Patterns in the Distribution of Coral Communities Across the Central Great Barrier Reef

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Summary. Despite the pre-eminence of the Great Barrier Reef, there has been little systematic description of its biotic communities, and in particular, of the corals themselves. Only recently have the problems of coral taxonomy been sufficiently resolved to allow a beginning to be made in rectifying this deficiency. The present study describes seventeen assemblages of corals which occupy the major habitat types found in and near the central Great Barrier Reef. The habitats studied range from the wave swept reef flats of Coral Sea atolls to the slopes of small reefs occupying sheltered, muddy conditions near the coast. These, and the array of reefs between, have characteristic suites of coral communities which provide the basis for a classification of reefs into non-Acropora reefs and various Acropora reefs. It is speculated that the faunistic differences are maintained because reefs are primarily self-seeded and because the majority of larvae from external sources are of species which are already present. The greatest diversity of both species and community types was found on reefs near the middle of the continental shelf, while the oceanic atolls and nearshore silt-affected reefs are almost equally depauperate.

Introduction

"Nowhere else in the seas is there such a bewildering range of living things, and perhaps nowhere else is the physical and biological pattern so uniform, characteristic and widespread as in the coral reef." In the light of the current emphasis in reef ecology on lack of uniformity at various scales (e.g. Connell 1978), recollection of this statement by Wells (1957) is perhaps timely. Overlying their diversity and patchiness, coral reefs have an ordered biological structure which is characteristic over large geographic areas. Comprehension of the biological pattern at this scale is a major ecological goal and is basic to many other areas of reef research.

In spite of the pre-eminence of the Great Barrier Reef (GBR), little is known about patterns in the distribution of its living communities. One reason is the extreme size and complexity of the GBR. It spans some 1,600 km of coastline and comprises more than 2,000 individual reefs located in 215,000 km$^2$ of ocean. These reefs are of innumerable shapes and sizes (Maxwell 1968) and occupy an enormous range of hydrologic and meteorologic conditions. Only recently has a concerted effort begun to document large scale patterns of biota in the GBR (see Williams 1982).

The aim of this study was to describe pattern in the distribution of coral communities on reefs in a large area in the central GBR extending from the coastline into the Coral Sea (see Fig. 1). Works on coral zonation in other reef provinces indicate that two spatial scales of pattern were to be expected - one associated with gross inshore-offshore gradients and another with local variability within the reefs (c.f. Rosen 1975; Adey and Burke 1977; Geister 1977). This study produces a scheme depicting apparent ordering of coral communities in relation to hydrodynamic forces, illumination, and position on the onshore-offshore transect. Two alternate hypotheses to account for the observed patterns are identified.

Study Reefs and Environment

The study was conducted during 1980–81 on eight reefs on the continental shelf [two inner shelf (or near shore), and three each mid- and outer shelf] and two from Coral Sea atolls. These four groups of reefs are located approximately 10, 50, 100 and 200 km offshore, respectively (see Fig. 1). A summary of reef morphology and environment is included in Fig. 2 and Table 1. The most important features to note are the presence on the Coral Sea reefs of a submerged reef flat not found elsewhere, the extensive reef flats on outer and middle shelf reef, and the virtual absence of reef flats from the inner shelf reefs.

The prevailing winds and waves in the region are from the east to south east (see Fig. 2) and the region is subjected to cyclonic winds occurring at approximately 5 year intervals. Spring tides at the inner shelf reefs have a mean
of approximately 3.4 m, and tides decrease uniformly seawards to a predicted mean of 2.9 m in the western Coral Sea (Maxwell 1968). The slopes of the mid-shelf study reefs are known to have suffered extensive coral mortality caused by *Acanthaster planci* in the period 1965–71 (Pearson 1974).

Apart from the obvious gradients in wave action, transparency and sediment outlined in Fig. 2 and Table 1, a marked cross shelf variation exists in other water properties. Nearshore reefs are affected by periods of reduced salinity, increased siltation and possibly nutrient enrichment, all resulting from outflows of nearby large rivers (Wolanski and Jones 1981). Unlike reefs on the outer half of the continental shelf, they are effectively isolated by distance from inputs from the Coral Sea. An upwelling of nutrient rich waters from the Coral Sea periodically bathes the outer reefs, and it has been suggested that this water also initiates a phytoplankton-zooplankton succession as it crosses the shelf (Andrews and Gentien 1982). The middle reefs (but not the outer reefs) are believed to receive periodic zooplankton blooms as a result of this intrusion.

**Materials and Methods**

**Field Procedure**

Coral surveys were conducted at discrete sites located along traverses which crossed all major habitats to a depth of approximately 30 m. The location of each traverse was selected after study of aerial photographs and preliminary reconnaissance using a manta-board (Done et al., in press). “Sites” were non-contiguous and irregularly spaced along the traverse (Fig. 5), their position being chosen on the basis of visible differences in reef topography. They were not physically delineated in any way and covered an area of 100–500 m².

A check list of corals was compiled for each site, and each species assigned a score (weight or importance value) on a five point scale, based on a subjective assessment of relative cover 1. Supplementary estimates

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1 Grading system based on estimated relative cover of hard corals. 1 = 1%–5%; 2 = 5%–10%; 3 = 11%–30%; 4 = 31%–80%; 5 = > 80%