

Disease and stress-induced mortality of corals in Indian reefs and observations on bleaching of corals in the Andamans

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A study was carried out in the Lakshadweep and Andaman islands and the Gulf of Kutch to assess the health of corals in Indian reefs. Disease, predation and stress were the major factors of coral mortality. Death caused by diseases – the black band disease (BBD), the white band disease (WBD) – necrotic lesions, and bleaching was observed in Kavaratti and Kadamat islands of Lakshadweep. The predatory starfish, *Acanthaster planci*, grazing on coral polyps was also noticed in these reefs. Large-scale silt deposition in the intertidal zone of Paga, Boria, Vadinar and Mangunda reefs in the gulf of Kutch buried the coral colonies and appeared to be the main cause of coral mortality. A severe incidence of coral bleaching was observed during July 1998 in some reefs in the Andamans. While more than 85% of corals near Ross island and Marina Park exhibited partial bleaching, up to 10% were totally bleached.

SEVERAL diseases and stress reactions in scleractinian corals from various parts of the world have been reported^{1,2}. Many of these diseases are microbially

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induced. The bacterium, *Sphingomonas* sp. has been proved to be a pathogen in Florida corals³. The cyanobacterium *Phormidium corallyticum*¹ causes black band disease (BBD) in *Montastrea* sp⁴. For many other diseases, such as the white band disease (WBD), microbial causative agent has not been established. Raghukumar and Raghukumar⁵ reported the occurrence of a fungus in association with diseased corals in Andaman waters. Increasing incidence of coral diseases is a concern for conservation of coral ecosystems, and therefore regular monitoring of coral reefs is recommended⁶. Although information on conservation and management in Indian coral reefs has been presented by Pillai⁷, a systematic survey of the present status of corals in Indian reefs is lacking. Therefore, we have initiated monitoring the status of health in Indian coral reefs, particularly in the Lakshadweep islands of the Arabian sea. We are presenting here our preliminary observations on the types of coral mortality occurring in these waters.

Surveys were conducted in: i) Kavaratti atoll and Kadamat atoll in the Lakshadweep group of islands in the Arabian sea; ii) Vadinar, Paga, Boria and Mangunda reefs (Gulf of Kutch) in the western coast of India, and iii) Ross island, North Bay, and Marina park in

the vicinity of Port Blair, Andaman islands (Figure 1). Observations were made in the intertidal region of the windward side of the island, the lagoon and the reef slope of the leeward sides of the island, in Kavaratti atoll and Kadamat atoll. Observation and collections of corals in the sub-tidal regions were made by skin and scuba diving. Presence of fungi in corals was detected by examining sections of 2–3 mm thickness under OLYMPUS SZH10 zoom stereo microscope. The same sections were examined for the presence of fungi after staining with 0.01% calcofluor (Sigma) for 5–10 seconds⁸ under OLYMPUS BX 60 epifluorescence microscope with blue excitation filter. Bleaching of corals in Andamans was estimated by snorkelling over parallel transects of 25 mm length. A total of 15 such transects were covered during one survey.

We observed four distinct kinds of disease symptoms in the Lakshadweep: i) necrotic lesions; ii) fleshy-algal over growth; iii) black band disease, and iv) white band disease.

Necrotic lesions were observed very frequently in *Porites lutea* which is common in the lagoons of Kavaratti and Kadamat islands. The disease is characterized by the presence of single or multiple necrotic patches on coral colony. Two types of necrotic patches were observed. In one type, the patches were surrounded by healthy polyps (Figure 2 a). This type occurred mostly on the upper side of the corals. In the second type the lesions occurred at the bottom of the coral in contact with the sediment and these lesions were not surrounded by healthy tissues. The necrotic patches



Figure 1. Location of sampling sties.

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were devoid of polyps, and were colonized by fleshy algae and cyanobacteria. The margins of the necrotic patches, showing a pink coloration, were surrounded by polyps. Both hyaline and melanized fungi were observed in these specimens.

Necrotic lesions were also extremely prevalent in *Porites* sp. in Marina Park, Andaman (Figure 2 *b*). About 90% of corals in these beds, comprising specimens of 15–30 cm in size, were affected.

Encrusting fleshy red algae were found on a few occasions on *Porites lutea* in Kavaratti lagoon, causing death of the underlying polyps (Figure 2 *c*).

The BBD was noticed occasionally on *Porites* sp. in Kavaratti atoll. This was characterized by a necrotic patch surrounded by a black line or band (Figure 2 *d*). The band width varied from 3 to 6 mm. The black band found on the small vertical lobes of the colony appeared to advance on the colony as the necrotic patch expanded upwards from the bottom. The dead portions of the corals were colonized by algae.

