occurred on patches located in low density areas outside and on the edge of the *Thalassia* beds than on patches in high density areas within the beds. They attributed this differential herbivory to a migration of herbivores from the reef towards the beds. We found that there was increased herbivory on patches in low density areas within the grass bed as well, suggesting that the pattern found in the 1993 study may be due more to density dependence than to a migratory pattern of herbivory.

Density dependent herbivory on *Thalassia* could be a factor influencing its distribution and reproductive strategy. *Thalassia* reproduces both sexually and by vegetative propagation. Vegetative propagation, which results in areas with high patch density, may be especially beneficial to *Thalassia* in areas of high predation pressure. The grass growing in dense beds would most likely be at an advantage over those growing in vulnerable isolated clumps.

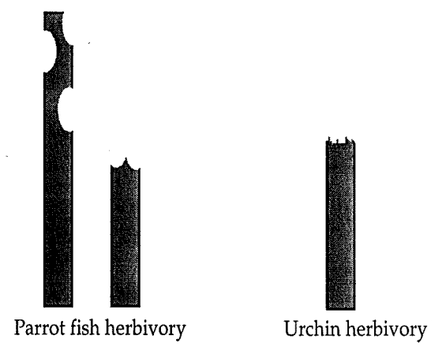

FIG. 2. Classifications of herbivory types.

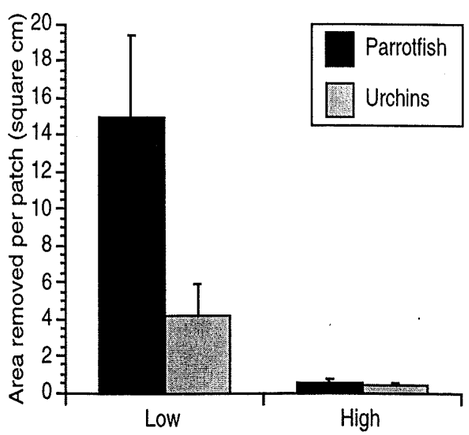

FIG. 3. Differential herbivory damage by parrotfish and urchins in low versus high density *Thalassia testinudum* areas.

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HERBIVORY AND EPIPHYTE LOAD ON TURTLE GRASS, *THALASSIA TESTUDINUM*, AS A FUNCTION OF DISTANCE FROM THE REEF CREST

CHRIS I. DUMS, JOSEPH W. GILBERTSON, ADAM J. SIEGEL, ANDREW TOLONEN

Abstract. Turtle grass, *Thalassia tetudinum*, is an important primary producer in coastal Caribbean waters, and dominates much of the back reef area at Discovery Bay, Jamaica. It is an important food source for marine organisms such as fish and urchins, and provides a substrate for the growth of several species of encrusting and filamentous algae. These epiphytic algae have been shown to increase the desirability of turtle grass to potential herbivores. We examined changes in *Thalassia* blade length, and epiphyte load with distance from the reef crest. Average blade length increased with distance from the reef. In addition, percent coverage by filamentous and encrusting algae varied with distance from the reef. Filamentous algae cover was highest furthest from the reef and encrusting algae showed no trend. While we found no difference in the number of blades having evidence of herbivory between the three distances, and while the number of blades damaged by parrot fish did not vary with distance, the number of blades damaged by urchins and scraping herbivores did. These differences could be due to several factors including water depth and turbulence, as well as distribution of herbivores. The differences in turtle grass distributions and epiphyte load with distance from the reef crest may affect the ecological interactions and distribution of organisms within the back reef area.

INTRODUCTION

Turtle grass, *Thalassia testudinum*, is an important primary producer in Caribbean coastal waters, and dominates much of the back reef area at Discovery Bay Marine Lab, Jamaica. *Thalassia* is a food source for many marine organisms including several species of fish and urchins. In addition, it provides a substrate for the growth of at least 113 species of algae (Harlin 1980, after Humm 1964). Of these resident algal types, two reside exclusively on sea grass; these include calciferous coralline algae and small filamentous brown algae (Harlin 1981, after Humm 1964).

In feeding preference experiments, turtle grass encrusted with algae has been shown to be the preferred food of the bucktoothed parrot fish *Sparisoma radians*, and turtle grass lacking an epibiont load was found to be its second most preferred food item (Lobel and Ogden 1981). *Thalassia* is also consumed by surgeon fish (*Acanthurus*) and squirrel fish (*Holocentrus*), as well as by a variety of echinoderm grazers including *Diadema antillarum, Trypneustes ventricosis*, and *Lytechinus variagatus.*

Most grazers which feed upon turtle grass, excluding bucktoothed parrot fish, which reside permanently in the sea grass, find protection from predators in the reef, and travel into the sea beds to forage. A region of sand, cleared of sea grass by reef dwelling herbivores exists between the reef and the sea grass beds. The existence of the cleared "halo" near the reef, along with the fact that many herbivores find shelter in the reef, suggests that herbivore pressure is greatest near the reef and will decrease with distance from the reef.

