APPENDIX I. Urchin abundance (and normalized variation) from mean abundance (small, large) at three reefs for each day and night sampled during our study and the mean abundance across all surveys by reef.

Reef	Day 1	Night 1	Day 2	Night 2	Day 3	Reef Mean
1	62, 17 (-0.39, -0.02)		118, 17 (0.16, -0.02)	97, 16 (-0.04, -0.08)	128, 19 (0.26, 0.10)	101.3, 17.3
2	5, 6 (-0.24, 0)	1, 5 (-0.85, -0.17)	12, 7 (0.82, 0.17)	4, 6 (-0.39, 0.00)	11, 6 (0.67, 0.00)	6.6, 6.0
3	11, 25 (0.96, -0.04)	2, 25 (-0.64, -0.04)	6, 31 (0.07, 0.19)	1, 25 (-0.82, -0.04)	8, 24 (0.43, -0.08)	5.6, 26.0

APPENDIX II. Urchins tagged during initial survey and presence at home crevice during subsequent surveys (night one (N1), day two (D2), night two (N2) and day three (D3)).

Reef	Size	Tag	Observed at home crevice
One*	large	clear	D2, N2, D3
		green/red	
		blue	D2, N2, D3
	small	clear	D2
		clear/green	D2, D3
		red	D2, D3
Two	large	blue	N1, D2, N2, D3
		red/blue	N1
	small	red	N2
		clear	
Three	large	clear	
		blue	
		red	N1
	small	green	D2, D3
		red	D2, D3

*Reef one was not surveyed on night one.

Distribution of small and large parrotfish in two tropical reef habitats

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Abstract: Parrotfish herbivory levels on *Thalassia testudinum* may be determined by the habitat characteristics within a coral reef. Herbivory has been shown to be higher in areas with greater structural complexity (Hay et al. 1983). Structural complexity provides fish with shelter and fish occupy shelters appropriate to their size. We hypothesized that parrotfish herbivory would vary in two different habitats in the back-reef of Discovery Bay, Jamaica. Assuming parrotfish prefer the structurally complex reef crest, we expected to see more evidence of grazing on *T. testudinum* in this habitat. We also hypothesized that grazing by small and large parrotfish would vary between the habitats. We predicted that herbivory by large fish would be greater on the reef crest if large fish are more common in areas where large shelters are available. We found no significant difference in the size distribution of parrotfish bite marks in the two areas of the reef. This suggests that small and large fish do not differ in their ability to forage and exist in either habitat on the reef. We did find that the overall amount of herbivory was greater on the reef crest than the back-reef, indicating that both small and large parrotfish prefer this heterogeneous and food rich habitat. Intense herbivore grazing in the reef crest may limit *T. testudinum* growth.

Key Words: back-reef, foraging turtlegrass, herbivory, reef crest, Scarus *spp.,* Sparisoma *spp.,* Thalassia testudinum

Introduction

Parrotfish, *Scarus* spp. and *Sparisoma* spp. are common in most reefs in the tropical western Atlantic. They are generalist herbivores but they are the only fish that frequently consume turtlegrass (Gilbert, pers. comm.). Past studies suggest that grazing on *Thalassia testudinum* could be important in structuring plant communities on a reef (Hay et al. 1983). We looked at spatial patterns in parrotfish herbivory in the back-reef at Discovery Bay, Jamaica to assess parrotfish distribution and the impact of these grazers on *T. testudinum*.

Many reef fish depend upon the structural complexity of a reef for shelter from physical stress and predators (Kawamata 1998). A previous study on the relationship between parrotfish herbivores and plant communities (Hay et al. 1983) found that parrotfish forage less in areas with decreased structural complexity. Assuming parrotfish are distributed according to habitat structure, we hypothesized that parrotfish herbivory would vary between two different reef habitats. We predicted that parrotfish prefer the more structurally complex reef crest, and that the level of herbivory on *T. testudinum* would be greater in this habitat.

Additionally, we hypothesized that large and small parrotfish would have different distribution patterns between these habitats. The distribution of large fish may be limited by the availability of large shelters, since fish select shelters corresponding to their size (Kawamata 1998). We predicted that because the reef crest has a greater number of large shelters available, large parrotfish herbivory on *T. testudinum* would be greatest near the reef crest habitat.

Methods

On 22 February 2002 at Discovery Bay, Jamaica, we collected healthy, undamaged blades (20 cm long) of *T. testudinum* with epiphytes from two habitats in the back-reef. A bundle of five blades was attached to a weighted clothespin and three bundles were placed close together at each of five replicate

locations in two areas: one ~3 m from the reef crest, and another ~30 m from the reef crest. Within each area, the replicate locations were 10 - 15 m apart along an East-West transect. We set out a total of 30 bundles of *T. testudinum* at 15:00 and collected them 24 hours later. To determine herbivory levels, we measured the remaining length of each blade piece and counted the number of distinguishable parrotfish bites (semi-circular). When possible we also classified parrotfish bites into two categories: large (>0.5 cm) and small (≤0.5 cm).

