Interactions between *Condylactis gigantea* and macroalgae

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Abstract: Macroalgae may compete with sessile macroinvertebrates for space and light in Caribbean Reefs. We hypothesized that algal mats could decrease microhabitat quality for the sea anemone *Condylactis gigantea*. We expected that experimentally placed *C. gigantea* would attach more readily on bare substrate than on substrate surrounded by algae. We also predicted that *C. gigantea* would move towards light in laboratory experiments and that this movement would be deterred by dense algal cover. Since algae may present obstacles for anemone establishment and growth, we hypothesized that *C. gigantea* should have adaptations, such as toxins, to compete with algae for space. We looked for observational evidence that *C. gigantea* clears or changes surrounding algal communities in nature. We also quantified whether *C. gigantea* decreases levels of herbivory from macrograzers such as fish. If *C. gigantea* does decrease herbivory, it would create a predator-free zone for its algal competitors. *C. gigantea* did not show preference between bare and algal covered substrate over 14 h in relocation experiments. However, evidence from our shading experiments demonstrated that *C. gigantea* will move towards light, and that movement to more preferred habitat may take at least three days. The shading experiments also showed that algal cover may be more difficult for anemones to move across than bare substrate. In the field, we observed two-thirds as much algal cover within an 11 cm radius of *C. gigantea* vs. points 30 cm away. Algae community compositions did not appear to differ between *C. gigantea* and control areas, although the lower algal cover in the zone surrounding *C. gigantea* lead to a decrease in richness per unit area. Herbivory rates on *Thalassia testudinum* did not differ between areas around *C. gigantea* and controls.

Key Words: anemones, habitat selection, Thalassia testinudum

INTRODUCTION

Macroalgal populations have increased in Discovery Bay, Jamaica over the last 15 years (Goreau 1992). While the increase in algal cover has adversely affected corals, the relationship between algae and other sedentary organisms has received less attention (Goreau 1992, Hughes 1994). Since sea anemones attach to reef substrate, they most likely compete with algae for space on the reef. We combined field observations with *in situ* and laboratory manipulations to discern: 1) how the algae community of the West Back Reef at Discovery Bay might affect the behavior of the sea anemone *Condylactis gigantea* (Actinaria: Actiniidae), and 2) how this algal commmunity might be affected by the anemone.

We hypothesized that dense algal cover could be detrimental to *C. gigantea* in three ways: 1) physically blocking either the pedal disk of an anemone from attaching to the substrate or tentacular movement, 2) shading symbiotic zooxanthellae, and 3) limiting an anemone's movement when the quality of its microhabitat should decline. We predicted that relocated *C. gigantea* would reattach more readily to crevices in bare rock than to substrate completely surrounded by algae. We also predicted that *C. gigantea* would move towards sunlight when shaded, but that such movement would be inhibited by dense algal cover.

Since algae may create less favorable growing conditions for anemones, we hypothesized that *C. gigantea* would usually be found in algae free zones. *C. gigantea* could preferentially select bare substrata, or they could employ toxins to destroy any neighboring algal tissue (Bak and Barsboom 1984). We predicted that areas immediately surrounding *C. gigantea* would have decreased algal cover. If anti-algal toxins are important for *C. gigantea*, we also expected to find differences in the composition of algal communities around the anemones, since some algae may have differing levels of resistance to this allelopathy.

Herbivorous fish and sea urchins are important regulators of algae populations (Carpenter 1986). If anemone nematocysts deter herbivores, anemones could potentially provide a refuge for their algal competitors. We predicted that rates of herbivory within the reaches of *C. gigantea* tentacles would be lower than rates in the surrounding environment. If algae are deleterious to *C. gigantea*, such a finding would indicate that *C. gigantea* may need to be especially adapted to deter encroaching algae.

METHODS

Experiments and observations were conducted at Discovery Bay Marine Laboratory, Discovery Bay, Jamaica between 5 and 13 March 1999. Field observations were made in the backreef immediately north of the laboratory. All organisms used in lab experiments were removed from an area within 10 m of shore.

Effects of macroalgal cover on *Condylactis gigantea* were tested *in situ* by placing eight individuals in bare rock crevices and eight individuals nestled into dense macroalgal mats (after moving algae aside to allow pedal disk reattachment). After 14 h, we assessed which anemones had moved from their initial locations.