Aside from herbivore pressure, another factor controlling turtle grass and epiphyte growth in the backreef is likely to be water depth and turbulence. There is an increase in water depth and a decrease in turbulence with increasing distance from the reef crest. These differences may well affect *Thalassia* growth and epibiont load upon the *Thalassia.* In general deeper less turbulent water conditions will lead to less stress upon the grasses and epiphytes.

Thus, we predicted that as a result of lower grazing pressure and differences in water depth and turbulence, there will be an increase in turtle grass length and epiphyte cover with increasing distance from the reef.

METHODS

On 23 February 1997 we collected *Thalassia* blades from within the backreef area of Discovery Bay, Jamaica. A 100 m. transect perpendicular to the reef crest was extended toward the shore, starting at

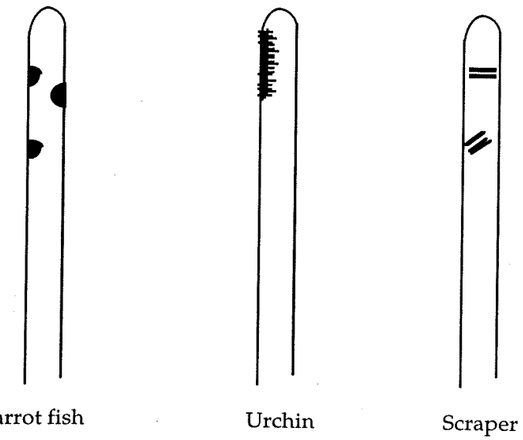

FIG. 1. Different types of herbivory on turtle grass.

the reefward edge of the *Thalassia* beds which dominate the back reef area. Three samples, of ten *Thalassia* blades each, were taken on each side of the transect line, at 5 m , 50 m, and 100 m. Each sampling location was separated by ten flipper kicks, and the ten closest *Thalassia* blades at each location were picked.

In the lab the length of each *Thalassia* blade was measured. In addition, the percent of the blade covered by encrusting algae, and by filamentous algae, was recorded. Finally, each blade was inspected for evidence of herbivory, and the type of herbivore, either parrot fish, urchin, or scraper, was identified based upon established patterns of herbivory (Fig. 1).

Results

The mean length of turtle grass increased with increasing distance from the reef crest (Fig. 2). Additionally, the abundance of epiphytic algal types (filamentous and encrusting) changed as a function of distance from the reef crest. There were more filamentous algae found on turtle grass blades at 100m from the reef crest than at 5m and 50m (One-way ANOVA, F=30.39, df=169, P<0.001; Fig. 3). There was also a significant difference in the percent of encrusting algae found on turtle grass across the three distances (One-way ANOVA, F=6.22, df=169, P=0.003; Fig. 3). However, there was no trend towards increasing encrusting algal cover with distance from the reef (Fig. 3).

Approximately 83% of the blades at all three distances showed evidence of herbivory. However, the types of herbivory varied across sites. The total number of blades damaged by urchins was greatest at the middle site (ChiSquare=10.11, df=167, P=0.006, Fig. 4) while the total number of blades damaged by parrotfish was consistent across all sites (ChiSquare=1.28, df=167, P=0.53; Fig. 4). The total number of blades damaged by scrapers varied between sites and showed no general trend (ChiSquare=5.94, df=167, P=0.05, Fig. 4).

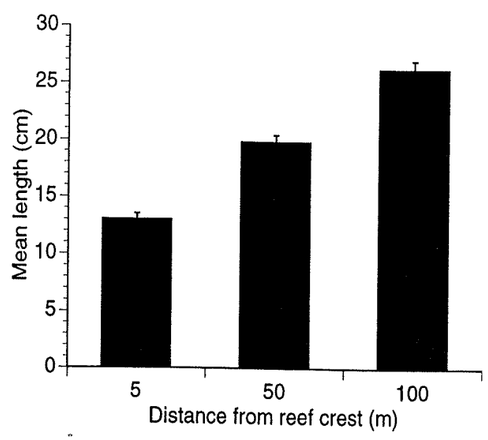

FIG. 2. Mean length of turtle grass blades at varying distances from the reef crest (N=60 blades at 5 m and 50 m, N=50 blades at 100m.)

Discussion

Our results support the hypothesis that average turtle grass length should increase with increasing distance from the reef. Other studies have shown that turtle grass density increases with increasing distance from the reef (Bizzarro et. al. 1992). Thus, turtle grass stands are shorter and less dense near the reef than farther away from the reef. This could be the result of increased herbivory nearer to the reef, of increased turbulence as a result of wave surge near the reef crest, or of a combination of both factors.

