

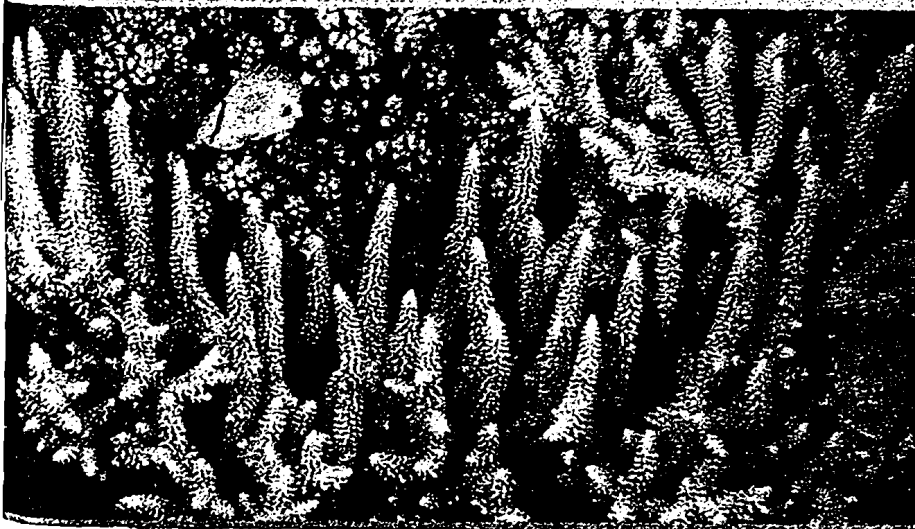
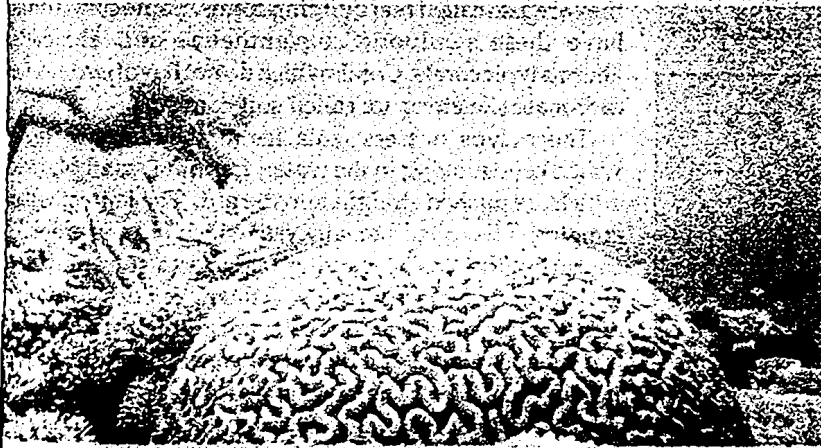


# CROWNING CORALS

The year 1997 was declared the "Year of the Reefs" by the International Oceanographic Commission.

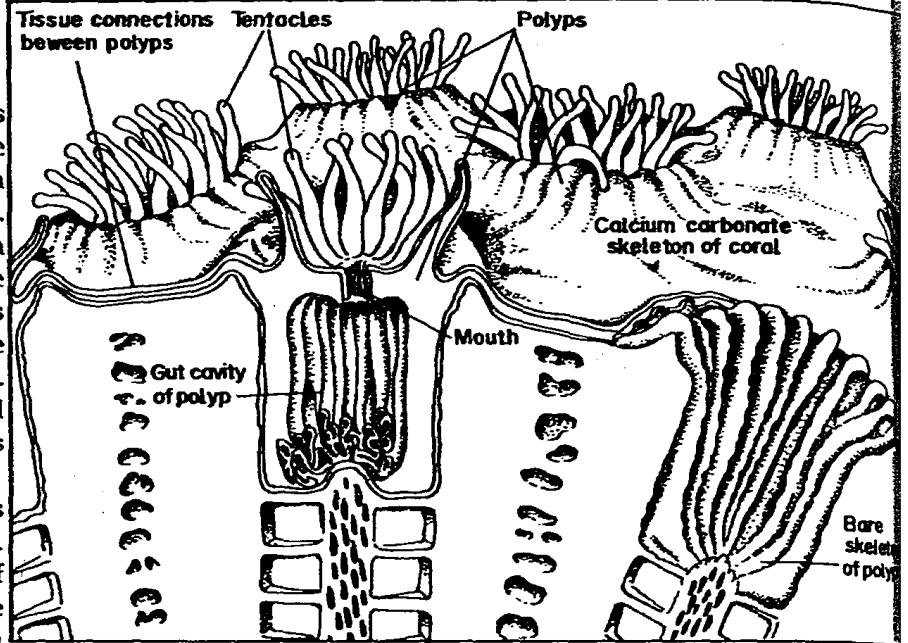
**CHANDRALATA  
RAGHUKUMAR**

takes this opportunity to make passionate plea to manage the sewage, oil and thermal pollution to help preserve the corals



