fragmentary Acro remains have been discovered in Oklahoma and Texas, as well as a few teeth in Maryland. Similar climatic conditions in these regions during the early Cretaceous period, as well as other fossil discoveries, suggest that Acro ranged across the low, flat coastal plains of the Southeast.

Comparison to *T. rex*

About the same length as *T. rex,* not quite as tall, one to two tons lighter. Acro possessed a less muscular, narrower skull than *T. rex* and had longer, more powerful forelimbs and shorter hind limbs. Its thinner teeth were used for tearing meat from bones, while *T. rex's* thicker teeth could crush bones.

Acro belonged to a different family of dinosaurs, unrelated to the ancestry of *T. rex*.

Dinosaur References

For Students in Grades K-2

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Thomas, David A., and James O Farlow. 1997. Tracking a Dinosaur Attack. *Scientific American* 277: 74-79.

For Teachers

Sharon Schiliro, ed. 1997. *NatureScope: Digging Into Dinosaurs.* New York: McGraw Hill Co. Resource for teachers grades K-8.

McGowan, Chris. 1997. M*ake Your Own Dinosaur Out of Chicken Bones.* New York: HarperCollins. Learn about bird and dinosaur skeletons as you create an *Apatosaurus* skeleton out of chicken bones.

Munsart, Craig. 1993. *Investigating Science with Dinosaurs.* Englewood, Co: Teacher Ideas Press. Excellent information and activities resource for grades 4-12.

Dinosaur Web Sites

http://www.naturalsciences.org/funstuff/faqs/acro.html
Acro FAQ—Frequently asked questions including illustrations, maps and other interesting links. Developed by the North Carolina Museum of Natural Sciences.

http://www.bhigr.com/pages/info/info_acro.htm
Detailed information and a slide show chronicling the Black Hills Institute's preparation of Acro's remains for display at the Museum.

http://dinosauricon.com/genera/acrocanthosaurus.html
Acrocanthosaurus described on The Dinosauricon, a Web site devoted to dinosaur information and illustration. Site includes classification information and several good *Acrocanthosaurus* images.

http://dinosauricon.com/genera/
Images and information on other dinosaurs mentioned in this activity guide. Note: In the near future this site will be moved to new location: http://dino.lm.com/.

Acrocanthosaurus atokensis

Measuring Dinosaurs

Exhibit Hall Activity

Grades K-2

Skills Practiced

- Measuring (standard and non-standard)
- Comparing

Concepts Explored

- Size of dinosaurs

Sample Objective

Students will be able to use standard and non-standard units of measurement to estimate the size of dinosaurs.

Background

Dinosaur size is a difficult concept for many students to grasp. Asking students to imagine a dinosaur the size of a chicken, a train locomotive, or a four-story building gets them one step closer to appreciating dinosaur size, but they still have to use their imaginations—after all, how many students have chickens, locomotives, or four-story buildings on hand? When you bring your students to visit the Museum's Terror of the South exhibit, they can get up close and personal with life-sized dinosaur skeletons and models. Using themselves as units of measurement, your students will get first-hand experience with dinosaur sizes.

Materials

- cloth measuring tape
- pencil
- blank sheet for recording data

Teacher Preparation

Collect the materials listed above.

Activity

As you and your students explore the *Acrocanthosaurus* exhibit, perform the following measuring activities as a group.

1. Find the life-sized model of a *Deinonychus* near the entrance of the Terror of the South exhibit. Imagine standing next to the dinosaur. How do you measure up? Are any of your students shorter than *Deinonychus*? Taller? Record your students' names in the appropriate categories.
   Shorter than *Deinonychus*
   Taller than *Deinonychus*
   Same size as *Deinonychus*
2. After entering the Terror of the South exhibit, estimate the lengths of the two dinosaurs on display, a life-sized *Pleurocoelus* model and a real *Acrocanthosaurus* skeleton, by forming a chain of students. Note: When the students form the chain, have them stretch their arms as far as they can and then hold hands with their neighbors. When you return to your classroom, you can reproduce both chains and determine the dinosaurs' lengths in feet or meters.
   Use a blank sheet to record the following:
   a. Number of students in the *Pleurocoelus* chain; names of the students in the chain.
   b. Number of students in the *Acrocanthosaurus* chain; names of the students in the chain.
4. Go to the dinosaur trackway display. There are several *Pleurocoelus* tracks and a single *Acrocanthosaurus* track on the floor under glass. Have your students stand over a *Pleurocoelus* footprint. How many students can fit into the track?
   Now have your students stand over the *Acrocanthosaurus* track. How many students fit into this footprint?
5. Go to the display containing the arms (from humerus to hand) of three different dinosaurs. Have your students compare the length of their arms to the length of the *Acrocanthosaurus, Tyrannosaurus,* and *Allosaurus* arms on display. Are there any students whose arms are the same length as *Acrocanthosaurus*' arm?
6. It is hard to tell the size of the three pterosaurs, called *Anhanguera*, soaring overhead. To get an idea of an *Anhanguera's* size, use a measuring tape to position 14 students at one-foot intervals along a straight line. When all the students are in position, the distance between the first and the last student will be 13 feet—or the wingspan of an *Anhanguera*.

