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Consequences of the 1998 coral bleaching event for the islands of the Western Indian Ocean

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Context

Coral reefs are vital for coastal populations and for human activities in general, as they provide people both with living resources and with "services" such as shore protection, sand accretion and coastal tourism.

The coral bleaching event of 1997-1998 summer is the most geographically wide spread and severe ever recorded. In the Indian Ocean, warm waters migrated from the South to the North during the first six months. As temperature stress was extreme and/or prolonged, mortality was catastrophically high in many areas (Kenya, Comoros, Seychelles, Tanzania, Maldives), the amount of dead corals ranging from 50-90%. Therefore, ITMEMS (International Tropical Marine Ecosystems Management Symposium) held in Townsville on 24 november 1998 recommended that a multi-disciplinary taskforce immediately be set up.

The coral bleaching event of summer 1997/1998.

Coral bleaching is a response to environmental stress, in particular high temperature, but it seems to be a multi-factorial response to a combination of temperature and other factors, such as irradiance and salinity changes.

According to the available data, Indian Ocean sea surface temperatures (SST) in the summer of 1997/1998 have been higher than previous years, and in some Seychelles reef flats 37°C was recorded (Robert, pers comm). SST data (IRD courtesy) indicate that hot spots affected the Mozambique Channel from December 97 to May 98.

Coral bleaching, affecting both hard corals and other symbiotic organisms, periodically occurs in the Western Indian Ocean region. Frequency and intensity of the precedent episodes have varied from place to place, but are generally underreported: 1893/84 summer, 1987, 1997/98 summer. For the Western Indian Ocean islands, the peak event occurred during March and April 1998.

Coral bleaching in French islands of the Indian Ocean

Réunion

Corals reefs are only fringing ones (12 km²), lying exclusively on the leeward (west) coast, but in the south-east region, corals may significantly cover volcanic substrates. The lagoonal areas are very shallow and few, but of great importance to tourism and recreational activities. Tourism is now the main source of income on the island.

Most of the inhabitants of Réunion live in the coastal zone (80% of 720 000 people). Overfishing of demersal fish (350 tonnes/year) has made the island dependent on seafood supply from external sources. Reefs have another important function: they protect the only white sandy beaches from

cyclones waves.

Coral communities in Réunion have been studied for 20 years now, and are well-known. The reefs include 55 genera and 149 species. The state of coral reefs is also well-known. Today, 28% of the reef flats are considered to be severely degraded by human activities (sewage pollution, destructive fishing practices, etc).

After a week of heavy rainfall, the 1998 bleaching and mortality event was noticed in late February at the Planch'alizé reef flat station (Milleporidae, Acroporidae, Pocilloporidae, Poritidae families). No bleaching was observed in the nearby station of Trois Châteaux, but bleaching was also noticed in the Saint Leu lagoon and on the outer slope, and in Sainte Rose (in the south-east).

The extent of the bleaching in Réunion was moderate, affecting only pre-stressed colonies. Recovery was good, except in Planch'alizé and Sainte Rose. Dead colonies are now covered by algal turfs with associated damselfish (*Stegastes* sp.).

Mayotte

Mayotte is a high volcanic island with a barrier reef (1,500 km² wide) with a deep lagoon (depth 70 m) - it is one of the known double-barrier reefs in the world. Fish associated with the coral reefs supply a major part of the animal protein, and is caught by nearly 3,600 fishermen. Fishing is reported as the second largest economic sector of Mayotte. The lagoon (*le Grand Lagon*) is a vital centre for tourism (9,000 visitors/year) and the potential for eco-tourism is great.

Around Mayotte, more than 200 species of coral have been identified, and the biodiversity of sponges, fish and other organisms is high (239 species has been counted in one place). The state of the fringing reefs is well-known: 50% are in good condition and 36% were degraded or dead before the 1998 bleaching event because of a strong, but less extensive, bleaching event in 1982/1983.

The 1998 bleaching and mortality event was intense and severe. All coral communities in the 0-10m range seem to have experienced moderate or severe bleaching. From April to August, local divers and scientists reported death as widespread, both in the lagoon and on the outer slopes. Up to 80% of the tabulate *Acropora* on the outer slope are now dead and covered by algal turfs and sediment. In August, bleaching of *Fungia* and soft corals was noticed in deep lagoonal places (15 m) by the local Fisheries and Marine Environment Service (SPEM).

One of the monitored side-effects of the bleaching was the massive contamination of dead colonies by the potentially toxic and epiphytic dinoflagellate *Gambierdiscus toxicus*. Samples collected by SPEM show that densities of this bioindicator exploded from 300 cells/g algae (average in 1993-1997) to 60 000 cells/g algae (October 1998). The environmental conditions are still suitable for contamination, and dinoflagellate density in December 1998 was 20 000 cells/g algae. Local authorities are now worried about the socio-economic consequences; this potential increase in the toxin production of the coral ecosystems of Mayotte could enter the food web and cause poisoning effects in humans.

Scattered islands

A number of scattered islands are located in the Mozambique Channel (Glorieuses, Juan de Nova, Bassas de India, Europa) and north of Réunion (Tromelin). Reef formations around these islands are either coral atolls or platforms (21 km²). As human activities in the area are few and restricted to meteorological stations, these reefs are some of the last examples of undisturbed coral reefs in the Indian Ocean region.

Very few studies have been conducted in the area in the past 20 years (except on marine turtles), and

coral biodiversity remains unknown.

The extension and gravity of the 1998 bleaching and mortality event is only known as anecdotal reports from military scuba divers. Around the islands in the Mozambique Channel, bleaching seems to have been massive.

Coral Bleaching in other COI island states

Comoros

Comoros consists of an archipelago of three islands, Grande Comore, Mohéli and Anjouan, surrounded by fringing reefs. In 1995, the Comoros population was 0.6 million.

