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2005 Florida Coast Deep Corals

Deep Gardens

Focus
Deep-sea coral reefs

Grade Level
5-6 (Life Science)

Focus Question
How do deep-sea coral reefs compare to coral reefs in shallow tropical waters?

Learning Objectives
Students will be able to compare and contrast deep-sea coral reefs with their shallow-water counterparts.

Students will be able to describe three types of coral associated with deep-sea coral reefs.

Students will be able to explain three benefits associated with deep-sea coral reefs.

Students will be able to explain why many scientists are concerned about the future of deep-sea coral reefs.

Materials
- ❒ Access to the internet, or copies of materials cited in "Learning Procedure"
- ❒ Copies of "Deep-Water Coral Reefs Report Guide," one copy for each student or student group
- ❒ Bulletin board or poster board

Audio/Visual Materials
None

Teaching Time
One or two 45-minute class periods

Seating Arrangement
Classroom style

Maximum Number of Students
30

Key Words
Deep-sea coral
Lophelia pertusa
Cnidaria

Background Information
Coral reefs are one of the most species-rich ecosystems on Earth. Shallow-water coral reefs have been widely studied and well-publicized, in contrast to reefs formed by deep-water corals. Recent studies suggest that deep-water reef ecosystems may have a diversity of species comparable to that of corals reefs in shallow waters, and have found deep-water coral species on continental margins worldwide. One of the most conspicuous differences between shallow- and deep-water corals is that most shallow-water species have symbiotic algae (zooxanthellae; pronounced zoh-zan-THEL-ee) living inside the coral tissue, and these algae play an important part in reef-building and biological productivity. Deep-water corals do not contain symbiotic algae (so these corals are termed "azooxanthellate"). Yet, there are just as many species of deepwater corals (slightly more, in fact) as there are species of shallow-water corals.

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. The major structure-building corals in the deep sea belong to the genus *Lophelia*, which has been intensively studied on deep-water coral reefs near the coasts of Europe. Most reports of Lophelia reefs in the Gulf of Mexico are 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 are 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.

While *Lophelia* corals are capable of building substantial reefs, they are also quite fragile, and 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 objectives of the Florida Coast Deep Corals Expedition are to:

- Map selected deep-water, high-relief coral ecosystems on southwestern and eastern regions of the Florida shelf;
- Describe biological communities associated with these reefs;
- Identify dominant fish species associated with these coral communities; and
- Describe the geologic and hydrographic features of each site.

In this lesson, students will explore the variety of corals found on deep-water coral reefs, potential benefits that these reefs offer, and why scientists are concerned about their future.

Learning Procedure

1. To prepare for this lesson, read the introductory essays for the 2005 Florida Coast Deep Corals expedition at http://oceanexplorer.noaa.gov/explorations/05deepcorals/welcome.html

2. Briefly review the basic biology and classification of the phylum Cnidaria (for an easy introduction to the phylum, check out http://www.ucmp.berkeley.edu/cnidaria/cnidaria.html). Alternatively, you may want to have students research answers to a series of questions based on the following list. Here are some points that you may want to include in this review:
   - 'Cnidaria' means 'stinging nettle' in Greek; the name comes from the stinging cells called nematocysts, which are the primary distinguishing characteristic of the phylum; nematocysts often contain toxins; some box jellies have toxins powerful enough to kill humans.
   - All Cnidarians live in water.
   - Cnidarians are radially symmetrical.
   - There are two body plans among the Cnidaria: the "jellyfish plan" is called a medusa, which has an umbrella-shaped body with the mouth facing downwards, surrounded by tentacles; the "flower plan" is called a polyp, which has a body resembling the trunk or stem of a plant with its mouth facing upwards, also surrounded by tentacles; the other end of the polyp is usually attached to a fixed 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.
   - 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 use photosynthesis to produce food that their cnidarian hosts are able to use; corals that do not have zooxanthellae are called azooxanthellate.
- 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 phylum Cnidaria is divided into four classes (there are more classes, but they only contain extinct species): class Anthozoa includes the corals, anemones, and sea pens; class Cubozoa includes the highly toxic box jellies; class Hydrozoa includes hydroids, fire corals, and animals resembling jellyfish like the Portuguese man-of-war; class Scyphozoa includes the true jellyfish.
- The life cycle of many cnidarians includes a polyp phase as well as a medusa phase, but there is never a medusa phase in the Anthozoa (for more about cnidarian reproduction, see the lesson plan, "Architects of the Deep Reef" at http://oceanexplorer.noaa.gov/explorations/03mex/background/edu/media/mexdh_architects.pdf).

