Macroinvertebrate communities associated with *Halimeda opuntia*

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Abstract: Macroalgae play an important role in coral reef ecosystems, serving as food sources, substrates for epiphytes and structured habitat for a variety of organisms. The plate-like thalli of one macroalga, *Halimeda opuntia*, provide shelter for diverse communities of invertebrates, including echinoderms, crustaceans and gastropods. We hypothesized that the invertebrate communities would differ from day to night due to variation in predation pressure, specifically predicting that higher diurnal predation pressure would lead to higher diversity and abundance of macro-invertebrates seeking refuge in *H. opuntia* during the day. We also tested the hypothesis that macro-invertebrates actively prefer *H. opuntia* over other potential algal hosts. Contrary to our prediction, we found that taxon richness and abundance in *H. opuntia* were higher at night than during the day. One explanation for this may be that macro-invertebrates such as errant polychaetes, which were abundant in the night samples, may forage during the day and seek refuge in the algae at night. We also found that macro-invertebrates did not preferentially choose *H. opuntia* over the other presented macroalgae. The high diversity and abundance of organisms found within *H. opuntia* may be a result of high survivorship in these algae. Since *H. opuntia* occurs in lower, more densely packed mats than other macroalgae, the organsisms within it may simply be subject to lower predation pressure and lower turbulence. Future studies could explore how predation pressure and macroalgal habitat structure affect the distribution and abundances of macro-invertebrates in coral reef communities.

Key Words: Decapoda, macroalgae, Ophiuroidea, Polychaeta, refuge

Introduction

Macroalgae play an important role in coral reef ecosystems, serving as a food source for fish, substrate for epiphytes and shelter for micro- and macro-invertebrates. *Halimeda opuntia* is one of the most important macroalgae on coral reefs because its low, densely packed vegetative structure provides refuge from predators for a variety of marine invertebrates, including crustaceans, worms and seaslugs (Kaplan 1982). Glastris et al. (2001) found that *H. opuntia* hosted a higher number of invertebrate taxa compared to 2 other dominant macroalgal species within the same reef. This high invertebrate abundance may be the result of active habitat selection by these organisms or higher survivorship within *H. opuntia* compared to other macroalgae. We hypothesized that due to diel variation in predation pressures, the species composition and abundance of macro-invertebrates in *H. opuntia* would differ between day and night. We predicted that higher diurnal predation pressures would lead to higher abundance and diversity of macro-invertebrates residing in *H. opuntia* during the day than at night. To determine the reason for high macro-invertebrate abundance in *H. opuntia*, we tested the hypothesis that macro-invertebrates actively prefer *H. opuntia* as habitat. We predicted that, given a choice of macroalgae, macro-invertebrates would tend to actively seek out *H. opuntia* as their algal host. Alternatively, if the high macro-invertebrate abundance were due solely to higher survivorship in *H. opuntia*, we would expect no preference for macroalgal species.

Methods

Diel Variation

The study was conducted at Discovery Bay Marine Laboratory, Jamaica. At approximately 09:00 and 22:00 on 23 February 2002, we collected 10 samples of *H. opuntia* from the

macroalgal mat on the western back-reef (within 5 m of the reef crest). We collected only isolated, similarly-sized individuals (clumps) within one meter of the ocean floor. Samples were immediately placed into individual plastic bags. In the lab, each algal clump was rinsed with fresh water and all macro-invertebrates were removed. We separated the macro-invertebrates into taxa and recorded abundance of each taxon per clump. We recorded the mass of the *H. opuntia* clumps after 30 hours of drying at room temperature.

We tested for relationships between clump size and abundance and richness of macro-invertebrates using linear regressions. Mean total abundance and taxon richness of macro-invertebrates per clump were compared between day and night using a Student's t-test. We also tested for differences in day versus night abundance within the major taxonomic groups using Student's t-tests.

