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2005 North Atlantic Stepping Stones Expedition

Friend, Foe, or ...

Focus
Symbiotic relationships with corals

Grade Level
5-6 (Life Science)

Focus Question
What are some of the associations that exist between corals and other species?

Learning Objectives
Students will be able to define and describe symbiotic, mutualistic, commensal, parasitic, facultative and obligatory relationships between organisms.

Students will be able to describe at least three species that have symbiotic relationships with corals, and discuss whether these relationships are mutualistic, commensal, or parasitic.

Materials
❒ None

Audio/Visual Materials
❒ (Optional) Equipment for viewing downloaded images of corals and the New England and Corner Rise Seamount chains

Teaching Time
One or two 45-minute class periods, plus time for student research

Seating Arrangement
Groups of two to four students

Maximum Number of Students
30

Key Words
Seamount
Symbiotic
Mutualistic
Commensal
Parasitic
Ophiuroid
Cirreped
Polychaete
Sipunculid

Background Information
Seamounts are undersea mountains formed by volcanic activity. These volcanoes may rise as much as 4,000 m (13,000 ft) from the ocean floor, either as isolated peaks or more often as chains that may be thousands of miles long. One of the best-known seamount chains is the Hawaiian Islands – Emperor Seamount Chain that stretches more than 6,000 km across the Pacific Ocean from Hawaii to near the Aleutian Islands west of Alaska. In the North Atlantic Ocean, the New England and Corner Rise Seamounts are part of a volcanic chain that extends from Canada to the African tectonic plate.

Seamounts interrupt ocean currents and cause nutrient-rich deep ocean water to flow up and across the seamount surface. As a result, biological productivity is higher around seamounts than in adjacent deep ocean habitats. Seamounts also have many hard surfaces that can serve as

attachment points for a variety of bottom-dwelling animals. By providing chains of favorable habitats that extend long distances across ocean basins, seamounts may serve as "stepping stones" that have a major role in dispersing deep-sea organisms. These dispersal processes have a fundamental impact on the biogeography (biological diversity and species composition) of all regions of the ocean environment. While the geology of seamounts has been studied to some extent, investigations of the role of seamounts in the ecology and evolution of deep-sea species are just beginning. The ultimate goal of the 2005 North Atlantic Stepping Stones Expedition is to determine whether seamounts function as "stepping stones" that allow organisms living on hard substrates to disperse among adjacent seamounts and extend their ranges across ocean basins. To achieve this goal, expedition scientists plan to collect video images and samples of living and fossil corals, as well as other animals living on and near the corals, from three sets of seamount peaks in the Corner Rise area and five seamounts in the New England Seamount Chain.

One of the major objectives of the North Atlantic Stepping Stones Expedition is to investigate relationships between corals and other associated invertebrates found on various seamounts in the New England and Corner Rise chains. In this lesson, students will examine some of the known relationships between corals and other invertebrates.

Learning Procedure

1. To prepare for this lesson, read the introductory essays for the 2005 North Atlantic Stepping Stones Expedition at http://oceanexplorer.noaa.gov/explorations.05stepstones/welcome.html. You may also want to review information on coral commensals from the 2004 Mountains in the Sea expedition (http://oceanexplorer.noaa.gov/explorations/04mountains/background/commensals/commensals.html).

   Download images that show the location of the New England and Corner Rise Seamount chains, as well as at least one type of coral found on the seamounts. [http://oceanexplorer.noaa.gov/explorations/05stepstones/background/plan/plan.html]

2. Show students a map or other visual image that shows the location of the New England and Corner Rise Seamount chains. Explain that seamounts are the remains of underwater volcanoes, and that they are islands of productivity compared to the surrounding environment. Briefly describe the 2005 North Atlantic Stepping Stones Expedition, emphasizing that the overall goal is to determine whether these seamounts actually serve as biological stepping stones," and a major activity to answer this question involves collecting living and fossil specimens from various seamounts in the chain.

   Briefly review the general biology of corals. Be sure students understand that corals are animals, typically feed on particulate materials or small animals, and often form colonies consisting of many animals. Contrast the "hard" corals that have skeletons of calcium carbonate (limestone) with the "soft" corals whose skeleton are formed by microscopic calcium carbonate spines (spicules) embedded in the corals' flesh.

   Show one or more images of corals found on the seamounts, and tell students that when these corals are collected, they often have one or more other species living on, in or close to the coral colony. Ask students to speculate on why these animals are so closely associated. Students should infer that at least one of the organisms is receiving some benefit from the association. Introduce or review the following relationships and terms:

   symbiotic – a relationship in which two organisms exist in close association, which may or may not benefit both organisms

mutualistic – a relationship between organisms in which both organisms benefit

commensal – a relationship between organisms in which one organism benefits and the other is not affected

parasitic – a relationship between organisms in which one organism benefits and the other is harmed

obligatory – an association that must exist if an organism is to survive

facultative – an association that is "optional" (i.e., the organism is capable of living without the association)

3. Tell students that their assignment is to examine some of the known relationships between corals and other invertebrates. Each group is to prepare a written report about an assigned invertebrate animal that is known to have some type of association with one or more corals. These reports should include:
   - A description of the general appearance and habits of the assigned animal;
   - A description of the coral with which the animal is associated; and
   - An explanation of whether the association is mutualistic, commensal, or parasitic.

