Lesson 10 - A

Interdisciplinary Mystery

Using a Large Coprolite to Understand an Ancient Environment

Summary
In this interdisciplinary mystery, students will work with coprolites from animals that lived around 66 million years ago. They will try to infer what animal produced the fossilized poop, how big the animal was, and something about its environment.

Objectives
Students will be able to:

1. Describe what can be learned by studying fossilized feces
2. Explain how coprolites provide insight into ancient environments
3. Explain what type of environment is better for preserving coprolites.

Estimated teaching time
NA

Groups
NA

Materials

- Worksheets and life-sized photographs of coprolites

Teacher Background
"Coprolite" is a scientific name for the fossilized excrement, feces or droppings of ancient animals. Oxford geology professor, Reverend Dr. William Buckland coined the term, meaning "dung-stone," in 1829. He used the term to describe oblong pebbles that he thought came from a marine reptile known as an ichthyosaur. Coprolites come from most taxa, including mammals, dinosaurs, crocodiles, and fish, and are found in a variety of shapes, sizes, and colors, ranging in age from hundreds of millions of years old to thousands of years old.

High calcium phosphate content is one of several criteria for determining whether one has found a coprolite. Phosphate helps mineralize the feces and most of it originates in the bones of animals eaten by the defecator. "You'd think that poop would squish, but under the right conditions, hardening can occur in less than two weeks," says Karen Chin, curator of paleontology at the University of Colorado Museum in Boulder. Herbivore coprolites are rarer because preservation requires an outside source of phosphate, such as marine sediments. They also contain more edible materials for scavengers, such as dung beetles, which left tunnels in a 77-million-year old, basketball-sized *Maiasaura* (a nine-meter-long, three-ton herbivorous dinosaur that walked upright on its hind legs) poop that Chin found in Wyoming.

Another telltale sign is shape. It is easier to identify smaller animals by their feces than larger animals. For example, Chin says, primitive fish such as sharks and lungfish produce characteristic spiral deposits, which can preserve beautifully as spiral coprolites. Feces from

larger animals tend not to hold their shape. Despite Chin's observations, most dinosaur excrement may simply have splatted when it landed, particularly if the output source was high above ground. Clearly most feces don't get fossilized; considering how much animals defecate in a lifetime, if more did fossilize, the world might be overrun with coprolites. Beyond splatting issues, other dung destroyers are weather, trampling and creatures eating the feces — called coprophagy.

Researchers study coprolites in order to get insights into an animal's diet. For example, no one suspected that dinosaur's ate wood till Chin found wood in the *Maiasaurua* coprolite. She has also discovered beetle trails in a coprolite, evidence of poop-eating insects tens of millions of years old. Coprolites might include bacteria, bones, teeth, scales, or shells, as well as pollen and other plant parts. "Historically, paleontologists looked at bones and skulls to reconstruct the organism. Now we are looking at the organism's paleoecology, and coprolites add biological information not available from any other source," says Chin.

Facilitating the activity

Pass out the worksheet and photographs to students. As noted in the introduction to this lesson, teachers should give a broad overview of activity to the students and tell them that each group is contributing to solving the overall issue of the paleoenvironment of the Hell Creek.

See Introduction to Lesson Ten for information on Assessment, Going Further, References, Teaching Standards, and Glossary.

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(See photo of large coprolite labeled Coprolite One)

1. The specimen in this photograph is fossilized feces, or poop, known scientifically as a coprolite. How big do you think the animal was that produced it? (circle all that apply)
   a. Chicken-size
   b. Human-size
   c. *Triceratops*-size
   d. *Tyrannosaurus*-size

2. Why do you think this?

3. When paleontologist Karen Chin studied this specimen, she found that it contained many bone fragments ranging in size from 2 mm to 34 mm long. What are two things that this tells us about the diet or dietary habits of the animal that made this?

4. What does the survival of this coprolite tell us about the environment in which it was deposited? (circle all that apply)
   a. It was deposited in a high-energy river, where it was carried away by fast moving water.
   b. It was deposited on a flood plain and quickly buried by fine-grained sand and in essence protected from further damage.
   c. It was deposited on top of a hill overlooking a lush valley, where wind, rain, and sunlight could alter it. The hilltop was also an area visited by animals ranging from poop-eating beetles to poop-stepping-on *Triceratops*.

5. Explain why you think this.

6. Based on its size and the items found within it, who do you think could have produced this coprolite? (circle all that apply)
   a. A very hungry and aggressive carnivorous mammal about the size of a rat.
   b. A *Hadrosaurus*, an herbivorous dinosaur
   c. A *Tyrannosaurus rex*, a meat-eater that ate anything it wanted.
   d. A gar, which is a type of fish.

7. What additional information would you need to figure out what animal it came from?

Lesson 10 - A

Interdisciplinary Mystery

Using a Small Coprolite to Understand an Ancient Environment

(See photo of small coprolite labeled Coprolite Two)

The specimen in the photograph is about twice life size. Adjacent pieces originally attached to center piece (4 cm wide). A microscopic view reveals no signs of undigested bones, muscles, or teeth.

1. The specimen in this photograph is fossilized feces, or poop, known scientifically as a coprolite. How big do you think the animal was that produced it? (circle all that apply)
   a. Chicken-size
   b. Blue Whale-size
   c. Human-size
   d. *Triceratops*-size

2. Why do you think this?

3. Paleontologists used a microscope to discover that this specimen contained small, scattered plant fragments making up 1–2% by volume. Do you think this indicates an herbivore or a carnivore? Why?

4. What does the survival of this coprolite tell us about the environment in which it was deposited? (circle all that apply)
   a. It was deposited in a high-energy river, where it was carried away by fast moving water.
   b. It was deposited on the banks of a slow-flowing, meandering stream, possibly on a spot where fine-grained sediments accumulate.
   c. It was deposited deep in an ocean, where the water quickly broke down soft non-bone rich deposits.
   d. It was deposited on the side of an active volcano, where regular flows of lava covered the landscape.

5. Explain why you think this.

6. Here are descriptions of some animals and the feces they produce. Which one do you think could have produced the coprolite above? (circle all that apply)
   a. Small meat eating dinosaur, runs on two legs, scat often contains bits of bones and teeth.
   b. Carnivorous turtle, internal anatomy of digestive tract often leads to grooved coprolites.
   c. Small crocodile (about 5 feet long), long narrow snout, because of the nature of their digestive tract, the remains of bones and teeth are rare in fossilized scat.
   d. A very aggressive and very large chicken, which produces many large piles of scat.

7. Explain why you think this.