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Exploring Alaska's Seamounts

Breaking Away (Or Not...)

Focus
Reproductive strategies among benthic seamount species

Grade Level
9-12 (Life Science)

Focus Question
Do benthic seamount species have special strategies for reproduction?

Learning Objectives
Students will be able to compare and contrast common reproductive strategies used by benthic invertebrates.

Students will be able to describe the most common reproductive strategies among benthic invertebrates on a seamount, and explain why these strategies are appropriate to seamount conditions.

Students will be able to describe how certain reproductive strategies favor survival of species on seamounts, and what changes on seamounts might favor other strategies.

Students will be able to discuss the implications of reproductive strategy to the conservation and protection of seamount communities.

Additional Information for Teachers of Deaf Students
In addition to the words listed as Key Words, the following words should be part of the vocabulary list.

Productivity
Habitats
Parallel
Deep sea corals
Reefs
Commercial fisheries
Climate
Skeletons
Bottom trawlers
Protection
Reproduce
Larvae
Metamorphose
Reproductive strategy
Conservation

The words listed as Key Words should be introduced prior to the activity. There are no formal signs in American Sign Language for any of these words and many are difficult to lipread.

This activity may take two class periods - one to introduce and do the taxonomic work and one to have discussion afterwards.

Materials
- ❒ Copies of Benthic Species List from the Cobb Seamount, one copy for each group

Audio/Visual Materials
None

Teaching Time
One 45-minute class period

Seating Arrangement

Groups of two to three students

Maximum Number of Students

24

Key Words

Seamount
Benthic
Taylor column
Planktonic
Direct release
Dispersal
Eddy
Endemic

Background Information

Seamounts are undersea mountains that rise from the ocean floor, often with heights of 3,000 m (10,000 ft) or more. Compared to the surrounding ocean waters, seamounts have high biological productivity, and provide habitats for a variety of plant, animal, and microbial species. Numerous seamounts have been discovered in the Gulf of Alaska. Many of these seamounts occur in long chains that parallel the west coast of the U.S. and Canada. One of the longest chains, known as the Axial-Cobb-Eikelberg-Patton chain, is being intensively studied by the Ocean Exploration 2002 Gulf of Alaska Expedition.

Several researchers on the Expedition are studying deep-sea corals. These animals have a hard skeleton like the familiar tropical reef corals, and often form branched shapes resembling trees or fans. Like their warm-water relatives, deep-sea corals form reefs and provide habitat to numerous other species. Besides being important to commercial fisheries, these corals are also of interest to scientists studying the Earth's long-term climate patterns. The chemical composition of the skeleton in deep-sea corals depends in part upon temperature conditions that exist when the skeleton is formed. Because some corals live for many years (decades or even centuries), their skeletons contain a record of temperature changes in remote ocean areas before modern monitoring instruments were available to scientists.

Unfortunately, seamount habitats are easily damaged by commercial trawl fishing. At the First International Symposium on Deep Sea Corals (August, 2000), scientists warned that more than half of the world's deep-sea coral reefs have been destroyed, and some believe that destruction of deep-sea corals by bottom trawlers is responsible for the decline of major fisheries, such as cod. The importance of deep-sea corals to scientific research, commercial fisheries, and other marine species makes protection of seamount habitats an urgent need.

But effective protection requires better information on the biology of these corals. One critical question concerns how deep-sea corals and other benthic seamount species reproduce. Most benthic marine invertebrates produce free-swimming or floating planktonic larvae that can be carried for many miles by ocean currents until the larvae settle to the bottom and change (metamorphose) into juvenile animals that usually resemble adults of the species. A longer larval phase allows for greater dispersal, and gives the species a wider geographic range. If deep-water corals and other benthic seamount species reproduce in a similar way, the larvae produced on a protected seamount might be carried far away from the protected area. This could mean that protecting only a few seamounts might not produce major improvements to deep-water coral populations on these seamounts.