The WBD was found on several massive corals in the reef slope of Kavaratti island. In this case a white band was present around a necrotic patch on the coral colony. The dead portion was devoid of polyps and appeared white. Older patches were colonized by algae.

Coral bleaching was common in Lakshadweep reef, although the incidence was low during our survey from April 96 to Feb. 98. Fully- and partially-bleached colonies were frequently noticed. Bleached colonies under water are easily identifiable by their white skeleton which is devoid of pigments. Colonies showing bleaching were observed to secrete excess mucus. While the fully-bleached colonies appeared totally white, partially-bleached ones showed moderate loss of their original colour and were also observed to secrete excess mucus.

A very high incidence of bleaching was noticed in July 1998 in the three Andaman reefs surveyed

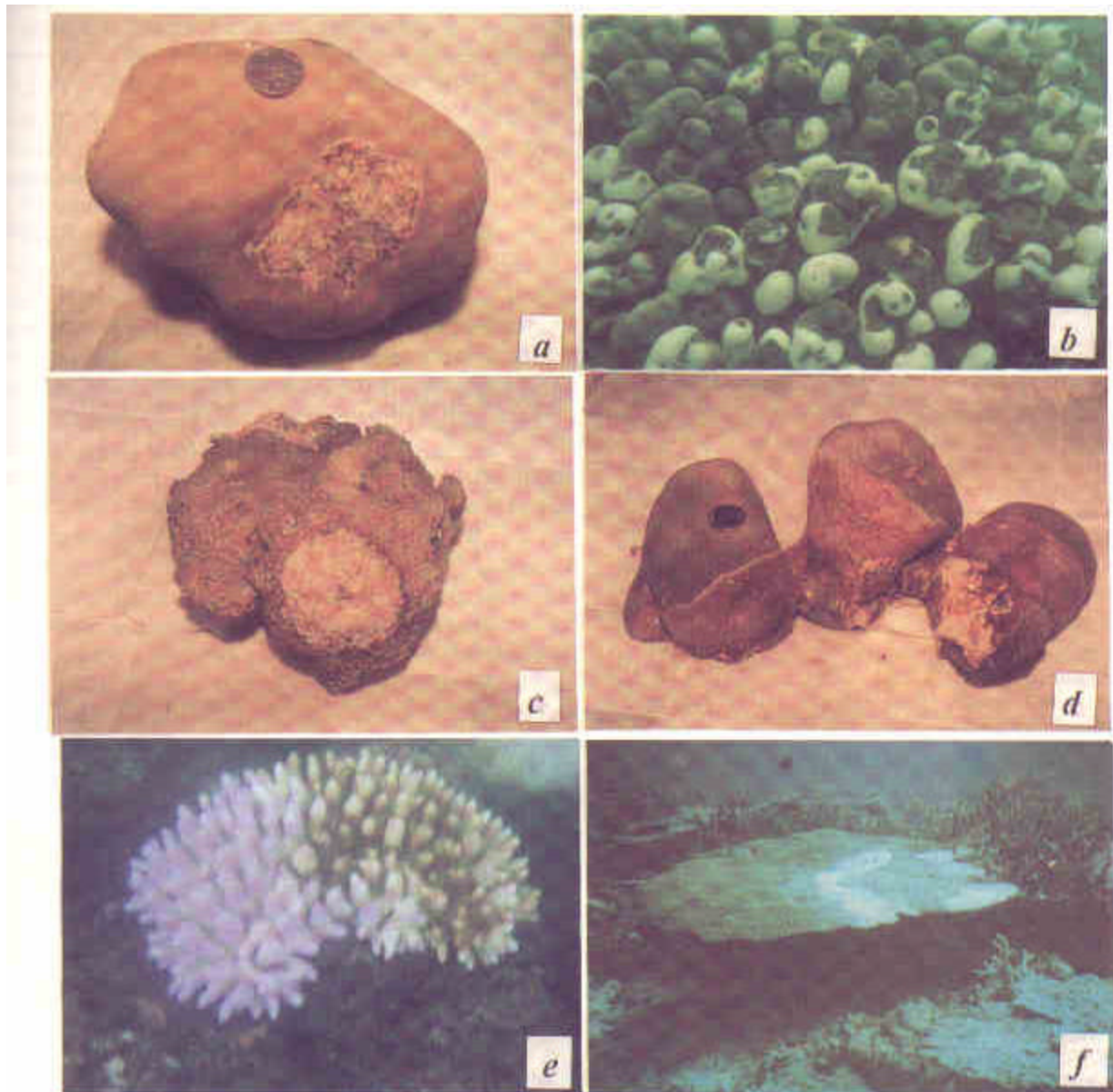


Figure 2 a-f. a, Necrotic lesions in *Porites* sp. at Kavaratti island, Lakshadweep; b, Bleaching and necrotic lesions in *Porites* sp. at Ross island, Andamans; c, Algal over-growth in *Porites* sp. at Kavaratti island, Lakshadweep; d, Black band disease (BBD) of a scleractinian coral, Kavaratti island, Lakshadweep; e, Partial bleaching of *Acropora* sp. at Ross island, Andamans; f, *Acropora* sp. grazed by the starfish *Acanthaster planci* at Kadamai island, Lakshadweep (white patches).

