DISTRIBUTION AND POLYP BEHAVIOR OF THREE PHENOTYPES OF *MONTASTREA* ACROSS TWO MICROHABITATS

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Abstract: Montastrea is a common Caribbean hard coral genus that grows in several different morphotypes (which may or may not represent different species), over a range of depths. We investigated the distribution of *Montastrea* morphotypes (boulder, lobed, encrusting) and whether the percent polyp openness during the middle of the day varied among morphotypes and across microhabitats. In Jackson Bay, Little Cayman, encrusting corals were more abundant on the sloping fore-reef face (5-10 m depth) while lobed and boulder corals were more abundant on the almost flat reef top (3-8 m depth). Boulder corals had the greatest polyp openness, and polyp openness decreased with depth for all morphotypes. Differences in habitat associations and polyp openness between morphotypes indicate distinct ecological roles, whether or not morphotypes are genetically isolated.

INTRODUCTION

Montastrea is a common Caribbean reef-building coral that grows as several morphotypes, which commonly occur between 5-23 m depth (Veghel and Back 1993). Currently, it is unclear whether the different morphotypes represent several related species (Humann 1993, Amral 1994, Szmant et al. 1997). If they represent a single species, they may be the result of genetic polymorphism or phenotypic plasticicty.

We focused on differences in habitat associations and polyp openness (zooplankton feeding) between *Montastrea* morphotypes.

Morphotypes clearly co-exist locally within a coral reef, but different morphotypes may survive and grow better in different habitats. Morphotypes may also differ in polyp openness. This could occur if, for example, some morphotypes provide better fish habitat, resulting in greater localized water disturbance from the swimming fish, causing polyps to close. Polyp openness might also differ among habitats. For example, in habitats with high turbulence, the encounter rate between polyps and zooplankton may be high, and polyps may open more as a result. Finally, polyp openness might depend on an interaction between morphotype and habitat. For example, a morphotype that tends to have open polyps in areas of low sedimentation may tend to close its polyps if sedimentation rate is high.

We examined the distribution and percent polyp openness of the major coral morphotypes (lobed,

boulder, and encrusting) within two adjacent environments, the almost flat reef top and the sloping reef face, at the "Sarah's Set" diving location in Jackson Bay, Little Cayman Island. The reef top contains more horizontal surface area with greater water movement from nearby wave action, while the deeper reef face contains more sloped or vertical substrate, with calmer water. The shallow reef top also allows greater direct light penetration to corals, while light is more diffuse on the sloped reef face.

We hypothesized that the different morphotypes of *Montastrea* would be associated with habitat conditions. We predicted that the encrusting morphotype would predominate on the sloping reef face, since its encrusting structure allows greater exposure to diffuse light. Since all corals are subject to bio-erosion and undercutting, we also predicted that the more massive lobed and boulder morphotypes would be less common on the sloping reef face where they may be less stable.

METHODS

We measured *Montastrea* morphotype distribution and polyp openness during four 60 minute periods, at 1400 on March 6 and at 0800, 1000 and 1400 on March 7, 2008 at the Sarah's Set dive site in Grape Tree Bay, Little Cayman Island.

The reef top was defined as the fairly flat hard coral area within 2 m of the drop off, and the reef faced was defined as the sharply sloping (60-90º) area between the reef top and the flat sandy bottom below. Using SCUBA, we swam along the reef top and reef face at all depths between 10 and 30 m, and located all *Montastrea* colonies > 0.25 m diameter within 2 m of the reef face. For each colony, we noted morphology (lobed, boulder, encrusting), microhabitat (reef top or reef face), depth, and estimated percent open polyps in 10% intervals.

We defined lobed morphotypes as colonies with multiple-column structures, with living polyps on their dome-like tops and algae that is often bioeroded in the lower crevices. We defined boulder morphotypes as colonies with a single mound. Encrusting morphotypes were colonies with a single plate, which could have complex shape and microtopography, depending on substrate morphology. Both encrusting and boulder morphotypes ranged from smooth to lumpy in surface texture.

We recorded fish abundance near each colony by counting all fish visible within 10 cm of the coral head.

To satisfy assumptions of normality, we square-root transformed data for fish abundance

and percent open coral polyps per coral head. We used a linear regression to examine the relationship between percent open coral polyps and depth. We examined the effect of microhabitat and morphology on percent open coral polyps per coral head and on fish abundance, using two full-factorial two-way ANOVAs. By plotting microhabitat and morphology against the residuals of a regression of percent open coral polyps versus depth, we corrected for variance in coral polyp openness due to depth.

