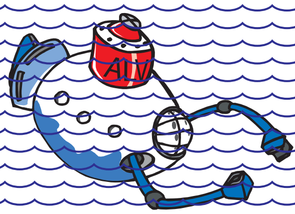

InVENT a Deep-Sea Invertebrate

Focus

Galapagos Rift Ecosystem - Structure and Function in Living Systems

Grade Level

Grade 5-6

Learning Objectives

Students will design an invertebrate capable of living near deep-sea hydrothermal vents, and in doing so, will learn about the unique adaptations that organisms must have in order to survive in the extreme environments of the deep sea.

Additional Information for Teachers of Deaf Students

The key words are integral to the unit but will be very difficult to introduce prior to the activity. They are really the material of the lesson. There are no formal signs in American Sign Language for any of these words and many are difficult to lip-read. If some of this information has not already been covered in your class, you may need to add an additional class period to teach vocabulary and teach some of the background information to the students prior to the activity. Having the vocabulary list on the board as a reference during the lesson will be extremely helpful.

Materials:

- ❒ Reference materials such as encyclopedias, life science textbooks, Internet sites
- ❒ Colored pencils or markers (one pack per student group)
- ❒ Animal Adaptation Chart (one copy per pair of students)
- ❒ Chart paper

Teaching Time

Two 45-minute sessions

Seating Arrangement:

Students will work in pairs for research.

Key Words

Benthic
Adaptations
Hydrothermal vent
Chemosynthesis
Photosynthesis
Plates
Carbohydrates
Ecosystems
Tubeworm
Invertebrate
Amphipod
Sessile
Organism
Deposition
Molten
Magma
Precipitate
Endosymbionts
Genetically

Background Information:

Twenty-five years ago, Jack Corliss, Robert Ballard, and other Woods Hole Oceanographic Institution oceanographers first observed *in situ* the hydrothermal vent system off the coast of the Galapagos Islands on the Galapagos Rift. The year was 1977. They amazed the world with the discovery of communities of organisms that were incredibly unique. But even more incredible was the discovery that these organisms could obtain sugar compounds through chemosynthesis rather than photosynthesis. In fact, chemosynthesis was the basis of the food web (*Ballard, 2000*). Since this discovery, there have been numerous hydrothermal vent systems discovered in the Pacific, Atlantic, and Indian Oceans.

Hydrothermal vents are areas in which seawater percolates back up through the cracks between plates of the Earth. Fresh lava flows are often found in these areas, but the hydrothermal vents are a product of deposition of chemical reactions created by the circulation of water in these cracks. As seawater is percolated deep down into the oceanic crust, it returns to the ocean through other openings in the crust after being heated to temperatures as high as 400°C. The ocean water to which it returns is often at 2°C and is under extreme pressure, since these areas exist over a mile beneath the surface of the ocean.

As this water passes through channels in the rock near molten magma beneath the oceanic crust, it takes up metal ions of iron, magnesium, copper, and zinc. Hydrogen and hydrogen sulfides are released from the plumes of the hydrothermal vents, along with metallic ions and metallic salts. The metals precipitate from the water to form the chimneys of the vents. Often hydrogen sulfides precipitate within the latticework of the vents (*Baker and Walker, 2000*). The hydrogen sulfides are combined with water and oxygen by chemosynthetic bacteria to form carbohydrates, or sugars. These sugars form the basis of the food web in the vent ecosystems. The chemosynthetic bacteria may exist freely or as endosymbionts within organisms of the vent communities.

Although the organisms in these systems must be able to withstand extreme temperatures, pH, pressure, and total darkness, there is an abundance of different life forms found in vent communities. The organisms of the vent communities are amazing life forms that are highly adapted to these vent environments. Adaptations are genetically-controlled characteristics that aid organisms in surviving and reproducing in their environments. Because of the wide diversity of habitats in the ocean, we see amazing degrees of adaptations in body form and function among marine organisms—and the organisms found living in hydrothermal vent communities are no exception. In fact, probably some of the most amazing adaptations for life on Earth can be found in these strange and beautiful creatures.

Why do these organisms look the way they do? What do they eat and how do they get their food? How do they protect themselves? How do they move and what do their young look like? How long do the adults live? How do they withstand the extreme pressure and heat in this extreme environment?

Organisms adapt to their environment in the following ways:

1) They need to be a certain shape, or form, depending on where they live.
2) They may or may not need to move around. Some organisms are sessile, or immobile. They only move in their larval stage. Once they reach their adult phase they stay in one place. They need some sort of adaptation to stay in that place. Other organisms move about. They need an adaptation to help them move.
3) All organisms need to feed in one way or

another. Some organisms filter food through gills, while others take in food through a mouth. They also need to get rid of wastes.