3. Assign one of the following coral species or groups to each student:
   Acanella sp.
   Antipatharia
   Callogorgia sp.
   Gorgonia sp.
   hydrocoral
   Lophelia pertusa
   Madrepora occulata
   octocoral
   Oculina varicosa
   Paragorgia
   Primnoa
   Scleractinia

   Tell students that their assignment is to find, copy, and label (with the name of the coral) a photograph of their assigned coral, and prepare a brief report (three to five paragraphs) that includes answers to questions on the "Deep-Water Coral Reefs Report Guide." You may choose to provide copies of the following articles, or provide the URL links, or allow students to discover these (or others) on their own:

   "What are deep-sea corals?" by Lance Morgan; Current 21(4):2-4; available online at http://www.mcbi.org/Current_Magazine/What_are_DSC.pdf

   "Trawlers Destroying Deep-Sea Reefs, Scientists Say," by John Pickrell; National Geographic News, February 19, 2004 (http://news.nationalgeographic.com/news/2004/02/0219_040219_seacorals.html)

4. Create a collage of deep-sea corals by having each student place the labeled photograph of their assigned coral on a bulletin board or a piece of poster board. Some notes about classification and common names are provided below (note that some authorities use Alcyonaria instead of Octocorallia):

   ***Acanella* sp.** (common name: bamboo coral; class Anthozoa, subclass Octocorallia)

   Antipatharia (common name: black coral; class Anthozoa, subclass Hexacorallia, order Antipatharia)

   ***Callogorgia* sp.** (common name: gold coral; class Anthozoa, subclass Octocorallia)

Gorgonia sp. (common name: sea fan; class Anthozoa, subclass Octocorallia)

hydrocoral (common name: fire coral; class Hydrozoa, order Milleporina)

Lophelia pertusa (class Anthozoa, subclass Zoantharia, order Scleractinia)

Madrepora occulata (class Anthozoa, subclass Zoantharia, order Scleractinia)

octocoral (common name: soft coral; class Anthozoa, subclass Octocorallia)

Oculina varicosa (common name: ivory tree coral; class Anthozoa, subclass Zoantharia, order Scleractinia)

Paragorgia (common name: bubblegum coral; class Anthozoa, subclass Octocorallia)

Primnoa (common name: red trees; class Anthozoa, subclass Octocorallia)

scleractinia (common name: stony coral; class Anthozoa, subclass Zoantharia, order Scleractinia)

5. Lead a discussion of students' answers to worksheet questions. Be sure students understand that deep-sea coral reefs are:
   - At least as diverse as their shallow-water counterparts;
   - Provide habitat for many other species (some of which are important human food species);
   - Probably include organisms that can provide useful drugs to treat human diseases; and
   - Are severely threatened by human activity, particularly bottom trawling and longlining.

   The following points should be included:
   - The majority of coral species live in colder, deeper waters.
   - *Lophelia pertusa* is found on deep-sea reefs on continental margins worldwide.
   - Because deep-sea exploration is difficult, our knowledge of deep-sea environments is very limited, and this has led to the widespread assumption that coral reefs are confined to shallow waters.
   - Gorgonians, alcyonaceans, pennatulaceans, and stoloniferans belong to the subclass Alcyonaria or Octocorallia and are collectively referred to as octocorals or soft corals.
   - Only members of the order Scleractinia actually form true coral "reefs."
   - Some deep-sea reefs in the North Atlantic have been found to harbor 1,300 invertebrate species.
   - Growth and reproduction in deep-sea corals is very slow.
   - Some deep-sea corals may be hundreds of years old; one individual has been dated at 1,800 years old.
   - At present, the greatest threat to deep-sea coral communities is bottom trawling.
   - In addition to deep-sea corals, sponges also form highly diverse communities in the deep ocean.

The Bridge Connection

http://www.vims.edu/bridge/ – In the "Site Navigation" menu on the left, click on "Ocean Science Topics," then "Biology," then "Invertebrates," then "Other Inverts" for links to more information about Cnidaria.

The "Me" Connection

Have students write a short essay on how deep-sea coral reefs could be of personal importance,

and how they might be personally affected by the widespread destruction of these reefs.

Connections to Other Subjects

English/Language Arts, Earth Science

Evaluation

Written reports and discussions in Steps 3 and 4 provide opportunities for assessment.

Extensions

1. Have students visit http://oceanexplorer.noaa.gov to keep up to date with the latest discoveries by the 2005 Florida Coast Deep Corals Expedition.

2. See the July 2005 issue of Current: the Journal of Marine Education for a special issue on deep-sea corals (available online at http://www.mcbi.org/Current_Magazine/Current_Magazine.htm), including three lesson plans for grade 5 - 12.