Extensions

Using the same measuring techniques your students used at the Museum, have students compare the size of objects around your school grounds to the size of the dinosaurs they saw at the Museum. Is a school bus as long as *Pleurocoelus* or *Acrocanthosaurus*? What can you find that is as long as the wingspan of *Anhanguera*?

Junior Paleontologists

Exhibit Hall Activity

Grades 3-8

Skills Practiced

- Observing
- Predicting
- Recording data
- Measuring

Concepts Explored

- Dinosaur behavior

Sample Objective

Students will be able to make predictions about dinosaur behavior based on observations.

Background

Paleontologists are scientists who study fossils, which are the remnants of organisms that lived in prehistoric times. Examples of fossils include leaf imprints, dinosaur bones, and tracks and trackways. Using fossil clues, paleontologists can learn what life was like millions of years ago. Scientists can use fossil plants to hypothesize about climate (i.e. hot, rainy, cold), habitat type (i.e. swamp, desert, rainforest), and what plant-eating organisms like dinosaurs and insects ate. By examining fossil bones, paleontologists usually can determine the identity of the animal, what it looked like, how it made its living (i.e. as a scavenger, a predator, or a plant-eater), whether it had received any injuries during its life, and, if it had been injured, whether the animal recovered from the injuries or died soon after receiving them. Scientists can use tracks and trackways to identify animals and to answer questions about the animal's life such as whether it lived alone or in a group, or whether it migrated or stayed in one place year-round.

Materials

- Junior Paleontologist Data Sheets
- pencils
- clipboards
- cloth measuring tapes

Teacher Preparation

1. Decide into how many groups you will divide your students for this activity and make one copy per group of the Junior Paleontologist Data Sheet.
2. Collect remaining materials listed above in the amounts needed to provide each group with one of each.
3. Many of the questions on the data sheet are subjective and ask the students to use their imaginations—these questions do not have right or wrong answers. Information found in the text panels accompanying displays can be used to answer the objective questions included on the data sheet.

Activity

Before your trip to the Museum, discuss paleontology with your students. What kinds of things can a paleontologist discover by studying fossilized objects such as bones, plants, insects, and tracks?

At the Museum, divide your students into groups and hand out copies of the data sheet. When you enter the Terror of the South exhibit, give your students time to explore the area and answer the questions on the data sheet.

Extensions

Show the Museum's Curiosity Class Dinosaur Detectives video (appropriate for grades 3-8). The video was produced for the Department of Public Instruction Starnet Satellite system. For more information visit our Web site at http://www.naturalsciences.org/education/resources_students.html

Junior Paleontologist Data Sheet

1. The life-sized *Pleurocoelus* model and the *Acrocanthosaurus* skeleton are arranged to show the moments before an attack that actually took place 110 million years ago. What do you think happened next? What kind of clues would help you figure out what happened?

2. Look carefully at the ribs of *Acrocanthosaurus*. Can you find any areas where the ribs look damaged? How do you think *Acrocanthosaurus* was injured? Can you find any other injuries on this dinosaur? (Look closely on the head, shoulder blade, and toes.)

   Using the measuring tape, estimate the lengths of both *Acrocanthosaurus* and *Pleurocoelus*.
   Acrocanthosaurus is _____feet long.
   Pleurocoelus is _____feet long.

4. Find the dinosaur trackway display.
   Using the measuring tape, estimate the size of a *Pleurocoelus* track. ____ inches
   Estimate the size of the *Acrocanthosaurus* track. _____ inches
   What can you learn about dinosaurs by studying their trackways?

5. *Acrocanthosaurus* usually reminds people of *Tyrannosaurus*, but *Acrocanthosaurus* lived about 50 million years before *Tyrannosaurus*.
   List some similarities and differences between these two predators.
   <u>Similarities</u> <u>Differences</u>

6. How would you describe the teeth of *Acrocanthosaurus*?
   What do the teeth remind you of?
   Why do you think the teeth are all different sizes?
   What do you think this dinosaur ate?

7. What type of animal is an *Anhanguera*?
   Where did it live?
   What did it eat?
   What is the wingspan of an *Anhanguera*? _____feet.
   Have two students from your group stand this distance apart.
   (Use the measuring tape to check the distance.)

Pleurocoelus Trackway

Exhibit Hall Activity

Grades 9-12

Skills Practiced

Math

- Using standard units of metric measurement

Science

- Predicting
- Collecting data

Concepts Explored

- Dinosaur trackways

Sample Objective

Students will be able to predict the speed of a dinosaur by analyzing its trackway.

Background

In the early 1950s, Roland T. Bird, a paleontologist with the American Museum of Natural History, went to Texas in search of carnivorous dinosaur tracks; he found some in the Paluxy River. In addition to finding the carnivore tracks he was seeking, he also uncovered a sauropod track, the first track of its kind ever discovered. The dinosaur tracks he found were later identified as belonging to *Acrocanthosaurus* (a carnivore) and *Pleurocoelus* (a sauropod). Additional research has shown that these tracks are part of a trackway that shows a *Pleurocoelus* being attacked by an *Acrocanthosaurus*.

Materials

- metric measuring tape
- pencils
- clipboards
- calculators
- student worksheets

Teacher Preparation

1. It is recommended that your students do the Dinosaur Trackways activity included in this guide before visiting the Museum and doing this exhibit hall activity.
2. Divide your students into groups of four or five or keep the groups used during the Dinosaur Trackways activity.
3. Collect the materials listed above in the amounts needed to provide each group with one of each.
4. Answers calculated by student groups may vary due to differences in measuring techniques.

