



## What's Happening to Coral Reefs? - Part I

### Why are Coral Reefs so Important?

The World Conservation Strategy, published by the International Union for Conservation of Nature and Natural Resources (IUCN) in 1980, identifies coral reefs as one of the 'essential ecological processes and life-support systems' necessary for food production, health and other aspects of human survival and sustainable development. They provide the fish, molluscs and crustaceans on which many coastal communities in developing countries depend and commercial fisheries are often indirectly dependent on reefs which provide a nursery ground for juveniles. Reefs protect the coastline against waves and storm surge, preventing erosion and contributing to the formation of sandy beaches and sheltered harbors. Tourism in many countries is based on reef-related activities and the aesthetic appeal and recreational value of reefs are of increasing economic importance.

Reefs are a source of raw materials and potential genetic resources. For example, corals and coral sand are used as building materials; stony corals are used to make lime and cement; black coral is used for jewelry. Stony corals, shells and aquarium fish are collected for a variety of decorative purposes. Reef organisms produce highly active biocompounds to deal with their crowded

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environment and many of these have antimicrobial, antitumor, antileukemia and a variety of other medical properties. Finally reefs play an important educational and scientific role with many people developing an interest in marine biology as a result of taking up scuba diving as a sport.

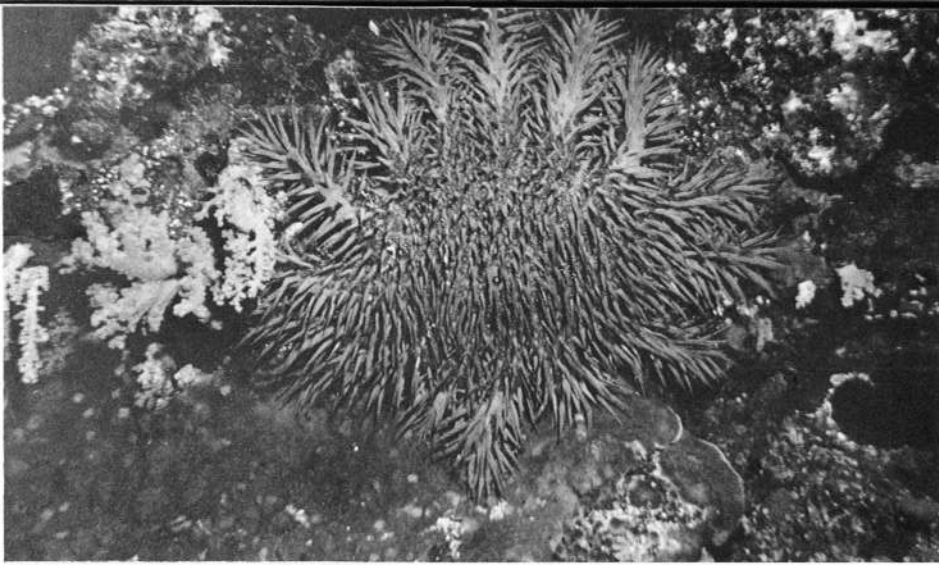
*Above:* Lionfish, one of the more spectacular coral reef fish. *Below:* Reefs have a glamor unequalled by most other ecosystems. Photo by P. Laboute, courtesy of the Aquarium de Noumea.



Reefs have a glamor unequalled by most other ecosystems but despite this, and often because of it, they are coming under increasing pressure. As with most natural resources of value to man, they are being exploited at a rapidly accelerating rate. Coral reefs can, in fact, be likened to tropical rain forests in their high levels of species diversity and productivity. As climax ecosystems their rate of recovery is slow and sustainable use on a large scale requires careful management.

### Why are Reefs so Vulnerable?

The corals which form the structural framework of the reef are highly specific in their requirements for light, temperature, water clarity, salinity and oxygen. The symbiotic zooxanthellae which live in their tissues have a minimum requirement for light, and the sedentary life style of corals makes them vulnerable to siltation. In general they have slow growth rates, ranging from 2 cm per year for the massive brain corals such as *Diploria* and *Montastrea* to 20 cm per year for branching corals such as *Acropora*. Adverse environmental conditions may cause even slower growth rates, failure of the reproductive mechanism and in extreme cases, a 'shut down reaction' which results in the expulsion of the zooxanthellae and the death of entire coral colonies.



Crown-of-thorns starfish on a Philippine reef.

Throughout history reefs have been damaged by natural events, sometimes disastrously. Hurricanes and storms, for example, have a major impact and can reduce large areas of reef to rubble through the breaking of branching corals and freshwater inundation. Usually, once conditions return to normal a reef will recover through a process of regrowth and recolonization. Recovery rates have been documented in Belize and Jamaica, and it has been found that in some cases such damage may even contribute to the diversity of the reef. Corals flourish best in temperatures of 25-29°C, and rarely survive below 20°C or in very high temperatures. Catastrophic low tides, especially if combined with high midday temperatures, can kill exposed portions of reefs as documented for example at Eilat in Israel, in Puerto Rico and in Panama. The recent El Niño appears to have had a widespread effect on corals in the Eastern Pacific, off Costa Rica, Panama and the Galapagos where sea temperatures rose to 31°C.