Table 1. Bleaching in the Andaman reefs

Station	Bleaching in massive corals (%)	Bleaching in branched corals (%)
Ross island	100	91
North Bay	98	100
Marina Park	83	89

Figure 2 a-f. *a*, Necrotic lesions in *Porites* sp. at Kavaratti island, Lakshadweep; *b*, Bleaching and necrotic lesions in *Porites* sp. at Ross island, Andamans; *c*, Algal over-growth in *Porites* sp. at Kavaratti island, Lakshadweep; *d*, Black band disease (BBD) of a scleractinian coral, Kavaratti island, Lakshadweep; *e*, Partial bleaching of *Acropora* sp. at Ross island, Andamans; *f*, *Acropora* sp. grazed by the starfish *Acanthaster planci* at Kadamat island, Lakshadweep (white patches).

Table 1. Bleaching in the Andaman reefs

(Figures 2 *b*, *e*; Table 1). More than 90% of the massive corals and more than 75% of the branched ones were affected in the three sites: Ross island, North Bay, and Marina Park. We have isolated a number of fungi from coral colonies with the corals showing: (i) necrotic lesions, and (ii) bleaching. We have isolated a number of fungi from healthy colonies as well.

The crown-of-thorns star fish, *Acanthaster planci*, a well-known predator of coral polyps was observed in Kavaratti lagoon as well as reef slopes of Kadamat island. The star fish was found in considerable numbers in the latter site. Corals grazed by the star fish appeared white and were devoid of polyps (Figure 2 *f*).

Corals with necrotic lesions, fleshy algal over growth, and silt deposition showed the presence of melanized

Table 2. Causes of coral mortality in different locations

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Area surveyed	Location	Period of time	Colony	Cause of mortality
Kavaratti	Lagoon	Apr. 96–Nov. 98	<i>Porites lutea</i>	Necrotic patch
Kavaratti	Lagoon and intertidal	Nov. 97 and Feb. 98	<i>P. lutea</i>	Bleaching
Kavaratti	Lagoon	Nov. 97 and Feb. 98	<i>Acropora palmata</i>	Bleaching
Kavaratti	Reef slope	Nov. 97 and Feb. 98	<i>A. humilis</i>	Bleaching
Kavaratti	Lagoon	Apr. 97	<i>P. lutea</i>	Predation by <i>Acanthaster planci</i>
Kavaratti	Lagoon	Apr. 97–Feb. 98	<i>P. lutea</i>	Black band disease
Kavaratti	Lagoon	Apr. 97–Feb. 98	<i>P. lutea</i>	Coralline algal over-growth
Kavaratti	Reef slope	Feb. 98	<i>Porites</i> sp.	White band disease
Kadamat	Reef slope	Feb. 98	<i>Acropora</i> sp.	Bleaching
Kadamat	Reef slope	Feb. 98	<i>Porites</i> sp.	Bleaching
Kadamat	Reef slope	Feb. 98	<i>Acropora</i> sp.	Predation by <i>Acanthaster planci</i>
Kadamat	Reef slope	Feb. 98	<i>Goniastraea</i> sp.	Bleaching
Kadamat	Reef slope	Feb. 98	<i>Siderastraea</i> sp.	Algal over-growth
Kadamat	Reef slope	Feb. 98	<i>A. humilis</i>	Algal over-growth
Kadamat	Reef slope	Feb. 98	<i>Acropora</i> sp.	Algal over-growth
Kadamat	Reef slope	Feb. 98	<i>Acropora</i> sp. (table coral)	Algal over-growth
Vadinar	Reef flat	Aug. 96	<i>Favia</i> sp.	Bleaching
Vadinar	Reef flat	Aug. 96	<i>Pseudosiderastrea</i> sp.	Bleaching
Vadinar	Reef flat	Aug. 96	<i>Favia</i> sp.	Sedimentation
Vadinar	Reef flat	Aug. 96	<i>Pseudosiderastrea</i> sp.	Sedimentation
Vadinar	Reef flat	Aug. 96	<i>P. lutea</i>	Sedimentation
(Paga reef)	Reef flat	Sep. 97	Dead reef	Sedimentation
(Mangunda reef)	Reef flat	Sep. 97	Dead reef	Sedimentation
Ross island, Marina Park and North Bay (Andaman island)	Fringing reef	July 98	All branching and massive corals	Bleaching
Ross island, Marina Park and North Bay (Andaman island)	Fringing reef	July 98	<i>Porites</i> sp.	Necrotic lesion

fungal hyphae. These fungal filaments were observed to be present from surface to subsurface and deeper in the coral section (Figure 3).