Activity

Before arriving at the Museum, discuss with your students the Paluxy River trackway and its significance. What information about dinosaur behavior have paleontologists been able to determine by studying the trackway?

When you arrive at the Museum, distribute required materials to the groups.

Have your students begin the activity by referring to the worksheet.

Extensions

Continue your students' investigation of dinosaurs by scheduling the Museum's distance learning program, *Dinosaurs*. For more information, contact Liz Baird, coordinator of distance learning, at 919.733.7450, ext. 621, or Liz.Baird@ncmail.net.

Student Worksheet

Pleurocoelus Trackway

1. Locate the display that contains the *Pleurocoelus* trackway. Identify the *Pleurocoelus* tracks (there is a single *Acrocanthosaurus* track in the display). Estimate and record *Pleurocoelus*' foot length and stride length. (Remember that stride length is the distance between the heel of one foot and the heel of the same foot, one step later.)

   foot length = _____m stride length = _____m

2. Determine the hip height of *Pleurocoelus* using the following equation:
   hip height = foot length x 4

3. Using the following equation, calculate *Pleurocoelus*' speed.

$$\text{speed} = \left(\sqrt{(\text{hip height})(9.8\ \text{m/s2})}\right)\left(\frac{\left[\frac{\text{stride length}}{\text{hip height}}\right]-0.77}{1.33}\right)$$

   speed = _____ m/s

4. Use the following formulas to estimate *Pleurocoelus*' gait.

   walking: stride length/hip height < 2.0
   trotting: stride length/hip height = 2.0 to 2.9
   running: stride length/hip height > 2.9

   Pleurocoelus was probably walking / trotting / running. (Circle one.)

Acrocanthosaurus Rubbings

Classroom Activity

Grades K - 2

Skills Practiced

Art

- Using different media to create art projects
- Fine motor coordination
- Manipulating small objects

Concepts

- Shapes of dinosaurs
- Body parts of dinosaurs

Sample Objective

Students will be able to identify a dinosaur from its outline.

Background

Young children are often fascinated by dinosaurs. They enjoy learning about the different dinosaurs, what they looked like, what they ate. In this activity, students will discover the Museum of Natural Sciences' newest dinosaur, *Acrocanthosaurus*.

Materials

for teacher

- white liquid glue (such as Elmer's™ glue)
- *Acrocanthosaurus* coloring sheet
- white paper, $8\,^1/_2$ x 11"
- card stock or cardboard

for students

- crayons
- white paper, $8\,^1/_2$ x 11"

Teacher Preparation

Before the students get involved in this activity, you must first make an *Acrocanthosaurus* rubbing template (you may want to make several instead of just one). To make the rubbing template follow the steps outlined below.

1. Place an *Acrocanthosaurus* coloring sheet on a flat surface located in an undisturbed area.
2. Lay a blank piece of white copier paper over the coloring sheet. Make sure you can see the *Acrocanthosaurus* drawing well enough to trace it onto the new sheet of paper.
3. Twist the nozzle of the glue bottle so that it is half open, place the tip of the glue bottle against the white copier paper, and, while gently squeezing the glue bottle such that a thin bead (about $^1/_{16}$ inch wide) of glue comes out, trace the outline of the *Acrocanthosaurus*. While you will not want to trace the finer details of the drawing with glue, you can put a dot of glue for the eye and a few small triangles to represent teeth and claws.
4. As the glue dries it will turn clear, making it difficult for your students to determine what animal is on the template. You can tell them what it is, or leave it a mystery for them to figure out.
5. When the template is dry, glue it to a sheet of card stock or cardboard to make it more durable.

