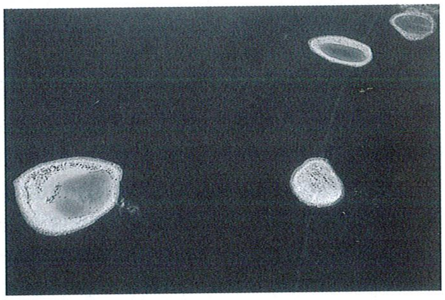
A Perspective on Reef Bleaching in the Maldives

By William R.Allison

The reefs of the Maldives, like coral reefs worldwide, have endured repeated sea level fluctuations and climatic change, and over the past few millennia, repeated ENSOs (El Niño-Southern Oscillation) presumably entailing reef bleaching. Recently the frequency and severity of ENSOs has increased. Whether or not this is a symptom of global warming, the observed coral mortality and island erosion are substantial reasons for concern. Maldives along with many of the world's coral reefs have recently experienced or are still in the grip of a severe bleaching event. Perhaps the most important actions to be taken are those that help to understand and preserve the integrity and self-repairing capabilities of the system. The government of Maldives, in association with the Global Coral Reef Monitoring Network and the author, is conducting research to monitor and interpret the effects of the 1998 and possible future events.

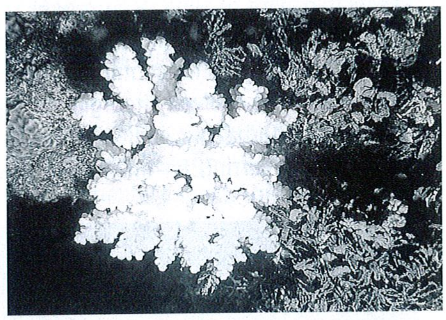
Sixty million years ago was a busy, uncertain time. The Indian Plate was poised to crash into Asia, supervolcanoes were erupting in Northern India and the dinosaurs were staging their last act. Coincident with the Age of Mammals, the Maldive archipelago was born as part of a string of volcanic mountain islands terminating in what are now called the Laccadives in the north and Diego Garcia in the south. Coral reefs eventually formed around these mountainous islands and later accumulated on top of them as they slowly sank beneath the waves. This process has continued until the present day, more or less as Darwin theorized in 1842, until there now lies atop the dead volcanoes approximately two km of coral reef-produced rock. This mass has been sculpted over geological time by frequent climate-change induced sea-level fluctuations, some of which exceeded 100 m. Storms have piled up coral debris and sand on reef flats and vegetation has bound this material to form islands. Although the whole mass continues to sink the commonly accepted rate of sinking of one or two millimeters per millennium is far exceeded by a reef building potential measured in tens of centimeters over the same time. Of more immediate concern are the factors that might interfere with the intimately related growth processes of reefs and islands. Two of the most pressing threats are sea temperature rise and various local human activities.



Maldivian Farus from the air

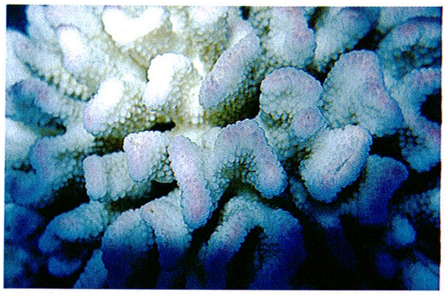
Coral reef growth is optimal where and when sea water is clear, warm and nutrient poor. Under these conditions corals can outcompete fleshy algae and coral reefs provide abundant material for island growth. But there are many factors, both human and natural, that can alter these conditions. Sea temperature is a key factor in at least two ways, because it affects sea level and coral health. Water volume and hence sea level changes with temperature. Water volume and hence sea level is affected by a variety of meteorological and oceanographic variables. For example, water expands when warmed and a rise of several degrees can increase sea-level by some tens of centimetres. The apparent high tide levels observed in the first half of 1998 may be related to the elevated sea temperatures observed during this time. Although such irregularities are not unusual they can effect island erosion and should be monitored for intensity and frequency. Elevated sea level allows more wave energy to pass over the reef and strike the shore at a higher level, producing shoreline erosion in some places and piling up rubble islands in others. Increased storm frequency and strength may amplify these processes. The effects of elevated temperature on corals are more direct, but poorly understood.

Reef-building corals live very close to their maximum temperature limit. When exposed to high temperature, corals often turn white, a phenomenon called coral bleaching. This happens when the small unicellular algae (called zooxanthellae) living in the coral tissues, leave their stressed and presumably stressful home. Impressive examples of this have occurred when sea temperatures have risen into the low 30's (°C) for several months causing entire reefs to turn white (reef bleaching). Although the dominant bleached colour is white, the absence of the algae allows other colours produced by some corals to be seen as luminescent pinks, blues and yellows. Some colonies do not bleach whereas their neighbours do, a contrast that begs investigation. Bleached corals are not necessarily dead, but after prolonged stress they may die, soon after which filamentous algae can be seen