**B**IODIVERSITY is seen at its best in two ecosystems of the world—the tropical rain forests and the coral reefs. One is responsible for productivity on land and the other in the sea. They are valuable for human welfare and are as much a world heritage as any man made construction in marble or precious metal. While much is known about the tropical rain forests the world of the corals is only now being explored.

Coral reefs are built mainly by corals containing a calcium carbonate skeleton. Each coral is a colony of thousands of coelenterate animals or polyps. The growing polyps accumulate calcium carbonate from ambient seawater and build massive calcareous skeletons around them. These skeletons vary in size and shape and form one of the parameters for classification of these organisms. There are plate-like corals, massive corals, mushroom-like corals, encrusting corals and branched corals. The zooxanthellae supply nutrients to corals and in turn get accommodation



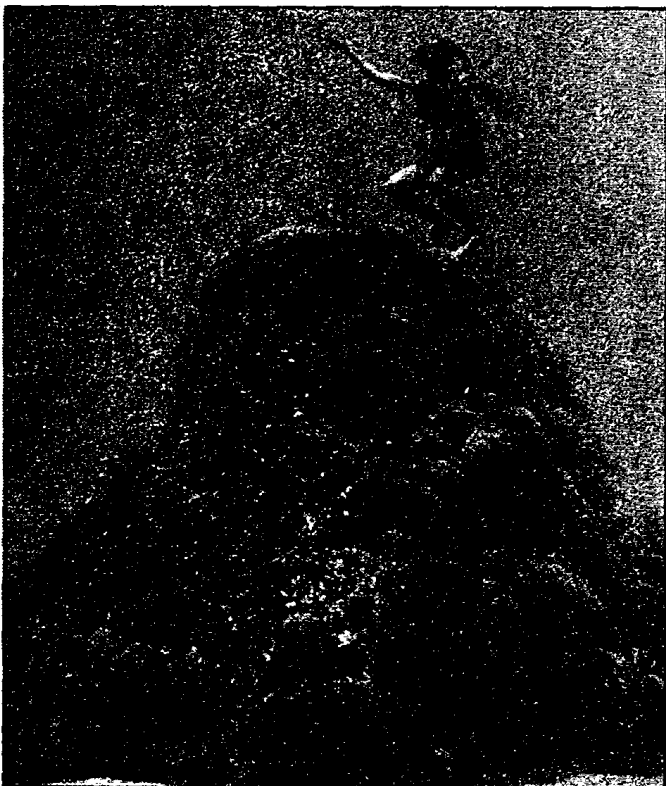
Schematic diagram showing cross-section of a coral

and certain essential nutrients from their hosts. This kind of association where both the partners "live together" for mutual benefit is called symbiotic relationship. Corals harbouring zooxanthellae are called hermatypic corals, they are also called reef building corals. Some corals do not have these symbiotic zooxanthellae and are called ahermatypic corals. Corals which do not have hard calcium carbonate skeletons are called soft corals.

The polyps possess tentacles at their mouth region which keep moving in the water, trapping small plankton which are pushed straight into the gut. The tentacles have stinging cells called nematocysts which aid the animal in capturing food. The moving tentacles also remove any sinking particles from settling on them. Besides, the polyps also secrete a mucilaginous substance which binds sinking sedimentary particles which are then whisked away by the moving tentacles. The mucilage also traps small animals which are then taken into guts by the moving tentacles. Polyps in most of the corals feed in the nights.

Corals reefs are found in waters upto a depth of 50-70m, well lighted zones having salinity of 32-35% and temperatures of above 20°C. Strong wave action supports good growth as it provides fresh oxygenated waters and renewed source of planktonic food material. Corals are sensitive to prolonged exposure to air.