Activity

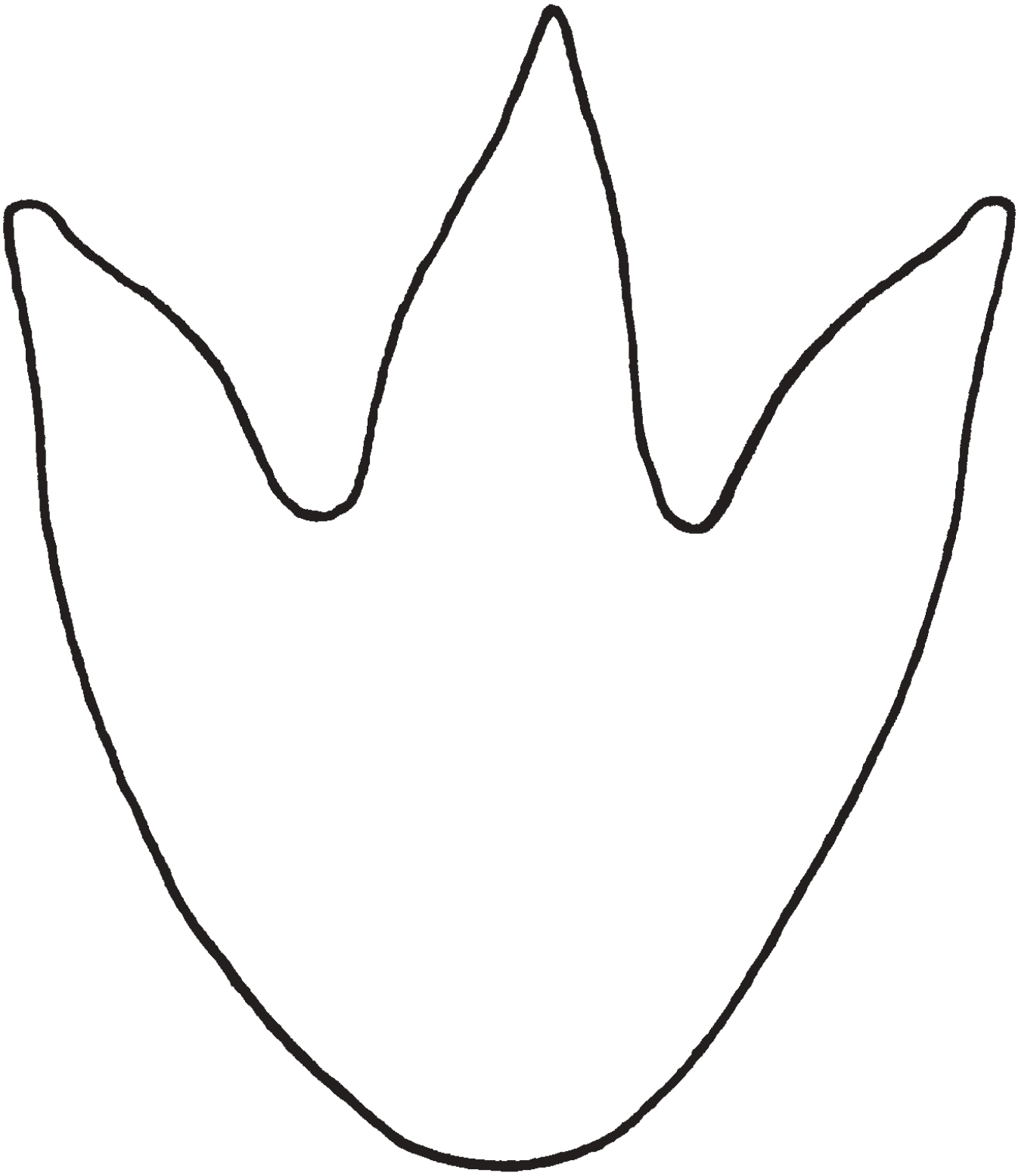
Make the rubbing template available to your students. Instruct them to place a blank piece of paper on top of the template and then to rub the side of a crayon gently across their blank paper. A picture of *Acrocanthosaurus* will "magically" appear on their paper.

Extensions

Hold a class discussion about *Acrocanthosaurus*. Ask your students what they already know about this dinosaur. What information can they discover simply by looking at the picture? Was this dinosaur a plant eater or a meat eater?

Have your students write a short story or a poem about *Acrocanthosaurus*.

Make a similar template using the *Acrocanthosaurus* foot print located on the reverse side of this sheet.



Scale 1:3
approximately 60 cm long
when enlarged to life size

Papier-mâché Eggs

Classroom Activity

Grades K-2

Skills Practiced

Art
- Using different media to create art projects
- Fine motor coordination
- Manipulating small objects
- Cutting paper using scissors

Math
- Measuring to the nearest inch

Science
- Using models to display data

Concepts Explored
- Reproductive strategy of dinosaurs
- Dinosaur egg shapes and sizes

Sample Objective

Students will be able to describe the size and shape of different dinosaur eggs.

Background

An exciting area of study in paleontology currently is the study of dinosaur eggs. Recent discoveries and new laboratory techniques have added to and changed what we know about dinosaurs and how they lived. Compared to the number of dinosaurs classified to date, the number of eggs which have been identified is relatively small. However, the amount of information that scientists can glean just from examining dinosaur eggs and their nests is incredible. For example, by studying dinosaur eggs, paleontologists can learn what kind of parents dinosaurs were, whether dinosaurs nested in colonies, what parents fed their hatchlings, and what embryonic dinosaurs looked like.

Use the table below to help your students create their own dinosaur eggs.

Dinosaur	**Egg Size**	**Egg Shape**
Hypselosaurus	10" diameter	round
Hypsilophodonts	6" long	potato shape
Maiasaura	8" long	oval
Mussasaurus	1" diameter	round
Oviraptor	6" to 8" long	potato shape
Troodon	4" long	oval
Troodon	6" long	oval

Materials
- rulers
- scissors
- newspapers cut into 1-inch wide strips
- papier-mâché paste (4 parts water to 1 part wallpaper paste)
- balloons, round and elongated shapes
- bucket for mixing wallpaper paste and water
- aluminum pie pans (or other medium-sized containers) for holding papier-mâché paste
- tempera paint and paint brushes

Teacher Preparation

There are several ways to do this activity. You can decide for the students which dinosaur egg(s) they will make or you can let them choose which one(s) they want to construct. All the students can make one type of dinosaur egg and put their eggs into a nest, or they can make eggs from different dinosaurs. For younger students, you will need to prepare many of the materials ahead of time (blow up the balloons to the appropriate sizes, cut the newspaper into strips, etc.). Older students can inflate the balloons themselves and use rulers to make sure their balloons reach the correct sizes.

