Lesson 10

Hell Creek Montana – Interdisciplinary Mystery

Summary
Montana's Hell Creek Formation is world famous for its fossils and rocks. In particular, they record one of the most famous events in geologic history, the extinction of the non-avian dinosaurs. Paleontologists initially focused on the fossils, including some of the best-known animals to walk the planet, such as *Triceratops* and *Tyrannosaurus rex*. Over time, researchers began to attempt to put together a fuller story of Montana 66 million years ago. They considered what the environment looked like, who ate whom and what they ate, and how some of these animals went extinct and how some survived. Doing this required an interdisciplinary approach working with geologists, paleobotanists, and geochemists, each of whom focused on a particular part of the story. Together they have been able to paint a picture of an incredible world.

In this lesson, students will work in teams, taking on different roles and attempting to understand the life and times of the period from around 70 to 60 million years ago. They will work with specimens and photographs and consider a series of questions. They will then present their analysis to the class.

This is a challenging Lesson as it requires students to make inferences, use critical thinking, compare what they see with what they have learned, and finally to bring together a variety of lines of evidence to draw a conclusion. It is necessary that the students have done most of the previous Lessons. We recommend that you begin by reviewing what has been learned previously and tell the students that what they are doing in this lesson will challenge them.

Objectives
Students will be able to:

1. Explain how accurate comprehension, synthesis and presentation of information are important for collaboration.
2. Describe the paleoenvironment of Montana around 66 mya.
3. Describe how paleontologists use fossils to reconstruct past environments.
4. Apply what they learned in past lessons to study novel fossil information.

Estimated teaching time
1-2 class sessions

Groups
Start as a classroom then divide into groups then come back together in the class.

Materials

- Worksheets for each group
- Specimens or photographs for each group

Teacher background
See handouts MYSTERY BACKGROUND and FOSSIL BACKGROUND.

Student background
Students will have to have completed at least lessons 2, 3, 4, and 5 or be familiar with fossils, how they form, and what one can learn from them; and rocks and how they form.

Set up
Classroom

Introducing the activity

1. Begin by reminding the students about the previous lessons they have been working on. This final lesson attempts to use the information they have acquired to better understand a single location at a single period of time. In this case, it is Montana 67 million years ago (mya), as preserved in the rocks of the Hell Creek Formation. Ask the students how they might go about figuring out what happened 66 mya. Ask them to consider what they have learned and how that might help them. You might get them to consider how they would solve a modern mystery, looking for clues, interviewing suspects, taking a variety of different angles. This is what they will be doing in this lesson.

2. Ask them to think about what sort of information they would want to know? They might include who or what (plants) lived then, what type of rocks were deposited, what was the climate like, what was the interaction between species, such as did one eat the other. What evidence do they think they won't be able to discover? (Again this gets back to questions of why and how, such as how exactly did one dinosaur kill another or why did certain animals eat certain plants.)

Facilitating the activity

1. Divide into five groups. Tell everyone that each group has a set of five activities that will help them focus on the environment of the Hell Creek Formation. Each activity addresses a slightly different aspect of the environment. Together the activities will allow the students to see how paleontologists rely on many lines of evidence to better understand paleoenvironments. Each group will tackle all of the questions in each of the separate parts of the lesson.

2. Pass out worksheets, photographs, and specimens to each group. Tell students that they should read the background material and then attempt to answer the questions on their worksheet. Remind them that their goal is come up with a picture/description of the environment. What interactions can they describe? What plants lived here? What animals lived here? Why do they know this? What additional information do they wish they had? What type of information will they not get from the fossil record?

Assessment

1. After students have worked on their specimens have the class gather back together and have the students discuss what they discovered. Are their contradictions between groups, meaning does one line of evidence indicate one environment and another one a different environment? Why or why not? You might want to have the students compile what they each group learned (or you could do this on a board), as way to see how the different lines of evidence provided different pieces of information.

2. Have each student write a short essay about the line of evidence they studied. What did they learn from the evidence? What additional information would they have liked? What surprised them most about what information their evidence provided?
3. Have them write a short essay explaining how all the various lines of evidence contributed to a more complete picture of the environment 66 million years ago.

Going further

1. As a class, do the same thing for the modern environment they live in, where groups have to go out and find different clues that would help someone in the future put together the ecosystem story.
2. Have them analyze a recent fossil discovery to see how the paleontologists put together the story of where that animal lived.

References

See disc with articles for Lesson Ten.

Teaching standards

Science Content Standard 1. Students, through the inquiry process, demonstrate the ability to design, conduct, evaluate, and communicate results and reasonable conclusions of scientific investigations.

Benchmark End of Grade 4, number 3 - Use data to describe and communicate the results of scientific investigations

Science Content Standard 4. Students, through the inquiry process, demonstrate knowledge of the composition, structures, processes and interactions of Earth's systems and other objects in space.

Benchmark End of Grade 4, number 3 Investigate fossils and make inferences about life, the plants, animals, and the environment at that time

E. Compare a fossil to a plant/animal living today

F. Infer what fossils tell us about past life and the environment.

Science Content Standard 5. Students, through the inquiry process, understand how scientific communities, cultures and societies

Benchmark End of Grade 4, number 3 - Simulate scientific collaboration by sharing and communicating ideas to identify and describe problems

Science Content Standard 1. Students, through the inquiry process, demonstrate the ability to design, conduct, evaluate, and communicate results and reasonable conclusions of scientific investigations.

Benchmark End of Grade 8, number 3 - Review, communicate and defend results of investigations, including considering alternative explanations.

Glossary

- Angiosperm – Flowering plants. They evolved around 130 million years ago.
- Browser – An animal that feeds on leaves, buds, and green stems. These types of food are easier to digest, so that the digestive system does not need to be quite so big.
- Coprolite – Fossilized poop, dung, feces. (You get the point; find your own euphemism.)
- Fossil – Remains, imprints or traces of an ancient organism that have been preserved in the rock record. Bones, shells, casts, tracks and excrement can all become fossils.

- Grazer – An animal that feeds primarily on grasses.
- Gymnosperm – Literally “naked seed,” plants such as conifers that reproduce with a seed not surrounded by a fruit.
- Trace fossils – Evidence of an animal’s activity, such as tracks, burrows, eggs, coprolites, and borings.
- Track – An animal footprint preserved in a soft medium.