

NOTE

Fish predation on the scleractinian coral *Madracis mirabilis* controls its depth distribution in the Florida Keys, USA

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ABSTRACT: We evaluated the role of fish predation as the mechanism controlling the local distribution of the scleractinian coral *Madracis mirabilis* on Conch Reef in the Florida Keys, USA. At many Caribbean sites, *M. mirabilis* is found at depths ranging from 1 to 63 m. However, at Conch Reef this coral is rarely found shallower than 20 m. *M. mirabilis* fragments transplanted from 26 to 13 m depth suffered significantly higher levels of fish predation than fragments transplanted from 26 to 20 m. These results indicate that fish predation potentially limits the vertical distribution of *M. mirabilis* on Caribbean reefs.

KEY WORDS: Fish predation · Coral distribution · *Madracis mirabilis*

Competition for space, habitat type, food availability, environmental conditions and natural disturbances have often been emphasized as important factors controlling coral distribution (Loya 1972, Porter 1972, 1974, 1976, Fishelson 1973, Lang 1973, Glynn 1976, 1988, Sammarco 1980, 1982, Wellington 1982a, Huston 1985, Glynn & Colgan 1988). Increasing evidence from field studies shows that predation by invertebrates (Robertson 1970, Glynn et al. 1972, 1979, Glynn 1976, McClanahan & Shafir 1990, McClanahan et al. 1996) and corallivorous reef fish (Glynn et al. 1972, Kaufman 1977, Brock 1979, Neudecker 1979, Wellington 1982b, Harmelin-Vivien & Bouchon-Navaro 1983, Littler et al. 1989) can play a direct role in shaping coral distribution and community structure (reviewed by Glynn 1990, Hixon 1997). Here, we present evidence that fish predation limits vertical distribution of the pocilloporid coral *Madracis mirabilis* on the Florida, USA reef tract.

Madracis mirabilis is commonly found throughout the Caribbean, South Florida and the Bahamas (Hu-

mann 1993). It forms densely packed clumps of small pencil-sized branches with blunt tips, small polyps which are light brown to yellow in appearance. *M. mirabilis* is found nearshore at a depth of 3 m at the Channel Two pass (24° 50' 05" N, 81° 41' 05" W) which links Florida Bay and the Florida reef track between Lower Matacumbe Key and Long Key (pers. obs.). At Conch Reef, Florida (24° 57' 05" N, 80° 28' 00" W), it is rarely found shallower than 20 m. In the course of experimentally assessing the source of carbon in the skeletal matrix of *M. mirabilis*, we observed evidence of heavy fish grazing on colonies transplanted from 26 to 13 m depth.

In this experiment, 8 distinct *Madracis mirabilis* coral colonies were collected at 26 m and each was divided into 8 fragments. Each individual fragment was cemented to an individual plexiglass disk. Four fragments from each coral head were transplanted to 13 m and 4 to 20 m (4 fragments colony⁻¹ × 2 depths × 8 colonies = 64 total sample size). All fragments were manipulated in an identical fashion at both depths. Coral fragments were collected approximately 6 wk later and treated in 5% sodium hypochlorite solution for 24 h. Because the number of branches per fragment was unequal, predation is reported here as a percentage, as follows:

$$\frac{\text{total number of fish bites}}{\text{(total number of branches/fragment)}} \times 100\%$$

In cases where the total number of bites exceeded the total number of branches (due to more than 1 bite/branch⁻¹) the percent predation value exceeded 100.

Overall mean percent predation was found to be significantly greater at 13 m than at 20 m (Table 1). With the exception of colony 2, the mean percent predation was consistently higher in shallow water. In some shallow water fragments, all branch tips were bitten off, yet none of the fragments in deeper water were in such

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Table 1. *Madracis mirabilis*. Mean percent predation per colony at each depth (n = 3 for colony 2 at 13 m and n = 4 for all other colonies at both depths). Mean percent predation was significantly higher at 13 m than at 20 m (Wilcoxon's signed-ranks test $T_s = 2$, n = 8, $p < 0.0117$)

Colony	Mean percent predation at 13 m	Mean percent predation at 20 m
1	61	0
2	7	28
3	125	21
4	108	26
5	102	29
6	75	17
7	37	32
8	83	10
Mean of means	74.75	20.38
SE	12.90	3.61

condition (Fig. 1). These results indicate that at Conch Reef predation by corallivorous fish plays a critical role in restricting the distribution of *Madracis mirabilis* to depths below 13 m. Although we did not directly observe fish predation on *M. mirabilis* since caged controls were not employed in this experimental design, the cusp-like bite marks revealed that parrotfish and/or pufferfish are likely to be responsible. No other evidence of damage due to handling or predation by other organisms was observed.