RESULTS

Coral morphotypes were distributed non-randomly among habitats (χ^2 = 20.65, r^2 = 0.67, P < 0.0001). Lobed and boulder morphotypes were more abundant on the reef top, while the encrusting morphotype was more abundant on the reef face (Figure 1).

Percent open polyps decreased with increasing depth (df = 1, 160, P < 0.0001), but depth explained little of the variation in polyp openness (r^2 = 0.10). Percent open polyps also differed by morphology (two-way ANOVA, df = 2,156, F = 47.39, P < 0.0001), but not microhabitat (df = 1, 156, F = 0.84, P = 0.36) when the effect of depth had been removed (by analyzing residuals; see Methods). Boulder corals opened their polyps more than lobed or encrusting morphotypes (Figure 2).

Fish abundance varied with morphology (two-way ANOVA, df = 2,156, F = 12.54, P < 0.0001) but not microhabitat (two-way ANOVA, df = 1,156, F = 1.02, P = 0.31) or depth (r^2 = 0.0004 df = 1, 160, P = 0.81). Fish were more abundant on lobed than on boulder or encrusting coral (Tukey's HSD α = 0.05).

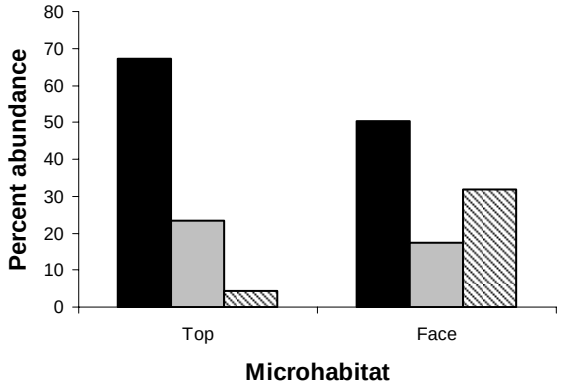

Figure 1. Percent of total *Montastrea* colonies contributed by the boulder (black), lobed (gray) and encrusting (hatched) morphotypes on the reef top and reef face at Sarah's Set dive site in Jackson Bay, Little Cayman Island. Data from 163 colonies sampled between 3-10 m depth.

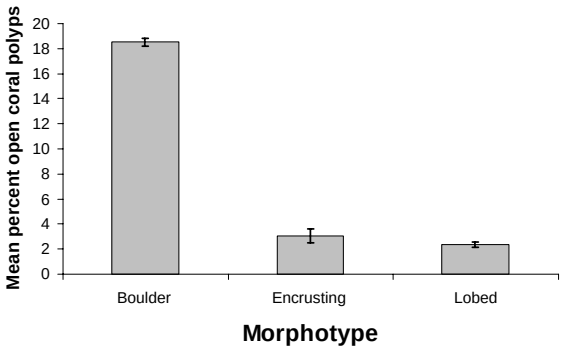

Figure 2. Mean percent open coral polyps (± 1 SE) by morphotype of the coral *Montastrea* at Sarah's Set in Jackson Bay, Little Cayman Island. Letters indicate differences as calculated by Tukeys HSD (α = 0.05). Data from 163 colonies sampled between 3-10 m.

DISCUSSION

Montastrea morphotypes had clear habitat associations. Lobed and boulder morphotypes dominated the reef top, where the horizontal substrate may better support these heavy upward-growing corals. Compared to the reef top, the steeply sloping (and sometimes vertical or overhanging) reef faces may provide better habitat for the encrusting morphotype. Here, there is less chance of being shaded by taller corals, given the more diffuse light at the greater depth of the reef face.

Polyp openness decreased with increasing depth. Corals may open their polyps more in shallow water since greater water activity increases zooplankton movement across the coral's surface, increasing encounter rates and potential prey capture (Sebens et al. 1998).

Greater fish abundance around lobed corals suggests that their greater rugosity compared to boulder or encrusting morphotypes provides a daytime habitat for many fish. These fish may cause greater localized water disturbance, which may reduce polyp openness in lobed corals even though they are distributed more in shallow waters where polyp openness is greater overall.

Montastrea morphotypes differed in distribution across habitats, polyp opening behavior and response to depth. If morphotypes represent phenotypic plasticity, *Montastrea* shows remarkable capacity to adjust to local environments during colony development. If the morphotypes represent a genetic polymorphism, our results suggest that different genotypes are favored in different habitats, perhaps maintaining a stable polymorphism in the species. Finally, if the morphotypes are distinct species, our findings indicate how small-scale variations in environmental conditions and depth can contribute to the species diversity of corals.

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