Fossil Kit Laboratory Investigation 3: Fossil Trackways

Investigation Summary: Students observe and measure the tracks of different types of animals. Students use properties of track size, shape, and stride length to determine the size and type of animal that made them.

Enduring Understandings	**Essential Questions**
• Trackways are fossils that record the behavior of animals.	• How do trace fossils record the behavior of animals? • What physical properties of animals can be determined from their tracks?
Students will know…	**Students will be able to…**
• Physical properties of the animal can be determined from trackways. • Trackways record how animals interact with their environment.	• Compare the tracks made by different types of vertebrates. • Observe and describe the properties of tracks. • Estimate properties of the animals that left the tracks.

Assessment Evidence

Completion of Investigation Worksheet
Science Notebook Entries (as applicable)

Evidence Outcomes
Students can:

a. Use evidence to develop a scientific explanation for:
    1. What fossils tell us about a prehistoric environment
    2. What conclusions can be drawn from similarities between fossil evidence and living organisms
b. Analyze and interpret data to generate evidence about the prehistoric environment
c. Evaluate whether reasoning and conclusions about given fossils are supported by evidence.

Vocabulary:

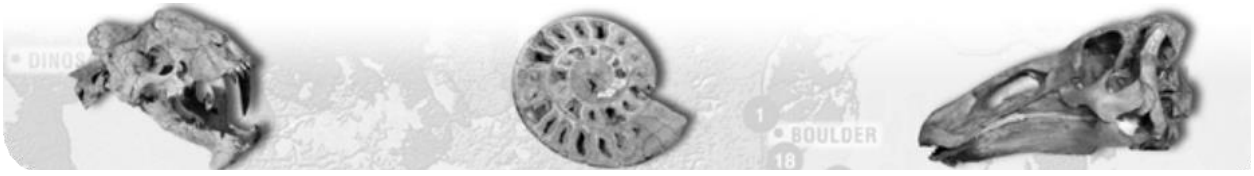
Hip height	Ichnofossil	Ichnologist
Synapsid	Step	Stride length
Theropod	Trace fossil	Trackway

Before You Teach

- Trace fossils are fossils that, although they don't preserve the organism that made them, give clues about the behavior of organisms long after they're gone.
- Common types of trace fossils include: footprints, trackways, burrows, fossil feces (coprolites) and predation markings (bite marks, etc.).
- Often, the organism that made the trace cannot be identified, but certain characteristics of the trace maker can be inferred.
- Some trace fossils give a snapshot of an event that happened long ago, with tracks made by multiple organisms overlapping and intersecting.
- Some of the oldest fossils preserved are trace fossils. Fossils that record bacteria living in sediments have been dated to 3.5 billion years!

This investigation focuses on one type of vertebrate trace fossils – tracks and trackways.

- Tracks can be preserved wherever animals and soft sediment are abundant: marks left along beaches or riverbanks are some of the most common. Even the sandstone that makes up the Flatirons above Boulder has tracks preserved in it.
- Trace fossil are often found in places where body fossil are not, meaning that all we know about the organisms that lived there comes from traces.



- Traces are also almost always preserved in place, so that paleontologists don't have to infer where a fossil came from or what kind of environment it lived in.
- Interpreting trackways can be very complicated, owing to the often complex behavior of the animals that make them, but some basic information about the animals can often be understood.

Additional Teacher Resources

Vocabulary:

Hip height – The distance from the ground to the hip of the animal.

Ichnofossil – Scientific term for trace fossil; ichno is a Greek word root meaning trace or track.

Ichnologist – A scientist who studies trace fossils.

Synapsid – The group of mammal-like reptiles that walked on four legs and are considered to be protomammals (pre-mammals) from the Permian and Triassic Periods. Examples are Lystrosaurus and Dicynodonts.

Step – The distance from one foot to the next.

Stride length – The distance from one foot to the next step with the same foot (e.g., from the back of the heel of the first left footprint to the back of the heel of the next left footprint).

Theropod – The group of dinosaurs that mostly walked upright on two legs. Examples are Tyrannosaurus Rex and Velociraptor.

