ACTIVITY

Onward and Upward?

INTRODUCTION Fossils—defined as any recognizable evidence of ancient organisms—open windows into the past, but also present scientists with several puzzles. When fossils of previously unidentified organisms are found, scientists attempt to interpret what the fossils reveal about the history of life on Earth. How complete is this new evidence? How does it fit in with what is already known? What does it mean in and of itself? The fossil record of life on Earth is incomplete, creating challenges to scientists who would like to chart the emergence and extinction of all living things in the 4.5 billion years since the formation of the earth. To their delight, "new" organisms are always coming to light, whether they are recognizable ancient remains or organisms living now but never before seen.

In this activity, you will create an *evolutionary tree*, that is, a logical pattern illustrating how a mythical organism known as "The Swingette" might have evolved over millions of years. Keep in mind that evolution is driven by randomness and chance, and that there may be "dead ends" in the evolution of this creature.

MATERIALS NEEDED

For each pair of students:

- 1 sheet of fossil drawings— "The Swingette"
- 1 large sheet of paper (11x17 inches or larger)
- scissors
- 1 glue stick or roll of cellophane tape

CAUTION: *Scissors may be sharp; handle with care.*

PROCEDURE

1. Cut out the 12 fossil drawings. You do not need to follow the lines exactly.
2. Place the fossil drawings on the large sheet of paper. Arrange them according to how you think this organism evolved over time.
3. Attach the fossil drawings to the paper either with a glue stick or tape and draw arrows between the drawings to create an evolutionary tree.
4. Add notations of your reasoning for the placement of the fossil drawings.

NOTE: There may be extinctions or gaps in the fossil record.

ANALYSIS

Write responses to the following in your notebook.

1. What general pattern of evolution did you choose? Why?
2. Do you think evolution always occurs in this way? Give an example of how it might not.
3. What might be some reasons for an organism to become extinct?
4. What is the value of fossils to scientists if they do not give us a complete picture?

CHARLES DARWIN'S THEORY—THEN AND NOW

READING

After graduating from the university, Charles Darwin (1809-1882) set sail on the H.M.S. *Beagle* in 1831 as both an unpaid dinner companion to the captain, who otherwise would dine alone, and as a naturalist. The mission of the *Beagle* and its crew was to chart the coastline of South America and continue around the world; it would be nearly five years before they returned to England (see Figure 10.1). At each stop along the way, Darwin went ashore, collecting and classifying organisms that few Europeans had ever seen. He experienced his first earthquake and climbed the Andes mountains where he found fossils of shellfish. He was intrigued by the finches on the Galapagos Islands, a series of islands of volcanic origin 600 miles off the shore of Ecuador in the

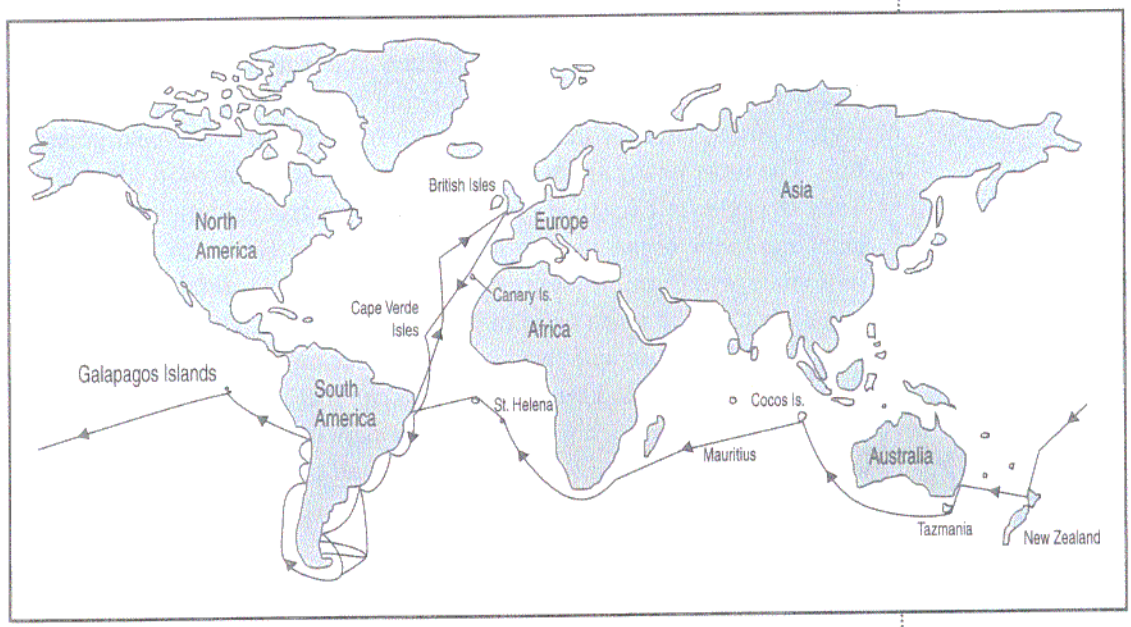

Figure 10.1
Voyage of the H.M.S. *Beagle*.