Corals reproduce by two methods. Sexual reproduction is by budding off a new individual from the polyp. Continued budding increases the size of the colony, but does not produce new colonies. If the corals get damaged and break off during storms or hurricanes, then the broken part with live polyps can develop into a new colony, settle on hard substratum and start new colonies. This



A diver explores the Pennercamp Coral Reef Preserve off Key Largo, Florida

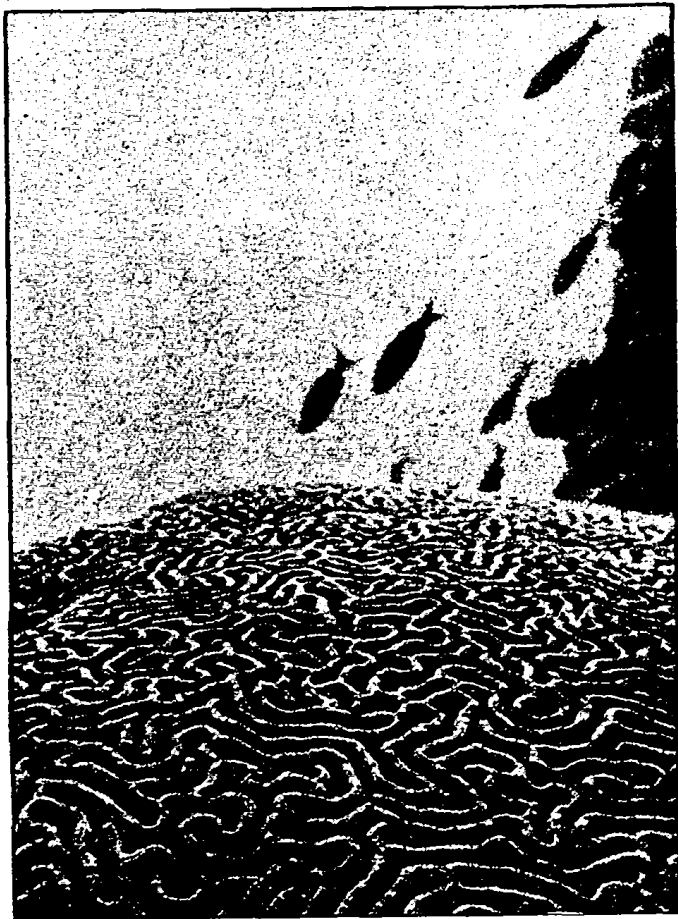
phenomenon has been observed in shallow waters with high temperatures and chronic levels of sedimentation. This exciting discovery appears to be a survival strategy by corals to tide over unfavourable environmental conditions.

Sexual reproduction results in production of free swimming planula larvae which settle on hard substratum and develop into a new colony. Since adult corals are fixed in one place, the planula larvae are the means of dispersal of the various coral species. Some of the corals are hermaphrodite where the male and female sex are in the same individual while some of species have separate sexes. Sexual reproduction is by two methods, broadcast spawning and brooding. During broadcast spawning, coral species release their eggs and sperms in water. The eggs are retained and fertilised in the polyps.

Coral reefs abound in a variety of fascinating animal life such as giant clams, sea cucumbers, sea anemones, sea urchins, sea fans, crown-of-thorns starfish and a variety of colorful fishes. Each of these animals have a special niche in this system. Different species of fishes are associated with seagrass, branched and massive corals, caves (the huge empty spaces between coral boulders are called caves) and sand. There are also night and daytime fishes. While the giant clam burrows into the coral rocks, sea anemones and sea fans grow attached to coral rocks. Sea urchins and crown-of-thorn starfish feed upon polyps of coral. Sea cucumber and cowries lie on the sea floor between corals and seagrass beds.

There is an immense competition for space and light in well growing reefs. Fast growing and upright forms of corals expand very fast and the encrusting massive corals which are in the shade of branching corals die. The slow growing forms extend filaments from their gastrovascular cavities and digest the tissue of overgrowing forms. Thus the colonies maintain a hierarchy in which each species attacks and kills those which are below it, and in turn is attacked by those above it. Animals like sea anemones have stinging cells. Fishes like scorpion and stone fish have venom as a defence mechanism. The sluggish sea cucumbers eject sticky fluid when attacked by predators.