Preference trials

We created habitat preference arenas to test whether macro-invertebrates actively seek out *H. opuntia* as an algal host. In addition to *H. opuntia*, three other locally abundant macroalgal species were collected: *Turbinariaturbinata sp.*, *Galaxaura oblongata* and *Bryothamnion triquetrum*. We removed all macro-invertebrates from the algae (with noticeably more individuals found in *H. opuntia* clumps) and separated the algae into similar-sized clumps. Clumps of each algal species were arranged in a continuous ring in a plastic tub (40 cm diameter, 20 cm depth; Fig. 1). Each arena was then placed in a water table to provide constant flowing seawater. Five brittlestars, 5 crabs and 5 polychaete worms (all originally found residing in *H. opuntia*) were released into the center of the tub. After 24 hours, we located the macro-invertebrates and recorded the algal species with which they were associated. We used a chi-square test to determine algal preference for all specimens released into the arena and for each of the three separate macro-invertebrate taxa. Organisms that escaped the arena or that were lost were not included in the analysis.

Results

Diel variation

We found 34 macro-invertebrate taxa in the clumps of *H. opuntia* (Table 1). The weight of the clumps ranged from 1.16 – 37.31 g. Neither abundance of macro-invertebrates

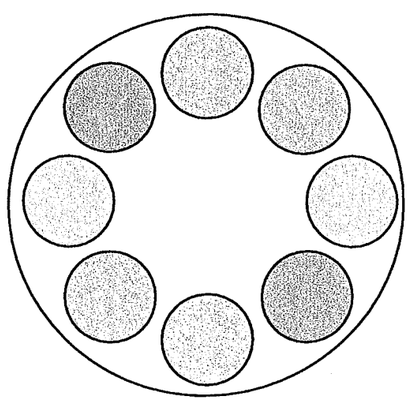

FIG. 1. Schematic of experimental arena. Each pattern represents one of the following algal species: *Halimeda opuntia, Bryothamnion triquetrum, Galaxaura oblongata and Turbinaria turbinata.*

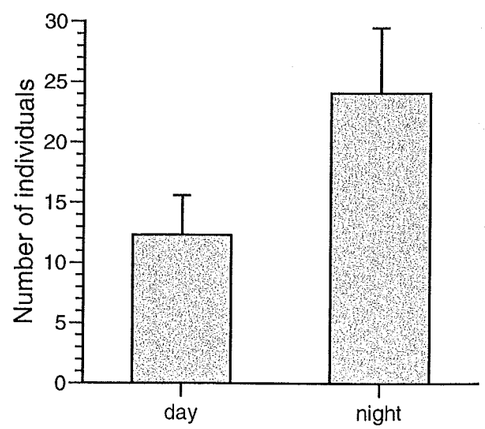

FIG. 2. Mean abundance (± SE) of macro-invertebrates in *Halimeda opuntia* clumps during the day and night.

nor taxon richness was related to mass of the *H. opuntia* clump ($F_{1,18} = 2.49$, $P = 0.13$ and $F_{1,18} = 3.87$, $P = 0.06$ respectively). Although richness appears marginally significant, this relationship was largely driven by one data point. There was also no relationship within day or night between size of *H. opuntia* clump and either abundance or richness. Mean clump mass did not differ between day and night ($t = 1.11$, $df = 18$, $P = 0.28$).

Mean abundance per clump was marginally higher at night than during the day ($t = 1.86$, $df = 18$, $P = 0.08$; Fig. 2). Mean richness per clump was higher at night ($t = 2.48$, $df = 18$, $P = 0.02$; Fig. 3). The most common taxonomic groups (Ophiuroidea, Decapoda, Polychaeta, Isopoda, Amphipoda and Gastropoda) were tested for day versus night differences in abundance; of these groups, only the polychaetes were more abundant at night ($t = 3.25$, $df = 18$, $P = 0.004$).

