

## Box 2–6

### Emerging Disease and Coral Reefs

Coral reefs throughout the world have been severely degraded during recent decades. Emerging diseases are a major factor in this degradation, primarily through the destruction of **scleractinian** stone-like corals that provide the basic framework for reefs. Initial reports of disease affecting reef-building corals appeared during the early 1970s and were viewed at that time as unique situations. Today, disease has been observed in more than 100 coral species (primarily **hard corals** but also some soft corals) on reefs in more than 50 countries.<sup>66</sup> The areas involved include popular diving locations such as the Caribbean islands, Fiji, the Red Sea, and the Great Barrier Reef of Australia. However, the prevalence and diversity of coral disease appears to be greatest in the tropical western Atlantic,<sup>374</sup> primarily within the Caribbean.<sup>66</sup> The number of distinct diseases being observed within this area, as well as globally, has increased substantially since the 1970s.

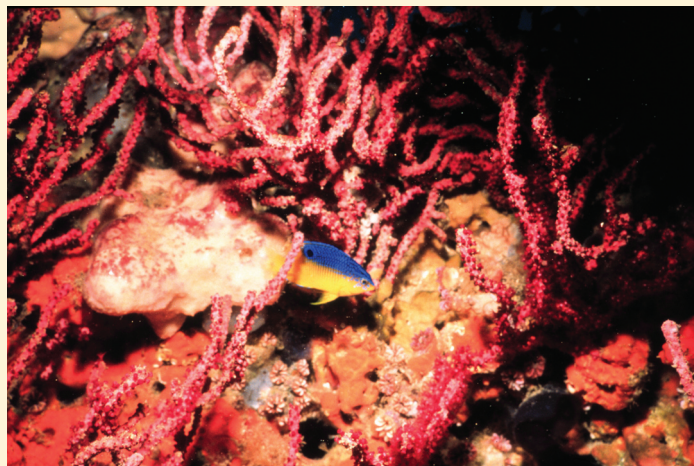


Photo courtesy of the National Oceanic and Atmospheric Administration

Coral reef and tropical fish off of the coast of North Carolina.

### Disease of Scleractinian Corals

#### Black-Band Disease

Black-band was the first disease reported to affect scleractinian corals and was first described in 1973 from Belize. Subsequently, reports followed during the 1970s from reefs off Bermuda and the Florida Keys.<sup>374</sup> Black-band disease is now known to exist throughout the Caribbean, in reefs of the Indo-Pacific (Philippines, Fiji), the Red Sea, and the Great Barrier Reef.<sup>374–376</sup> Hard corals such as star coral, fire corals, and soft corals such as **gorgonians** (sea fans) are affected. **Acroporids** (branching corals) have been found infected on the Great Barrier Reef.<sup>377</sup> Significant mortality from black-band disease has occurred in at least 13 species of coral<sup>378</sup> and it is a major factor in the recent decline (1990s) of hard corals on reefs off Jamaica.<sup>375</sup>

Black-band disease is caused by a microbial mat consisting of a complex of organisms. The most dominant species are the cyanobacterium *Phormidium corallyticum* and bacterium of the genus *Beggiatoa*. Other species in the mat

complex include numerous heterotrophic bacteria (organisms that derive energy from consumption or absorption of other organisms), marine fungi, and bacteria of the genus *Desulfovibrio*.<sup>379,380</sup>



Photo courtesy of the National Oceanic and Atmospheric Administration

Black-band disease.

### Red-Band Disease

Red-band infections of corals were first noted during the early 1980s and thought to be a variant of black-band disease infecting sea fans off Belize,<sup>374</sup> but was described as a separate disease based on observations made during 1991 at a site southwest of Bimini in the Bahamas.<sup>381,382</sup> This disease is also known to be present on the west coast of Puerto Rico and in the Florida Keys<sup>383</sup> and may be present as brown-band disease on the Great Barrier Reef. Infections have occurred in 20 coral species in five scleractinian families.<sup>374</sup>

A microbial mat similar to that for black-band disease is involved but differs in species composition, migration across the coral, and daily activity.<sup>381</sup> Red-band disease is associated with a cyanobacterium of the group *Oscillatoria* spp. but the primary cyanobacteria present in the red-band may differ between geographic locations. Other organisms known to be part of the mat complex are other cyanobacteria, the bacterium *Beggiatoa*, heterotrophic bacteria, and the nematode *Araeolaimus*.<sup>374,383</sup>

### White-Band Disease

**Acroporid** corals from St. Croix, U.S. Virgin Islands, were first reported infected with white-band disease in the 1970s. Massive mortality of elkhorn corals occurred in 1977 on the reefs of Buck Island and Tague Bay and was part of a progressive destruction of the majority of Caribbean *Acropora* during the late 1970s and early 1980s.<sup>374,383</sup> This disease is widespread, occurring in reefs throughout the Caribbean from the Florida Keys to Panama and Nicaragua. It is also present in reefs of the Philippines, the Red Sea, the Gulf of Oman (Arabian Sea), and the Great Barrier Reef.<sup>374</sup> White-band disease attacks multiple species of scleractinian corals but has been most destructive of branching corals.