Zooxanthellae associated with corals impart color to the corals. They are the major primary producers of food in the coral ecosystem. The primary producers are like plants on land which form the basis of life. They use light and atmospheric carbon dioxide and produce organic food which is transported to polyps which are then eaten by animals. Seagrass and seaweeds are the other major primary producers in coral lagoons. The decomposing matter (also called detritus) from these two groups of plants sustains a large number of microfauna and microorganisms and is a source of food for detritus feeding animals. Besides, leachates from dead and decomposing plants and algae

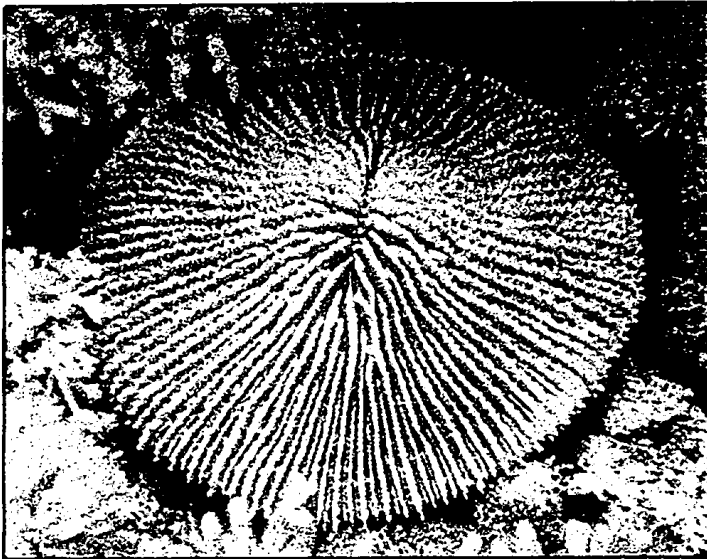


*A brain coral formation in the Pennercamp Coral Reef Preserve*

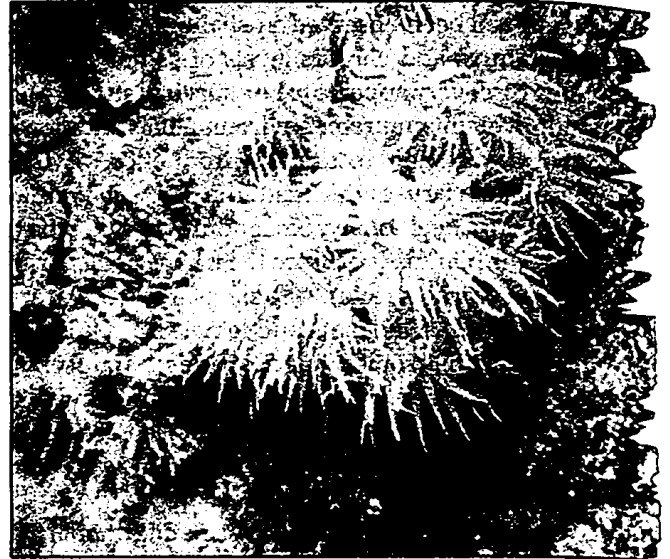
enrich the lagoon water. The algae which grow on coral boulders and contribute to the primary production are an important component of this ecosystem. The algal community also sustains a large community of grazing animals. These algae are called turf algae. The calcium carbonate skeletons of corals are also hosts to green and blue-green algae which bore inside these hard structures and are called endolithic forms. These also contribute substantially to the primary production in the lagoon. Thus large benthic reef algae, coralline algae, turf algae, endolithic algae, phytoplankton, sand algae, zooxanthellae and seagrasses are the major primary producers.

Large cavities, sometimes as large as caves, are an important part of the reef. These "seemingly" empty spaces shelter an array of coral fishes differing in hues and forms. These cavities trap sediments produced by the death of corals, coralline algae, molluscs etc. The sediments and dead organisms which are trapped in these cavities form important geological records.

Major coral reefs in India are found in the Lakshadweep islands in the west and the Andaman and Nicobar islands in the east. Besides, minor reefs are found in the Gulf of Kutch on the west coast and Palk Bay and the Gulf of



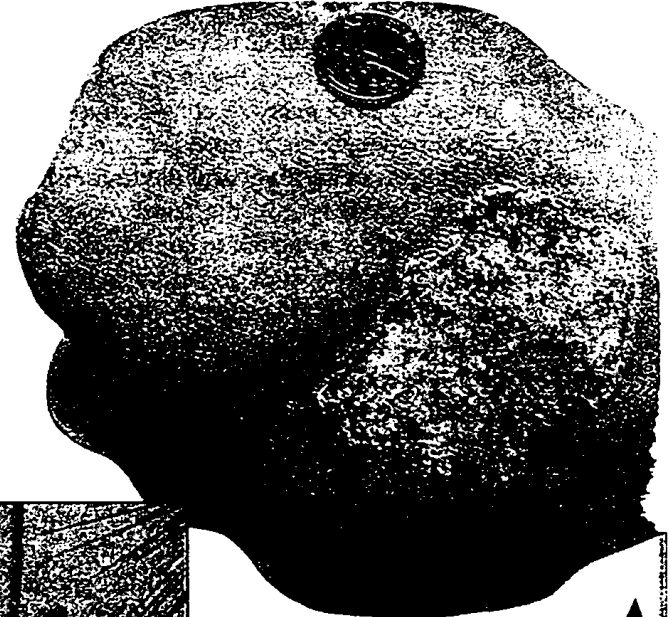
*Mushroom corals are produced by one large polyp*