To test the ability of *C. gigantea* to move to more favorable habitat, and to determine to what degree macroalgae inhibit this movement, we introduced 15 individuals to an outdoor marine tank. Water for the tank was pumped from the bay and circulated continuously. All anemones were provided rock refuge and allowed to adjust to their new surroundings for 36 h before experimental manipulation. Three treatments, each with five anemones, were set up in the tank: 1) shaded on rock substrate, 2) shaded on substrate surrounded by macroalgae, and 3) unshaded on rock substrate. Shade structures were constructed of thin sheetmetal (0.6 m x 3 m) supported by cement blocks, ~20 cm above the tank floor. Locations of each anemone were marked at the onset of the experiment (Fig. 1). The experiment was terminated after 40 h, when the displacement of each individual was recorded.

In the backreef, algal communities closely surrounding *C. gigantea* were assessed by removing circular samples (using petri dishes with 2.75 cm radius) of macroalgae from each of four randomly chosen directions 8 cm from the center of the focal anemone's oral disk. For comparison, we took four samples at a 'control' point 30 cm away from the organism in a randomly selected direction in a similar microhabitat. Percent algal cover was recorded in a circular area (11 cm radius) surrounding the anemone and the control point.

Finally, we tested the effect of *C. gigantea* on herbivory on nearby vegetation. Due to the complications of assessing herbivore damage on macroalgae, we calculated percent tissue loss on seagrass blades (*Thalassia testudinum*) as an indicator of algal herbivory. Sets of five undamaged, 8 cm long seagrass blades were attached to clothespins and weighted next to *C. gigantea* individuals (n=15). A second set of five blades was placed in a similar habitat approximately 30 cm from each anemone. Blades were left in the field for 7 h from 930 h to 1630 h.

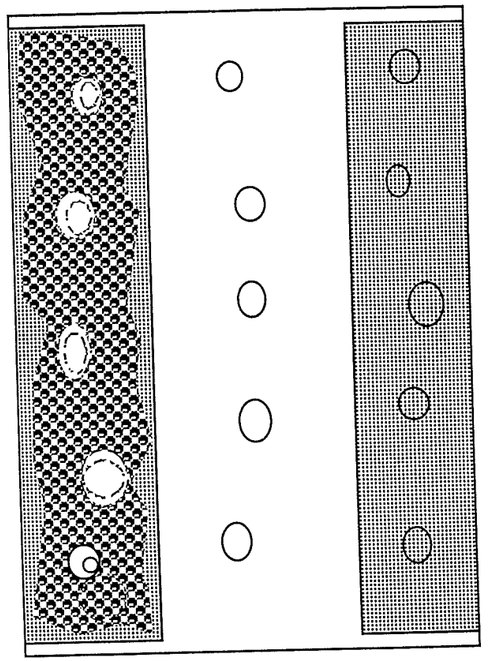

Fig. 1. Design of shading experiment. (A) represents shaded treatment with algae, (B) represents control, and (c) represents shaded, non-algal treatments.

RESULTS

Condylactis gigantea experimentally placed in the field did not show evidence of substrate preference. Fourteen hours after being

Table 1. Macroalgae species composition around *Condylactis gigantea* individuals at Discovery Bay, Jamaica.

Algal Species	Occurrences around *C. gigantea*	Occurrences in control samples
Acanthophora spicifera	1	3
Amphiroa fragilissima	1	7
Amphiroa rigida	13	8
Caulerpa racemosa	1	2
Chaetomorpha linum	11	11
Cladophoropsis macromeres	3	7
Coelothrix irregularis	15	14
Dictyota cervicornis	7	9
Halimeda spp.	8	10
Hypnea musciformis	0	3
Galaxaura oblongata	1	1
Galaxaura sp.	0	2
Laurencia intricata	1	1
Laurencia papillota	1	0
Laurencia sp.	1	0
Spyridia hypnoides	3	3
Ventricaria ventricosa	2	7
Volonia spp.	1	1
Total species	16	16

relocated, six of eight individuals placed on bare substrate and five of eight placed on algae-surrounded substrate remained in the same place, suggesting no effect of macroalgae on attachment within this time frame.

Evidence of habitat selection was, however, shown in tank experiments where all ten anemones in shade treatments moved 10-25 cm toward the sunlit area. Most movement occurred 36 h into the treatments. Individuals in these trials did appear to avoid algae covered substrate as three of the five individuals in the algae treatment used the metal shade structure to reach light. Only one individual in the unshaded control treatment moved during the experiment.

