Inside the rainforests of the sea
Coral reefs and their endangerment

To a typical middle school student (and many adults), coral is perceived as a nonliving rock, rather than as the complex living ecosystem it truly is. Even though underwater films show the great abundance of life along coral reefs, students often hold the misconception that the coral itself is non-living, due to the difficulty in observing the tiny organisms that create the coral substrate; students tend to believe that coral simply serves as shelter for other marine life. After all, houses for humans are nonliving shelters, so why should coral reefs be any different for marine life?

For a science teacher, studying coral and coral reefs provides an opportunity to present numerous scientific concepts in an integrated manner. The concepts of radial symmetry, biodiversity, symbiosis, interdependence, endangerment, and climate change all apply to coral reef biology/ecology. In addition, the study of coral reefs cuts across subject areas as well, with integration of language arts, mathematics/statistics, and social sciences. To aid you in exploring coral reefs with your students, here's a primer on the scientific basics and also some ideas to consider for your classroom.

What is coral?

Coral is a marine animal that belongs to the phylum Cnidaria, which also contains jellyfish. Cnidarians are *radially symmetric*, which means that a bisector (line) can be drawn through the organism at any point and the two equal halves produced will be mirror images to each other. This is in contrast with most organisms, which are *bilaterally symmetric* (such as humans). Corals have a central canal with one end surrounded by stinging tentacles. Most corals live in colonies, rather than independently like other jellyfish.

During the mating season, coral polyps release eggs and sperm into the water, and when an egg and a sperm meet and the egg is fertilized, a larva called a *planula* is formed. The planula resembles a tiny jellyfish and floats in the water until it attaches to a hard surface. The larva then begins to combine the carbon dioxide (CO_2) and calcium (Ca) in the water to make calcium carbonate ($CaCO_3$), also known as limestone. The calcium carbonate builds up around the polyp like a shell, with the appearance of a vase surrounding the small coral polyp living inside. Numbering close to 1,000, different coral species create shapes ranging from mushrooms to moose antlers, cabbages, tabletops, wire strands, fluted pillars, and wrinkled brains.

Because they are *sessile* (nonmoving), corals feed by sticking their tentacles out of their "shell" and waving them in the water current, stinging floating plankton and bringing the plankton into their oral groove for consump-

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tion. Interestingly, corals are considered nocturnal, as most of their activity occurs at night.

The bright colors of coral come from the symbiotic relationship that corals have with an algae called *zooxanthellae*. Zooxanthellae live within the coral animal's tissue and carry out photosynthesis, which provides energy for themselves and the coral. The zooxanthellae benefit from their interaction with the coral by having a protected shelter. This type of symbiosis is an example of *mutualism*, where both participants in the relationship benefit. An interesting note for teachers: corals provide a great way to highlight the different types of symbiosis. Students often perceive all symbiotic relationships as being positive for both participants, but this is obviously not the case—corals can be used to demonstrate mutualism, with other examples used to contrast it to parasitism, commensalism, and ammensalism.

When environmental conditions become stressed (by excess heat, light, or chemical pollutants, for example), zooxanthellae may be expelled by the coral polyps, thus leaving the coral in an energy deficit and without color. This process is referred to as *coral bleaching*. If the coral is recolonized by zooxanthellae quickly enough, the coral may recover; if not, the coral will die. Coral bleaching can be caused by increases in temperature of as little as 1–2°C above average annual maximum temperatures. As discussed in my Inside Global Warming column (see October 2006 *Science Scope*), the recent increase in mean global temperature has affected ocean temperatures, and they continue to be on the rise.

What is a coral reef, as opposed to coral?

Coral reefs are the most biologically diverse ecosystems of the ocean, and on land their biodiversity is rivaled only by the tropical rainforests (WWF 2006) Although coral reefs cover less than 1% of the Earth's surface, they are home to 25% of all marine fish species, and additional species of mollusks, echinoderms, and sponges.

Considered the largest living structure on the Earth, coral reefs can consist of colonies of approximately one million individual coral polyps. Only one particular type of tropical coral, *hermatypic*, forms coral reefs; other types of non-reef coral are found all around the world. In reefs, when coral polyps die, new ones land and grow on top of the old empty shells. No matter the size of the reef, all coral colonies are made up of tiny individual polyps.

Why should we care what happens to coral reefs?

The majority of humans live in coastal regions, and many people depend on living coral reefs for protection from storm surges and erosion. A case in point: A team of researchers from the United States and Sri Lanka studied the southwest coast of Sri Lanka's effects from the December 26, 2004, tsunami and concluded that the illegal mining of corals permitted far more onshore destruction from the tsunami than occurred in nearby areas where coral reefs were intact (Fernando et al. 2005). As another example, if it were not for coral reefs, portions of Florida and other well-populated landforms would be under water.

