CORAL COMMUNITY STRUCTURE ON THE WEST FORE REEF IN DISCOVERY BAY, JAMAICA

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Abstract. Prior to 1980, the reef at Discovery Bay Marine Laboratory, Jamaica, West Indies, had been undisturbed for over 60 years, but it has since undergone a series of catastrophic disruptions. In order to examine the effects of these past disturbances as well as changing abiotic factors over a depth gradient, we censused the coral community occurring on the fore reef at Discovery Bay from 2-70 ft depth. We found that coral diversity and abundance increased with increasing depth, and that in two species, size of colonies were highest at intermediate depths. We compared the current coral diversity on the forereef to a record of pre-disturbance diversity, and found that current diversity is highest.

Key Words: coral, community structure, coral diversity

INTRODUCTION

The fore reef at Discovery Bay, Jamaica, West Indies is a well-developed reef system (Huston 1985a) and is unique in the extent to which it has been studied. Significant amounts of data were collected on the community composition and structure of the reef prior to the early 1980s, when two hurricane evensts caused mass destruction of the reef ecosystem (Tunnicliffe 1983). Prior to this event, the Discovery Bay reef had not seen any large scale disturbance in 63 years. Since then, the reef has also experienced a significant die-off of the long-spined urchin, *Diadema antillarum* in 1983 due to a pathogen (Liddell 1987). These major disturbance events are likely to have caused enormous changes in the coral communities on the reef, as they resulted in widespread reduction of living corals on the reef.

It was proposed in 1977 that the relative lack of diversity on the fore reef at Discovery Bay was due to competitive exclusion by a few species due to a lack of significant disturbances (Huston 1985a). It is thus important to document the distribution and abundances of coral species on the reef, not only to understand how they have changed since major disturbances, but also to understand the mechanisms that may be at work in determining coral community composition. The objective of this study was to examine how coral communities in the west fore reef change with depth and to compare this to the data collected from this site twenty years ago.

We predicted that both coral diversity and abundance would increase with depth as coral is restricted by fewer limiting factors. Turbulence lessens with increasing depth, and although light decreases with depth, at the depth to which we dove, it is not so reduced as to exclude species. We hypothesized that colony size would increase with depth as a greater number of mature colonies would have survived hurricane damage and colonies would be less subject to daily turbulence stress than in the shallows. We expected to see differences in species abundances and an increased diversity from the pre-hurricane community as a result of the reduction of dominant species.

METHODS

Observations were made at Discovery Bay, Jamaica, West Indies on 6-11 March, 1997. With the aid of SCUBA apparatus, fifteen 5 m transects were made on the west fore reef by stretching a weighted line over the reef surface at randomly selected sites of various depth from 2-70 ft. In each transect, total number of coral colonies occurring within an area of one m to the right or left of the transect line were counted. All corals were identified to the species level, and the depth at which each individual colony occurred was recorded in feet, as it was reported by a depth gauge. The Shannon-Weiner index (H'ln) was used to compare diversity among depths and with Huston et al.'s estimates of diversity from 1977.

Size of four types of coral were recorded at depths of 10 ft, 30 ft, and 60 ft. Five each of *Porites porites* (finger coral), *Gorgonia ventalina* (common sea fan), *Agaricia sp.* (lettuce coral), and *Siderastrea radians* (lesser starlet coral) were randomly selected at each of these three depths. Length, width and height were recorded in cm, and a volume for each was calculated. These four species were chosen because they were common representatives of four different coral mophologies.

RESULTS

We found that both coral colony abundance and diversity increased over a depth gradient of 2 to 70 ft (Fig. 1). Further, diversity of corals, as calculated by the Shannon-Weiner index, was found to be greater in general than it was in the west fore reef at Discovery Bay in 1977 (Liddell 1987, Fig. 2).

We found that *P. porites* ($F=2.89$, $df=14$, $P=0.094$) and *G. ventalina* ($F=5.90$, $df=14$, $P=0.016$) increased in size from 10 ft to 30 ft in depth, and then decreased in size at a depth of 60 ft. There were no differences in the sizes of either *Agaricia* sp. ($F=0.88$, $df=14$, $P=0.44$) or *S. radians* ($F=0.60$, $df=14$, $P=0.564$) with depth.

DISCUSSION

Increasing depth is marked by a number of changes in abiotic factors that affect the growth of coral. These factors include sedimentation and temperature as well as wave energy and light intensity, the latter two having a strong influence on the community composition t a given depth. The increase in coral diversity with depth may be partially explained by the decrease in turbulence with increased depth. Less turbulence would allow co-existence by corals of many growth forms, and act as an intermediate disturbance to increase diversity. Morphologies able to withstand high wave action without fracturing, would be favored in the shallows, but not at depth. Light intensity is high close to the surface. Photosaturation can inhibit calcification, limiting some species at shallow depths (Done). In the top 10 m of water, light intensity is reduced by 60-80% (Huston 1985c). Light starts to become a limiting factor to photosynthesis when reduced to 10% of surface value (Done). With depth the growth rates of many corals including *A. palmata, A. cervicornis, P. astreoides, M. annularis,* and *P. porites* are decreased (Huston 1985c). Fast growers become limited and can no longer dominate, allowing for greater diversity. Flat species, capable of efficiently intercepting lower light levels, can compete with tall, branching species capable of shading.

The low abundance at shallow depths and the increase in abundance with depth can be explained by two factors. First, the damaged caused by Hurricane Allen decreased with depth (Woodley, 1981), leaving a greater number of viable colonies, which still exist. Second, the extensive hurricane damage to the *Acropora* spp. which had dominated the West Fore Reef coral community (Tunnicliffe 1983; Woodley 1981) resulted in a habitat unsupportive of coral colonization. The three dimensionality of the reef was decreased, smothering deeper corals which had survived the storm (Knowlton 1981). The hard substrata of coral skeleton fragments is rapidly colonized by coralline algae and boring sponges (Ohlhorst and Liddell, 1981 cited in Liddell, 1987) and coral is replaced by other faster growing organisms.

The increase in colony size at intermediate depths for *P. porites* and *G. ventalina* may be due to the lack of limitations by either wave action or light. The average colony sizes of *Agaricia sp.* and *S. radians* did not change with depth. Both of these have low, flat morphologies less affected by wave action but greater exposed to light. The growth rate of these species are not greatly influenced by turbulence or light between 0-20 m.

Hurricane Allen largely destroyed the Fore Reef at Discovery Bay, which had remained largely undisturbed for 63 years (Woodley 1981). The storm almost completely eradicated the dominant *Acropora sp.* leaving a more diverse successional coral community. Following the hurricane, the *D. antillarum* mortality event in 1983, intensified its destructive effect. Community dominance by coral is only possible when herbivory keeps algae at low levels (Done). The *Diadema* die off resulted in a substantial increase in algae abundance and a corresponding decline of corals (Hughes 1987). The amount of hurricane damaged coral rubble made this rapid algal rise possible. Studies have shown that algae cannot settle on live coral tissue (Hughes 1987). The reduced herbivory on algae, resulting from the die off, allowed fleshy algae to dominate over calcareous algae futher decreased the possibility of coral re-recruitment, since calcareous algae often serves as a substrate for coral settlement (Huston 1985b). The last seventeen years have drastically altered the west fore reef at Discovery Bay. The substrate available for colonization, the viable species locally distributing larval recruits, and the reef community are all changed from pre-hurricane conditions. The coral community of the west fore reef found by this study is successional and dynamic, and will likely never resemble the coral community existing before August 1980. Successive studies pursuing the same aims as this one could illuminate the patterns of change in the shifting community of the coral reef.

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TABLE 1. Coral species found in 15 transects each surveying 10 m^2 of the West Fore Reef of Discovery Bay. Corals are listed from greatest to least abundance.*

coral	common name	number of colonies seen	depth at which most colonies found
Agaricia sp.	lettuce coral	127	68 feet
Porites porites	finger coral	99	68
Porites astreoides	mustard hill coral	54	68
Montastraea annularis	boulder star coral	43	68
Siderastrea radians	lesser starlet coral	32	42
Eunicea sp.	sea rod	25	56
Madracis pharensis	star coral	20	56
Meandrina meandrites	maze coral	19	63
Millepora alcicornis	branching fire coral	19	18
Millepora complanata	blade fire coral	17	10
Gorgonia ventalina	common sea fan	15	18
Stephanocoenia mechelinii	blushing star coral	14	63
Agaricia grahamae	Graham's sheet coral	13	68
Siderastrea siderea	massive starlet coral	10	56
Acropora cervicornis	staghorn coral	9	56
Madracis mirabilis	yellow pencil coral	7	56
Stylaster roseus	rose lace coral	6	33
Madracis formosa	eight-ray fingercoral	6	56
Pseudopterogorgia bipinnata	bipinnate sea plume	5	41
Eusmilia fastigiata	smooth flower coral	5	42
Dichocoenia stokesii	elliptical star coral	4	10
Diplora strigosa	symmetrical brain coral	4	10
Favia fragum	golfball coral	3	33
Leptoseris cucullata	sunray lettuce coral	2	52
Pseudoplexaura sp.	porous sea rod	2	52
Gorgonia mariae	wide mesh sea fan	2	36
Scolymia sp.	solitary disk coral	2	42
Solenastrea hyades	knobby star coral	2	63
Montastrea cavernosa	great star coral	2	63
Manicina areolata	rose coral	1	18
Diploria labyrinthiformis	grooved brain coral	1	10