*Dwarf corals have brightly coloured polyps*

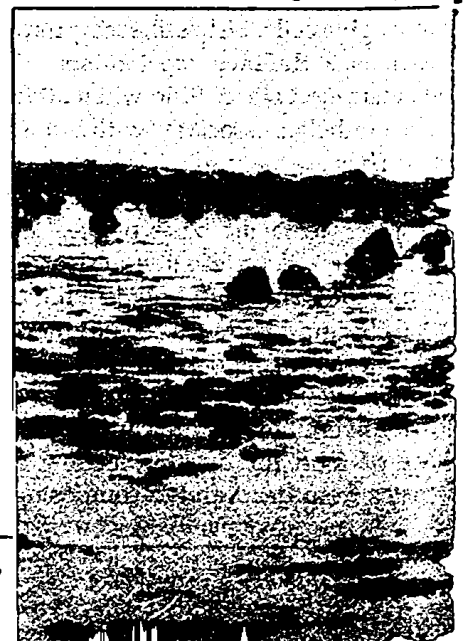
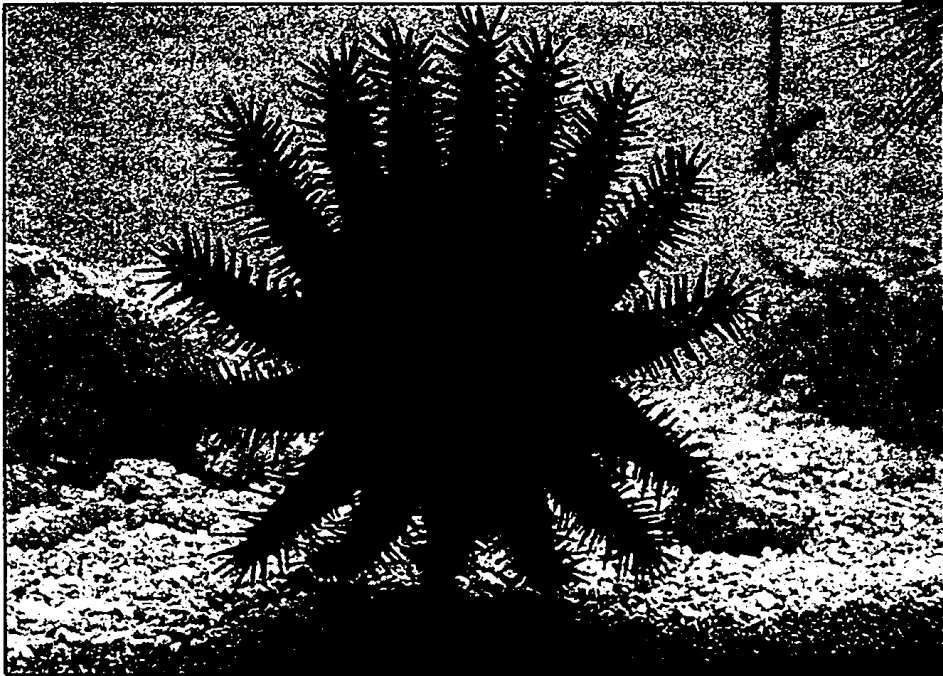
Mannar on the east coast. The islands in the Lakshadweep are built on coral atolls on a volcanic submerged ridge. These islands have lagoons on their western side, the outermost boundary of which has coral reefs.

