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The Gulf of Mexico Deepwater Habitats Expedition

Architects of the Deep Reef

Focus
Reproduction in Cnidaria

Grade Level
5-6 (Life Science)

Focus Question
What reproductive strategies might be used by the deep-sea coral *Lophelia pertusa*?

Learning Objectives
Students will be able to identify and describe at least five characteristics of Cnidaria.

Students will be able to compare and contrast the four classes of Cnidaria.

Students will be able to describe typical reproductive strategies used by Cnidaria.

Students will be able to infer which of these strategies are likely to be used by the deep-sea coral *Lophelia pertusa*, and will be able to describe the advantages of these strategies.

Materials
❒ Drawing materials for making posters

Audio/Visual Materials
❒ Chalkboard, marker board with markers, or overhead transparencies for group discussions

Teaching Time
One 45-minute class period, plus time for student research and for making posters

Seating Arrangement
Groups of 2-4 students

Maximum Number of Students
30

Key Words
Lophelia pertusa
Cnidaria
Nematocyst
Zooxanthellae
Medusa
Polyp
Planula
Anthozoa
Hydrostatic skeleton

Background Information
Deep-water coral reefs were discovered in the Gulf of Mexico nearly 50 years ago, but very little is known about the ecology of these communities or the basic biology of the corals that produce them. In contrast, deep-water coral reefs near the coasts of Europe have been intensively studied, and scientists have found a great abundance and variety of species associated with these communities. *Lophelia pertusa* is the dominant coral species in these communities. Technically, *Lophelia* is ahermatypic (non-reef-building), but branches of living coral grow on mounds of dead coral branches that can be several meters deep and hundreds of meters long. Unlike hermatypic corals that produce reefs in shallower waters, *Lophelia* does not have symbiotic algae and receives nutrition from plankton and particulate material captured by its polyps from the

surrounding water. *Lophelia* mounds alter the flow of currents and provide habitats for a variety of filter feeders. Several commercially-important species are associated with *Lophelia* reefs in European waters, and scientists suspect that the same may be true for deep-water reefs in the Gulf of Mexico. But they don't know for sure, because most of these communities are almost entirely unexplored.

Most reports of *Lophelia* reefs in the Gulf of Mexico were the result of investigations directed toward hydrocarbon seepage and/or chemosynthetic communities. Scientists studying deep-water reefs on the Norwegian continental shelf have found that many large *Lophelia* banks occur at sites where there were relatively high levels of light hydrocarbons present in the sediments. The reason for this correlation is not known, nor is it known whether a similar correlation exists in the hydrocarbon-rich Gulf of Mexico.

As scientists have begun to learn more about *Lophelia* reefs, there is increasing concern that these reefs and their associated resources may be in serious danger. Many investigations have reported large-scale damage due to commercial fishing trawlers, and there is also concern about damage that might result from exploration and extraction of fossil fuels. The primary objectives of the Gulf of Mexico Deepwater Habitats Expedition are:

- to locate deep-water coral reefs in the Gulf of Mexico;
- to describe biological communities and geological features associated with these reefs; and
- to improve our understanding of the ecology of *Lophelia* and deep-water reef communities.

One of the secondary objectives of this expedition is to begin to gather information about how *Lophelia* corals reproduce. This information is critical to finding possible ways to restore damaged reefs, as well as to understanding interactions between *Lophelia pertusa* and other organisms in deep-reef communities. This lesson is intended to introduce students to the phylum Cnidaria, reproductive strategies used by different groups within this phylum, and the ecological advantages of these strategies.

Learning Procedure

1. Briefly review background information on the Gulf of Mexico Deepwater Habitats Expedition, and deep-water reefs. Be sure students understand that these reefs have a high diversity of species and large number of individual organisms like coral reefs in shallower water, but are virtually unexplored in the Gulf of Mexico. Compare and contrast deep-water reef corals (e.g., *Lophelia pertusa*) with reef-building corals in shallow water. Visit http://oceanexplorer.noaa.gov/explorations/islands01/background/islands/sup10_lophelia.html for more background on *Lophelia* reefs. Explain that very little is known about the life history of *Lophelia pertusa*, but this information is very important to understanding the best ways to protect *Lophelia* reefs. Discuss how the scientific method could be used to help learn more about how these corals reproduce: scientists review what is known about similar organisms, develop one or more hypotheses about reproduction in *Lophelia*, and then devise experiments to test these hypotheses. Tell students that their assignment will be to work through the first two steps of this process.

2. Tell students that corals are members of the phylum Cnidaria, and that their assignment is to:

   (a) Prepare a written report that will include:
   - at least three characteristics of cnidarians;
   - descriptions of the four classes of this phylum, with drawings or photographs of a typical animal of each class;
   - descriptions of different reproductive strategies used by cnidarians; and
   - a discussion of the most likely reproductive strategy or strategies used by *Lophelia pertusa*, and what advantages this strategy or strategies might offer to this species.

(b) Prepare a poster illustrating the life history that they hypothesize for *Lophelia pertusa*.

You may want to suggest that students visit http://www.vims.edu/bridge/otherinverts.html as a starting point for their research.

