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Title

Monitoring of coral reefs on contrasting sites (Mayotte and Iles Eparses) in the Mozambique Channel, Indian Ocean: Application to management

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ABSTRACT**Background**

Understanding the functioning of coral reefs and their resilience to disturbances requires study of sites subjected to contrasting anthropogenic pressure while undergoing similar climatic forcing. The SIREME program (Monitoring and inventory of coral reefs of Mayotte and the Iles Eparses, 10e FED Indian Ocean) was conducted in the Indian Ocean to measure and elucidate the state of health of coral reefs at Mayotte, where the reefs are subject to high anthropogenic pressure, and Iles Eparses (Glorieuses Islands and Europa) where these pressures are minimal.

Methods

Expeditions in 2015 at Glorieuses, and in Mayotte and Europa in 2016 enabled monitoring of various organisms: corals (and associated diseases), fish and microplankton. An inventory of soft corals and habitat mapping using satellite and field data were also undertaken. The degree of connectivity between reef populations in the Mozambique Channel was assessed through

genetic studies and current data between islands were generated using a hydrodynamic model. Finally, monitoring indicators have been proposed to managers to assess the health status of coral reefs and to estimate the effectiveness of management measures.

Results

Concerning the health of coral reefs in Mayotte, the levels of benthic cover and the taxonomic distribution of corals varied widely according to locality and reef geomorphology, with the best coral health observed on the inner and fringing reefs. The coral and fish diversities were high, as was the total species richness, due to the favourable geological and hydrodynamic conditions in the north of the Mozambique Channel. Nevertheless, fish biomass was clearly declining at all the stations over the last decade, a consequence of high fishing pressure, in particular on the higher trophic level species. Coral bleaching monitoring in Mayotte revealed an average colony mortality of 24% in 2016 but almost half of the coral colonies were not affected.

In the Iles Eparses, the coral reefs were in very good health, which was reflected either by very high coral cover (e.g. Europa: CV 80% on average and >235 coral sp) or by the dominance of "living corals-crustose coralline algae" compared to soft algae (e.g. Glorieuses). A high prevalence of coral diseases (> 31%) was recorded at Glorieuses at some stations near Lys Island, which can be explained by the proximity of colonies of thousands of seabirds that can be vectors and/or reservoirs of diseases released via faecal contamination. In contrast, a very low disease prevalence was observed at Europa (2%), which confirmed the exceptional state of health of its coral reefs. Fish communities were characterized by high proportions of predators (groupers, snappers, snappers, jacks, sharks) and large adult individuals. Nevertheless, at Glorieuses, although fish biomasses remained higher relative to anthropogenically-affected sites elsewhere in the Indian Ocean, this has decreased specifically in terms of pelagic species probably preferentially targeted by illegal fishing. Hydrological analyses of water chemistry and biological indicators confirmed the ultra-oligotrophic status of the Glorieuses, its waters being characterized by very low concentrations of picocyanobacteria and nitrogen and carbon nutrients. In terms of bacterial contamination, there was no evidence of faecal contamination (coliforms and streptococci) at Glorieuses, whereas some stations in Mayotte exhibited high contamination levels and poor water quality compared to WFD (EU Water Framework Directive) thresholds. Indices integrating the autotrophic (and not heterotrophic) trophic levels thus provided relevant information on the health status of the systems studied.

Conclusion

The selection of priority sites for conservation (species and/or habitats) is now under discussion with managers and this needs to be balanced with other considerations that can be taken into account such as the functional role or the particular biology of certain species of interest, as well as socio-economic concerns. The exceptional coral reef of Europa displayed reef communities that are close to "pristine", suggesting that they could be reference areas for the Southwest Indian Ocean. Long-term scientific studies of these environments is essential to monitor changes in their condition and propose appropriate management measures in the context of climate change that is rapidly impacting populations and ecosystems.