Areas surrounding anemones in the field had a third less algal cover than nearby areas (Wilcoxon, X^2=6.90, df=1, P=0.009). Consistent with this finding, we found fewer algae species on average around *C. gigantea* than in plots 30 cm away from any anemone (Table 1, 4.7 spp. ± 0.36 vs. 5.8 spp. ± 0.48, means ± SE, Paired t-test, t=-1.88, df=14, P=0.04). Most common species were found equally between the two sites, except for *Amphiroa fragelissima* and *Cladomorpha macromeres.*, which occurred most frequently away from the anemone.

We found no differences in percent herbivory around and away from *C. gigantea* individuals (Paired t-test , t= 0.62, df=14, P=0.73).

DISCUSSION

Condylactis gigantea does not appear to be strongly affected by competition with macroalgae for substrate space, at least in the short term. After 14 h, we found no difference in movement between *C. gigantea* placed on bare vs. macroalgal covered substrate. Our experimental design may have affected these results, as we had to move algae aside initially to allow pedal disk reattachment. Therefore, even the *C. gigantea* in the algae were attached to bare substrate under the algal mat. It may also be possible that habitat preference occurs over a longer time period.

Evidence from our shading experiment suggests that active habitat selection by *C. gigantea* may be better measured on a time scale of days rather than hours. The anemones actively chose favorable (sunlit) habitats, as 100% of the ten experimentally shaded individuals showed movement toward sunlight after 3 days. However, after 1 day, there was virtually no evidence for such movement. Thus, it would appear that if algae generate deep shade in the field, anemones may attempt to relocate.

The effects of algal cover on *C. gigantea* movement is still unclear. While all individuals in the algae treatment moved toward the sunlight, only one of them appeared to move across the algal substrate, whereas the

other four climbed up above the algae onto the shade structure. While *C. gigantea* may be able to move through substrate with a heavy algal mat, it appears as though they prefer bare substrate for movement.

We found that substrate adjacent to the anemone in the backreef had significantly less algal cover than paired anemone-free sites in similar microhabitats. It is unclear, however, whether the anemones are actively choosing more bare substrate, or somehow modifying the area immediately surrounding them. Bak and Barsboom (1984) showed that certain filamentous algal species were inhibited from establishing on slides painted with extracts from *C. gigantea* tentacles, although this effect was not demonstrated on any ecological level. *C. gigantea* has been shown to destroy coral tissue (Sebens 1976), but it has never been demonstrated, to our knowledge, that they can have similar effects on macroalgae in nature.

If only certain algal species are able to colonize the area around *C. gigantea* , then *C. gigantea* may be able to modify the algal communities in its immediate vicinities. On average, we found significantly fewer species surrounding anemones than in equal-area control samples. This may be due to the lower algal cover around anemones, so a richness measure standardized by algal biomass rather than area may be necessary to make species richness comparisons. We found the same total number of species (16) around anemones and controls, which indicates that *C. gigantea* may not exclude most macroalgae on the reef.

There was no obvious evidence that algal species occurring around anemones had a higher frequency of morphological characteristics (e.g., high calcification) that could decrease susceptibility to potentially antagonistic behavior from *C. gigantea*. However, the fleshy *Cladophoropsis* sp. occurred more frequently away from the anemones than adjacent to it, suggesting it may be susceptible to *C. gigantea* tentacular toxins. A manipulative experiment is needed to determine the degree to which anemones can affect adjacent algal species.

The *T. testudinum* implant experiment showed that there was no decrease in herbivory around anemones providing some support that the lower percent algal cover around *C. gigantea* may be due to an effect of this anemone on the surrounding algal community. We had predicted that stinging nematocysts in *C. gigantea* tentacles would potentially keep herbivores away, yet herbivory was equal in both treatments. If algae are important competitors for space, it would be disadvantageous to the anemone to protect the algae. Bites recorded were from parrotfish or urchins, which may be large enough to be unaffected by the stinging nematocysts. Micrograzers may be more affected by the presence of anemones.

In general, it would appear that *C. gigantea* may move in response to changes in microhabitat quality. Since algae are important spatial competitors on the reef, anemones may need to relocate or employ more aggressive strategies to maintain the algae-free areas we observed around *C. gigantea* in the field.

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