Population explosions of coral predators may cause damage. Outbreaks of the Crown-of-Thorns starfish, *Acanthaster planci*, caused concern in many parts of the world although it now appears that the damage is not as long lasting as had been previously feared. Similar problems have arisen with population outbreaks of other organisms, such as the sea urchin *Diadema* in the Red Sea and the gastropod *Drupella* in the Philippines and Japan. Corals are susceptible to disease, such as the 'white-band' and 'black-line' diseases which have periodically broken out in parts of the Caribbean and recently there have been reports

of widespread coral bleaching and death in the Indian Ocean, Pacific and Caribbean the cause of which is unknown. In many cases it is still not known whether these population explosions and diseases are natural events or whether they have been triggered by man's activities.

#### What is Man's Impact?

Reefs subjected to human activities appear to have less capacity to regenerate, largely because the impact tends to be longer lasting and more intense. Over 80 countries possess coral reefs, and with a few exceptions, such as Australia and the U.S.A., all are developing nations. The coastal areas adjacent to reefs are sometimes densely populated and urban development, terrestrial run-off and effluents all affect shallow coastal waters. Fringing reefs, lying immediately offshore, are particularly vulnerable to pollutants and sediments washed off the land. Atoll and barrier reefs are less vulnerable but may be affected by pollutants carried on oceanic currents or released from ships. Like all marine environments, reefs may be affected by activities taking place many miles away, such as siltation arising from deforestation inland, or pollution emanating from a source in a different country. Threats to coral reefs are being reviewed by the Coral Reef Group of the IUCN Ecology Commission in preparation for the 5th International Coral Reef Congress in 1985 and are summarized here.

#### Siltation

Smothering of the coral polyps by sediment causes oxygen depletion and recolonization by planulae larvae is

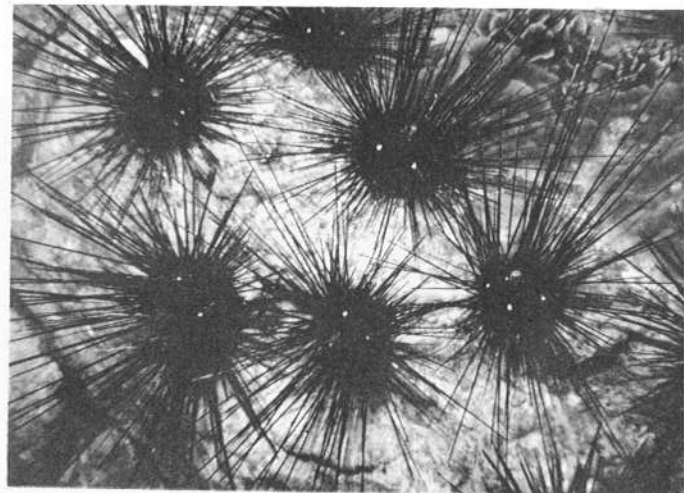
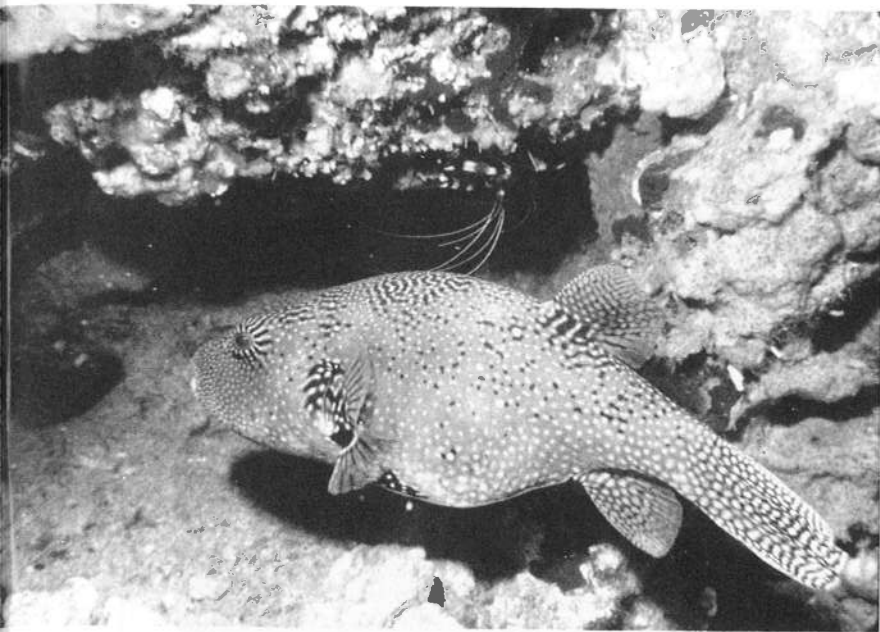
inhibited by silty substrates. Coral growth tends to be slower where sediments are regularly disturbed and increased turbidity lowers light intensity inhibiting photosynthesis by the symbiotic zooxanthellae. In the clearest seas corals are restricted to depths of less than 30 m and are generally found much shallower. Logging and slash-and-burn agriculture, leading to erosion and increased soil run-off, have caused noticeable siltation on reefs in the Philippines, Puerto Rico, Indonesia, Brazil, the Marianas and Guam and many other countries. These effects are compounded by agricultural fertilizers, pesticides and other pollutants in the soil run-off. Destruction of mangroves, which act as sediment traps, has caused increased siltation in several countries including Indonesia.