Trace fossil – Trace fossils are traces or marks left behind by an organism. Unlike molds and casts, which are evidence or replicas of skeletal remains or body impressions, trace fossils are disturbances in the earth from an animal's (or plant's) activity such as resting, locomotion, or feeding.

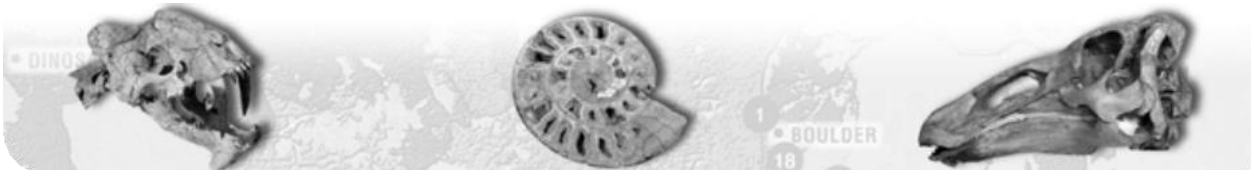
Trackway – A set of tracks or footprints left by an animal.

Online Resources

http://www.ucmp.berkeley.edu/education/teachers.php is a website that features valuable and easy to understand paleontology resources for teachers.

http://www.newyorkscienceteacher.com/sci/esl/es/spanish-es.pdf is a website that lists Spanish translations of Earth Science Terms.

http://puzzlemaker.discoveryeducation.com/ is a website where you can easily create your own crossword puzzles or word searches using the listed vocabulary words.



Laboratory Investigation 3, Part 1: Synapsid Trackways

Materials:

Synapsid trackway

Cast of Synapsid track

10 Rulers

Investigation Worksheet

Conducting the Investigation:

1. Introduce trace fossils.

Tell students that this investigation involves examining trace fossils, and that a trace fossil records the behavior of an organism.

Tell students that they are going to be ichnologists, which are a special type of paleontologist, and that the study of fossil tracks and trackways is called ichnology.

Ichnology is an important component of paleontology enabling us to understand how animals moved, or what kinds of environments they lived in.

Ask students to think about all of the different kinds of movements they do during the day, and to imagine what it would look like if they made a mark every time their feet or other parts of their bodies touched the ground. There would be a huge number of different types of marks that just one person would leave.

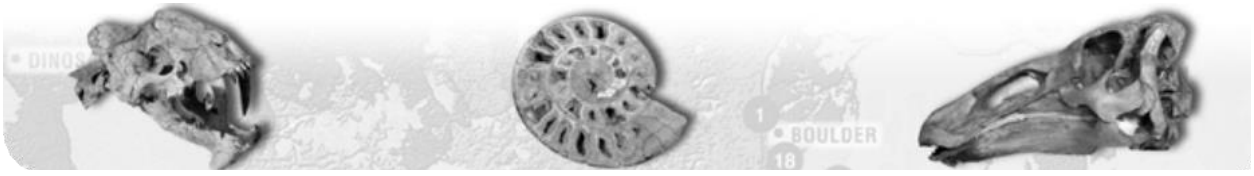
When paleontologists find trace fossils, the traces are often of a behavior that the organism did most often: burrowing in the mud, walking around, nesting, or resting.

2. Introduce fossil trackways.

In this investigation, students will be interpreting tracks made by animals while the animals were walking. Paleontologists and ichnologists call these kinds of tracks “trackways.”

Ask students to brainstorm the types of information that could be obtained about the animal that made a trackway.

Tell students that their challenge is to examine the trackways and to interpret as much as they can about the animal that made them, making and recording measurements on their Investigation Worksheet.



3. Introduce the trackway.

Have students examine the trackway and make initial observations about the number and relative size of the animal that made them.

- Demonstrate that trackway width is measured from the outside of the left foot to the outside of the right foot of a single track.
- The footprint is measured from the front of one footprint (the left, for example) to the back of the same footprint.
- The step is measured as the distance from the front of one foot (the left, for example) to the heel of the next foot (the right).
- The stride is measured as the distance between the heel of one foot (the left, for example) and the point at which that same foot touches down again. The stride measurement captures the distance traveled from the left foot step to the next left foot step.

