Fossil detectives

Middle school students can examine the fossil record and use evidence about paleoenvironments to develop an understanding of structure and function in living systems and changes over time in Earth history. Earth history is based on the study of rocks and the fossils associated with sedimentary rocks. To answer questions about past life on Earth, paleontologists use many branches of science, including anatomy, comparative morphology, biometrics, pathology, botany, ecology, phylogeny, paleoenvironment reconstruction, and art.

In this enrichment activity, students work in teams to research an assigned geologic time period. They determine available habitats, food sources and types (animal, plant; woody, herbaceous, etc.), cover sources, methods of getting food, defense, and reproduction that would allow an animal to live in the assigned paleoenvironment. Then they create a diorama to display their findings.

Turtle treads

To begin, it is helpful to facilitate a discussion to determine what students understand about fossils and the stories they have to tell us. Start by passing some sample fossils among the students. Ask students if they have been fossil hunting, if they know how fossils are formed, and how old they think the sample fossils may be. Geologists use the principle of *uniformitarianism* to help unscramble geologic puzzles. This is the premise that the physical and chemical laws of nature have remained constant over geologic time. While discussing, help students to see that, if natural laws have not changed, natural processes governed by those laws have not changed either. How can your students use this to understand how physiology and phylogeny may have responded to paleoenvironments?

An example to consider with your students to illustrate uniformitarianism is turtles. The first fossil turtles date from the Triassic period, more than 200 million years ago. Over time, two types of turtles appeared in the fossil record and are found on Earth today: sea turtles and land turtles. The sea turtle's front legs resemble flippers, and its carapace is streamlined. Both these physical features help sea turtles to move through their ocean habitat. The land turtles have stumpy legs suited for life on land. Their carapaces often form a high dome, allowing them to withdraw their head and legs inside the shell as protection against land-based predators.

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These adaptations are as successful for turtles today as they were when they first appear in the fossil record. To involve the students in this information, I use puppets and model skulls (available from several life science education suppliers), which can illustrate motion, to help them understand characteristics of sea and land turtles. Videos may also be used to illustrate turtle locomotion.

Ask students how sea turtles and land turtles protect themselves from predators. What might a predator who can catch and eat each type of turtle look like? How might the turtle's structure or behavior change in response to attacks by a specific type of predator? Have them brainstorm as a class the answers to these questions.

Continue this line of discussion until students understand how known information about turtles and turtle fossils may be used to draw conclusions about how organisms adapt to changing environments. Have students name other organisms that have characteristics that allow them to succeed in specific habitats. How and why do squirrels climb trees? Why does a humming bird have a long, narrow bill?

Fossils in our own backyards

Connecting the study of Earth history to the area in which you are teaching can enrich this activity. The state of Oregon, where I teach, has fossil locations that provide evidence the state was ocean millions of years ago. Then, plate tectonics carried the North American continent westward, mountain ranges were created and weathered, and the climate changed dramatically over geologic time. This story is told by an amazingly continuous fossil record.

Teachers and students can use the website of the University of California at Berkeley's Museum of Paleontology to locate information about particular states (see Resource). This website has a wealth of paleontology information and photographs of plant and animal fossils. You may wish to use this information to select a particular time period, from the Precambrian to the Quaternary, for your students to investigate. While websites are known to change, this one has been consistently getting better over the four years I have used it.

Creating the dioramas

The combination of science and art creates an excellent cooperative learning activity. The activity should take place over several days, up to a few weeks. The goals are for teams of two or three students to use the library and the internet to research an assigned paleoenvironment's components; identify and describe the relationships between their proposed organism's structure and function; identify and describe the factors that influenced or changed the balance of populations; and communicate their conclusions in a 10-minute oral report, illustrated by a diorama.

Each team is assigned to research a specific time period and design an organism that will be uniquely suited to live and thrive in a habitat of that time. Students may be assigned to research the same or different periods of geologic time. Before they begin the research, the teams will answer questions to help them design an organism (see Activity Sheet on page 54). They will report on their questions and answers when they share their completed dioramas with the full class. It is helpful to have the teams report their progress to the teacher prior to beginning their dioramas to allow coaching through any misconceptions that may arise. This is also an opportunity for formative assessment.