#### Industrial and agricultural pollution

Organic pollution and sewage lead to eutrophication and smothering of corals by algae. Such pollution caused the almost total destruction of the Kaneohe Coral Gardens on Hawaii. Increasing sewage levels in lagoons in the Marshall Islands and other Pacific islands may ultimately affect their reefs. Thermal pollution affects reproduction and may cause expulsion of zooxanthellae. Serious oil pollution leads to the death of corals while low level oil pollution may affect reproduction. In Kuwait the level of oil pollution has been calculated at 47 times the average for a marine environment of that size; oil and phosphate pollution has caused reef damage at Eilat in Israel and oil pollution is an increasing threat to reefs in Mexico. Mine tailings from copper and tin mines have caused reef damage for example at Marinduque, Philippines and Phuket, Thailand, through the combined effects of pollution and siltation.

#### Coastal development

This includes activities such as filling to provide sites for industry, housing, recreation, airports and farmland; extraction of lagoon sand for use in construction; and dredging to create, deepen or improve harbors and create ports and marinas. Such activities increase turbidity, alter water circulation and even cause the destruction of entire reef systems.



Left: Pufferfish from Cebu, Philippines. Removal of such fish from parts of the Red Sea may have contributed to a plague of their prey, the sea urchin *Diadema* (right). Photos by Roger Pullin.

There are many examples of such problems. The proposed airport at Shiraho, Okinawa, Japan threatens to destroy the very reefs that attract the tourists for whom the airport is being built. In Palau a proposed oil tanker super-harbor could destroy one of the most important reef areas in the Pacific. In the Line Islands, the construction of the airforce base at Palmyra Island lagoon destroyed the entire reef ecosystem and in Singapore the only remaining reefs are now on offshore islands. In French Polynesia, Moorea at one time had 14 sand extraction sites along 60 km length of coast. Similar activities are threatening reefs in Guam, Ponape, Yap and many other Pacific islands.

#### *Coral mining*

The removal of large portions of the reef framework for industrial purposes such as lime and cement production or for building materials (usually the larger, slow growing species are used), leads to beach erosion. Coral mining is having serious effects in many countries including Sri Lanka, Maldives, Indonesia, India, Sabah and the Philippines.

#### *Overexploitation of reef species*

This is becoming an increasing problem in countries where cash economies have been introduced relatively recently (e.g., Pacific islands), in those with high

population growth rates (e.g., Southeast Asia), and in those where tourism has expanded rapidly (e.g., Caribbean). In most cases, the concern is not that the species will become extinct (reef species usually have wide ranges) but that the productivity of the reef is lowered. The aquarium fish trade has caused local problems at Pulau Seribu, Indonesia, in the Philippines and in Sri Lanka. Coral and shell collecting by tourists and commercial collectors is intensive in many countries, such as Kenya, Guam and the Seychelles. The Philippines is the center of the commercial trade and there is considerable concern about the damage being caused locally to reefs by the collection of stony corals and the depletion of certain particularly popular shells such as the giant clam. Spiny lobsters, trochus and a variety of other reef invertebrates show signs of overcollection in many countries.

#### *Damaging fishing methods*

Explosives and poison have caused problems in many parts of the Indo-Pacific, e.g., Tanzania, Guam, N. Marianas, Palau, Ponape, the Philippines, Malaysia, Thailand and in the Bahamas where bleach was often used. Besides destroying areas of reef, such methods cause enormous wastage of fish and reef invertebrates. Spearfishing by scuba divers results in the removal of large predators

which may cause an imbalance in the ecosystem. For example, the removal of triggerfishes and pufferfishes in the Red Sea may have contributed to the population explosions of their prey, the sea urchin *Diadema*, which may be a predator on coral.

#### *Intensive recreational use*

This leads to a variety of problems including anchor damage, boat groundings, damage to the reef by trampling and walking, littering, and increased exploitation of marine resources. In the Caribbean, 25 out of 37 countries have reported tourism as being a factor in the deterioration of the reefs and Kenya, Maldives, Seychelles, Mauritius, Sri Lanka, the Philippines, Australia and Indonesia are among the many other countries where such problems have arisen.

#### *Military activities*

The effects on reefs of bombing as at Vieques Island in Puerto Rico and the use of atolls for atomic testing as in the Marshalls (Bikini and Eniwetok) and in the Tuamotus (Mururoa and Fangatufa), need little elaboration.

#### *Mineral exploration*

Oil exploration may cause increasing problems; drilling muds create clouds of sediment; ship channels are dredged and there is increased likelihood of oil pollution. This is likely to be a problem in a number of countries. ●

In the next Newsletter issue, the author will describe steps being taken to halt damage to coral reefs.