Use bird eggs to discuss with students what is known about eggs in general, their sizes, shapes, and colors. What is the relationship between an animal's size and the egg it lays? For example, an ostrich lays an egg that is 6 inches long in contrast to a hummingbird's tiny egg. Which dinosaurs do they think had the largest eggs? If available, the article from *National Geographic* by Philip Currie entitled "The Great Dinosaur Egg Hunt" has excellent illustrations of the wide variety of shapes and sizes found in fossil dinosaur eggs. (See Dinosaur References for complete citation.)

For images of dinosaur on egg list, check the Dinosauricon Web site listed in references on page 4.

Activity

1. Distribute balloons, newspaper strips, and pie pans to your students. The pie pans can be shared by two or three students. If doing this activity indoors, you will probably want to spread uncut newspapers on the floor or desks where the students will be working.
2. If inflating the balloons themselves, have each student work with a partner. While one student inflates a balloon, the second student should measure the balloon with the ruler. When the balloon reaches the correct size for the egg being modeled, it should be tied off. The students should reverse roles so that each has an opportunity to measure and to inflate a balloon.
3. Once each student has an inflated balloon, pour papier-mâché paste into the pie pans. Instruct the students to dip the newspaper strips into the paste and then to run the strips through their fingers to remove excess paste before applying them to their balloons. The entire surface of the balloon should be covered with dipped strips of newspaper. Larger balloons may require more than one layer of papier-mâché to be strong enough when dry.
4. Once the balloons are completely covered with papier-mâché, place the model eggs on uncut newspaper in an undisturbed location in the classroom and allow them to dry completely. Before they forget which egg is theirs, have students write their names next to their eggs on the uncut newspaper.
5. When the eggs are dry, have the students paint their eggs. Since little is known about the color of dinosaurs or their eggs, let your students' imaginations determine what color(s) to use.

Extensions

Have students imagine what their baby dinosaur would look like if it hatched out of their papier-mâché egg. Instruct them to draw a picture of their baby dinosaur.

Have the students construct a dinosaur nest out of recyclable materials (newspaper, paper towel rolls, etc.) and place their papier-mâché eggs in the nest.

Create Your Own
Life-sized *Acrocanthosaurus*

Classroom Activity

Grades 3-8

Skills Practiced

Math
- Drawing objects to scale
- Exploring positions on grids
- Solving spatial problems

Science
- Collecting and displaying data

Concepts Explored
- Size of dinosaurs

Sample Objective

Students will work together to create a life-sized drawing of a dinosaur.

Background

The concept of how big (or small) dinosaurs were is difficult for most people to grasp since there is no direct way to experience their size. Comparisons such as "*Apatosaurus* was three stories tall" or "*Compsognathus* was the size of a chicken" help us visualize the size of these ancient reptiles, but they fail to give us the personal experience that most of us need to fully appreciate the majesty of dinosaurs. By using the following activity to create a life-sized version of *Acrocanthosaurus*, students will become intimately involved with just how big *Acrocanthosaurus* really was.

Materials
- pencils
- clear tape
- masking tape
- location that will hold a 18' x 40' drawing of *Acrocanthosaurus*
- rulers
- black markers
- 4' x 4' pieces of blank paper (if paper this large is unavailable, you may tape together several smaller pieces of paper into a 4 foot square piece)
- *Acrocanthosaurus* picture with numbered grid overlay (included with this activity)
- old newspapers

Teacher Preparation

1. Make a copy of the *Acrocanthosaurus* picture overlaid with the numbered grid located on the reverse side of this sheet. You may want to enlarge the picture to make copying the drawing easier for your students.
2. Cut the copy along the grid lines, making sure that the grid lines do not appear on the cut-up squares.
3. Dispose of any square that does not have a number in the upper right-hand corner.
4. Draw a diagram of the numbered grid without the *Acrocanthosaurus* picture on it and post the blank grid where the students will be able to refer to it.
5. Assign each student a numbered square. Make a list of the numbers and record the names of the students assigned to each square. Post this list next to the blank numbered grid made during step 4.
6. Distribute the numbered squares to the appropriate students. Give each student a 4' x 4' piece of blank paper and make sure they all have pencils.

Activity

1. Instruct the students to copy in pencil the marks on their small squares onto the larger pieces of paper, making sure to include the numbers in the upper right-hand corners of the squares. Remind the students to use the entire piece of paper and to draw all the way to the edge of the paper.
2. Once each student has transferred the marks to the larger pieces of paper, they must check that their lines connect with the lines on adjacent grid spaces. Have the students refer to the list of grid numbers and student names and to the blank numbered grid posted on the wall to determine whose work adjoins theirs.
3. As soon as all adjoining marks have been checked and adjusted (if necessary), have the students go over the pencil marks (except the numbers in the upper right-hand corner) with black markers. To protect surfaces from the markers, you may want your students to place old newspapers underneath their papers before they use the markers.
4. Assemble the pieces of paper at the pre-selected location, using masking tape to secure the squares together. Your class now has a life-sized *Acrocanthosaurus*. If a suitable wall is available, display the *Acrocanthosaurus* on it so the students can fully appreciate how big this dinosaur was.