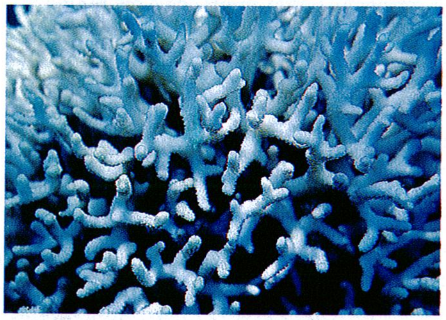
Acropora corals bleach easily

growing on them. The fast growing branching and table corals in the family Acroporidae are among the first to bleach and the most likely to die. In contrast, the massive or boulder corals, which grow



Bleached but live coral

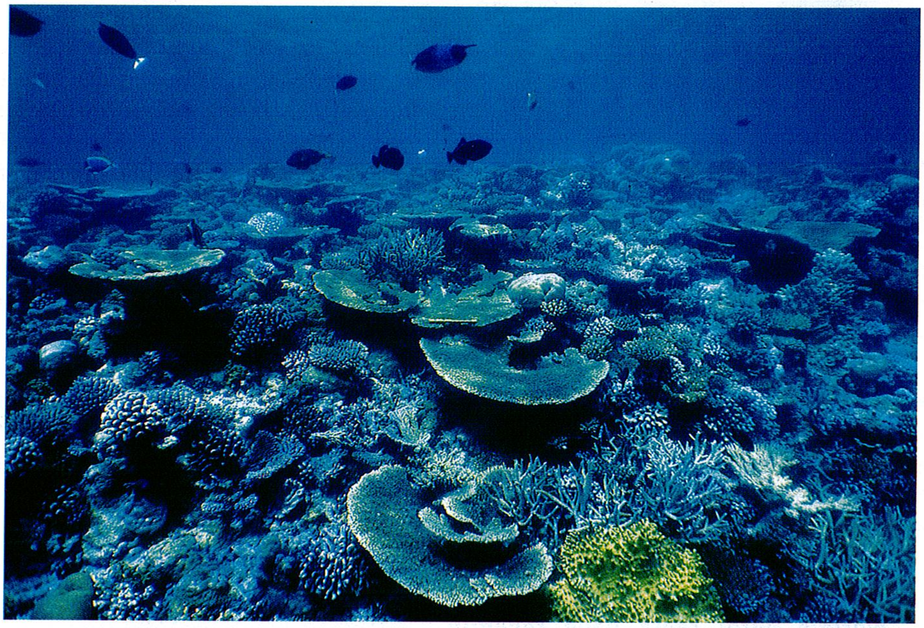
slowly, are resistant to most stresses. If environmental change did not occur occasionally, the fast-growing species of coral might take over the reef. The skeletons of dead corals are gradually weakened by erosion and eventually break down. Although this reduces the effectiveness of the reef as a sea defense system, much of the loose material is swept onto the reef flat and perhaps onto islands by storms. It can thus provide a shallow barrier and material for natural island building processes. Such island-building processes assume abundant, low-growing shoreline bushes and shrubs which like a net, catch and hold the debris cast up by storm waves.



Bleached dead with light algae

Usually reef bleaching events have been associated with El Niño occurrences and paleoclimatic records show these occurring every 10 or 20 years for centuries. The fact that corals have evolved strategies to cope with such perturbations indicates that they have been occurring for millions of years and are part of reef existence. Until recently, almost all observations of bleaching in the Maldives were confined to the central tourism sector where high temperatures and extensive bleaching were first reported in 1987 (Ministry of Tourism, 1987). I observed moderate events in 1992 and 1997. An important event was recorded in the Indo-Pacific in 1983 (Glynn, 1988) of which no record may be found in Maldives. The 1987 bleaching event may have had effects similar to the present event, for when the author began surveying Maldivian reefs in the early 1990's, live large corals of the types sensitive to high temperature were rare and many Maldivian reef tops featured live, healthy resistant corals sitting amidst tracts of dead branching table corals - very similar to what may be observed today. It is encouraging to know that by 1995 the quantity of sensitive corals had increased substantially. For example, on one of the few reefs for which historical data exists, a reef located in Ari Atoll, coral cover was estimated at 80% during the 1958 Xarifa Expedition (Scheer, 1972). My data shows that prior to 1992 this dropped to 17% but by 1995 was up to 70%.

Live massive coral beside dead Acropora



The corals on this reef have recovered since 1980s

Based on these considerations, the tentative forecast for Maldives and most of the Indo-Pacific is for increased erosion and substantial coral mortality. As the dead corals erode erosion will continue probably mitigated by any temperature-related sea level fall that may occur and by increased shallow-water accumulation of coral debris. Fish populations will be affected in contrasting ways. In the short run, food for herbivores such as parrot and surgeon fishes will increase in the form of algae growing on dead corals. By consuming algae these fish open space for coral to settle. The fish in turn are preyed upon by predators such as groupers, jacks, sharks etc. Some of these predators also eat predators on coral. Over the next five years or so the dead coral will break down, reducing the surface area for algal growth and the available shelter for many fish, such as baitfish. Simultaneously, assuming successful recruitment of new coral larvae, no repeat of a strong ENSO or other disturbance, new coral colonization and growth could be apparent within a year. Insofar as the very limited data available from the past is a reliable guide, and assuming no further serious disturbance for

Reef fish depend on corals for shelter

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