In May 1998, bleaching was observed around Grande Comore and Mohéli islands. Local scientists involved in the COI-Reef Monitoring Programme reported that roughly 55% of the corals had died during the 1997/98 bleaching event. On the reef slopes of Grande Comore, bleaching was observed as 50 m round patches, probably linked to underground freshwater runoff.

Madagascar

With a coastline of 4,800 km, Madagascar has well-developed reefs, including barrier reefs on the East coast (Masoala area, Tamatave) and mainly on the West coast (from south to north). Reef formations cover more than 1,000 km around the island. The reefs of Tuléar (south-west) are scientifically well-known and are surveyed by IHSM (Institut Halieutique et des Sciences Marines).

In 1995, the Madagascar population was 14.9 million and in 1996, tourism arrivals were 85,000.

Bleaching was first reported in March 1998, by diving clubs in Belo/mer (South West). A scientific expedition showed that 30% of the hard corals were bleached (Maharavo, 1998). In February and March, temperatures were 32-33°C. Discolouration of photosynthetic, non-symbiotic marine organisms such as macroalgae was also noticed. Other locations around the island subject to bleaching were: Masoala, Mananara-Nord, Mitsio archipelago, Tuléar, Nosy Bé and Sainte Marie.

Mauritius

In 1995, the Mauritius population was 1.2 million. In Mauritius, tourism is particularly well-developed, with about 487,000 arrivals in 1996. As lagoons, which offer sheltered waters and sandy beaches, are very attractive for tourism and recreational activities, preservation of coral reefs is important.

Around Mauritius, the extension of coral reefs is 300 km² of fringing reefs and a barrier reef in the south-west. In the large lagoon of Rodrigues, the lagoon cover 200 km², and on the Cargados Carajos shoals 190 km² (Salm, 1996).

There was a minor bleaching event in Mauritius in 1998, with moderate and patchy occurrence in localised areas. Surveys showed 1-15% bleaching in many locations. Temperatures were about 3°C above the normal 27°C (Wilkinson, 1998). No data are available for the islands of Rodrigues and Cargados Carajos (also known as St Brandon Islands).

Seychelles

The Seychelles, made up of 115 scattered islands, also covers 1,374,000 km² of ocean. Fringing reefs are found around the granitic islands of the Mahé group, and coral islands and patch reefs are the main reef formations around the other islands.

In 1995, Seychelles population was 0.1 million. Through tourism and fishing, coastal and marine resources contribute the most to the national economy. International tourism (130,900 visitors in 1996)

contribute greatly to the economy of Seychelles. Fish is the main source of protein in the Seychellois diet (75 kg/person a year), and in 1997 a fleet of approximately 400 boats landed around 4,000 tonnes of fish. Both tourism and fisheries are dependent on the quality of the marine environment.

In May 1998, Goreau's team assessed the bleaching event in 14 locations around the Seychelles islands, as part of a monitoring programme run by the Seychelles Marine Park Authority (MPA). Baseline data on the locations were available on videotapes, recorded in mid-1997. The extent of recent coral death was ranging from 50% to more than 90%. From March to May, extensive bleaching down to 23 m was reported for Aldabra, Providence and Alphonse groups. Temperatures recorded *in situ* were high, from 29-34°C, with the exceptional 37°C in some lagoons. *Acropora* spp. and other shallow water branching species were most affected. Bleaching of other marine organisms was also recorded, for example soft corals, sea anemones and giant clams. Since then, some signs of recruitment has been seen on the outer atolls.

In January 1999, dead corals around the main island of Mahé were covered by numerous filamentous algae. The density of potentially toxic dinoflagellates living on the dead colonies was assessed through the COI/REP programme VIGITOX.

Capacity of the Islands countries in terms of expertise and physical resources

At a regional level, the Environmental Programme of the Indian Ocean Commission (COI/REP) has focused its activities on two areas:

1. The Reef Programme

A functional network was established in 1997, with national focal points (sub-nodes). A coral reef methodology monitoring handbook has been approved by the countries and is now available. The Indian Ocean Commission Reef Action Plan (PAR/COI) includes monitoring of coral reefs as an important activity.

In 1998, GCRMN-COI surveys were carried out in the five countries before and during the bleaching event, in March and in July/December. Twenty-four stations were monitored according to the adapted manual, using parameters such as coral cover, algae, abiotic substrate and ichthyologic population. One addition to the English *et ali.* (1994) manual was the assessment of reef flats, which are directly affected by human-based activities.

In April/May 1999, PAR/COI will conduct a new survey which will include more monitoring stations and a post-bleaching assessment. These activities are partly funded by the European Union and partly through national resources. Reef network stakeholders will meet in June to exchange collected data, including bleaching impacts.

The Reef network connects all the relevant focal institutions from the five member countries. The activities are considered as national components of the global GCRMN, and COI is a sub-node for ICRI-GCRMN. For the period 2000-2004, funding from the World Bank should be available for implementation of the GCRMN programme, but only for the four ACP countries (Comoros, Madagascar, Mauritius and Seychelles). Réunion, as part of the European Community, cannot be supported by these funding agencies.

2. The Ecotoxicology Programme

The Ecotoxicology Programme was created in 1998 and the action plan for 1999 will focus on a VIGITOX programme and a field-guide handbook on collection and treatment of microalgal and fish material. A VIGITOX assessment is already underway, a quick response to investigate the eventual links between coral bleaching and the risk for human poisoning through consumption of reef fishes,

through contamination of dead corals by toxinogenic microalgae. Pilot reefs affected by coral bleaching have been selected for data collection, and the levels of toxicity in fish bioindicators will be evaluated.

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