Extensions

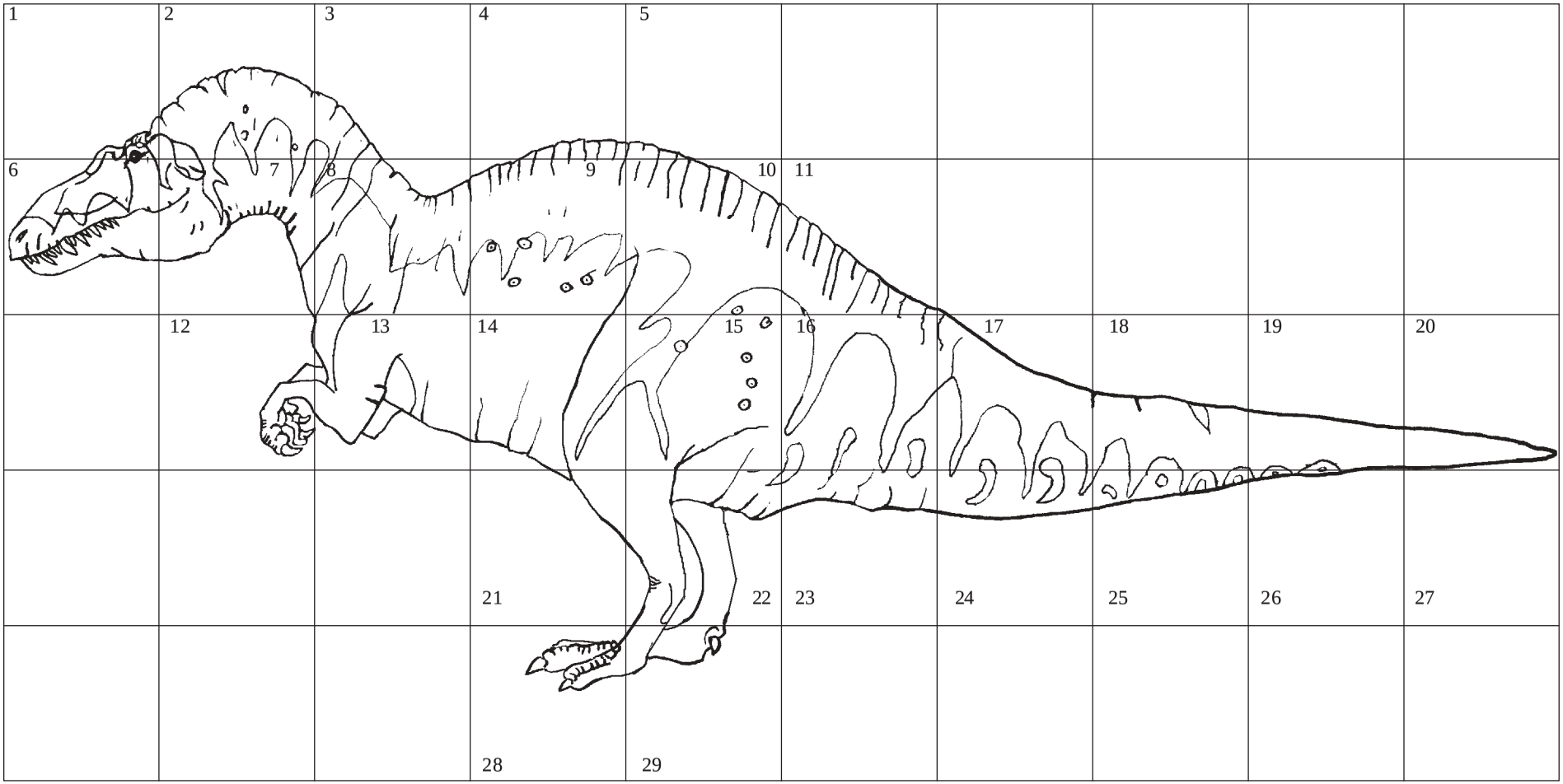
Discuss with your students where and how *Acrocanthosaurus* lived. Based on this information, ask your students to imagine what *Acrocanthosaurus* might have looked like when alive. What color was it? Discuss camouflage and how it might have helped a predator like *Acrocanthosaurus* get closer to its prey before it attacked. Based on their ideas, have the students add color to their life-sized *Acrocanthosaurus*.

Continue the activity by designing a mural based around the enlarged *Acrocanthosaurus* drawing. Use the information and the drawings provided on the following pages to create the mural.

Compare the size of *Acrocanthosaurus* to that of people and objects around the classroom.

Life-sized *Acrocanthosaurus*

Each grid block represents a 4 foot by 4 foot square. There are 29 numbered blocks to reproduce. The remaining unnumbered blocks are blank.

