Influence of coral bleaching on the fauna of Tutia Reef, Tanzania

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Influence of coral bleaching on the fauna of Tutia Reef, Tanzania

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Abstract

In 1998, coral reefs of Tanzania were severely affected by bleaching. The coral mortality that followed caused a concern for coral reef degradation and overall resource depletion. In this study, we investigated coral bleaching effects on the coral reef fauna at Tutia Reef in Mafia Island Marine Park, Tanzania. Corals from adjacent reef patches of the species *Acropora formosa* were transplanted into plots, and reef structure and associated fish assemblages were examined before and after the bleaching event. Following the coral bleaching, 88% of all corals died. A year after the event, a large proportion of the dead corals was still standing. As surviving and dead corals were from different clones, results suggested that genetic variation might influence bleaching tolerance.

After the bleaching event, a change in fish community composition, with an increase in fish abundance, could be seen. Species diversity, however, was less affected. There was a correlation between structural complexity and fish densities after disturbance. This indicates that the reef may uphold an abundant fish population as long as the architectural structure is intact. The impact that the coral beaching event may have on fisheries is difficult to anticipate. The Tutia Reef supports a multi-species fishery and a variety of techniques are used. As a broad range of species are targeted, including smaller fishes, catches may not be reduced as long as the reef structure is sustained. If reef degradation follows, however, fish abundance is likely to decrease.

Introduction

Large areas with coral reefs are found along the coast of Tanzania, including Pemba, Zanzibar and Mafia islands. The reefs provide coastal populations with important resources, especially fisheries. In Zanzibar, for example, more than 23,000 fishermen are supported by reef fisheries alone (Johnstone *et al.*, 1998). Corals are also used as building material (Coughanowr *et al.*, 1996). In addition, tourism is a growing business, with reef diving being a major attraction (Anderson, 1998). However, the utilisation of coral reefs for subsistence or as a source of income is accompanied by resource depletion. Many coral reefs in Tanzania show signs of habitat degradation, one reason being the use of destructive fishing methods (Johnstone *et al.*, 1998), and as a consequence catches are decreasing (Shah *et al.*, 1997).

In 1998, the coral bleaching event added to ongoing human disturbances, and further increased coral degradation. Comparatively high bleaching impacts were reported from Tanzania, and in some areas subsequent coral mortality reached 90 % (Wilkinson *et al.*, 1998; 1999). For example, Mafia Island, situated south of Zanzibar and 20 km east off the Rufiji River delta, was severely affected. The waters around Mafia Island comprise some of the richest marine habitats in East Africa (Horrill & Ngoile, 1991), and contains the Mafia Island Marine Park (MIMP). The people of Mafia Island depend on the coral reefs for their livelihoods, and there has been a concern for the resource impoverishment that may follow the bleaching event.

This paper presents preliminary data from a research project on the effects of coral bleaching on the reef fauna at Tutia Reef, Mafia Island, and discusses the socio-economic consequences the disturbance may have. More detailed results will be reported elsewhere (Lindahl *et al.*, in prep.), and for further discussions on the influence of coral bleaching on reef fauna, see Lindahl (1999) and Öhman (1999) in this report.

Methods

The study was carried out on Tutia Reef, Mafia Island, Tanzania (Figure 1). Thirty-two plots of staghorn corals, *Acropora formosa*, were transplanted from adjacent reef patches in 1995, two years before the first census (Lindahl 1998). In two separate sites within the reef area (200 m apart), plots measuring 2.5 x 2.5 m were prepared in a back reef area of 3 m depth, on a substrate with a mixture of coral rubble and sand.

Living coral cover of *A. formosa* was estimated through point sampling of randomly taken photographs fo each plot. Structural complexity was estimated from 1998 measurements of the height of coral branches in five 10 cm sections of two parallel line transects laid out across the plots. The fish were identified to lowest identifiable taxa and counted by a stationary SCUBA diver spending 10 minutes on each plot. The timed counts were replicated three times on different days.