On the other hand, species with shorter larval stages do not have the advantage of broad dispersal, but are able to remain in favorable local environments. Some species do not have a free larval stage, but brood their larvae inside the adult animal or in egg cases until metamorphosis. If benthic seamount species use similar strategies to keep their offspring nearby, protecting selected seamounts could be an effective way to improve populations of corals and other species on those seamounts that may have been damaged by human activities or natural events.

Other forces may tend to keep larvae from drifting away. Seamounts are often exposed to strong, steady ocean currents. When these currents impinge on a seamount, they cause an upwelling of deep cold water. This cold water has a higher density than surrounding water and tends to sink. This combination of water movements can cause an eddy to form that is known as a Taylor column. Taylor columns may remain over seamounts for several weeks, and can effectively trap larvae that would otherwise be carried away.

The question of reproductive strategy is fundamental to protecting and managing seamount resources, and is one of the focal points of the Ocean Exploration 2002 Gulf of Alaska Expedition.

Learning Procedure

Note: This activity uses data that were collected from several investigations on the Cobb Seamount. Because of difficulties in collecting samples and because only a portion of the collected data are used here, the data in this activity do not represent a complete inventory of benthic species on this seamount.

1. Explain that seamounts are the remains of underwater volcanoes, and that they are islands of productivity compared to the surrounding environment. Although seamounts have not been extensively explored, expeditions to seamounts often report many species that are new to science and many that appear to be endemic to a particular group of seamounts. Describe the major reproductive strategies found among benthic invertebrates, and explain that this activity is intended to help predict which strategies are most common on Gulf of Alaska seamounts.

2. Distribute copies of Benthic Species List from the Cobb Seamount to each group, and assign one or two taxonomic classes to each group. If students are unfamiliar with these classes, you may want to have them do a brief library or Internet search to acquaint themselves with these animals.

3. Have each group summarize the total number of individuals that use each type of reproductive strategy, and the total number of species that use each type of reproductive strategy. Pool the data from all groups to prepare a summary of data for all taxonomic classes.

4. Lead a discussion to interpret these results. What reproductive strategies are most common overall (total number of individuals)? What strategies are used by most species? How can this be explained from our knowledge of seamounts (isolated mountains, often far from land, in deep ocean environments, exposed to strong ocean currents)? Would we not expect more species to use direct development? Even with a pelagic life of only a few weeks, what is there to keep the larvae from being swept far away from the seamount? And if they are swept away, what is the chance of their finding another suitable habitat before they metamorphose?

   A variety of explanations are possible, and students should be encouraged to hypothesize. If eddies are suggested as a possibility, explain the phenomenon of Taylor columns, and point out that the persistence of these eddies for several weeks offers a good resolution to the puzzle of how species are able to make the short pelagic life history strategy work. If no one makes this suggestion, lead the students to consider what might happen when strong currents encounter a seamount.

   Discuss the evolutionary advantages and disadvantages of the different reproductive strategies exhibited on seamounts. Which strategies appear to offer the best survival prospects on seamounts? What changes on seamounts might favor other strategies?

Finally, discuss the implications of these results for conservation and protection of seamount communities (many seamount species may not be widely dispersed, making it more likely that individual seamounts will have some unique species; and since such unique species are not likely to be widely dispersed, these species are particularly vulnerable to extinction).

The BRIDGE Connection

www.vims.edu/bridge/biology.html

The "Me" Connection

Have students select one of the taxonomic classes represented in the species list and prepare a first-person report on a day in the life of these animals, and how they are adapted for life on seamounts.

Connections to Other Subjects

English/Language Arts, Geography, Mathematics

Evaluation

If individual evaluations are desired, have students write their interpretations of the data prior to the group discussion, and/or have them prepare individual commentaries on the implications of the results for conservation and protection of seamount communities.

Extensions

Have students visit http://oceanexplorer.noaa.gov to keep up to date with the latest Gulf of Alaska Expedition discoveries.