The original form of white-band disease that emerged in the 1970s is referred to as Type I. Type II, a more aggressive form relative to the speed of disease progression in infected coral, emerged during the early 1990s.<sup>377,383</sup> and has only been found in the Bahamas. Both diseases appear to be due to bacterial infections. Bacterial aggregates have been identified in some, but not all cases of Type I disease. Specific species of bacteria have not been identified as the cause for this disease. Bacteria similar to *Vibrio carchariae* have been identified as a probable agent for Type II disease.<sup>384</sup>

### Yellow-Band Disease (Yellow-Blotch Disease)

Some authors refer to this disease as yellow-blotch disease in the Caribbean and yellow-band disease in the Arabian Gulf. Yellow-band disease was first reported as ring bleaching in the 1970s.<sup>385</sup> In 1990 it was first associated with bleached corals in the Cayman Islands,<sup>386</sup> and in 1994 it was first noted as an independent disease in the lower Florida Keys.<sup>374</sup> Yellow-band disease is now known to occur in many Caribbean reefs.<sup>383</sup> Recent transect studies (1997–1998) revealed that this disease affects as much as 90 percent of star coral.<sup>385</sup> It is the latest coral disease in Colombian waters (observed in April 1998) and the cause

of a major epizootic affecting several coral species.<sup>387</sup> Yellow-band disease has also been observed in pristine reefs in San Salvador waters<sup>377</sup> and in the Arabian Gulf at Jebel Ali in Dubai, United Arab Emirates.<sup>388</sup>

Yellow-band disease affects star coral in the Florida Keys and in the Netherlands Antilles, but different species

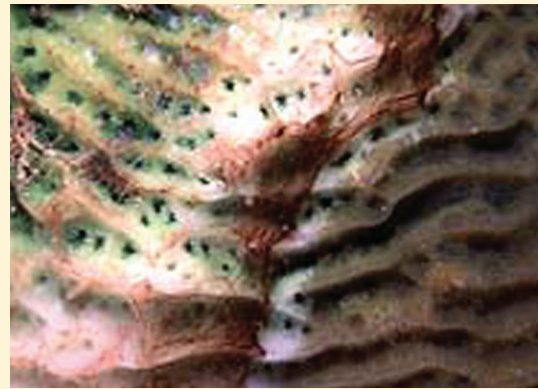


Photo courtesy of the National Oceanic and Atmospheric Administration

Red-band disease.



Photo courtesy of the National Oceanic and Atmospheric Administration

White-band disease.

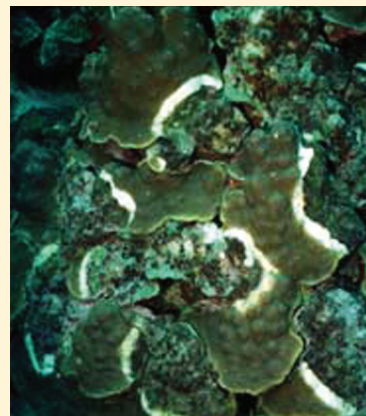


Photo courtesy of the National Oceanic and Atmospheric Administration

Yellow-band disease.

including branching corals are affected in the Arabian Gulf. Prior to its appearance in Colombian waters, this disease had only been known to affect two species of corals (star coral and mountainous star coral). An additional seven coral species were found affected in Colombia.<sup>387</sup> The cause of this disease is unknown, but may be of bacterial origin.<sup>374</sup>

### Rapid Wasting Disease

This disease syndrome was first noted in Bonaire, Netherlands Antilles during late 1996. It is a rapidly spreading new condition that exists throughout the Caribbean affecting star coral and brain coral, two of the major reef builders of this region.<sup>377,383</sup> A filamentous fungus and a ciliate (protozoan) parasite associated with the fungus were originally thought to be responsible for rapid wasting disease.<sup>72,383,389</sup> However, recent observations indicate that **parrotfish** feeding on the coral may be the primary cause of this syndrome.<sup>388</sup>

### Dark-Spot Disease

First observed in 1990, this disease affects massive starlet coral and some other star corals throughout the Caribbean. Transects during 1997–1998 disclosed up to 56 percent of those species of corals to be affected.<sup>383,385</sup> Dark-spot disease was the first record of a coral disease in Colombia (1990 at the Rosario Islands) and has affected 10 coral species in reefs of that country.<sup>387</sup> The pathogen involved is unknown.