To examine herbivory levels, we used non-parametric Wilcoxon tests to compare the lengths of sea grass blades remaining and the total number of parrotfish bites at the two sites. We counted the number of small and large bites visible on the remaining pieces of turtlegrass and compared these between areas using a chi-square test. While counting the number of parrotfish bite marks, we also noted the presence of urchin grazing, characterized by rough, uneven damage.

Results

There was no significant difference in the frequencies of large and small parrotfish bites within the two areas ($\chi^2 = 1.89$, df = 1, P = 0.169; Fig. 1). However, there was a significant difference in the number of bites on blades on the reef crest and in the back-reef (Wilcoxon, P < 0.001; Fig. 2). Sea grass blades gathered from the reef crest area were significantly shorter than those from the back-reef area (mean ± SE = 12.0 ± 0.7, 18.3 ± 0.5; Wilcoxon, P < 0.001). We observed more urchin damage on back-reef blades than on those placed near the reef crest, although we did not quantify this type of herbivory.

Discussion

Large and small parrotfish do not appear to be distributed unevenly between the two habitats. It appears that neither the wave action on the reef crest, nor the greater amount of refuge, differentially affect the foraging ability of small and large fish. In Discovery Bay, over-fishing has severely reduced the number of large fish, and the size differences between fish may not be great enough for disturbance and competition to differentially affect their distribution. Over-fishing has also reduced the number of piscivorous fish present, so parrotfish have little need for refuge sites located near the crest. However, since bites were sometimes overlapping and we had difficulty determining their size, the difference in distribution may not have been fully apparent. Future studies could investigate the relationship between parrotfish distribution and size by visually observing fish in both habitat locations.

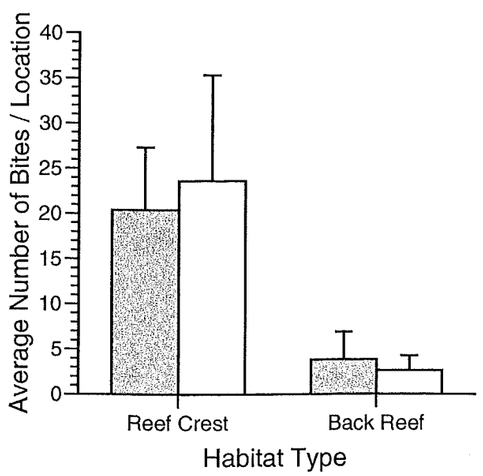

FIG. 1. Average number of large (solid) and small (open) parrotfish bite marks (± SE) on *Thalassia testudinum* in each sampling location (replicate) on the reef crest and in the back reef.

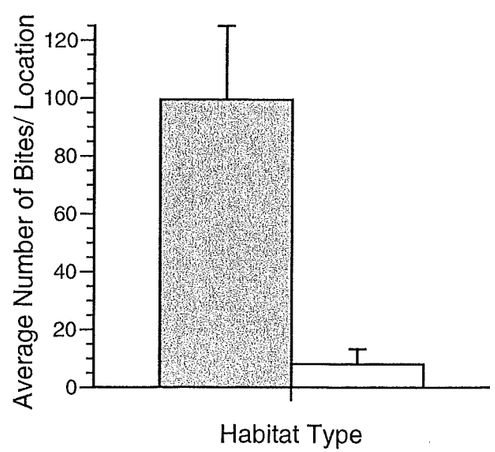

FIG. 2. Average number of total parrotfish bite marks (± SE) on *Thalassia testudinum* in each sampling location (replicate) on the reef crest (solid) and in the back reef (open).

We found significantly greater herbivory ~3 m from the reef crest than ~30 m away at the edge of large *T. testudinum* beds. Surprisingly, a previous study (McLaren et al. 2000) found no significant difference in herbivory levels on *T. testudinum* ~3 m from the reef crest and in back-reef *T. testudinum* beds over 100 m away. However, occasionally herbivory was high close to the reef crest, causing high variation in that treatment, while herbivory was consistently low away from the crest. Both their data and ours suggest that the reef crest habitat periodically suffers from higher parrotfish foraging. Parrotfish preference for the reef crest may be due to the greater spatial heterogeneity of the reef crest that likely provides more refuge from predators and/or due to the presence of at least three different foods (macroalgae, *T. testudinum* and coral). Parrotfish seem to be more abundant on the reef crest, rarely leaving to graze *T. testudinum* beds in the back-reef. Perhaps there is little advantage to foraging on *T. testudinum* away from the protection and food resources of the reef crest. We observed that the *T. testudinum* on the reef crest was sparser, shorter and had fewer epiphytes than that on the back-reef. This indicates that intense grazing may be limiting *T. testudinum* growth and distribution. Within coral reef ecosystems, higher herbivory levels at the reef crest could reduce the abundance of *T. testudinum* in this transition zone between the back- and fore-reefs. Factors that determine parrotfish distribution could indirectly affect the large-scale spatial patterns of *T. testudinum*.

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