Resources

http://oceanexplorer.noaa.gov/explorations – Web site for NOAA's Ocean Exploration program

Pickrell, J. 2004. Trawlers Destroying Deep-Sea Reefs, Scientists Say. National Geographic News. http://news.nationalgeographic.com/news/2004/02/0219_040219_seacorals.html

http://www.mcbi.org/Current_Magazine/Current_Magazine.htm – A special issue of Current: the Journal of Marine Education on deep-sea corals.

Morgan, L. E. 2005. What are deep-sea corals? Current 21(4):2-4; available online at http://www.mcbi.org/Current_Magazine/What_are_DSC.pdf

Reed, J. K. and S. W. Ross. 2005. Deep-water reefs off the southeastern U.S.: Recent discoveries and research. Current 21(4): 33-37; available online at http://www.mcbi.org/Current_Magazine/Southeastern_US.pdf

Frame, C. and H. Gillelan. 2005. Threats to deep-sea corals and their conservation in U.S. waters. Current 21(4):46-47; available online at http://www.mcbi.org/Current_Magazine/Threats_Conservation.pdf

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

http://www.oceanicresearch.org/ – The Oceanic Research Group Web site; 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 Web site, 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 Web site; includes explanations of the major classes, a glossary of terms and diagrams and photos

http://www.calacademy.org/research/izg/calwildfall2000.pdf – 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

http://oceanexplorer.noaa.gov/gallery/livingocean/livingocean_coral.html – Ocean Explorer photograph gallery

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

National Science Education Standards

Content Standard A: Science As 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 D: Earth and Space Science

- Structure of the earth system

Content Standard E: Science and Technology

- Understandings about science and technology

Content Standard F: Science in Personal and Social Perspectives

- Populations, resources, and environments
- Risks and benefits
- Science and technology in society

Content Standard G: History and Nature of Science

- Science as a human endeavor
- Nature of science

For More Information

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Student Handout
Deep-Water Coral Reefs Report Guide

1. Are more coral species found in warm, shallow water or cold, deep water?

_____

2. What is one species of deep-sea coral that is found in large reefs on the European continental margin from Norway to Portugal?

_____

3. Why have coral reefs been considered to be confined to shallow waters?

_____

_____

_____

4. Gorgonians, alcyonaceans, pennatulaceans, and stoloniferans belong to the subclass _____ and are collectively referred to as _____.

_____

5. Only members of the order _____ actually form true coral "reefs."

_____

6. Some deep-sea reefs in the North Atlantic have been found to harbor _____ invertebrate species.

_____

7. How rapidly to deep-sea corals grow and reproduce?

_____

8. How long do deep-sea corals live?

_____

9. At present, what is the greatest threat to deep-sea coral communities?

_____

10. In addition to deep-sea corals, what other invertebrates form highly diverse communities in the deep ocean?

_____

_____

Teacher Answers
Deep-Water Coral Reefs Report Guide

1. Are more coral species found in warm, shallow water or cold, deep water?
   - The majority of coral species live in colder, deeper waters.

2. What is one species of deep-sea coral that is found in large reefs on the European continental margin from Norway to Portugal?
   - *Lophelia pertusa* is found on deep-sea reefs on continental margins worldwide.

3. Why have coral reefs been considered to be confined to shallow waters?
   - Because deep-sea exploration is difficult, our knowledge of deep-sea environments is very limited, and this has led to the widespread assumption that coral reefs are confined to shallow waters.

4. Gorgonians, alcyonaceans, pennatulaceans, and stoloniferans belong to the subclass _____ and are collectively referred to as _____.
   - Gorgonians, alcyonaceans, pennatulaceans, and stoloniferans belong to the subclass Alcyonaria or Octocorallia and are collectively referred to as octocorals or soft corals.

5. Only members of the order _____ actually form true coral "reefs."
   - Only members of the order scleractinia actually form true coral "reefs."

6. Some deep-sea reefs in the North Atlantic have been found to harbor _____ invertebrate species.
   - Some deep-sea reefs in the North Atlantic have been found to harbor 1,300 invertebrate species.

7. How rapidly to deep-sea corals grow and reproduce?
   - Growth and reproduction in deep-sea corals is very slow

8. How long do deep-sea corals live?
   - Some deep-sea corals may be hundreds of years old; one individual has been dated at 1,800 years old.

9. At present, what is the greatest threat to deep-sea coral communities?
   - At present, the greatest threat to deep-sea coral communities is bottom trawling.

10. In addition to deep-sea corals, what other invertebrates form highly diverse communities in the deep ocean?
    - In addition to deep-sea corals, sponges also form highly diverse communities in the deep ocean.