4. Pass out the rulers and Investigation Worksheets and review what they will be recording.

5. Have students make initial observations of the trackway.

Students should measure the footprint, step, and stride and observe differences and similarities in size and shape. Students should record their observations on their Investigation Worksheet.

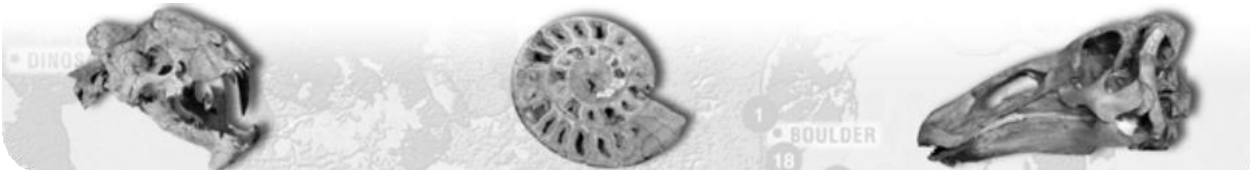
6. Discuss and compare initial observations.

What types of observations did you make about the trackway?

Is this a single animal, or are there tracks of multiple animals?

What was the size of the footprint? Of the step? Of the stride?

What can you tell about the animal from this trackway?



Laboratory Investigation 3, Part 2: Theropod Trackways

Materials:

Theropod trackway

Cast of Theropod track

10 Rulers

Investigation Worksheet

Conducting the Investigation

1. This exercise is very similar to Part 1 in that students are going to examine and measure a set of tracks. However, this time they are going to calculate how long the animal was that made the tracks, based on the trackway measurements.

Tell students that their challenge is to examine the theropod trackway, to record measurements on their Investigation Worksheet, and then calculate how long the theropod was and how fast it was moving.

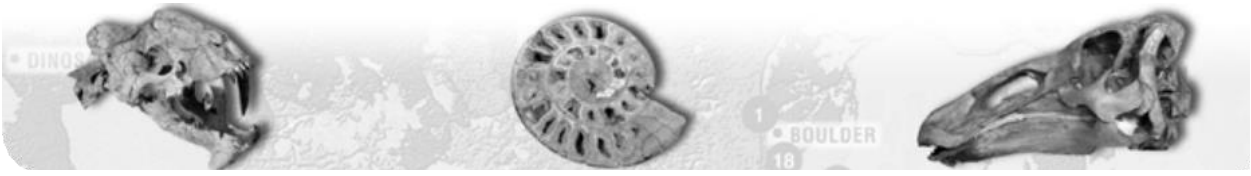
2. Introduce the trackway. Have students examine the trackway and make initial observations.

- The footprint length is measured from the back of the heel to the tip of the longest toe on the same footprint.
- The step length is measured as the distance between one foot (the left, for example) and the next foot (the right).
- The stride is measured as the distance between one foot (the left, for example) and the point at which that same foot touches down again. The stride measurement captures the distance traveled from the left foot step to the next left foot step again. Make sure to measure to and from the same place on the foot prints (e.g. from the heel of the first left foot print to the heel of the next left foot print).

3. The students should already have their Investigation Worksheet and rulers from Part 1. Have students make initial observations of the theropod trackway. The students should observe the shape of the footprints in this trackway and record how they differ from the synapsid trackway. Students should record their observations on their Investigation Worksheet.

4. Next the students should measure the footprint, step, and stride.

5. With these numbers they can calculate the hip height of the dinosaur. This is just the footprint length multiplied by 4. This calculation is a simple approximation for theropod dinosaurs.



6. Then they will calculate the length of the dinosaur by multiplying the hip height by 4.5. Again, this is a simple approximation that works for most theropod dinosaurs. It also depends on whether the neck of the dinosaur was stretched out or held back and more upright. Please note: there are, of course, exceptions where this approximation will not apply.

7. Discuss and compare observations:

What types of observations did you make about the trackway?

How was it different from the synapsid?