On an economic note, it is estimated that coral reefs provide $375 billion per year around the world in goods and services (The Nature Conservancy 2006). Coral reefs contribute about 25% of the total fish catch in developing countries, providing food for one billion people in Asia alone (WWF 2006). The calmer area behind a reef can shelter sea grass beds and mangrove forests that serve as nurseries for the young of additional fish and mollusk species, thus adding more organisms to the food web.

In addition to these physical and economic benefits, coral reefs also have demonstrated medical importance to humans. Coral reefs have been used in the treatment of cancer, HIV, cardiovascular diseases, and ulcers; they have also been used for human bone grafts (The Nature Conservancy 2006).

How are coral reefs endangered?

Within the last 15 to 20 years, the amount of live coral cover has declined dramatically due to both human and natural causes. Ten percent of the world's reefs have been completely destroyed. In the Philippines, where coral reef destruction is the worst, over 70% of the reefs have been destroyed and only 5% are said to be in good condition (Ocean World 2004). Human activities, including those associated with global warming, are threatening coral reef survival. Increasing sea temperatures stress corals and cause damage, including the coral bleaching mentioned previously. The increasing temperature also increases algal growth on top of the coral, and as a result the zooxanthellae are not able to perform photosynthesis as effectively, if at all. Overfishing also removes fish that would normally consume the algae and keep it in check. This compounded result adds to coral death—without the energy from photosynthesis, the zooxanthellae and coral die.

Physical damage to reefs by boat anchors, boat groundings, dredging, pollution, and overfishing also cause tremendous reef deterioration. For example, a single anchor drop from a cruise ship in the Virgin Islands in 1988 led to the destruction of 300 meters of reef, with no significant recovery of hard coral eight years later (Rogers 2006). The installation of mooring buoys and limits on the size of vessels allowed in reef-occupied waters have resulted in less pressure on coral reefs, but in some areas there is little coral left to protect.

Fishermen also do enormous direct damage to coral reefs. The fish that live in reefs are very valuable as pets and food. To trap these fish, some fishermen employ blast-fishing techniques, where reefs are shattered with dynamite. Others drop cyanide poison into the water to stun fish so they are easier to catch, but in doing so they also kill the coral. Most of the reefs in the Philippines have been destroyed by such fishing techniques.

Natural causes, such as hurricanes and other major storms, have greatly affected coral reefs. While little can be done to prevent such storms, their effects can be monitored and reefs protected by creating artificial barriers around them. The greatest fear is that future hurricanes and storms, combined with human-related stresses, may tip the balance so that recovery of coral reefs becomes impossible. If the present rate of destruction continues, it is estimated that 70% of the world's coral reefs will be destroyed by the year 2050. As a result, today's adolescents are going to be critical decision-makers with regard to changing policies and practices that endanger coral reef ecosystems in the years to come.

Classroom ideas

As mentioned in the introduction, coral reef study provides an opportunity for integrated science (life-physical-Earth) instruction, as well as interdisciplinary instruction with other subject areas. Here are a just a few suggestions for student projects:

- Explore the many forms of calcium carbonate in our everyday lives by comparing sources and discussing how carbonate is critical to maintaining ocean pH.
- Combine coral reef study in science with social studies by exploring the regions of the world where coral reefs are present and their impact on the local geography, tourism, lifestyle, and economics.
- Create a public-awareness campaign contests for students to produce promotional brochures, flyers, or videos (such as could be played on school television announcements) on how coral reefs are important and what can be done to save them.
- Compare and contrast coral reefs to the rainforest in language arts, with attention to the biodiversity, geography, economic importance, and current destruction and repair efforts.
- Debate whether or not tourism and fishing around coral reefs should be limited or banned, with representation from both sides of the argument.
- Recreate a coral reef ecosystem in your classroom by labeling the zones of the reef and having students research, create models of, and prepare an oral presentation on organisms that occupy the reef.

References

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Resources

Coral Reef Alliance—*www.coralreefalliance.org*

Coral Ecosystems SciGuide—*http//sciguides.nsta.org*

Lichtarowicz, A. Destruction of coral reefs. *www.bbc.co.uk/worldservice/learningenglish/newsenglish/witn/2005/09/050905_reefs.shtml*. This website and story are very useful as they have a vocabulary bank and ESL students can listen to both the story and the vocabulary words to help them learn English and science.

Planetary Coral Reef Foundation—*www.pcrf.org*

Reef Relief—*www.reefrelief.org/library.html*

Time Magazine for Kids article “Can We Rescue the Reefs?” Has student-friendly language to help them understand the crisis. *www.timeforkids.com/TFK/magazines/story/0,6277,59687,00.html*

The Scott Aquarium—*www.usm.edu/aquarium/old/coralreef/index.html*. Offers a fantastic guide for middle level educators full of activities on coral and coral reefs (available in Spanish).

Sea World—*www.seaworld.org/infobooks/Coral/home.html*. Offers a number of free fact sheets and a Grow Your Own Coral activity.

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