Silt deposition appeared to be the major cause of coral mortality in the intertidal regions of the Gulf of Kutch. Death of corals appeared to have been caused by settlement of the fine sediment on the coral colonies, smothering the polyps to death. The thickness of the sediment on the colony ranged from a few millimeters to several centimeters.

This is the first report on the occurrence of coral disease and mortality in the Lakshadweep islands and the Gujarat coast. The disease symptoms observed by us closely resembled those reported earlier in literature from coral reefs in many parts of the world¹. Necrotic lesions, resulting in partial mortality, are common among scleractinian corals⁹ and symptoms of partial mortality described earlier by other workers were observed by us during our present survey. Such necrotic patches may be caused by fishes, divers and diseases. Microbial pathogens might also cause such dead patches. We have observed fungal hyphae in healthy, diseased and dead portions of *Porites lutea* showing necrotic patches. Fungal hyphae have also been reported in association with black band disease¹⁰. Involvement of fungi in causing partial mortality in *Porites lutea* observed by us needs to be confirmed by applying Koch's postulates.

The BBD is a widely reported disease from various parts of the world¹. However, we noticed this only on a

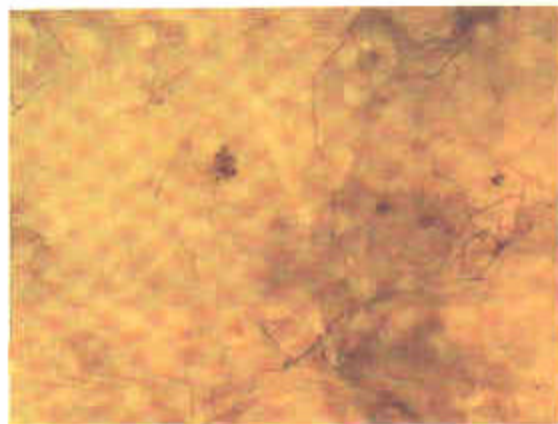


Figure 3. Endolithic fungal filaments seen in the vertical section of *Porites* sp. at Kavaratti island, Lakshadweep.

few occasions. The cyanobacterium, *Phormidium corallyticum*, is the known cause of BBD. We too noticed the presence of a *Phormidium* sp. in association with the BBD. The WBD observed by us in our survey is similar to that reported by Gladfelter¹¹. The causal agent of WBD is not known.

Bleaching was a common symptom observed in our survey. Factors that trigger this physiological status have still not been identified. Stress-inducing factors like elevated

sea surface temperature (SST) (ref. 12), pollution and pathogens are believed to be some of the causal factors. It will be worth examining the relationship between the extreme incidence of bleaching observed by us in July 1998 in Andaman and the SST during the summer of this year. Similar high incidences of bleaching have been reported this year from Seychelles, Maldives, and Sri Lanka reefs (Jason Rubens and Thomas Goreau, pers. commun.). A species of *Vibrio* has been described recently to be causing bleaching of the coral *Oculina patagonica* in the coast of Israel¹³. Disturbances in biodiversity and the removal of predatory animals may result in increase in population of *Acanthaster planci*, the predator of corals¹⁴. Corals grazed by the star fish could be distinguished from bleached colonies. While the former had the trails of predation and a bare skeleton without polyps, the bleached colonies did not show any trails of predation and the corals still retained their polyps. The star fish was always associated with the grazed colonies.

Silt deposition was observed to cause a high incidence of coral mortality in the Gulf of Kutch, Gujarat. Increased construction activities and altered tidal currents in the areas could be a major cause for this. The deleterious effects of quarrying and mining on Indian coral reefs have been described by Patel¹⁵, Rashid¹⁶, and Wafar¹⁷. Most corals in this area were almost buried under silt. Intercolonial space between coral colonies in Paga reef revealed silt deposition of few mm to two feet in thickness.

Thus, during our survey of two years, we observed various factors which result in the different disease symptoms of corals. Table 2 summarizes the causes of coral mortality in different locations.

Global reef monitoring in the name of 'Reef check 97' (ref. 6) was carried out in 31 countries during the Year of Coral Reefs in 1997. India was not a participant in the event. Such monitoring programmes should be given priority as these help in assessing reef health and evolve long-term strategies to preserve and protect them.

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