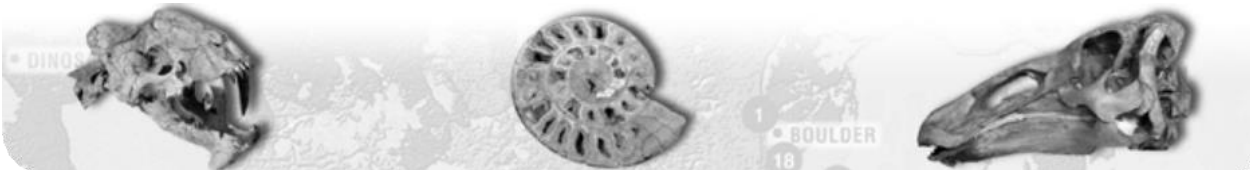
What was the size of the footprint?

What was the size of the step? Of the stride?

What did you calculate for the hip height?

How long did you estimate the animal to be?

Was the animal running or walking?



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Laboratory Investigation 3, Part 1: Synapsid Trackways

For this exercise, use the trackway sample to do the following:

1. Observe the trackway. What do you think is happening, based on the trackway?

2. How many animals are recorded in the trackway?

3. Measure:
    a. Footprint length = _____
    b. Step = _____
    c. Stride length = _____

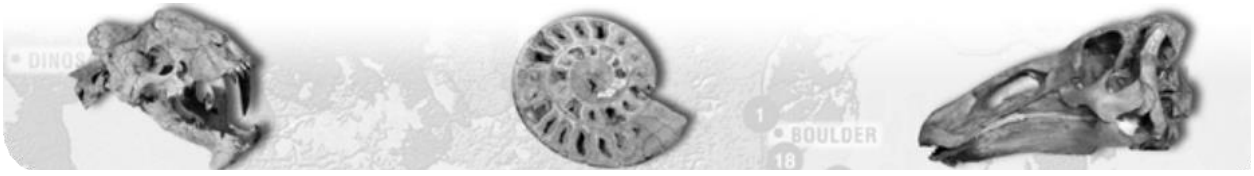
4. Draw the footprint here:

5. Draw the trackway here:

6. What can you tell about the animal from this trackway?

7. Why is the right hind foot track larger than the other tracks?

8. How fast do you think this animal was going?



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Laboratory Investigation 3, Part 2: Theropod Trackways

For this exercise, use the theropod trackway sample to do the following:

1. Observe the trackway and draw one of the footprints here.

2. How are the footprints different from the synapsid footprints?

3. Measure:
   a. Footprint length = _____
   b. Step length = _____
   c. Stride length = _____

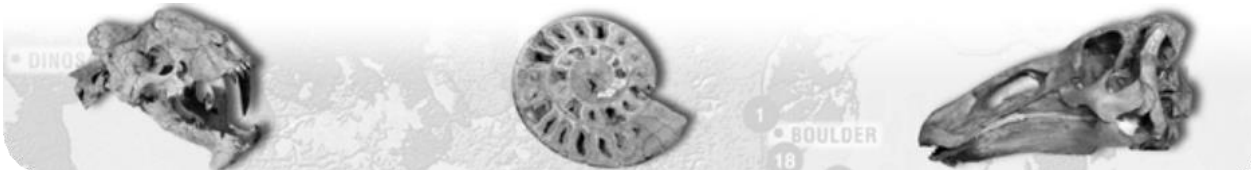
4. Next calculate the hip height. Hip Height = Footprint length x 4

   Hip Height = _____ x 4 = _____
   (Footprint length) (Hip height)

5. To estimate how long the theropod was, multiply the hip height times 4.5

   Theropod length = _____ x 4.5 = _____
   (Hip height) (Theropod length)

6. How fast do you think this animal was going?



Laboratory Investigation 3: Vocabulary for Fossil Trackways

Hip height – The distance from the ground to the hip of the dinosaur.

Ichnofossil – The scientific term for trace fossil.

Ichnologist – A scientist who studies trace fossils.

Synapsid – The group of mammal-like reptiles that walked on four legs and are considered to be protomammals (pre-mammals) from the Permian and Triassic Periods. Examples are Lystrosaurus and Dicynodonts.

Step – The distance from one foot to the next.