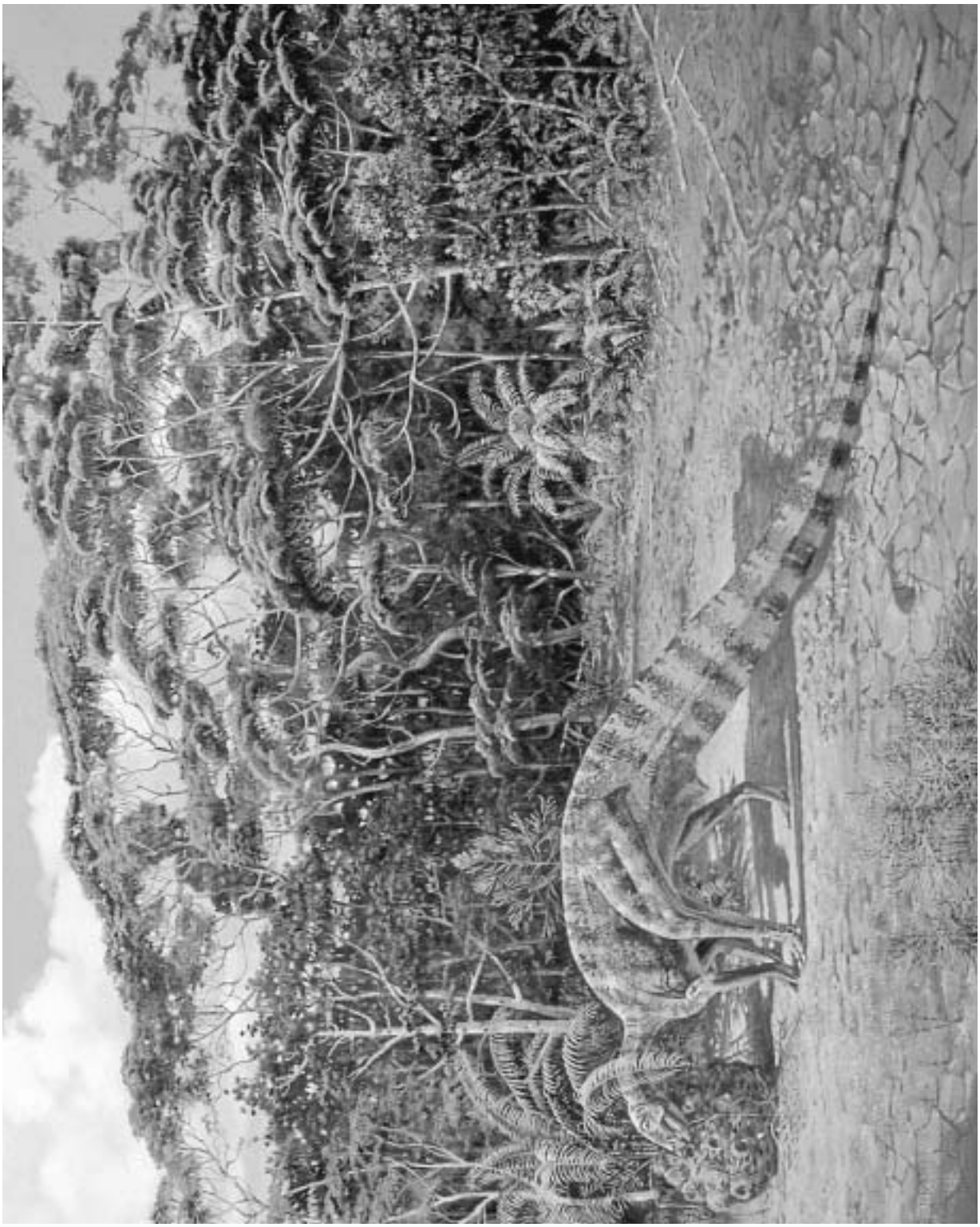


Acrocanthosauran Environment

Details of *Sauropelta* by Ely Kish, from *Odyssey in Time: Dinosaurs of North America* by Dr. Dale Russell. Reproduced with permission of the Canadian Museum of Nature, Ottawa, Ontario, Canada.

Fossil evidence indicates that, at the time of its death, the Museum's *Acrocanthosaurus* was walking along the shores of a freshwater estuary near the ocean. The soil, made of coral sands, was white. In the background were cycads and conifers common at the time. Other dinosaurs that probably shared its habitat included ornithomimids, sauropods, *Deinonychus*, and *Tenontosaurus* (probably striped black and white like a zebra). In addition to dinosaurs, there were turtles, lizards, salamanders, frogs, small crocodiles, and rat-sized, opossum-like mammals. The above illustration depicts how *Acrocanthosaurus*' environment might have looked.

Acrocanthosauran Environment



Microvenator and *Tenontosaurus* by Ely Kish, from *Odyssey in Time: Dinosaurs of North America* by Dr. Dale Russell. Reproduced with permission of the Canadian Museum of Nature, Ottawa, Ontario, Canada.

Here is another illustration depicting *Acrocanthosaurus'* environment.

Tenontosaurus feeds on the fruit of a cycad-like plant. Note the plants with palm-like leaves (cycads) in the background, as well as the taller primitive conifers.

Dinosaur Trackways

Classroom Activity

Grades 9-12

Skills Practiced

Math
- Using standard units of metric measurement
- Graphing
- Determining slope
- Working with scale

Science
- Experimenting
- Collecting and displaying data
- Predicting

Concepts Explored

Dinosaur trackways

Sample Objectives

Students will be able to use an equation to predict the speed of both human and dinosaur subjects.

Background

One of the ways paleontologists learn about how dinosaurs lived is to study dinosaurian trackways. A trackway can provide a scientist with a wide variety of information, from a dinosaur's size to its social life. With the right formulas, trackways can even tell us how fast dinosaurs may have moved. During this activity, students will collect data on human trackways and then will use what they discover to make predictions about a sample *Acrocanthosaurus* trackway. An article in *Scientific American* entitled "Tracking a Dinosaur" (for a complete citation see Dinosaur References) illustrates how scientists used an *Acrocanthosaurus* trackway to learn about its hunting style.