Preference trials

The invertebrates, regardless of taxa classification, showed no preference for any of the 4 algal species ($\chi^2 = 2.00$, $df = 3$, $P = 0.57$; $n = 58$). One ophiuroid and one polychaete were not recovered after 24 hours. None of the three taxonomic groups showed

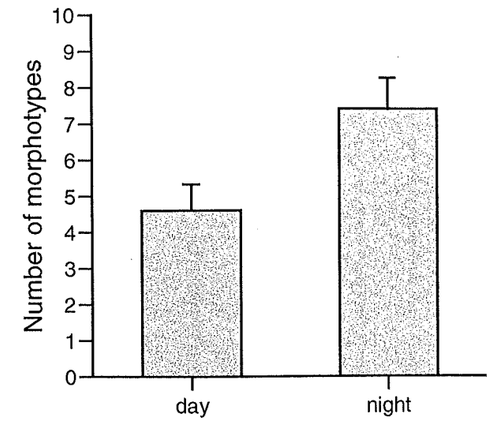

FIG. 3. Mean number of taxa (± SE) of macro-invertebrates found in *Halimeda opuntia* clumps during the day and night.

any preference for algal species (Ophiuroidea: $\chi^2 = 3.11$, $df = 3$, $P = 0.38$; Decapoda: $\chi^2 = 2.00$, $df = 3$, $P = 0.57$; Polychaeta: $\chi^2 = 6.05$, $df = 3$, $P = 0.11$).

Discussion

Contrary to our prediction, abundance and richness of macro-invertebrates were higher at night than during the day. During the day, many organisms could be actively

TABLE 1. Richness and abundance of macro-invertebrate taxa per clump of *Halimeda opuntia* during the day and night. *indicates a significant difference between day and night (P = 0.004).

Taxa	Number of morphotypes	Day abundance (mean ± SE)	Night abundance (mean ± SE)
Anthozoa	2	0.20 ± 0.13	0.10 ± 0.10
Sipuncula	1	0.10 ± 0.10	0
Polychaeta	10	2.10 ± 0.46*	8.90 ± 2.04*
Decapoda	4	1.20 ± 0.44	1.10 ± 0.38
Isopoda	2	1.60 ± 1.08	2.00 ± 0.73
Amphipoda	4	5.70 ± 2.63	8.20 ± 2.91
Gastropoda	6	0.50 ± 0.31	0.80 ± 0.29
Ophiuroidea	3	0.90 ± 0.60	2.00 ± 1.10
Echinoidea	1	0	0.10 ± 0.10
Holothuroidea	1	0	0.90 ± 0.59
Total	34	12.30 ± 3.28	24.10 ± 5.41

foraging, while at night they may seek refuge in macroalgae. This may be especially true for the polychaetes, which were driving a large portion of our day versus night differences in abundance and richness and overall accounted for 54% of the variation in total abundance. Alternatively, zooplankton may migrate upward into the water column to forage at night (Porter and Porter 1977). Some of these zooplankton, such as amphipods, isopods and larval polychaetes, may settle into macroalgae during the night, which could explain our observations of higher abundance and richness.

According to island biogeography theory, we would expect higher abundance and species richness on larger islands, as was found for the macroalga *Penicillus capitatus* (Stoner 1985). In clumps of *H. opuntia,* we found no relationship between size of the clump and either abundance or richness of macro-invertebrates. This suggests that island biogeography theory does not apply to these *H. opuntia* patches. Instead, it appears that *H. opuntia* is one alga among a matrix of many algal species and organisms are free to move among them. Future studies should examine a broader range of clump sizes in a variety of microhabitats to further validate the patterns we found.

Although *H. opuntia* exists in a matrix of other algae, studies have shown that invertebrates are more abundant in it (Glastris et al 2001; pers. obs.). In our experimental arenas, organisms (adults and juveniles) did not actively prefer *H. opuntia.* Perhaps larval stages show an active preference through some cue in *H. opuntia;* further studies could test this hypothesis. It is also possible that larvae disperse randomly among algal species. The growth morphology of *H. opuntia* is dense and low to the substrate, creating a refuge from predation and turbulence for these larvae. The larvae that settle in other algae, for example in the stalk-like structure of *T. turbinata,* could be exposed to higher predation and increased turbulence from wave action. Thus macro-invertebrates may not actively choose *H. opuntia,* but instead may experience higher survival in the refuge of its dense structure, resulting in the distribution pattern observed by Glastris et al. (2001).

Predation, together with the three-dimensional habitat structure provided by macroalgal species, could be responsible for the patterns in macro-invertebrate distribution and abundance that we found. Further studies could explore the interaction of these two factors by adding predators in controlled experiments and by manipulating other algae species in the field to resemble the growth form of *H. opuntia.*

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