The changes in abundance and diversity of fish over time were analysed with a pairwise T-test, and related to structural complexity using Spearman Rank Correlations. The ANOSIM permutation test (analysis of similarities) was performed (5,000 permutations) to test for significant differences in fish community composition before and after bleaching (Clarke & Ainsworth, 1988). To quantify how much different fish taxa contributed to changes in fish community composition, the SIMPER procedure was used (Clarke, 1993).

Results and discussion

In 28 of the 32 plots all corals died after the bleaching event. The live coral cover in the remaining four plots was only marginally affected. Since each plot was transplanted with corals belonging to what we believe is a distinct clone, and no clone was used at more than one plot, the difference in survival after the disturbance can be an indication of within-species genetical variability in sensitivity to coral bleaching. Similar results were found in a study by Edmunds (1994) in the Caribbean.

In the 1998 census in this study, most of the corals that died after the bleaching event were standing intact, thus upholding the structural complexity fo the reef. However, the relatively fragile, dead branches of staghorn coral will be more sensitive to erosion by physical and biological processes than live corals. A study of a coral reef destroyed by an *Acanthaster planci* infestation showed that the dead corals turned into rubble within a few years, resulting in a drastic decrease in fish abundance and diversity (Sano *et al.*, 1987). Such erosion of the coral reef may also expose lagoonal areas and the shoreline to increased wave-action, leading to the destruction of other important and productive habitats. In addition, the coral mortality may have a negative effect on the economically important coral mining for construction materials and lime production. This industry, however, mainly targets massive corals such as various *Porites* spp, which were less affected by the bleaching event than *Acropora* (Wilkinson *et al.*, 1999).

In terms of fishery resources, the critical question is how bleaching and subsequent coral mortality will influence fish abundance and species composition. In this study, a 39% increase in fish numbers was seen between 1997 and 1998, while species diversity remained fairly constant. An analysis using the multivariate ANOSIM test showed that the fish community changed significantly between years ($p < 0.001$). According to the SIMPER test, various herbivorous fishes such as scarids, acanthurids and grazing pomacentrids made the most significant contribution to the shift in the fish community composition. The increasing abundance of herbivores may be an indirect effect of coral mortality, which often leads to an increase in algal growth. However, the relationship between food resources and fish densities is not straightforward, since fish populations may be limited by recruitment (Doherty & Fowler, 1994) or other factors. In a study carried out at the Great Barrier Reef, for example, herbivores did not respond to increased algae cover following a Crown-of-thorns starfish infestation (Hart *et al.*, 1996).

The consequences that a fish population shift may have on the future development of the fish community on Tutia Reef is difficult to anticipate, and it is difficult to foresee its implications for the fishery. A range of biotic and abiotic factors influences coral reef fish communities and, in addition, a reef fishery is typically multi-technique and multispecific (Öhman, 1999). Fishermen at Mafia Island commonly use small-meshed nets, indiscriminately targeting a range of fish species, including smaller reef fish (pers. obs.).

This study did not show any reduction in fish abundance as a result of the coral mortality following the coral bleaching event. Hence, the impact on fishery resources could be of minor importance. The crucial factor, however, is the fate of reef structure and complexity. As many reef-fish species are closely associated with the reef habitat, coral destruction is likely to affect the fish community (Jones & Syms, 1998).

Many habitat variables have been shown to relate to fish community parameters, and habitat degradation could alter fish numbers (Sano *et al.*, 1984; 1987; Munday *et al.*, 1997; Öhman *et al.*, 1997; 1998; Öhman & Rajasuriya, 1998). The results of this study suggest that reef structure is important for fish density and species diversity. There was a significant correlation (Spearman rank correlation) between structural complexity and fish abundance ($r = 0.86$, $p < 0.05$), as well as between structural complexity and the number of fish taxa ($r = 0.76$, $p < 0.05$) after the bleaching. Hence, if the corals break down and are turned into rubble, it could severely reduce fish numbers. For the same reason, a rich fish community could proliferate if the reef structure remains intact.

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Home | Status report 8