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FACTORS AFFECTING THE STRUCTURE AND DYNAMICS OF SUBTIDAL COMMUNITIES CHARACTERISED BY SPONGES

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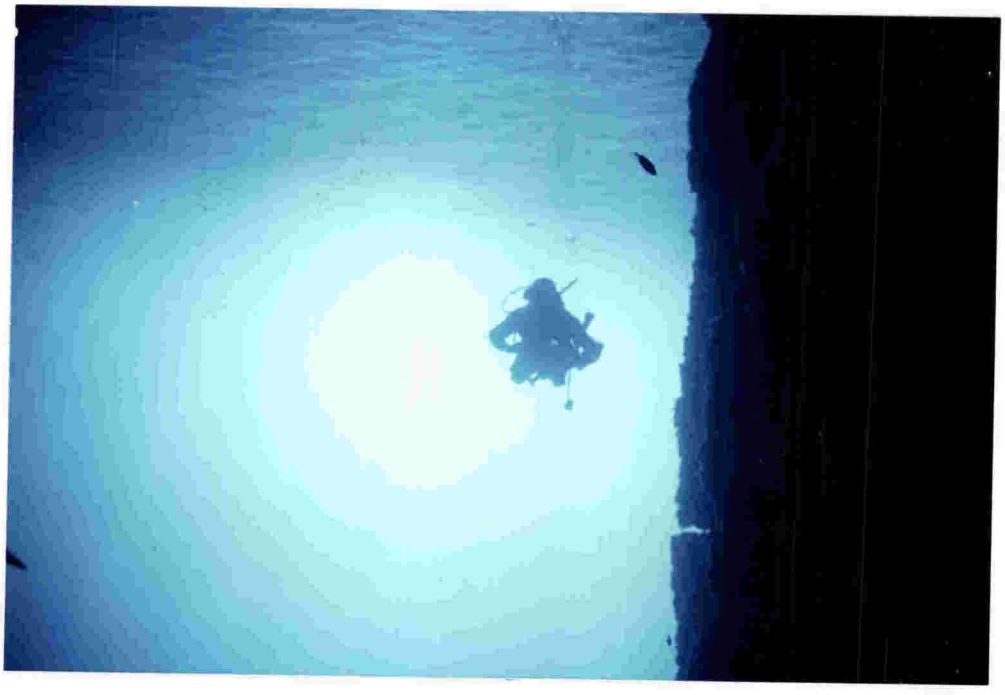
FRONTISPIECE The Sponge Garden

The Eastern Wall,
Riko Riko Cave
Poor Knights Islands



ABSTRACT

Two subtidal reef communities characterised by sponges were examined to assess two distinct aspects of marine benthic community ecology which have not previously received much attention. The first study focused on the role of settlement events in the origin and maintenance of community structure and involved investigation of factors affecting dispersion, settlement and recruitment of sponge propagules. The second examined how natural gradients in ambient physical conditions, in the absence of disturbance, affected size structure and species interactions within the community.

Settlement events were examined on a reef flat which was covered by a shallow sediment overlayer. The distribution and abundance of established sponges was found to be highly correlated with sediment regimes. The sponge community was shown to be stable over time and able to resist disturbance by storms because of the presence of turfing algae. Sponge settlement was inhibited by the sediment overlayer. Established sponges were found clumped into oblong groups orientated east-west and there were many instances where sponges were found closely associated.

Adjacent areas were characterised by deeper unstable sediments and fewer sponges. Storms contoured sediments into ripples and scoured oblong east-west orientated

patches of basal rock. Sediments were also sorted during storms such that particles of large grain size were left around the edges of ripples and over the scoured rock patches. The basal reef of both the stable and unstable areas was covered in a mosaic of encrusting algal and sponge species which tolerated the sediment overlayer. This assemblage was also exposed during storms.

Sponges reproduced in a number of ways, but asexual propagules were the most successful. Sponges from several orders produced buds which developed in a complex manner. Buds adhered to rock and shell fragments of large size which acted as anchors, or attached to other buds irrespective of genotype. The change in weight and shape increased the likelihood that buds would gravitate into the scoured patches of basal rock. Bud loss off the reef was minimal. Buds were able to settle onto the basal rock patches and did so almost exclusively onto bare rock. A high degree of 'selectivity' of settlement site by buds was imparted by altering developmental rate during the settlement process in response to the substrate type. Polymastia granulosa buds exhibited an additional developmental sequence not previously reported for any colonial organism. Buds either settled directly in suitable conditions, or developed further along a different pathway. Buds which did not come into contact with basal rock elongated and appeared to be capable of digging into sediments. The elongated bud then broke up along its length into smaller particles, termed 'beads', which were

capable of movement and invariably settled onto gravel fragments.

Sponges were shown to settle onto scoured rock patches during storms and were eventually covered by sediments. Subsequent survivorship and recruitment depended species specifically on sediment depth and quality. Settlement patterns matched the observed dispersion patterns of established sponges and suggested a mechanism whereby the community had originated and how structure was maintained. These hypotheses were tested experimentally in situ and in the laboratory.

The importance of asexual modes of reproduction, and settlement mediated by physical disturbance appears to be a common formula for recruitment by colonial marine organisms. Recruitment events were found to explain the distributional patterns of the established population.

The structure of populations of thin encrusting species on vertical reef walls was examined in a novel manner whereby the mean size and density of individuals was quantified and related to gradients in the ambient physical environment. This was achieved by examining the benthic communities on a range of subtidal reef walls of uniform slope and aspect, but which were subject to natural gradients in physical conditions. The species composition of each of the six reefs studied was similar but the size structure of communties changed within each reef system in response to gradients in light intensity and water

movement. Fish and urchin disturbance was shown to be unimportant and there was no indication that storms disrupted communities. The implications of changes in size structure of populations on interactions between component species in different ambient conditions were examined.

The eastern wall of two cave, archway and open reef systems was surveyed according to a stratified sampling design where each reef was divided by depth and distance along the wall. Different taxonomic/morphological groups were found at particular positions on reef walls. Thin encrusting algal species were found to be one of the most abundant groups. It was assumed that the individual size of encrusting species at each wall position reflected long term ambient environmental conditions as well as the ability of each species to maintain itself against overgrowth by neighbours. By relating the population size structure of different taxa with indices for light intensity and water movement recorded at each wall position within each reef, it was shown that community structure varied markedly on the same reef wall as a function of ambient physical conditions. Changes in proportional species composition, notably from thin encrusting algal dominated assemblages to sponge characterised assemblages, with decreasing light intensity were accompanied by changes in the individual size structure of populations. At each wall position all species exhibited similar individual size. Individual size decreased and density of individuals of all species increased with decreasing light intensity. In

conditions where light levels were not sufficient to support algae, individual size of encrusting fauna increased with increasing water movement. The implications of these observations on competitive interactions between encrusting species was examined. The outcome of competitive interactions between the same species was found to vary depending on wall position.

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