4) All organisms need protection from predators and environmental stress. This protection may be camouflage, special body parts, a heavy, protective outer layer, and/or some form of locomotion, or a metabolic process to handle stress.

5) All organisms need to reproduce, and their young often look very different from the adults.

Scientists have discovered over 300 new species of organisms associated with vent communities around the world. Probably the most notable are the giant tubeworms, which can reach 6 feet in length. These are the fastest growing invertebrates known to mankind. Other worms, such as the Jericho worm, are about the size of a pencil and live in tubes that look like accordions. Another type of worm, named Alvinellids by scientists, was also discovered at vent communities. These worms were named after the Woods Hole Oceanographic Institution's manned submersible, Alvin.

Other organisms that have adapted to life near vents include clams, mussels, and shrimp. Amphipods, small lobsters, sea anemones, fish, and octopi have also been found in these extreme environments.

The discoveries of scientists as they continue to explore the ocean depths at hydrothermal vents continue to intrigue the scientific community and the world. Jack Corliss, one of the first observers of hydrothermal vents, has proposed that life evolved from hydrothermal vent communities over 3 billion years ago (Hoyt, 2001). As scientists begin to explore new rift system communities around hydrothermal vents, they continue to discover new species of organisms. The rich data provided by these hydrothermal vent systems will continue to produce intense speculation about the origins of life on Earth.

Learning Procedure

1. Discuss the Background Information, as appropriate, with your students. Have them brainstorm what they think it might be like to live in the deep sea near hydrothermal vents and record their answers on chart paper. Students need to remember the parameters of the ecosystem, such as extremely cold water, extremely hot water rising from the vents, no light, and the presence of chemosynthetic bacteria. Further brainstorm with your students about the kinds of adaptations that organisms might need to live in the extreme conditions associated with hydrothermal vent ecosystems. Record these answers on chart paper.
2. Ask each student pair to research, using available references (Internet, encyclopedias, and/or textbooks), organisms found near hydrothermal vent communities. Each pair should be directed to www.divediscover.whoi.edu
3. Distribute one copy of the Animal Adaptation Chart for each pair of students.
4. Ask each student pair to design and draw an invertebrate capable of living near a hydrothermal vent ecosystem. Each invertebrate must exhibit adaptations in body form (for both young and adult stages),

locomotion, feeding, and protection. The pair should name their "new" organism, and describe to the class as they display their drawing what their organism's body shape is and why it is shaped that way, how it moves, how it feeds, how it protects itself, and what its young look like and why they look the way they do.

The BRIDGE Connection:

http://www.vims.edu/bridge/vents.html
Go to this site for a BRIDGE Ocean AdVENTure on hydrothermal vents.

The "Me" Connection

Ask students to think about what types of adaptations they would have to have as humans if the temperature of the air were to rise such that desert conditions existed everywhere on Earth.

Connection to Other Subjects

Art, English/Language Arts

Evaluation

Adaptation Charts from each student pair may be evaluated for completeness and student drawings may be evaluated for understanding of adaptations.

Extensions

Have your students visit http://oceanexplorer@noaa.gov and www.divediscover.whoi.edu with a member of their family each day to keep up to date with the latest Galapagos Rift Expedition discoveries.

Have students write a story about "A Day in the Life of..." for the animal they chose to design. They should explain the unique adaptations of the animal within the story.

The student pairs could get together with other student pairs to form a food web that incorporates several of the animals they designed.

Students should research the animals that actually live in hydrothermal vent communities.

Resources

http://oceanexplorer@noaa.gov and www.divediscover.whoi.edu - Follow the Galapagos Rift Expedition daily as documentaries and discoveries are posted each day for your classroom use. A wealth of resource information can also be found at both of these sites.

National Science Education Standards:

Life Science Content Standard C:

- Structure and Function in Living Systems
- Reproduction and Heredity
- Regulation and Behavior
- Populations and Ecosystems
- Diversity and Adaptations of Organisms

Activity adapted from Design a Deep Sea Invertebrate, developed by Robin Sheek and Donna Ouzts, Laing Middle School, Charleston County School District, Deep East 2001 Educators Guide

Student Sheet
Animal Adaptation Chart

Directions:
Use references provided to complete the following chart for your invertebrate.

Draw a picture of your animal:

Describe its body form:

Describe how it moves:

Describe how it feeds:

Describe how it protects itself:

Describe what its young look like: