from each other in the mangrove cove on the edges of *T. testudinum* beds.

After 24 hours in the water, we removed the blades and measured final blade area by placing the leaves on a grid of 3mm squares and counting the number of missing squares. We calculated original area of blade by multiplying blade width by 14 cm and subtracting simulated herbivory. Percent removed by herbivorous fish was then calculated by subtracting the final blade area from the original blade area and dividing the result by the original blade area. Of the original 180 blades, a total of 20 leaves were lost (0-2 per replicate) from clothespin enclosures. The leaves of two sets of treatments were pooled within replicates because these treatments were mixed up (probably winds or currents scattered them) between the different sites. In addition, one replicate of control leaves was not included because waves carried it ≈ 5m away from original placement. We used a one-way ANOVA to analyze the effect of simulated herbivory on subsequent parrotfish herbivory. Proportion of blade area removed was arcsin-transformed prior to analysis. Figure 1 exhibits non-transformed data.

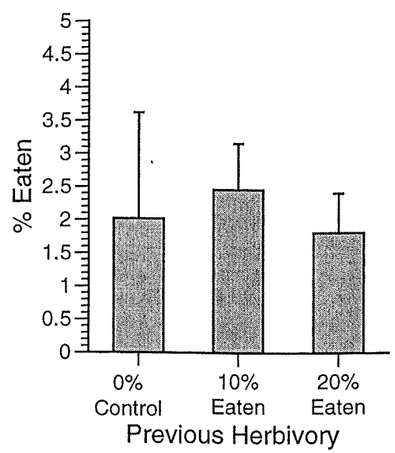

FIG. 1. Herbivory on *Thalassia testudinum* blades with preexisting simulated herbivory levels. Mean ± 1 SE.

RESULTS

We found that simulated previous herbivory on *T. testudinum* blades had no effect on fish foraging preference. Percentage of leaf blade removed was similar between the control and 10 % and 20 % levels of simulated prior herbivory treatments ($F_{2, 12} = 0.45$, $P = 0.65$; Fig. 1).

DISCUSSION

Herbivorous fish are not affected by prior herbivory on turtle grass blades. They feed on both damaged and undamaged blades indiscriminately. Therefore, it appears that any possible secondary metabolites induced by herbivory do not deter subsequent feeding on blades; nor are previous bites a visual cue to blade palatability.

Initally, our results suggest that the predictions of the optimal foraging theory would not apply to *T. testudinum* blades. However, observational data taken at the time of the study suggest that herbivorous fish feed in short bouts within a patch, spending little feeding time per blade. This suggests that it is more efficient for fish to feed continuously within a patch than to waste handling time assessing the available leaf area per blade. Thus, herbivorous fish may choose which turtle grass beds to feed in, perhaps by visual cues of patch density or epiphyte load instead of previous herbivory. It would be interesting for future studies to examine the effect of *T. testudinum* patch density on herbivorous fish foraging patterns.

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THE EFFECT OF BLADE HEIGHT ON *THALASSIA TESTUDINUM* HERBIVORY

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Abstract. Turtle grass *(Thalassia testudinum)* is fed upon by parrotfish and urchins. Given that grazing pressure varies with and depends upon the presence and abundance of herbivores (Odgen 1976), we hypothesized that turtle grass patch height would be determined by the intensity of grazing pressure. We also hypothesized that grass blades extending beyond the usual height of the blades in the grass bed would be more readily eaten. To test this, we placed bunches of grass blades above grasses in short grass beds near the reef crest and tall grass beds near the shore to see if more apparent blades received more herbivory and to see if there was an effect of bed height. We found that herbivory was significantly higher in the low grass sites, but that there was no difference in amount of herbivory between heightened blades vs. blades placed at the same height as the grass bed. We believe that location of the turtle grass bed is most important in determining amount of herbivory. More specifically, the closer a bed is to the reef, where herbivorous fish seek refuge, the more herbivory it will receive.

Key words: parrotfish, surgeonfish, turtle grass, herbivore-plant relationships.