Notes

Setting the Context

Session One

Students are familiar with the concept that organisms and structures change over time. They see people age, malls being developed on what was wooded land, and computers becoming obsolete almost as soon as they reach the retail store. In this Setting the Context, students will be given "fossil" drawings and will create an evolutionary tree that shows the passage from an indistinct "blob" through intermediate forms to its current form of "The Swingette." You may wish to show students an example of a "Tree of Life" (see Advance Preparation).

TEACHING STRATEGY

A diagram of an evolutionary tree of life is often found in the taxonomy and/or evolution sections of a biology textbook. Although the history of life on Earth is often pictured as a tree, some evolutionary biologists think that the analogy of a bush, with its many branches and twigs, is more accurate. Although the tree/bush shows that earlier organisms seem to be simpler in structure and function while later organisms are more complex, encourage students to think in terms of an evolutionary flow and not of one that is hierarchical with "lower" and "higher" forms. Many complex organisms have died out and many simple forms have survived for billions of years.

Begin class by having the students read the Prologue and the Introduction to "Onward and Upward?" Divide the class into pairs and distribute one copy of the Blackline Master "The Swingette" to each pair. Allow students about 20 minutes to complete the Procedure and write responses to the Analysis in their notebooks.

Prologue and "Onward and Upward?": Student Manual pages 115–117.

DISCUSSION QUESTIONS

When students have finished, you may wish to have several pairs of students volunteer to present their trees and their explanations. You may continue the discussion by having students respond to the following questions (modified from the Student Manual):

- Is there any "right" answer to this activity? Why or why not?
- What general pattern of evolution is illustrated? *(It is expected that students will have arranged trees in a simple-to-complex pattern.)*
- What might be a real-world example of evolution not following this pattern? *(Students may not be able to respond to this question. However, you may ask them to think why a "blob" such as an ameba still exists on Earth; or how some organisms seem to have devolved, such as eyeless fish in the depths of the ocean; or what organisms appear after mass extinctions.)*

ASSESSMENT

Are the students' trees and their explanations for the progression logical?

SCIENCE BACKGROUND

There are three main patterns of evolution—divergent, convergent, and parallel. Divergent evolution, also known as a form of adaptive radiation, occurs after the opening of new environments and results in the formation of new species. Vertebrate evolution is an example of divergent evolution. In convergent evolution, species that are not closely related to each other, but live in similar environments, have developed similar structures, for example, fish and dolphins. Convergent organisms have analogous structures which, while different in origin, have the same function. In parallel evolution, species that are related and live in similar environments—such as gulls and ducks—evolve along similar paths.

- What might be some reasons for extinction? *(Student responses may name humans as the main cause for extinctions, but remind them that extinctions occurred long before humans appeared on Earth. Have students explore the natural events that cause extinctions, such as climate changes, volcanic eruptions and other natural forces, predator-prey relationships, parasites and disease.)*
- What is the value of fossils to scientists if they do not give us a complete picture? *(Students should respond that each new discovery adds to our knowledge of earlier organisms, and advances in dating techniques accurately place fossils in evolutionary time.)*

"Charles Darwin's Theory—Then and Now":
Student Manual pages 117–119.

HOMEWORK

Have students read "Charles Darwin's Theory—Then and Now" and write responses to the Analysis. This reading develops Darwin's theory of natural selection and explains the thinking behind his precepts using current knowledge of genetics.

TEACHING STRATEGY

The concept of evolution may be controversial among some students and disbelieved by others. It is, however, the thread that connects biology for, as Theodosius Dobzhansky said in 1973, "Nothing in biology makes sense except in the light of evolution." You may wish to be guided by the National Association of Biology Teachers' Statement on the Teaching of Evolution which states in part:

- Natural selection, the primary mechanism for evolutionary changes, can be demonstrated with numerous, convincing examples, both extant and extinct.
- Natural selection...has no specific direction or goal, including survival of a species.
- In science, a theory is not a guess or an approximation but an extensive explanation developed from well-documented, reproducible sets of experimentally derived data from repeated observations of natural processes.
- Students can maintain their religious beliefs and learn the scientific foundations of evolution.