# DIURNAL PATTERNS OF PARROTFISH HERBIVORY ON *THALASSIA TESTUDINUM*

ELVINA C. CHOW

*Abstract:* Parrotfish are major herbivores of turtlegrass in coral reef systems. At Discovery Bay, Jamaica, these fishes exhibit diel behavior, with most activity concentrated during daylight hours. I hypothesized that herbivory on turtlegrass would change throughout the day due to changes in parrotfish activity. I predicted that herbivory would be greatest during the day, especially in the morning hours, and lowest at night when parrotfish are known to be inactive. I tested this hypothesis by monitoring herbivory rates in experimental turtlegrass patches at Discovery Bay through the day: morning, midday, evening, and night. Parrotfish herbivory was highest in the morning and lower for the remainder of the day. These results suggest that parrotfish feeding activity is concentrated in the morning hours, which is probably when they are most hungry, after a 12 h period of rest.

*Key Words: day active fish, diel feeding, temporal differences, turtle grass*

## INTRODUCTION

Turtlegrass, *Thalassia testudinum*, is a major producer of primary biomass in coral reef systems, and its consumption is one of the main dynamics in tropical marine food webs (Kirsch et al. 2002). However, little has been done to identify the feeding behaviors of its consumers.

Parrotfish are one of the main consumers of turtlegrass in coral reef ecosystems. These fishes are diurnally active and are commonly found feeding on turtlegrass beds during the day. At night they rest and sleep, sheltering themselves with grass blades (Lobel 1981).

In this study, I investigated feeding rates of parrotfish in *T. testudinum* beds. Although parrotfish must forage during the day, I hypothesized that foraging rates during the daytime are not constant. More specifically, I predicted that parrotfish grazing would be highest in the morning because they require more calories after not eating during the night. After intense grazing in the morning, parrotfish may reduce their feeding rate over the course of the day because they become less hungry and have consumed enough to meet their dietary needs for the day.

## METHODS

On 22-23 February 2005, I measured parrotfish herbivory rates in a large *T. testudinum* bed near the lagoon at Discovery Bay Marine Laboratory, Jamaica. The study site was located 150 m west of the Marine Lab in a turtle grass bed covering an area of approximately 3000 $m^2$ (Fig. 1).

I used *T. testudinum* implants to estimate grazing at different times of the day. Each implant consisted of three *T. testudinum* blade tips that had no visual evidence of herbivory trimmed to 12 cm in length. Each implant was clipped to a weighted clothespin. Turtle grass blades were taken from the dock area. Ten replicate groups

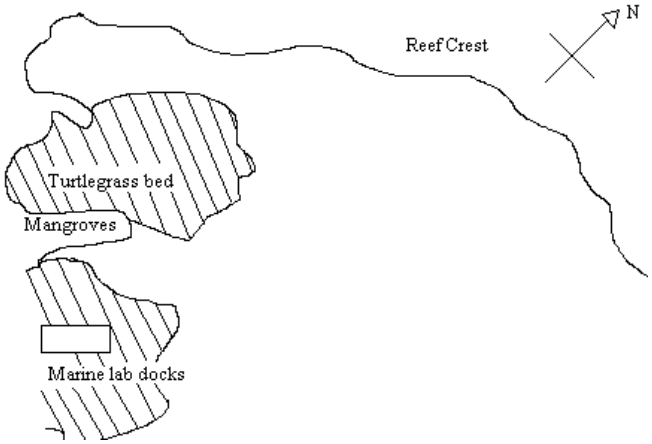


Figure 1. Turtle grass bed site used to test parrotfish herbivory patterns in Discovery Bay, Jamaica. Turtle grass bed is approximately 3000 $m^2$.

of four clothespins (12 leaves per group, 120 leaves total) were haphazardly placed within the *T. testudinum* bed. Clothespins within each group were placed approximately 0.2 m apart, and replicates were 5 m apart. Implants were left *in situ* for 4-hr periods during different times of the day: morning (0700 - 1100), midday (1100 - 1500), evening (1500 - 1900), and night (1800 - 2000). After each period, I collected the leaf implants and replaced them with new ones.

Herbivory was quantified at the end of each time period by measuring the percentage of areal leaf loss. Leaf losses to parrotfish grazers were estimated by subtracting the initial measurement of leaf area from leaf area remaining after 4 h. *Thalassia testudinum* blades that had been completely removed from the clothespin prior to my collection were counted as 100% herbivory. Percentage of herbivory was calculated as:

[(area of leaf loss/total area of blade) x 100]

Data were analyzed using JMP 5.0.1. A mixed model ANOVA was used to examine how parrotfish herbivory on *T. testidinum* changed over the course of the day with time of day as a fixed effect and patch as a random effect. Post-hoc comparisons were made using tukey's HSD.

## RESULTS

Field observations over four hours at the study site revealed that parrotfish were the only fish grazing on *T. testudinum* blades. Furthermore, no sea urchins were observed in this area, and none of the collected blades were damaged by sea urchin grazing. All herbivory on *T. testudinum* implants in the study site was therefore attributed to parrotfish grazing.