Materials

- location in classroom to display large class graph (blackboard or overhead projector)
- chalk
- outside location with paved surface or sidewalk
- clean old socks (students can bring pairs from home)
- dishpan half filled with water
- metric measuring tapes
- stopwatches
- student worksheets
- pencils
- *Acrocanthosaurus* trackway sheet
- butcher paper (optional)
- black marker (optional)

Teacher Preparation

1. Make copies of the student worksheet located on the following pages.
2. On the blackboard or an overhead projector, draw the axes for the graph that students will use to determine the relationship of foot length to hip height.
3. Prepare *Acrocanthosaurus* trackway for students either by making copies of the trackway sheet located on the last page of this activity or by enlarging the trackway to life-size and then transferring it onto butcher paper using a black marker. If you do not enlarge the trackway to life-size, you will need to tell your students to what scale the trackway on the sheet is drawn so they can take scale into consideration when they do their calculations.

Activity

1. Divide students into groups of four or five. Assign students to the following jobs: group leader (keeps group on task and reads directions to group members), recorder, timer, and measurer(s).
2. Distribute measuring tapes, old socks, chalk, worksheets, and pencils to the groups.
3. Have the students begin the activity. When the groups are ready to perform the outside part of the activity, make the water-filled dishpan available to them.
4. When the students reach step 8 on the Student Worksheet, hand out the sample *Acrocanthosaurus* trackway.

Student Worksheet

Dinosaur Trackways

1. Measure foot lengths and hip heights for each member of your group and record the information in the table below. Plot your measurements on the class graph. Hip height is the distance from the top of your hip to the ground. To determine where your hip is, bend at the waist and then, with your finger, follow the crease created to the outside of your leg. Keeping your finger on that point, stand up straight and roll your leg and foot in and out. The movement should feel like it starts from the point where your finger is. This point is the top of your hip.

Group member	foot length (m)	hip height (m)

2. When all groups have recorded their data on the class graph, draw a best-fit line through the data points and calculate the slope of the line. The slope of the line is the relationship between foot length and hip height.

   Foot length–hip height relationship as determined from class data = _____

3. Obtain your teacher's foot length and record it. Using the relationship between foot length and hip height you calculated in step 2, predict your teacher's hip height. Now obtain your teacher's actual hip height.

   Teacher's foot length = _____ m

   Predicted hip height = _____ m

   Actual hip height = _____ m

   How do the predicted and actual hip heights compare?

   _____

   _____

4. Gather your materials and go outside to the location your teacher has selected. Someone in your group will need to volunteer for the next part of this activity. Indicate on the table in step 1 who the volunteer is.

5. Draw start and finish lines 15 meters apart on the ground. Have the volunteer take off his or her shoes and socks and put on the old pair of socks your teacher gave you.

6. Have the volunteer wet his or her feet and stand at the start line. Time how long it takes for the volunteer to walk to the finish line. Before the footprints in the trackway dry, measure and record the volunteer's walking stride length. (Stride length is the distance between the heel of one foot and the heel of the same foot, one step later.) Have the volunteer re-wet his or her feet and stand at the start line again. Time how long it takes the volunteer to run to the finish line. Before the footprints in the trackway dry, measure and record the volunteer's running stride length. Calculate walking and running speeds using Equation 1.

gait	distance (m)	time (s)	speed (m/s)	stride length (m)
walk	15 (m)			
run	15 (m)			

Equation 1: $\text{speed} = \frac{\text{distance traveled}}{\text{time}}$

7. Using equation 2, calculate the walking and running speeds of the volunteer.

Equation 2: $\text{speed} = \left(\sqrt{(\text{hip height})(9.8\ {}^{m}/_{s^2})}\right)\left(\frac{\left[\frac{\text{stride length}}{\text{hip height}}\right] - 0.77}{1.33}\right)$

Calculated walking speed = _____ m/s

Calculated running speed = _____ m/s

How do the speeds calculated with equation 1 compare to the speeds calculated with equation 2?

_____

_____

_____

8. Return to the classroom and obtain an *Acrocanthosaurus* trackway from your teacher. If the trackway you receive from your teacher is not life-sized, determine the scale to which the tracks are drawn and use this information to convert your scaled-down measurements into life-sized measurements. Measure *Acrocanthosaurus*' foot length and stride length.

foot length = _____ m stride length = _____ m

9. The relationship between hip height and foot length of bipedal (walked on two legs) dinosaurs is **hip height = foot length x 4.** How does this equation compare to the relationship you determined for humans in step 2?

_____

_____

_____

10. Using the equations given in steps 7 and 9, calculate *Acrocanthosaurus*' hip height and speed.

hip height = _____m

speed = _____m/s

11. Use the following formulas to determine *Acrocanthosaurus*' gait.

walking: stride length/hip height < 2.0
trotting: stride length/hip height = 2.0 to 2.9
running: stride length/hip height > 2.9

Acrocanthosaurus was probably walking / trotting / running. (Circle one.)

Student Worksheet

Dinosaur Trackways