The Bay of Fire

Imagine entering a quiet tropical bay at night. There are no lights on shore, and on a moonless night the spectacle is unforgettable. As the propeller of your boat churns the black water, an intense blue-green light is left behind, like an eerie trail of cool fire. Outside the bay you see a few sparks of light as you approach, but inside the bay things are very different. Long streaks of light shoot like fireworks beneath the boat. They are created by fleeing fish. A swim in the bay is even more spectacular. Your dive into the water is accompanied by a blinding flood of light, and sparks scatter out as you wave your arms.

Such light effects result from an unusual concentration of bioluminescent dinoflagellates, a natural and permanent phenomenon in a few select locations such as *Bahía Fosforescente*, or Phosphorescent Bay, in southwestern Puerto Rico.

Bioluminescent Bay is a more apt name because the light is produced by living organisms. The bay's most important source of bioluminescence is *Pyrodinium bahamense*, a unicellular, photosynthetic dinoflagellate about 40 microns (μm) (0.004 cm, or 0.0015 in) in diameter. As many as 720,000 individuals may be found in a gallon of water, many more than outside the bay. The bay is small, about 90 acres, fan-shaped, and it does not exceed 4.5 m (15 ft) in depth. The main reason that the dinoflagellates are concentrated there is that the bay is connected to the open sea by a narrow, shallow channel. As water containing the dinoflagellates flows into the bay, evaporation in the shallow water causes the surface water to sink because of the increase in salinity and therefore density. Evaporation is enhanced by the dry and sunny days. *Pyrodinium* cells stay near the surface and are therefore not carried out as the denser water flows out along the bottom of the shallow entrance. The tidal range is only about a foot at the most, so water exchange with the outside is limited. The bay thus acts as a trap that keeps the dinoflagellates from leaving.

Bahía Fosforescente, Puerto Rico.

Of all the planktonic organisms that enter the bay, why is *Pyrodinium* favored? A key factor seems to be the thick mangrove trees bordering the bay. They grow along the muddy shores, together with all kinds of organisms living attached to their roots. Mangrove leaves fall into the water, where intense bacterial decomposition increases the organic nutrient levels in the water. Some nutrients essential to the growth of *Pyrodinium*, perhaps vitamins, may be released by bacteria or other microorganisms.

Bahía Fosforescente is protected to keep the critical natural balance intact, but bioluminescence has noticeably decreased during recent years. A few other bays, termed "bio bays," in Puerto Rico fortunately show even more spectacular bioluminescence, Laguna Grande on the northeastern tip of the island and Puerto Mosquito on the island of Vieques.

dinoflagellates are generally responsible for the diffuse bioluminescence sometimes seen on the sea surface. This effect is, of course, seen only at night. It is especially bright if the water is disturbed by a boat or when a wave crashes on the shore.

A group of round, golden brown dinoflagellates called **zooxanthellae** live in close association with a variety of animals. Animals harboring zooxanthellae range from sponges and sea anemones to giant clams. It is perhaps in reef-building corals where zooxanthellae are most significant (see Fig. 14.1). They fix carbon dioxide by photosynthesis, release organic matter used by the coral, and help in the formation of the coral skeleton (see "Coral Nutrition," p. 309).

A few highly modified dinoflagellates are parasites of seaweeds and some marine animals. Like zooxanthellae, these highly specialized forms reveal their true nature by having life cycles that include free-swimming stages resembling typical dinoflagellates.

One such dinoflagellate is *Pfiesteria*, sometimes called the "phantom dinoflagellate" because it spends most of its life as a harmless resting stage, or cyst, in the sediment. It has been suggested that coastal pollution in the form of excessive nutrients can trigger blooms of *Pfiesteria*. *Pfiesteria* and *Pfiesteria*-like microorganisms are responsible for deadly open sores on fishes. *Pfiesteria* causes the sores by producing a recently discovered toxin, not by actively feeding on the fishes' tissues as first thought. These parasites are also known to be harmful to crabs, oysters, and clams and have been implicated in sores and in symptoms such as temporary memory loss in humans.

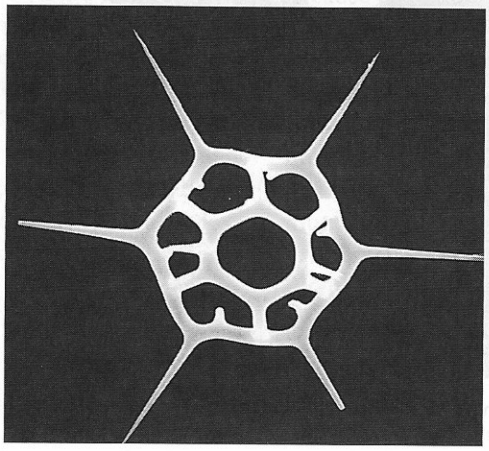

FIGURE 5.9 Skeleton of *Dictyocha speculum*, a silicoflagellate.

Dinoflagellates are unicellular organisms that have two unequal flagella. Some are noted for their emission of light. Zooxanthellae are dinoflagellates that are symbiotic with marine animals, especially reef corals.

Other Unicellular Algae

Three additional groups may be abundant in some areas and thus very significant primary producers in the plankton (see Table 15.1, p. 336). **Silicoflagellates** (division, or phylum, **Chrysophyta**) are characterized by a star-shaped internal skeleton made of silica (Fig. 5.9) and two flagella of different lengths. Fossil silicoflagellates are common in marine sediments and can be used to date