INTRODUCTION

Parrotfish and urchins are the two primary herbivores of turtle grass *(Thalassia testudinum)*, a common aquatic plant in the Caribbean Sea. These herbivores live in the shelter of reefs and venture short distances into adjacent grass beds to feed (Randall 1965). Given that grazing pressure varies with and depends upon the presence and abundance of herbivores (Ogden 1976), we hypothesized that turtle grass patch height is determined by the intensity of grazing pressure. We also hypothesized that grass blades extending beyond the usual height of the blades in the grass bed would be more readily eaten. We predicted that blades in patches of short grass would experience more herbivory than those in patches of tall grass. We also predicted that experimentally heightened grass blades would experience more herbivory than blades at the average patch height because they should be more visible to herbivores.

METHODS

On February 25-26 1998, we measured turtle grass herbivory in Discovery Bay, Jamaica. We performed experiments in two locations which had markedly different heights of grass beds. The short grass was 50 m from the reef crest and had an average blade height of ~ 15 cm. The tall grass was 10 m from shore and the average blade height was ~ 40 cm. We collected intact grass blades from one turtle grass patch near shore. All blades taken had visually similar epiphyte loads. In each location we placed 10 groups of 6 blades each at the average blade height of the grass bed, and ~ 15 cm above the average height. Blades were attached to clothespins, and anchored using three bolts. We retrieved the implanted grasses after 20 hrs. We measured percent herbivory by estimating the area of each blade missing using graph paper. A two-way ANOVA was used to examine the effects of patch height, blade height, and patch height x blade height interaction on arc sine transformed data.

RESULTS

Herbivory appeared to be exclusively by parrotfishes. Herbivory was greater in the short grass patch than the tall grass patch ($F_{1,36} = 8.21$, $P = 0.007$, Fig. 1), but within a location, theamount of herbivory was not affected by blade height ($F_{1,36} = 0.21$, $P = 0.65$). There was no interaction between blade height and patch height ($F_{1,36} = 0.69$, $P = 0.41$; Fig. 1).

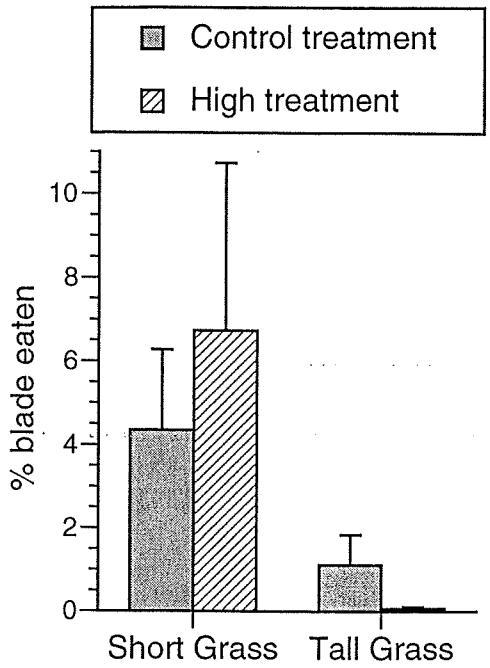

FIG. 1. Parrotfish herbivory of *Thalassia testudinum*blades of average patch height and blades raised ~ 15 cm above the average patch height in short and tall patches.

DISCUSSION

Since herbivorous fish fed more in areas with short turtle grass than tall grass, herbivory may influence blade height. Fish fed indiscriminately on blades the average height of grass beds and those placed above the average height, indicating that blade visibility does not attract fish. Location of a grass bed is likely an important factor in determining the extent to which it is eaten. In our treatments, the short bed of grass was closer to the reef than the taller bed. It has been shown that a halo effect occurs around Caribbean reefs (Randall 1965), because fish seek refuge in these patch reefs and only venture short distances to feed. Despite the 50 m distance, the turtle grass beds near the reef may experience more herbivory and are thus shorter than patches farther away from the reef which have less herbivory pressure, enabling them to grow taller. Factors such as sediment depth, sediment type, wave action, and water depth may also be important in influencing grass height.

The height of grass beds may affect the communities of fish and invertebrates that reside within them. Shorter beds offer less refuge from predators, and lower biomass of grass in the shorter beds may also limit the amount and the diversity of organisms residing there. Growth rates of grass between habitats could differ as well. Shorter grasses may regenerate faster to compensate for loss to herbivores, while longer grasses may become senescent without herbivory pressure. Future studies could examine the effect of grass bed height on both the diversity of grass dwelling organisms and turtle grass growth rate.

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