Resources

http://oceanexplorer.noaa.gov - Follow the Gulf of Alaska Expedition daily as documentaries and discoveries are posted each day for your classroom use. A wealth of information can also be found at this site.

http://www.sciencegems.com - Science education resources

http://www-sci.lib.uci.edu/HSG/Ref.html - References on just about everything

Parker, T. and V. Tunnicliffe, 1994. Dispersal strategies of the biota on an oceanic seamount: Implications for ecology and biogeography. Biol. Bull. 187:336-345. (The research paper on which this activity is based)

National Science Education Standards

Content Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

Content Standard C: Life Science

- Biological evolution

Content Standard F: Science in Personal and Social Perspectives

- Natural resources

For More Information

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Selected by Science Educators from NSTA

Student Handout

Benthic Species List from the Cobb Seamount (based on Parker and Tunnicliffe, 1994)

Phylum	Class	Species	Number of Individuals	Reproductive Strategy
Porifera	Desmospongiae	*Halichrondria panicea*	6	pelagic, <2 wk
Cnidaria	Hydrozoa	*Allopora verrilli*	11	direct release
	Anthozoa	*Metridium senile*	5	pelagic, <2 wk
		Corynactis californica	17	direct release
Annelida	Polychaeta	*Crucigera zygophora*	18	pelagic, 2-8 wk
		Northria conchylega	1	direct release
		Phyllochaetopterus prolifica	11	direct release
		Protula pacifica	2	pelagic, <2 wk
		Lumbrineris inflata	14	pelagic, <2 wk
Arthropoda	Amphipoda	*Caprella alaskana*	17	direct release
		Caprella laeviuscula	5	direct release
		Proboloides sp.	4	direct release
		Micropleustes sp.	13	direct release
		Parapleustes sp.	19	direct release
		Maera sp.	1	direct release
	Isopoda	*Ianiropsis tridens*	4	direct release
		Munna uniquita	3	direct release
		Munna chromatocephala	6	direct release
	Tanaidacaea	*Leptochelia* sp.	4	direct release
		Paratanais sp.	5	direct release
	Malacostraca	*Chorilia longipes*	3	pelagic, 2-8 wk
		Oregonia gracilis	4	pelagic, 2-8 wk
Mollusca	Gastropoda	*Margarites marginatus*	4	direct release
		Calliostoma annulatum	1	pelagic, <2 wk
		Calliostoma ligatum	4	pelagic, <2 wk
		Diodora aspera	1	direct release
		Searlisia dira	4	direct release
		Granulina margaritula	3	direct release
	Bivalvia	*Crassodoma gigantea*	10	pelagic, >8 wk
		Macoma balthica	1	pelagic, 2-8 wk
		Modiolus modiolus	2	pelagic, 2-8 wk
		Petricola pholadiformis	1	pelagic, 2-8 wk
Brachiopoda	Articulata	*Platidia hornii*	5	pelagic, <2 wk
Bryozoa	Cyclostomata	*Bicrisia edwardsiana*	6	pelagic, <2 wk
		Crisia occidentalis	4	pelagic, <2 wk
		Filicrisia franciscana	3	pelagic, <2 wk
	Cheilostomata	*Bugula* sp.	3	pelagic, <2 wk
		Lyrula sp.	5	pelagic, <2 wk
Sipuncula		*Phascolosoma agassize*	4	pelagic, <2 wk
Echinodermata	Asteroidea	*Pycnopodia helianthiodes*	3	pelagic, >8 wk
		Crossaster papposus	5	pelagic, 2-8 wk
		Henricia sanguinolenta	2	direct release
		Henricia leviuscula	4	direct release
		Leptasterias hexactis	1	direct release
	Crinoidea	*Florometra serratissima*	15	pelagic, >8 wk
	Echinoidea	*Strongylocentrotus franciscanus*	19	pelagic, >8 wk