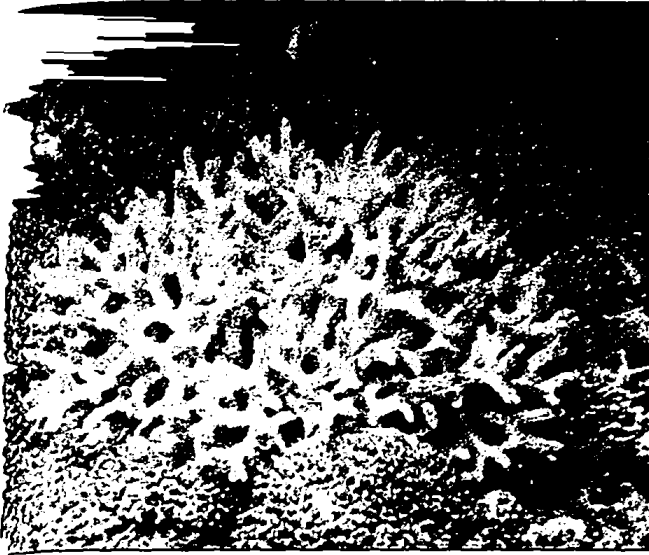
The bottom profile of a typical atoll shows seagrass and seaweed beds near the shore, lagoon with live corals in the centre, a narrow zone of dead coral debris near the reef crest followed by a reef slope. These reefs slope towards the oceanic side and harbour some of the richest flourishing and flamboyant coral flora. Scuba diving is an excellent tool for observing these wonders of nature. The reef slope in the lagoon side is termed the leeward slope. Windward slope on the other side of the island is wave beaten and