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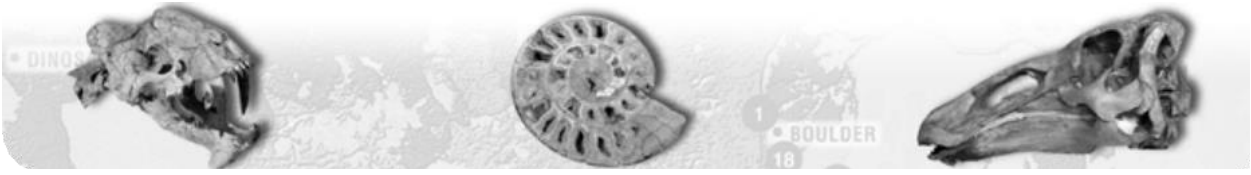


Laboratory Investigation 3, Part 1: Synapsid Trackways – Answer Key

For this exercise, use the trackway sample to do the following:

1. Observe the trackway. What do you think is happening, based on the trackway? *The synapsid is walking.*

2. How many animals are recorded in the trackway? *One.*

3. Measure:
    a. Footprint length = about *1.5 inches*
    b. Step = *about 1.5 inches*
    c. Stride length = about *4.5 inches*

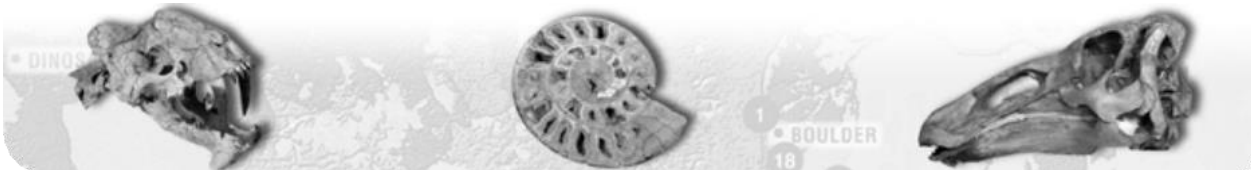
4. Draw the footprint here:

5. Draw the trackway here:

6. What can you tell about the animal from this trackway? *The synapsid has four feet, four toes, and is small.*

7. Why is the right hind foot track larger than the other tracks? *The synapsid is walking on the side of a hill in sand. The tracks on the right are larger because the sand piled up on the downhill side of the trackway.*

8. How fast do you think this animal was going? *Probably pretty slow.*



Laboratory Investigation 3, Part 2: Theropod Trackways – Answer Key

For this exercise, use the theropod trackway sample to do the following:

1. Observe the trackway and draw one of the footprints here.

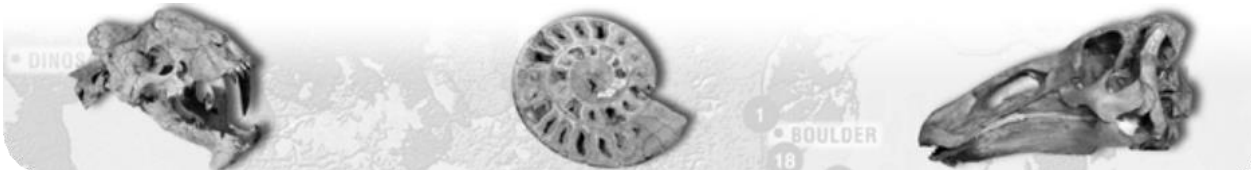
2. How are the footprints different from the synapsid footprints?
   They clearly have three toes.

3. Measure:
   a. Footprint length = *about 3 inches*
   b. Step length = *about 10 to 13 inches*
   c. Stride length = *about 30 inches*

4. Next calculate the hip height. Hip Height = Footprint length x 4

   Hip Height = ____*3 inches*_____ x 4 = _____*12 inches*_____
   (Footprint length) (Hip height)

5. To estimate how long the theropod was we will multiply the hip height times 4.5

   Theropod length = _____*12 inches*_____ x 4.5 = _____*54 inches*_____
   (Hip height) (Theropod length)

6. How fast do you think this animal was going? *Faster than the synapsid.*