Situations where fish predation limits the zonation patterns of corals have also been reported in the branching coral *Pocillopora damicornis* (Neudecker 1979, Wellington 1982b) and massive *Pavona* spp. (Wellington 1982b) in the Pacific, for *Montastraea annularis* and *Acropora cervicornis* in Jamaica (Kaufman 1977) and for *Porites astreoides* and *Porites*

furcata in Belize (Littler et al. 1989). The pattern of predation observed in this study was also reported by Neudecker (1979) for *P. damicornis*. Further, Littler et al. (1989) suggested that the degree of fish predation is influenced by proximity to refugia for the corallivores and coral palatability. However, these factors do not appear to be applicable to Conch Reef where topographic complexity and refugia increase with depth (pers. obs.) in opposition to the observed increase in predation across the experimental depth, and where deep water *M. mirabilis* is susceptible to predation when transplanted to shallower depths.

Field studies examining the direct role of corallivorous fishes on coral zonation are limited (Kaufman 1977, Neudecker 1979, Wellington 1982b, Littler et al. 1989, reviewed by Glynn 1990, Hixon 1997). Our observations provide further evidence that fish predation can be an important factor limiting the vertical distribution of reef corals.

Acknowledgements. We thank the staff of the National Undersea Research Center's Florida Keys Program (UNCW) for their support during 'Aquarius' mission No. 17 and the Jason Foundation for Education (Jason Project VII) for financial assistance. For their assistance in the field we thank K. Sebens, G. Taylor, K. Wood and D. J. Roller. We also thank Dr C. Birkeland and 3 anonymous reviewers for their helpful comments on the manuscript.

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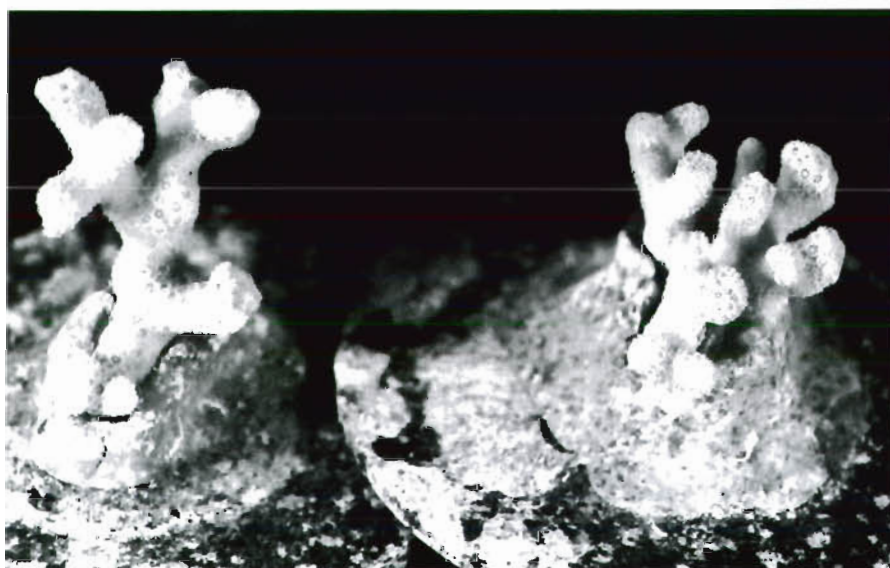


Fig. 1. *Madracis mirabilis* fragments: from 13 m with branch tips bitten off (on left) and from 20 m with intact branch tips (on right)

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Editorial responsibility: Charles Birkeland (Contributing Editor), Mangilao, Guam

*Submitted: June 30, 1997; Accepted: September 21, 1997
Proofs received from author(s): November 18, 1997*