*A coral showing necrotic patch*

*A crown-of-thorns starfish*

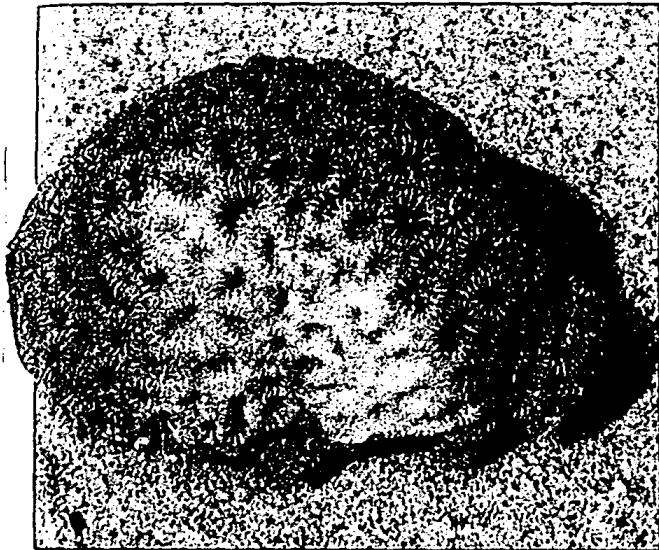




*Reef-building corals grow in warm seas*



*Soft corals like deer's antlers*

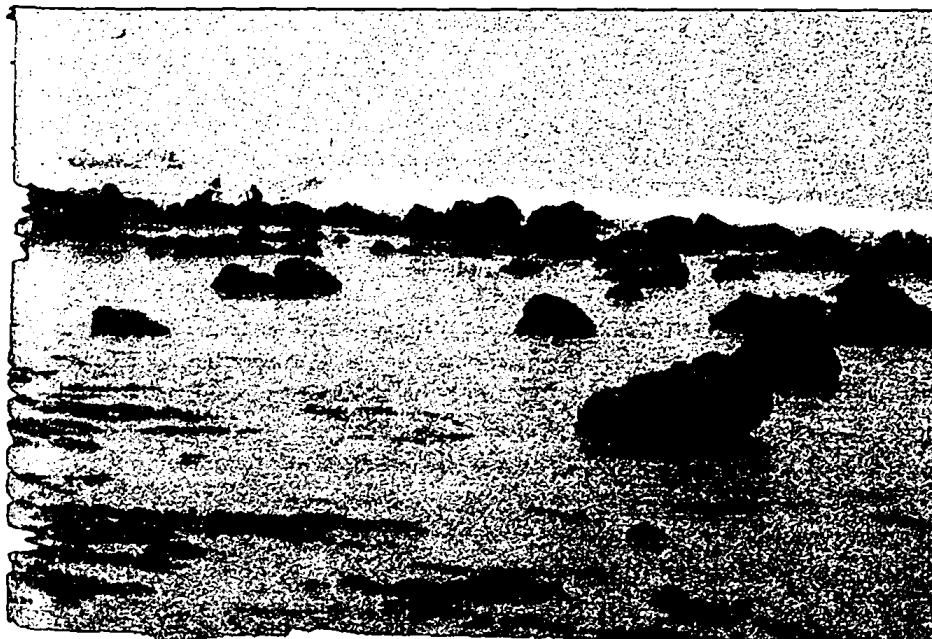


*A coral showing bleaching*



*Sea fan corals are known for their bright colours*

*Reef flat on the windward side of Kavaratti atoll off the Lakshadweep Islands*



difficult for diving. This region harbours diverse coral and algal biota. Both sides are marked by distinct rubble banks containing dead coral boulders. There are basically three major types of coral reefs. The fringing reefs are found near the shore where temperatures are above 20°C, salinity around 35‰ and low turbidity. In India they are found in the Gulf of Mannar on the east coast and around Andaman and Nicobar islands.

Barrier reefs are separated from shore by a lagoon. The width of the lagoon varies and with a narrowing of the lagoon, the barrier reef can become a



fringing reef. The largest barrier reef is the Great Barrier Reef of Australia. It is 2,000 km long, varies in width from 15-350 km and covers an area of 225,000 km<sup>2</sup>.

Atolls are annular reefs that develop at or near the surface of the sea. Maldives and the Lakshadweep islands are good examples of atolls.

All the reefs have reef flat and reef slopes. Reef flats support low cover and/or diversity of coral fauna, dominated by one or two characteristic species. The species are uniformly exposed to excessive light and temperatures, and a longer duration of subaerial exposure. Corals on the reef slopes are exposed to light and water movement. Both hermatypic and ahermatypic species are found here. The reef slopes are rich in diversity of corals.

The lagoons have coralline sand which give them a typical blue green color. A distinct zonation of seaweeds and seagrass near the shore and massive and branched corals towards reef side is the common pattern in the lagoons of the Lakshadweep islands. In the Andamans, besides seagrass, mangroves line the shore of lagoon. Here, very often we find massive corals growing besides the prop roots of mangroves.

Often a loose sediment is converted into a solid rock. This is known as lithification. It occurs mostly on the seaward side and to a certain extent also on the leeward side. The cavities found in the coral rocks by organisms which bore into them (also called endolithic or boring organisms) are filled by loose sediments, originated from destruction and bioerosion of calcareous structures. These sediments vary from unconsolidated to friable to completely cemented forms. The cementation is brought about by physico-chemical and biological precipitation of calcium carbonate. The endolithic organisms play an important role in marine cementation. Marine lithification also leads to formation of new substrates for subsequent colonization by reef organisms.

A combination of both constructive and destructive process leads to reef growth. Further reef growth occurs by increase in the supply of both organic material and calcium carbonate which is inorganic in nature. Calcium carbonate is added either through biological and/or sedimentological accretion. Erosion is the principle mechanism leading to the destruction of reef. The erosion can be physical, mechanical or biological. The primary eroders are sponges, echinoids, molluscs, etc. Damage to corals is caused by parrot fish and other browsers and grazers of epilithic algae and polyps from the coral surface. Boring into basal regions of corals can make them weak and then they can be easily dislodged by waves.

Reefs all over the world are dwindling fast. The major agents of destruction of coral reefs are abiotic and biotic such as hurricanes, bioerosion, sedimentation, eutrophication, pollution, predation and diseases.

Turbulence caused by hurricanes and typhoons can uproot and topple branched corals and also sometimes massive corals. Its effect is mostly visible on corals in shallow waters.

Excessive and indiscriminate removal of corals and dredging of coral sand by the cement industry are the major threats to Indian reefs. Construction of jetties and other island development activities invariably increase the silt and sediment deposition on live corals and this kills them. In some of the reefs, growth rate of corals does not match their destruction, and therefore these reefs appear dead.

Agents of bioerosion are boring and grazing animals and microbial borings. Grazers like parrot fishes feed on turf algae on the corals and in this process scrape at living coral skeleton. Major part of the gut contents of such grazers are found to consist of inorganic material such as calcium carbonate. Finely powdered carbonate material is excreted by these grazers. Parrot fish grazing has been estimated to account for 0.6% of total bioerosion in the Carribean Islands. Echinoids are the most important bioeroders and ingest large quantities of inorganic material while grazing algae. The echinoid population is increasing due to overfishing of triggerfish, pufferfish and emperorfish which are their predators.

Fungi and endolithic algae penetrate coral substrates and cause bioerosion. Live endolithic algae are commonly visible as a greenish band just below the live coral tissue in a longitudinal section of a coral. Many of the endolithic blue-green algae (cyanobacteria) have 5-10 µm wide special boring filaments. Bioeroders are constantly destroying the framework of reefs. If bioerosion exceeds reef growth, then the reef will be destroyed.

