

Coral Mortality in Reefs: The Cause and Effect; A Central Concern for Reef Monitoring

Chandralata Raghukumar¹

During the International Year of the Reefs (IYOR), a major event called Reef Check 1997 was launched. The purpose of this was to survey the health of corals in the Caribbean. During the survey, living corals were counted along transects besides the dead and dying corals, bleached and diseased corals. In the past two decades, a variety of symptoms which plague corals are being reported from the world over. Destruction of corals can be caused by abiotic and/or biotic agents or a combination of both. Bioerosion, sedimentation and pollution are some of the major abiotic causes. The biotic causes are unbalanced predation, competitors for substratum and diseases. The major visible effects of these causative agents are partial mortality in massive corals, bleaching, black-band and white-band disease.

Partial mortality

Whenever a coral surface is damaged, the tissue surrounding this lesion regenerates and grows inwards to recover the wounds. However, when this does not occur, the result is partial mortality which appears as a bare patch of skeleton on the surface of the coral. This regeneration capacity varies in different species of corals and is used as an indicator of physiological condition of coral. It has therefore, been recommended as a tool for assessing health of corals in a reef. Our field observations have shown the presence of multiple open lesions littering the living tissue of coral colonies. These patches were observed to be colonised later by algae and other boring animals which ultimately weaken the coral skeleton. Many coral reefs lose more living tissue cover through such chronic partial mortality than total death due to calamities like hurricanes or storms (Meesters *et al.* 1996; 1997). Permanent lesions on corals indicate low regeneration capacity of corals in a population and this might be indicative of stress on this population.

Bleaching

The phenomenon of bleaching is of widespread global occurrence. Bleaching of corals is either due to loss of zooxanthellae or reduction in chlorophyll per zooxanthellae. As a result, the coral tissue loses its colour exposing white skeletal calcium carbonate. Three different mechanisms which could account for the reduction in zooxanthellae have been proposed (Brown *et al.* 1995). These are i) the zooxanthellae may be degraded *in situ*. Distorted zooxanthellae have been detected in partially and full bleached material, ii) release of zooxanthellae from endodermis into coelenteron of the polyps and iii) release of intact endodermal cells with their intracellular zooxanthellae out of polyp's tissue. Elevated temperature plays a critical role in bleaching. Bleaching in turn affects coral growth, reproduction and regeneration. The response of different coral species towards bleaching differs. It

¹ Biological Oceanography Division, National Institute of Oceanography, Dona Paula, Goa 403 004

affects colony density and coverage. How the elevated temperature affect the zooxanthellae is the basic question which still remains unanswered.

Black-band disease

Excessive nutrients such as nitrates and phosphates supplied by sewage waters from land act as fertilisers for seagrasses and mangroves, but they are fatal to corals which are adapted to nutrient poor or oligotrophic waters. Algae, cyanobacteria, fungi and bacteria thrive in such waters. Algae grow as tufts on coral scars. The algal patch develops into a black ring around a bare white skeletal patch and hence the name black-band disease (BBD). As the algal band advances it kills more coral tissue. The growth of algal band varies in different species of corals. The older, dead part gets overgrown with various epilithic algae which trap very fine sediment. Small corals can get killed this way in a very short time of few weeks. On larger colonies, the infection may disappear completely or remain restricted.

One such cyanobacterial infection called BBD caused by *Phonidium corallyticum* has been reported to occur throughout the Caribbean. How the infection begins and where the pathogen comes from are not known. Healthy corals directly in contact with infected colonies show infection. When the two are kept apart at a distance of < 2mm in aquarium tanks, the healthy ones do not show symptoms of infection even after many days (Rutzler *et al.* 1983). Cyanobacterial trichomes were not found in the Plankton tows. The results from all over the world show that this pathogen play an important role in regulation of population. The killed colonies also create primary space for further recruitment. BBD is shown to be directly dependent on higher temperatures (Antonius, 1981). Injured corals become infected with *P. corallyticum* more easily. Less than 2 % of Caribbean corals are reported to be infected with BBD (see Edmunds, 1991). Scleractinian and Octocorals are quite susceptible to the disease.

We have observed a dark brown fungus, *Scolecobasidium* sp associated with massive corals showing necrotic patches in the Andamans (Raghukumar and Raghukumar, 198 1) and latter also in the Lakshadweep islands.

White-band disease

No pathogen associated with this disease is reported yet. The disease is so termed because of denuded exposed white skeleton of calcium carbonate. It appears as a simple interface in a coral colony. It is mostly reported in *Acropora palmata*, *Diploria* sp and *Montastrea* sp. It is believed that white-band disease (WBD) can serve as a starting point for BBD which can kill a substantial part of coral. It appears that WBD might be manifested in response to some stress causing factors.

Causes

The primary causal agents of the above discussed maladies are described below. They are sedimentation, eutrophication and pollution. All these factors individually and/ or in combination cause stress to corals.

Sedimentation

Deforestation, construction and coastal development, dredging and other developmental activities can increase the sediment load in coastal waters and cause damage to coral reef ecosystem. A detailed study carried out in the Great Barrier reef has shown that the effect of sedimentation varies with morphologically different species of corals, sedimentation rates, turbidity, quantity, size and composition of sediment, its nutrient and bacterial loads (Stafford-Smith, 1992). Chronic sedimentation can cause total or partial mortality or bleaching depending on the response of corals.

We have observed excessive deposit of sediment on coral colonies in the Gulf of Kutch and these corals exhibit partial or total mortality. Similar sediment deposition and the resulting mortality of massive corals is noticed on massive corals in the lagoon of Kavaratti (Lakshadweep) and in the Vandoor Marine National park, Port Blair (Andamans).

Eutrophication

Corals are always found in oligotrophic waters. The coral reef ecosystem is an excellent example of well managed nutrient budget. The organic carbon fixed by the photosynthetic symbionts, the zooxanthellae is supplied to coral polyps and the essential amino acids released by polyps are utilised by the zooxanthellae. The land run-off adds extra nutrients to this ecosystem. Excessive nutrients encourages growth of sea grasses and algae which in turn release a lot of dissolved nutrients in the form of leachates and these are killers of corals.

Recommendations

Under the coral reef monitoring programme, the primary health of corals should be a main concern. During the coral reef monitoring programme, a few selected sites need to be monitored over a period of time for their response towards regeneration of lesions. Regeneration is important for survival of corals. It affects growth, reproduction, disease resistance and competitive ability (see Oren *et al.* 1997.).

The above mentioned effects of various causal organisms or events are destructive and long-lasting. Excessive nutrients and sedimentation and various diseases can destroy entire coral reef. Coral reef monitoring program should identify reefs in various localities and monitor them routinely for various diseases. This will help us in understanding the causes of diseases and thus evolve strategies to eliminate them.

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