3. Have each group present a summary of their findings. Tabulate key facts about Cnidaria on a chalkboard, marker board, or overhead transparencies. These facts should include:
   - 'Cnidaria' means 'stinging nettle' in Greek;
   - there are four classes of Cnidaria: Anthozoa (corals, anemones, and sea pens), Cubozoa (highly toxic box jellies), Hydrozoa (hydroids, fire corals, and animals resembling jellyfish like the Portuguese man-of-war), and Scyphozoa (true jellyfish);
   - all cnidarians live in water;
   - cnidarians are radially symmetrical;
   - there are two body plans among the Cnidaria: the medusa is the "jellyfish plan" with an umbrella-shaped body having the mouth facing downwards, surrounded by tentacles; the polyp is the "flower plan" with a mouth facing upwards and also surrounded by tentacles; the other end of the polyp is usually attached to a fixed surface;
   - cnidarians have a distinct upper and lower surface; the surface with the mouth is called the oral surface, and the opposite side is called the aboral surface;
   - cnidarians have nerve cells and muscles, but do not have organs such as brains, hearts, circulatory or excretory systems;
   - cnidarians have simple digestive systems without an anus; the mouth is used for output as well as input;
   - cnidarians have stinging cells called nematocysts (which are the primary distinguishing characteristic of the phylum); these stingers often contain toxins that account for the sting of jellyfishes; some box jellies have toxins powerful enough to kill humans;
   - most cnidarians are carnivorous; many feed on small particles of detritus and plankton, but others are able to capture and eat large prey;
   - some cnidarians, including many corals, have symbiotic single-celled algae called zooxanthellae that produce food by photosynthesis; the cnidarians are able to use this food, and provide the zooxanthellae with protection and simple minerals;
   - many cnidarians, including many corals, are colonial, with many individual animals living together as one organism;
   - cnidarians maintain their shape with fluids inside their bodies (this is called a hydrostatic skeleton);
   - some cnidarians also produce a hard internal skeleton of limestone (this is what makes some of the "rocks" that form coral reefs);
   - some corals are used to make jewelry; coral reefs protect many coastal areas from erosion and storm damage, provide habitat and nursery areas for fishes that provide food for many people around the world, and support tourist industries in many countries; some reef-dwelling organisms are the source for important pharmaceuticals;
   - the life cycle of many cnidarians includes a polyp phase as well as a medusa phase; in Anthozoa (which include *Lophelia pertusa*), though, there is never a medusa phase;
   - most cnidarians release eggs and sperm simultaneously into the water, so fertilization is external;
   - in many corals, ova and sperm are located in the same polyp; fertilization takes place inside the gastrovascular cavity, and the larvae are ejected through the mouth;
   - a fertilized cnidarian egg develops into a free-swimming larva called a planula;
   - planula larvae are pear shaped and fringed with cilia that give them limited swimming ability;
   - planula larvae eventually settle down and develop into polyps;
   - in some cnidarians, polyps may reproduce asexually by budding off more polyps or by

budding off medusa forms; these medusae swim off and develop into adults that may eventually produce gametes that develop into planulae; Anthozoa (including *Lophelia pertusa*) never produce medusae.

Students' posters of hypothetical *Lophelia* reproduction may include production of new polyps by asexual budding from an adult polyp or colony, and/or production of gametes from an adult polyp or colony that develop into planulae and eventually metamorphose into new polyps. Ideally, posters would include both possibilities. Posters should not include medusa at any stage, since these are not found among members of the class Anthozoa, which includes *Lophelia*.

The Bridge Connection

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

The "Me" Connection

Have students write a short essay describing ways that cnidarians or deep-water coral reefs might be important to their own lives.

Connections to Other Subjects

English/Language Arts, Earth Science

Evaluation

Written reports and posters provide opportunities for assessment.

Extensions

Log on to http://oceanexplorer.noaa.gov to keep up to date with the latest Gulf of Mexico Deepwater Habitats Expedition discoveries, and to find out what researchers are learning about deep-water coral communities.

Resources

http://oceanica.cofc.edu/activities.htm – Project Oceanica website, with a variety of resources on ocean exploration topics

http://tolweb.org/tree/phylogeny.html – The Tree of Life website

Roberts, S. and M. Hirshfield. Deep Sea Corals: Out of sight but no longer out of mind. http://www.oceana.org/uploads/oceana_coral_report.pdf – Background on deep-water coral reefs

http://www.oceanicresearch.org/ – The Oceanic Research Group website; lots of photos, but note that they are very explicit about their copyrights; check out "Cnidarians: Simple but Deadly Animals!" by Jonathan Bird, which provides an easy introduction designed for classroom use

http://www.mesa.edu.au/friends/seashores/index.html – "Life on Australian Seashores" by Keith Davey on the Marine Education Society of Australasia website, with an easy introduction to Cnidaria, including their method of reproduction.

http://www-biol.paisley.ac.uk/courses/Tatner/biomedia/units/cnid1.htm – Phylum Cnidaria on Biomedia of the Glasgow University Zoological Museum on the Biological Sciences, University of Paisley, Scotland website; includes explanations of the major classes, a glossary of terms and diagrams and photos.

http://www.calacademy.org/calwild/fall2000/sea_venoms.html – Article from California Wild: "Stinging Seas —Tread Softly In Tropical Waters" by Gary C. Williams; an introduction to the venomous nature of tropical cnidarians, why and how they do it

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
- Reproduction and heredity
- 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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