predation due to fish trapping probably allowed herbivorous fish populations to explode, making fish the dominant grazers in *Thalassia* beds in Discovery Bay.

To better address whether fish and urchins feed preferentially near to or far from reefs, future studies should distribute replicates among multiple patch reefs. Since we used only one patch reef, our results might not reflect more general trends in fish and urchin feeding behavior.

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# HERBIVORE RESPONSE TO TURTLE GRASS (*THALASIA TESTUDINUM*) LEAF INVERSION

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*Abstract.* Herbivorous fish at Discovery Bay, Jamaica, have been shown to forage preferentially on the tips of *Thalasia testudinum* (turtle grass) leaves, where epibiont abundance is greatest. Fish may use visual cues in assessing epibiont presence and choosing where to graze. We hypothesized that herbivorous fish would select the epibiont-rich tips of the leaves, even if the leaves were inverted. We found that the distance from the base of the leaf to the lowest bite was smaller for inverted leaves, and that the proportion of leaf area removed did not differ from normally aligned leaves. Therefore, the fish appear to deviate from normal feeding habits in order to select for epibionts.

## INTRODUCTION

*Thalasia testudinum* (turtle grass) is commonly found growing on shallow flats of inshore tropical waters. Turtle grass is eaten by a variety of sea urchins, herbivorous fish, and turtles. Because turtle grass leaves grow from the base of the meristem, the oldest part of each blade is at its tip. These leaves host many types of encrusting epiflora and fauna (epibionts). The concentration of epibionts increases with the age of the leaf and so is highest at the tip of the leaf.

Herbivores, such as parrotfish (Scaridae), foraging on turtle grass, may obtain more of nutrients from consumption of epibionts than from the leaf matter. Herbivorous fish feed selectively on turtle grass leaves with epibionts, and concentrate their feeding on the tips of the leaves. Berry et al. (1994) demonstrated that these fish prefer leaves with simulated epibionts over leaves without epibionts. Therefore, the fish appear to be making a visual assessment of which leaves and on which parts of those leaves to feed, based on the abundance of epibionts.

We hypothesized that herbivorous fish would select the most beneficial portion of a turtle grass leaf (i.e. hosting the highest abundance of epibionts), even if normal feeding behavior has to be altered. We predicted that they would feed preferentially on the tips of turtle grass blades when the leaves were experimentally inverted.

## METHODS

We conducted our survey at the Discovery Bay Marine Laboratory, Jamaica, West Indies. Turtle grass leaves were collected and our experiment performed in the west back-reef area, approximately 100 m from shore.

We collected 120 ungrazed turtle grass leaves and trimmed each to a length of 15 cm. The trimmed end of each leaf was rounded to resemble a natural blade tip. All leaves were grouped into bundles of six, 10 bundles of controls with the tips facing up, and 10 bundles of treatments in which the leaves were inverted. Clothes pins were used to separate the bundles, and two pins, one containing control leaves, one containing treatment leaves, were attached to a weight. On 21 February 1995, ten weights were placed at 2 m intervals, along a 20 m transect. The transect was located in approximately 2 m of water along the boundary between a dense turtle grass bed and an adjacent sandy area.

The weights and leaves were retrieved after 24 hours and, for each leaf, we measured the distance from the bottom of the blade to first bite and the approximate proportion of blade area removed. We also calculated the proportion of leaves with bites in the bottom 5 cm of the blade.

For statistical analysis, proportions were arcsine transformed to meet the assumption of normality.

## RESULTS

The distance from the base of the leaf to the first bite was significantly lower on inverted treatment leaves (x=2.2cm, SE=0.57) than on control (x=6.8, SE=0.57) leaves (t=-5.1, df=49, p<0.001; Fig. 1). The arcsine transformation of the proportion of leaves containing bites in the bottom five cm was not significantly

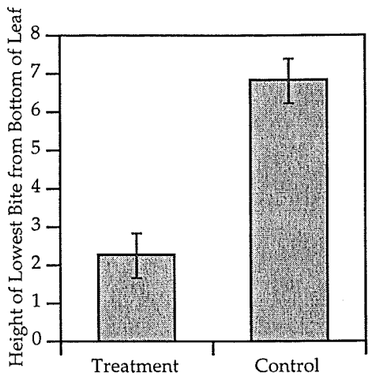


FIG. 1. Average distance from the bottom of the leaf to the first bite. Treatment N=50, Control N=59 (some leaves were not bitten) .

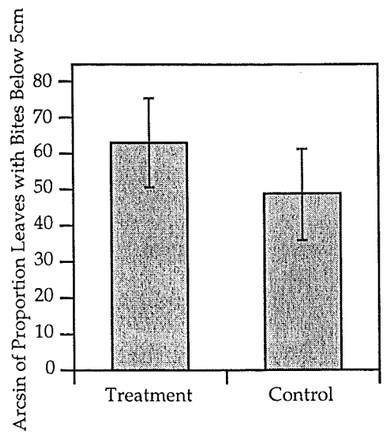


FIG. 2. Proportion of leaves with one or more bites on the bottom 5 cm (arcsine transformed). Treatment N=60, Control N=60.

different in the treatment (x=63, SE=12.4) and the control (x=48.5, SE=12.9; t=1.14, df=9, p=0.282; Fig. 2). The arcsine transformation of the percent of leaf removed was not significantly different in treatment (x=37.35, SE=3.84) and control (x=39.81, SE=2.65) leaves (t=-0.95, df=59, p=0.348; Fig. 3).

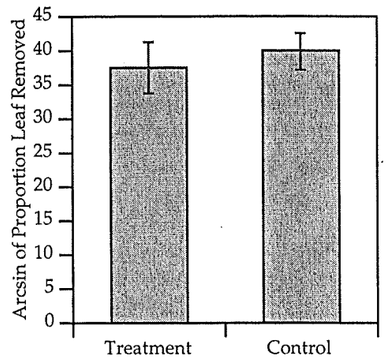


FIG. 3. Average proportion of leaf area removed (arcsine transformed). Treatment N=60, Control N=60.

## DISCUSSION

Since the lowest bite on treatment leaves was lower than on control leaves, this indicates parrotfish can recognize epibionts anywhere on a blade, and will change their feeding behavior in order to obtain them. There were not more treatment leaves with bites on the bottom third (five cm) than control leaves, although there is a trend in this direction. This may be because control leaves often had epibionts growing on the bottom third, attracting fish to graze on this region. Future studies could control for this by scraping off epibionts on the bottom half of each leaf to ensure that control and treatment leaves had the same amount of epibiont coverage.

Since there was no difference in the leaf area removed between controls and treatments, fish probably remove the same amount of leaf biomass, regardless of location of epibionts. This further supports our hypothesis that fish will alter typical grazing behavior in order to eat epibionts where they are most abundant. If there are





potential costs to this altered behavior, such as additional foraging time or decreased predator awareness, the benefits gained should outweigh the costs.

Observationally, we noticed much more herbivory on leaves that were on sand than those in the grass bed. Since we had paired replicates at each point, our results are probably not affected. Further study could examine differential grazing in open (sand bed) versus dense (grass bed) habitats, to see how much effect habitat has on amount or plasticity of feeding behavior.

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