If students are to create their dioramas in class, you will need to give each team a shoebox or something similar and art supplies such as craft sticks, modeling clay, construction paper, cardboard, and colored pens. If you use shoeboxes, keep the lids so the dioramas can be stacked neatly between class work periods.

Set aside a time period for the teams to give their reports. Plan 15 minutes per report to allow for questions from other students and discussion. Make it special by inviting the principal or other teachers to attend. Each member of the team should give a segment of the oral report. Be sure students know how much time they have for their reports and what they are expected to report on. When the report is concluded, other students should be given the opportunity to ask questions or

challenge assumptions of the presenting team. The dioramas and oral reports provide opportunity for assessment of the performance tasks by both the teacher and the other student teams.

Where's the inquiry?

It is true that this activity does not involve students in a classic laboratory activity. However, students do design an investigation; gather, analyze and interpret information; and develop a model to communicate their explanation of life in a paleo-environment. The creative thinking and artistic components of this activity are popular with most students. This lesson can be adapted to early Earth history units by asking students to pose the question, "Why did dinosaurs become what they did?" instead of the familiar question, "Why did they become extinct?" Students use the same investigation and analytical skills to review the fossil record and interpret how dinosaurs evolved in the paleoenvironments of the Mesozoic Era.

In *Assessing Student Understanding in Science*, Enger and Yager state, "Although there is no consensus regarding what kinds of science content are necessary for scientific literacy, a scientifically literate person is believed to be one who appreciates the strengths and limitations of science and who knows how to use scientific knowledge and scientific ways of thinking for living a better life and for making rational social decisions" (2001). When they become fossil detectives, students have the opportunity to build their scientific knowledge and think scientifically as they answer questions about past life on Earth.

Resource

University of California at Berkeley's Museum of Paleontology —*www.ucmp.berkeley.edu*

References

Enger, S.K., and R.E. Yager. 2001. *Assessing student understanding in science: A standards-based K–12 handbook*. Thousand Oaks, CA: Corwin Press.

Thompson (Bourdeau), V., and A.C. Bourdeau. 2000. *Oregon 4-H Earth science project leader guide: Be a fossil detective*. Corvallis, OR: Oregon State University Extension and Experiment Station Communications.

Become a fossil detective

You and your team are fossil detectives. You will identify information you need to compare and contrast life-forms of the Clarno period. You will research information about the fossil record in books and on the internet. Create a bibliography of all the books and resources your team uses in the project. Each team will create a diorama depicting an organism they design to live in the Clarno period. You will use your science investigation skills, imaginations, and art talent in this project. Your team will also present a 10-minute presentation about your research and the design of the organism in your diorama. Be sure all members of the team have a chance to contribute.

Procedures

1 Give your team a name.

2. Work with your team to answer the questions below on a separate sheet of paper.
   - What do you need to know about habitats in the Clarno period to begin to design an organism?
   - What do you need to know about food sources available to organisms?
   - What do you need to know about defenses that an organism might use?
   - What do you need to know about possible methods of reproduction and rearing of young?
3. When your team has answers to the questions, ask your teacher to review them and your written bibliography before you begin to construct your diorama.
4. Your diorama should illustrate the information your team will present in your 10-minute oral report.
5. In your oral report, be sure to clearly explain not only how the organism looks and behaves, but also why you chose these characteristics and behaviors. Each member of the team should give a segment of the report. At the conclusion of your report, the other teams will have the opportunity to ask you about the conclusions you have made to create the diorama.

The diorama should illustrate the critical elements of the life of your proposed organism. Each of the characteristics and behaviors listed below is worth 1–5 points. The maximum number of points possible for each team for this project is 30.

- Food supply
- Water supply
- Type of shelter
- Method of defense
- Method of reproduction and rearing of young
- Bibliography documenting references and resources used