Predation of coral polyps by crown-of-thorn star fish, *Acanthaster planci*, can cause great mortality of corals. Long lasting community changes follow such mortalities. The problem of *Acanthaster* caused mortality is reported occasionally from the Andaman and the Lakshadweep islands also. Large scale removal of cowries which are predators of crown-of-thorn star fish is suspected to be one of the causes of the increased population of *Acanthaster*.

Deforestation, dredging and other human activities on the coast and in the reef area can increase the sediment loads in coastal waters and lagoons and cause serious damage to coral reefs. Heavy sedimentation and associated turbidity can cause mortality of corals in reefs. The sediment settles on the surface of the corals and kills polyps. High turbidity reduces the light for photosynthetic zooxanthellae. There are differences in behavioural responses of corals to sediments which affects the species diversity under such stressful conditions.

Numerous studies have shown detrimental effects of elevated phosphate and nitrate concentrations on coral survival. Alterations from coral dominance to fleshy algal dominance have often been associated with excessive nutrient increases. Increased nutrients from sewage sources, agricultural run-off from terrestrial sources and siltation, due to deforestation are damage the coral ecosystems.

Pollution by oil spill and oil transport, thermal pollution and fresh water inflow are other major threats to corals growing along the urban and industrialised centres.

An algal infection called black band disease (BBD) caused

by the cyanobacterium *Phormidium corallyticum* is responsible for widespread mortalities of reef forming massive corals like *Porites*, *Goniopora*, *Goniastrea*, *Diploria* and *Montastrea*. The causal organism of BBD forms a thick black line of around 1 cm between the dead necrotic patch and living tissues. As this line progress further, the necrotic patch becomes bigger in size. Under normal conditions the corals secrete mucus which helps in removing any foreign bodies from settling on them. The foreign body wrapped in a sheet of mucus is then pushed away by the moving tentacles. When the corals are loaded with heavy sediment this

defence mechanism fails and the pathogen gets established on the coral surface and causes the disease. The causal organism can be isolated from this black line, cultured in the laboratory and used for experimental inoculation on healthy corals in aquarium tanks. Use of antibiotics like streptomycin, penicillin and erythromycin have been found to arrest and stop the advance of the BBD in experimental tanks. This approach to control the disease is not practical and therefore the only control measure is to reduce the stressful conditions which lead to BBD infection in nature.

Another commonly reported disease is the white band disease (WBD). The causal organism of WBD is not known yet. The organisms associated with WBD have been isolated and used for inoculating healthy corals which never produced a WBD. It is not contagious like BBD. It cannot even be arrested by antibiotics. It is suspected that WBD is a precursor to BBD infection.

Bleaching is another commonly observed malady which

strikes corals. Bleaching is a general term describing pale color of corals usually associated with loss of zooxanthellae and/or their photosynthetic pigments from the coral tissue. It is generally accepted that bleaching is due to environmental stress. It is correlated with elevated sea surface temperatures and global warming due to greenhouse gas emissions. Other environmental factors like visible and UV radiation, low salinity, high sedimentation rates, industrial, agricultural and sewage pollution are also suspected to be responsible for the worldwide phenomenon of coral bleaching.



A coral showing black-band disease

A large number of massive corals have been observed in the Lakshadweep and the Andaman and Nicobar islands having large necrotic or dead patches covered with sediment and most often overgrown with algae. A dark brown fungus in the subsurface region (below 1-2 cms) is constantly observed to be associated with such dead patches. The BBD organism, the cyanobacterium, *Phormidium corallyticum* is not found in these dead patches.

Rehabilitation of reef flats degraded by coral mining in the Gulf of Kutch and Gulf of Mannar can be attempted by resorting to use of artificial reef structures. Artificial reef

structures such as concrete blocks of a hollow cube design or plain concrete mattresses have been used in Maldives for settlement of coral larvae. The success story of Maldives in rehabilitation of denuded reefs is often repeated. If island nations like Maldives could achieve this, India could definitely do it. An in-depth study on reproductive biology of corals will also help us in rejuvenation of the denuded reefs.

A concerted effort from academicians, governmental and non-governmental bodies to educate the public and build awareness about the rich, diverse biological resources is warranted. A better management of our sewage, oil and thermal pollution will take us a long way in preserving the biodiversity of coral and associated flora and fauna in our land.

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