   Say that in some cases students may have to make educated guesses about the relationships, but they will still need to explain their reasoning based on information collected through their research.

   Assign one of the following animals to each group:
   - ophiuroids
   - cirrepeds
   - polychaetes
   - sipunculids

4. Have each student group make an oral presentation of their results. The following points should be included:
   - Ophiuroids (also known as brittle stars) are echinoderms with much thinner appendages than the common starfish. Studies of ophiuroids living in association with antipatharian corals (soft corals, black corals) have found that a single ophiuroid may remain on the same coral colony for more than five years, and some species have never been found on any other organism. Experiments have shown that the ophiuroid feeds on mucus produced by the coral polyps, as well as on plankton captured by the coral. This may be considered a commensal relationship if only the ophiuroid benefits, or even a parasitic relationship if the ophiuroid takes food away from the coral. But the association may also be mutualistic, since it is possible that movement of the ophiuroid across the surface of the coral may clear away suspended material that might smother the polyps.

   - Cirrepeds are barnacles, and are relatives of shrimps, crabs, and other crustacea. Some cirrepeds are able to burrow into living coral colonies and form swellings (called "galls") that cause individual coral animals to increase to many times their normal size. This association is known to occur in many coral groups, including the Oculininae which includes corals that form branched colonies as much as one meter tall and are important contributors to forming deepwater reefs. This association also occurs in corals belonging to the group Dendrophyllidae which may form colonies or live as single polyps in turbid waters and on sediments (these corals also are symbiotic with sipunculids, as described below). This is appears to be a parasitic relationship, since no benefit is evident to the coral from this association and the appearance of the galls gives the coral an "abnormal" appearance. But it is possible that no

damage is done to the coral, in which case the relationship would be commensal. It is also possible that the coral receives some unknown benefit from the association, in which case the relationship would be mutualistic.

- There are many examples of symbiotic polychaetes. One review documents 292 species of commensal polychaetes that are involved in 713 different relationships, and 81 species of parasitic polychaetes that are involved in 253 relationships. Corals are second only to the echinoderms in the number of commensal relationships with polychaetes. Several species in the family Scyllidae have symbiotic relationships with gorgonian corals (sea fans). Many of these associations are obligate for the polychaetes, whose appendages (setae) become modified to hold onto the coral (but are less suited for independent locomotion), and whose coloration often matches that of their coral host. "Christmas tree worms" (e.g, *Spirobranchus* sp., family Serpulidae are obligate symbionts that are associated with many "hard" corals, typically the most abundant and accessible coral species available in a given area. There is some evidence that some *Spirobranchus* species preferr to live in aggregations with other worms, rather than spread out over the entire available area of coral (this would be important for species with two sexes that release their gametes to the open water). These associations are probably commensal, since they clearly benefit the polychaetes and do not appear to harm or benefit the host corals (although worms that bore into coral skeletons are sometimes considered parasitic, even though it is difficult to demonstrate definite harm to the coral).

- Sipunculids (commonly known as "peanut worms") form associations with Dendrophyllidae corals which often occur as solitary polyps in turbid waters and on sediments (although colonies of interconnected polyps are also formed by some species). Free-floating larvae of the corals settle onto small shells and begin to grow into their adult form. When the coral has grown large enough to nearly engulf the shell, the sipunculid moves into the shell and maintains a channel through the coral skeleton to the outside. The sipunculid feeds by extending a sort of tongue (proboscis) onto the surrounding sediment, and this action causes the coral and peanut worm to move to a different position, and keeps both animals from being buried. This is probably an example of mutualism, since the coral definitely benefits from the motion that avoids being buried, and the sipunculid probably benefit from the protection of the surrounding coral tissue.

The Bridge Connection

http://www.vims.edu/bridge/otherinverts.html

The "Me" Connection

Have students write a short essay describing a symbiotic relationship that they personally have or have had with another species. They should classify this relationship as commensal, mutualistic, or parasitic, and say why the relationship is obligate or facultative.

Connections to Other Subjects

English/Language Arts

Evaluation

Student reports and class discussions provide opportunities for assessment.

Extensions

1. Have students visit http://oceanexplorer.noaa.gov/explorations.05stepstones/welcome.html to keep up to date with the latest discoveries by the North Atlantic Stepping Stones Expedition.

2. Visit http://www.bigelow.org/reefwatch2001/activities/grades2-5/reef_partnership.PDF for another activity on symbiotic relationships.

Resources

http://oceanexplorer.noaa.gov/explorations.05stepstones/welcome.html – The North Atlantic Stepping Stones Expedition Web site

http://www.tolweb.org – Web site for the Tree of Life Project, with information about many groups of living organisms

http://www.pbs.org/wgbh/nova/teachers/activities/2609_abyss.html – NOVA online activity on symbiotic relationships

http://www.ceab.csic.es/~dani/main.pdf – Symbiotic Polychaetes: Review of known species

National Science Education Standards

Content Standard A: Science As Inquiry

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

Content Standard C: Life Science

- Structure and function in living systems
- Populations and ecosystems
- Diversity and adaptations of organisms

Content Standard F: Science in Personal and Social Perspectives

- Populations, resources, and environments

For More Information

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