### White Pox Disease

Elkhorn coral was found affected by white pox disease around 1995 in the Florida Keys. Rapid geographic expansion has followed and this disease now occurs throughout most of the Caribbean. An unknown infectious agent is believed to be the cause for this disease.<sup>72,383</sup>

### Coral (white) Plague

There are two distinct forms of white plague. Type I is a slowly progressing infectious disease and was first reported in 1977 on Alligator Reef in the Florida Keys. It has been documented for several species of nonbranching

corals such as brain coral and fleshy coral. Type II white plague was also first observed in Alligator Reef (1995), but in contrast to Type I, is a rapidly spreading disease.<sup>377,383</sup>

The 17 scleractinian coral species infected is the greatest number of these corals ever reported for any disease in the Caribbean region. Only nonbranching corals are affected. Type II white plague is the first known disease of elliptical star coral, the primary species affected during epizootics.<sup>390</sup>

Three major epizootics of Type II white plague have occurred in different reef areas of south Florida: the middle Keys in 1995; the southern Keys and Dry Tortugas during 1996; and reefs north of Miami during 1997. White plague (Type I and Type II combined) was first reported in Colombian reefs in 1994 affecting only one species (*Montastraea cavernosa*). It is now widespread and has affected 21 hard coral species.<sup>387</sup> A single dominant bacterium associated with the disease line has been isolated and shown to be contagious under experimental conditions. This organism is most closely related to *Sphingomonas*.<sup>390</sup>

## Disease of Other Reef Organisms

### Coralline Algal Disease [Coralline Lethal Orange Disease (CLOD)]

The orange-yellow growth of an unidentified bacterium that attacks coralline algae (*Porolithon* spp.) gives this disease its name.<sup>383</sup> Initially observed in June 1993, coralline algal disease has spread over 10,000 km, affecting



Photo courtesy of the National Oceanic and Atmospheric Administration

Coral (white) plague.



Photo courtesy of the National Oceanic and Atmospheric Administration

Dark-spot disease.



Photo courtesy of the National Oceanic and Atmospheric Administration

Coralline algae disease.



South Pacific reefs from the Cook Islands to the Mariana Islands.<sup>391</sup> In 1996, a new condition that attacks these algae but has a different appearance appeared in the Caribbean. Between 25 to 75 percent of the coralline algae has been killed at some Caribbean sites.<sup>383</sup>

### Sea Fan Disease

Sea fans are soft coral life forms. Mass mortality events involving these species were first reported in the Caribbean during the 1980s: Trinidad (1981/82); Costa Rica (1982/83); Panama (1982/83); Colombia and San Andrea Island (1986/88). The causative agent, although unknown, was highly virulent, resulting in almost total mortality. Disease appeared to be restricted to the Caribbean continental coasts. A second, less virulent, epizootic wave, extending at least 2,500 km, began in January 1995. This event reached at least from Trinidad westwards to the Panama/Colombia border in the southern Caribbean, and northwestwards to the Bahamas and the Florida Keys in the northern Caribbean.<sup>392</sup> This latest event has been shown to be caused by a fungus (*Apergillus sydowii*).<sup>393-395</sup>

### Sponge Disease

Die-offs of barrel sponges have been reported from the Florida Keys since the 1980s. In 1996, mass mortality



Photo courtesy of the National Oceanic and Atmospheric Administration

Sea fan disease.

(40–50 percent) affected the barrel sponge population in reefs along Palm Beach, Florida. The previous year mortality occurred off Key Largo in the Florida Keys.<sup>396</sup> Mortality is caused by a rotting disease that leaves holes in the sponge frame.

A rapidly spreading disease of large barrel sponges (*Xestospongia muta*) appeared in the Belize Barrier Reef Tract during 1996 and spread to Curacao, Tobago, and Panama. Several different species of sponges were affected in Panama and a different species of barrel sponge in Tobago.<sup>383</sup> The pathogen involved has not been identified for any of the sponge disease events.

### Sea Urchin Disease

During 1983 and 1984 the black long-spined sea urchin suffered mass mortality from disease throughout its entire geographic range. That initial epizootic is thought to be the most widespread epizootic ever recorded for a marine invertebrate.<sup>397,398</sup> Approximately 3.5 million square km (not counting Bermuda) were impacted by this event.<sup>398</sup> In 1983, Jamaican reefs alone lost about 100 million sea urchins during an 8-week period.<sup>71</sup> A second epizootic followed in 1984, further stressing any survivors from the previous event.<sup>397</sup> Densities of this species in Jamaica were reduced by 99 percent from pre-die-off estimates and have remained suppressed.<sup>71</sup> A similar die-off struck the Florida Keys during May 1991.<sup>569</sup> Additional mass mortalities from 1995–1997 affected sea urchins in Puerto Rico, Antigua, Aruba, Jamaica, and Curacao.<sup>383</sup> Mass mortalities from 1980 to 1982 reduced green sea urchin populations in Nova Scotia by about 90 percent.<sup>62</sup> The pattern of mortality associated with sea urchin die-offs is consistent with infectious disease, but the causative agent(s) have not been determined. An amoeboid protist, *Labyrinthula* spp., is thought to be the cause of the Nova Scotia die-off.

Numerous other maladies have also appeared as diseases of reef organisms during recent years. For example, in 1996 an unnamed new disease appeared in Brazil in a colonial benthic (bottom dwelling) organism, commonly found on shallow reefs in the western Atlantic. Bacteria are thought to be the primary pathogens, and fungi and other organisms are most likely secondary invaders; it is widespread along the Brazilian coast but not seen elsewhere.<sup>399</sup>

Noted reef biologists are obviously quite concerned about the magnitude of disease:

“The spread of coral reef diseases has become so commonplace, and with such intensity, that they have become the major cause of accelerating coral mortality in many locations and are likely to become far more prevalent in coming years” (Goreau et al.).<sup>383</sup>