

Coral Disease: An Emerging Threat to the World's Remaining Reefs



Caribbean sea fan *Gorgonia ventalina* with multiple lesions, caused by the fungal disease aspergillosis. This is characterised by purple or colored areas around dead tissue and exposed skeleton. (E. Weil)

The Coral Reef Targeted Research & Capacity Building for Management Program (CRTR) is a leading international coral reef research initiative that provides a coordinated approach to credible, factual and scientifically-proven knowledge for improved coral reef management.

The CRTR Program is a proactive research and capacity building partnership that aims to lay the foundation in filling crucial knowledge gaps in the core research areas of Coral Bleaching, Connectivity, Coral Diseases, Coral Restoration and Remediation, Remote Sensing and Modeling and Decision Support.

Each of these research areas are facilitated by Working Groups underpinned by the skills of many of the world's leading coral reef researchers. The CRTR also supports four Centres of Excellence in priority regions, serving as important regional centres for building confidence and skills in research, training and capacity building.

The CRTR Program is a partnership between the Global Environment Facility, the World Bank, The University of Queensland (Australia), the United States National Oceanic and Atmospheric Administration (NOAA) and approximately 50 research institutes & other third parties around the world.

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Coral reefs serve multiple uses. They supply coastal communities with fish, providing both essential dietary protein and income. They protect coastal environments and infrastructure from storm and wave damage. They generate billions of dollars in tourism revenue. They also provide habitat for an unknown number of species some of which are considered key to the discovery of new pharmaceuticals.

Both the prevalence and geographic spread of coral diseases have increased in recent decades. Major impacts of disease were initially detected

in the Caribbean with the near extinction of staghorn corals, the primary reef builders that once characterized Caribbean coral reef ecosystems. Diseases are now known to cause significant coral death in the Indo-Pacific, Mediterranean and Red Sea as well.

These vital nearshore ecosystems face a range of stressors such as exposure to excess silt, nutrients and chemical pollutants from land-based activities, and destructive fishing.

Further stress is created by increases in sea temperature associated with climate change.

Recommended actions to manage coral disease include:

1. Establish Marine Protected Areas in strategic locations
2. Adopt "ridge to reef" management approaches which recognise that human activities can have a huge impact on downstream ecosystems
3. Improve reef resilience, water quality and protect biodiversity through local policy and management measures
4. Ensure Marine Protected Areas are effective
5. Enforce or create legislation to protect critical species

For more information see page 3, *What can be done about coral disease?*

Coral Disease

Stressed coral means sick coral

As with all living organisms, stress compromises the health of corals. One effect of multiple chronic stresses is an increase in infectious diseases that can kill corals and threatens the longevity, resilience and productivity of the entire reef.

Warming sea surface temperatures encourage infectious disease by impairing the defense mechanisms of the coral host and by increasing the virulence or growth rate of disease-causing micro-organisms. Seasonally warmer temperatures may also enable some diseases to expand their range into reef areas where colder temperatures previously limited their population growth.

An overabundance of nutrients, particularly nitrogen and carbon compounds, can enhance the progression of disease across a coral colony. Silt can smother coral tissues and deliver nutrients and micro-organisms to a reef.

Recent studies suggest that degrading environmental quality may tip the balance from low levels of disease to outbreak levels in vulnerable reefs.

Coral diseases

Coral diseases include infectious syndromes (a group of signs or symptoms that occur together and characterise something abnormal) caused by microbial agents as well as non-infectious diseases caused by heat stress, toxins and other agents.

At present, the dominant diseases known in the Caribbean are yellow band disease, white plague and white band disease. The diseases most commonly affecting Indo-Pacific corals are white syndromes, skeletal eroding band and growth anomalies (Figure 1).

Although many coral diseases affect multiple common species, the cause of more than half of them is not known. This highlights the current challenges scientists face in understanding and managing coral diseases.



Chronic highly turbid conditions from silt can stress and kill corals (L.Raymundo)

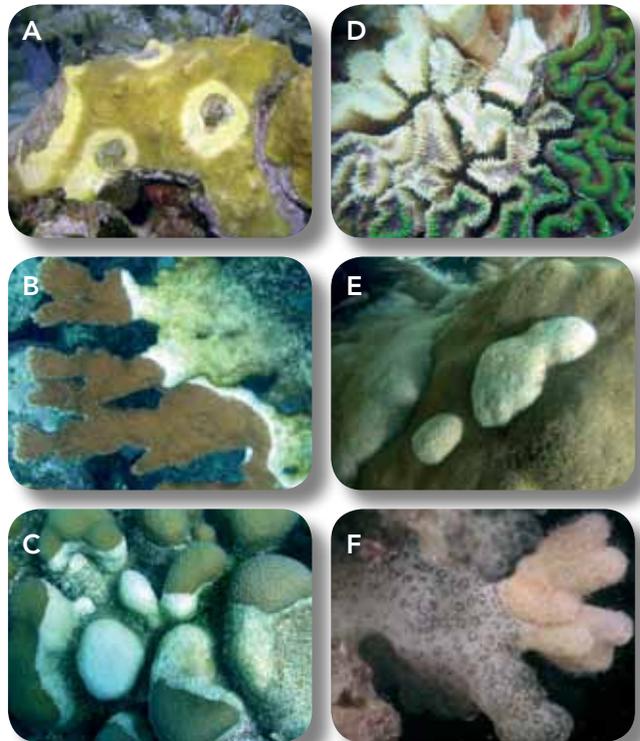


Figure 1. Six common diseases affecting corals around the world. From the Caribbean: A) yellow band disease; B) white band disease; C) white plague. From the Indo-Pacific: D) a white syndrome; E) growth anomalies; F) skeletal eroding band



A colony of the Caribbean coral *Siderastrea siderea* showing dark spots disease, which can cause mortality over time. A cause for the disease has not been identified. (E.Weil)

What can be done about coral disease?