Herbivory on *T. testudinum* ranged from 0.25 - 15.2% over the course of the day. The two-way ANOVA revealed that herbivory was a function of time-of-day ($F = 6.49$, $df = 1, 467$, $P < 0.001$; Fig. 2). Herbivory was greatest in the morning, and remained low for the rest of the day ($F = 24.0$, $df = 3, 467$, $P < 0.001$; tukey's HSD < 0.05; Fig. 2). There was no effect of replicate patches on the rate of herbivory ($F = 0.67$, $df = 36, 467$, $P < 0.74$). This indicates that the variation in herbiviory throughout the day was consistent across replicates.

## DISCUSSION

Parrotfish grazing on *T. testudinum* was significantly higher in the morning, which supports my hypothesis that there is differential parrotfish feeding over the course of the day. This suggests that

parrotfish are probably most hungry in the morning after not eating in the night and require greater amounts of resources in the morning to be active during the day.

Although I did not expect to see any feeding at night, the night period had 0.25% herbivory on *T. testudinum* leaves. Since light may be the environmental cue for feeding, parrotfish may still be feeding as late as 1900, which was two hours into the "night" treatments. Future studies could quantify parrotfish feeding during periods of full darkness to determine if parrotfish do feed at night. Even with grazing in the night treatment, the morning treatment exhibited the highest level of herbivory. This result may be driven by several factors including hunger, predation, and competition.

It is possible that parrotfish may feed in the early morning to decrease predation activity. Although one cost of foraging throughout the day is expending energy, there may also be costs from increased exposure to predators, with the costs of day-time exposure exceeding the potential benefits of increased energy gains. However, this is highly unlikely in Discovery Bay given that this area has been heavily overfished, thereby decimating many fish populations including parrotfish predators. It is also inconsistent with the flurry of herbivory I observed in the morning, when predators are known to be inactive (Kirsch et al. 2002).

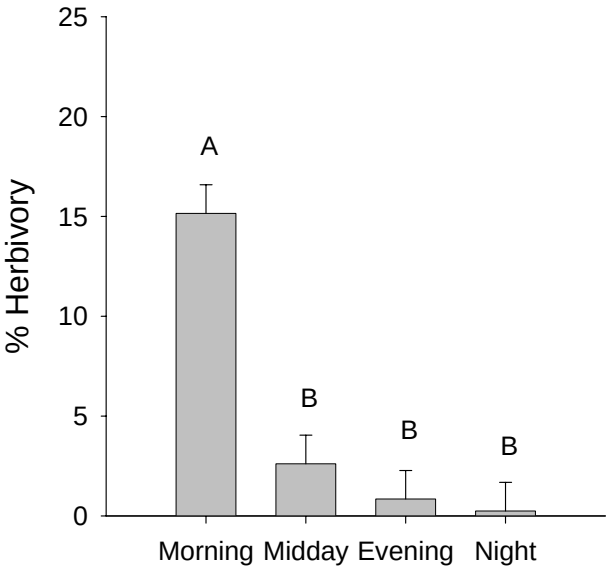


Figure 2. Percent of implanted *Thalassia testudinum* leaves eaten by parrotfish throughout the day.

The temporal changes of parrotfish grazing may also be attributed to competition for resources during the day. As sea urchins are major herbivores of *T. testudinum*, competition with these echinoderms may influence parrotfish grazing. There are three commonly occurring species of sea urchins at Discovery Bay. Only the West Indian sea egg, *Tripneustes ventricosus*, exclusively grazes on turtlegrass. This species of sea urchin grazes during the day and often moves out of turtlegrass beds at night to rest on rocks and rubble (Lawrence et al. 2001). Unfortunately, little is known about their grazing rates over the course of the day. An additional study could examine *T. ventricosus* herbivory rates during the daytime to determine if grazing patterns of *T. ventricosus* could contribute to the diel feeding pattern in parrotfish.

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# DIURNAL CHANGES IN *TRIPNEUSTES VENTRICOSUS* COVERING RESPONSE IN *THALASSIA TESTUDINUM* SEA GRASS BEDS

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*Abstract:* The urchin *Tripneustes ventricosus* uses its tube feet and spines to cover itself with sea grass blades or other debris. We examined this behavior as a defense against solar radiation. We hypothesized that the degree of covering by *T. ventricosus* would change according to the degree of solar radiation over the course of the day. We predicted that covering would be highest in the afternoon, lower in the morning and evening, and lowest at night. Covering response may also be affected by available material. We predicted that *T. ventricosus* would cover itself more in areas of high-density sea grass than low-density sea grass. We measured percent cover in *T. ventricosus* individuals at different times of day in high- and low-density sea grass areas. Coverage was highest in the afternoon and lowest at night for both sea grass densities. Percent cover was significantly higher for urchins in high-density sea grass areas than in low-density areas for all times during the day, but not at night. These results indicate that *T. ventricosus* is able to detect and respond to changing levels of solar radiation by changing its percent cover.

*Key Words: covering behavior, salt and pepper urchin, solar radiation*

## INTRODUCTION

*Tripneustes ventricosus*, the salt and pepper urchin, uses its tube feet and spines to cover itself with shells, sea grass blades and other debris (Lewis 1958). Several explanations have been suggested for this covering response, including protection from wave surge and predators (Kehas et al. 2004); however, there is strong evidence that the primary purpose for covering behavior is to screen solar radiation (Fierce and Lapin 2004, Kehas et al. 2004, Lewis 1958). When grass fragments are covering