We found that epiphytic growth on turtle grass changes with increasing distance from the reef. Percent cover of filamentous algae increased significantly as distance from the reef increased. Past studies have shown that parrot fish preferred turtle grass blades covered with filamentous algae (Lobel and Ogden 1981) and that parrot fish herbivory decreases with increasing distance from the reef (Bizzarro et. al. 1992). Thus, the distribution of filamentous algae may be influenced by parrot fish herbivory.

Our results showed no significant trends in parrotfish herbivory as a function of distance from the reef crest. This may be because our sampling design was not able to detect differences in amount of parrotfish herbivory. This is quite possible considering that past studies have shown parrot fish herbivory to significantly increases with increasing distance from the reef (Bizzarro et. al, 1992). Our sampling methods tested only for the presence of herbivory and not the intensity or magnitude of herbivory damage.

We found that the number of blades damaged by urchins was greatest at intermediate distances from the reef. This is contrary to what we expected. It is interesting that at intermediate distances from the reef crest, urchin grazing was most frequent and encrusting algae was least abundant. This may suggest that urchins forage preferentially in areas of low encrusting algae cover.

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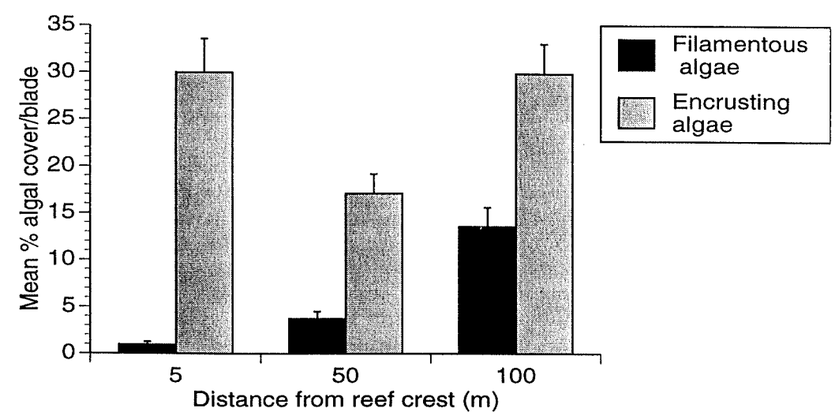

FIG. 3. Mean percent algal cover per blade of both filamentous and encrusting algae on turtle grass blades at varying distances from the reef crest (N=60 blades at 5m and 50m, N=50 blades at 100m.).

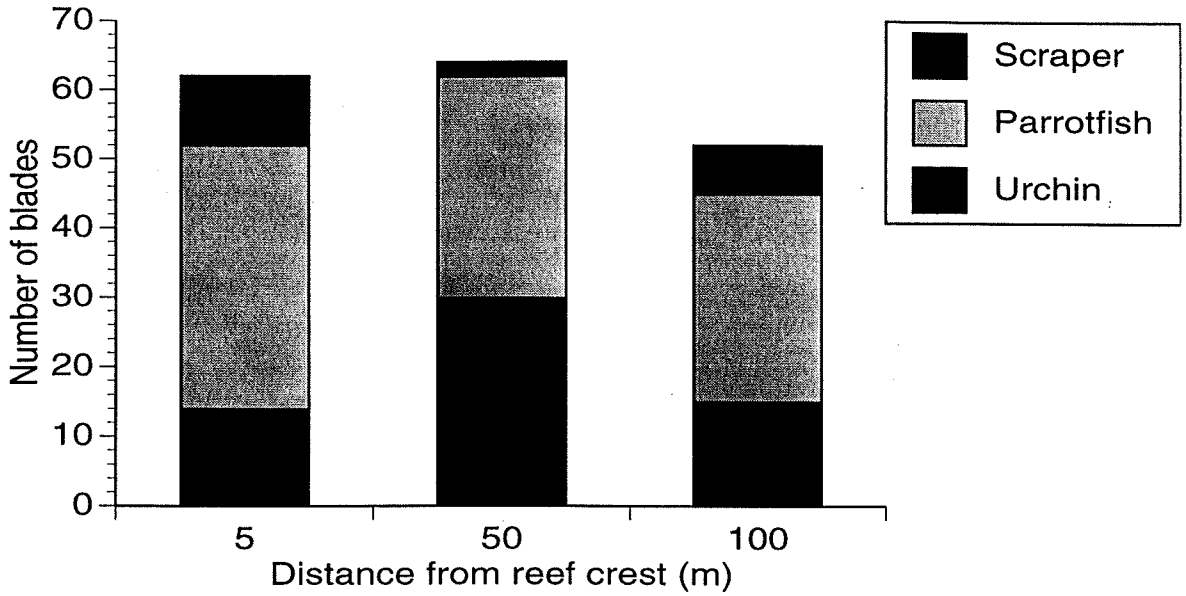

FIG. 4. Type of herbivory on turtle grass blades at various distances from the reef crest (N=60 blades at 5m and 50m, N=50 blades at 100m.) Note: total number of blades may exceed 60 at 5m and 50m and 50 at 100m since individual blades may have suffered more then one type of herbivory.