- A study completed by the CRTR Program’s Disease Working Group has shown that, in the Philippines region, Marine Protected Areas (reefs protected from all harvesting activities) have significantly less disease than adjacent reefs which were fished (Figure 2). Therefore, establishment and enforcement of MPAs is one management option to be considered.
- Environmental influences such as warm water temperature, increased dissolved nutrients and/or bacterial loads, and dissolved pollutants affect the coral’s ability to defend itself against disease-causing microbes. Significant improvement in water quality (i.e. nutrient removal) by all local stakeholders, including government, should be an urgent priority. Because human activities on land have huge impacts on downstream ecosystems, a “ridge-to-reef” management approach should become standard practice by local communities.
- Actions by local politicians and managers can greatly improve the reef environment, so they can better withstand impacts from human activities from upstream and along the coast, and from future impacts resulting from climate change. Management of coral disease requires increasing the resilience of coral reefs through improvements in water quality, and protecting biodiversity. Such actions may include improving sewage treatment, preventing soil erosion, and eliminating destructive fishing practices.
- Biodiversity can be better protected through the establishment of MPAs in places that are known to be very diverse or to be habitat for critical species. Ensuring the effectiveness of MPAs is crucial if they are to function as intended. This can be achieved through political support of local stakeholders, training for managers and local advocates, and educating the public on the function and importance of MPAs.
- Critical species can also be protected through enforcement of legislation that controls or bans their harvesting. Creation of such legislation may be required where it does not already exist.

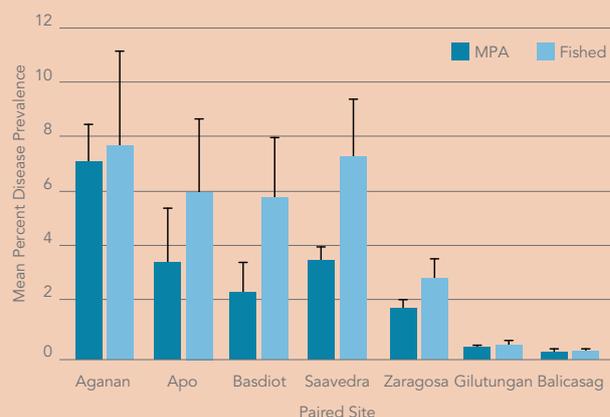


Figure 2. Percentage of diseased corals growing inside and out of Marine Protected Areas in the central Philippines. Raymundo et al. 2009.

Research into coral disease

New studies are increasing our understanding of disease spread and long-term impacts to coral growth and life expectancy. We now know that poor environmental quality can enhance rates of disease progression on corals and may make them more susceptible to disease-causing agents, so reducing human-induced impacts can promote healthy reefs. Significant progress has been made in understanding the geographic and temporal trends in disease, coral immune defense capabilities, and the importance of the microbial environment to coral health.

Tremendous progress has been made by the Coral Reef Targeted Research & Capacity Building for Management (CRTR) Program in understanding the causes and impacts of disease. However, as a science, coral disease is in its infancy and tools for its study and management are still being developed in the face of the growing urgency to improve the condition of coral reefs worldwide. Highlights of the efforts of the CRTR Coral Disease Working Group include:

- Broadening the number and global representation of reef areas that have been surveyed for baseline levels of disease
- Establishing long-term monitoring sites for disease impacts on coral community change and links between seasonal temperature fluctuations and disease severity in both Caribbean and Indo-Pacific reefs
- Investigating which environmental and water quality parameters have the greatest influence on disease impacts
- Testing mechanisms of coral immunity and defense, and understanding how these are modified by changing environmental parameters
- Increasing understanding of the role of microbes in both maintaining coral health and causing disease.

New studies are underway to determine what aspects of fish communities promote healthy coral reefs. Another innovative, ecologically-based approach involves the study of how phages control coral disease on reefs.

Disease as a structuring force: The case of Caribbean Yellow Band Disease

Caribbean yellow band disease (YBD) causes lesions, tissue loss and, ultimately, coral death. It was first reported in the Florida Keys in 1997, although there are indications that it was affecting corals in the 1980s. In 1999, YBD was observed throughout the Caribbean and north to Bermuda only in certain seasons. It is now pervasive throughout the region and has recently been observed in the Indo-Pacific. YBD is a major threat to *Montastraea*, one of the most important reef-building corals in the Caribbean. A combination of four *Vibrio* bacterial species is suspected to cause YBD in both Caribbean and Indo-Pacific corals. Prevalence and lesion growth rate are temperature-dependent, and the rate of tissue loss in YBD-infected colonies is also linked with increased nutrient concentrations and high water temperatures. Both the prevalence of YBD and rates of tissue loss (virulence) in infected colonies increased from 2003 to 2008 in several monitored reefs off La Parguera, Puerto Rico. These increases were more drastic during warm seasons. The increase in prevalence may also

reflect an increase in the number of new disease cases. If this is so, then we would expect prevalence to remain high due to the warmer temperatures until all susceptible colonies die from the disease. This would impact the underlying structure of the entire reef system, thereby reducing an important ecosystem service of coastal protection from storms.



Figure 3. The impact of YBD, white plague and bleaching in a single colony of Caribbean *Montastraea faveolata* over five years (E.Weil)

