WEAR SUNSCREEN: DIFFERENCES IN COVERING BEHAVIOR AND COVERING MATERIAL PREFERENCE IN *LYTECHINUS VARIEGATUS* AND *TRIPNEUSTES VENTRICOSUS*

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Abstract: Two sea urchin species, *Tripneustes ventricosus* and *Lytechinus variegatus*, dominate the turtle grass (*Thalassia testudinum)* beds and coral rubble areas of the west back reef at Discovery Bay, Jamaica. Both species of sea urchin cover their aboral surface with materials from their habitat (such as turtle grass and coral rubble), and must invest energy to collect and hold this covering material. Based on preliminary field observations, we hypothesized that *L. variegatus* would cover more of its aboral surface and with heavier materials than *T. ventricosus*, and that immediate habitat type would also affect covering material preference. To test this, we observed differences in covering behavior of individual sea urchins in the field in each of three habitats: turtle grass beds, coral reef, and mixed. We also presented individuals with an equal proportion of turtle grass and coral rubble in experimental tanks. We recorded the percent of aboral surface an individual covered and what proportion of the covered surface consisted of turtle grass versus coral rubble. Our results from observational and experimental data support the hypotheses that *L. variegatus* covers more and with heavier materials than *T. ventricosus*, and that habitat affects covering material preference for *L. variegatus.*

Key Words: Tripneustes ventricosus, Lytechinus variegatus, Thalassia testudinum, *covering behavior, UV radiation*

INTRODUCTION

Sea urchins play an important role in maintaining coral reef ecosystems by grazing algae on the substratum, thus enabling coral colony establishment (Aronson and Precht 2000). This is especially important in Discovery Bay, Jamaica, where hurricane disturbance destroyed much of the coral reef, and created open habitat for algal growth (Woodley et al. 1981). Discovery Bay's back reef features two species of sea urchin, *Lytechinus variegatus* and *Tripneustes ventricosus,* that occupy habitat consisting of both turtle grass (*Thalassia testudinum)* and coral rubble.

Both urchins exhibit a covering behavior, in which they cover their aboral surface with materials from their habitat such as turtle grass, macroalgae, shells, and coral rubble. Preliminary observations suggested that *L. variegatus* and *T. ventricosus* differed in the total amount of aboral surface covered, and that the materials that both species used as covering differed across habitats. In general, *L. variegatus* tended to cover more and used mostly coral rubble (dead coral fragments and shells) to cover while *T. ventricosus* tended to cover less and used mostly turtle grass. Additionally, availability of covering material seemed to affect what each urchin used. We investigated whether these differences in covering behavior were related to species or habitat, using both field observations and laboratory experiments.

Based on our preliminary observations, we expected that *L. variegatus*

would cover a greater percent of its aboral surface than *T. ventricosus*, regardless of habitat. We also expected that *L. variegatus* would use coral rubble to cover more often while *T. ventricosus* would use turtle grass. Similarly, in experiments where each urchin species was presented with an equal mixture of turtle grass and coral rubble, we expected *L. variegatus* to cover more and to preferentially choose coral rubble to cover. We expected *T. ventricosus* to cover less and to preferentially choose turtle grass to cover.

Alternatively, covering behavior may be primarily related to habitat, in which case urchins would cover more with the dominant habitat material. Urchins presented with an equal mixture of turtle grass and coral rubble should therefore display no preference in covering materials. However, if covering behavior is related to original habitat, urchins should cover more with whatever material dominated their original habitat.

METHODS

On the afternoon of 22 February 2006, we observed 144 sea urchins in the west back reef in Discovery Bay, Jamaica across a range of depths between 1 and 3 m. We haphazardly selected 24 sea urchins of each species in each of 3 habitats: 1) mostly (>70%) turtle grass, 2) 50:50 turtle grass and coral rubble, and 3) mostly (>70%) coral rubble. We recorded the percent of aboral surface covered, and what percent of covering materials consisted of turtle grass or coral rubble.

On the morning of 22 February 2006, we collected six *L. variegatus* individuals and six *T. ventricosus* individuals for lab manipulations from each of three habitat types: 1) mostly turtle grass (>70%), 2) 50:50 turtle grass and coral rubble, and 3) mostly coral rubble (>70%), from the west back reef. From 10:30 to 14:30 on 23 February 2006, we observed the covering behavior of each urchin in outdoor tanks (24 x 36 x 64 cm) with running seawater, in direct sunlight. Each tank had a sandy bottom (~1 cm deep), and contained the same covering material: 30 blades of turtle grass, (~15 x 1.5 cm^2 per blade) collected from turtle grass beds in the west back reef, and 30 pieces of coral rubble (rubble and shells ~2-3 cm diameter) collected from the aboral surface of sea urchins during data collection in the west back reef. Incident light intensity was similar across trials (1075 - 1584 $\mu mol\ s^{-1}\ m^{-2}$) and water temperatures varied between 28.5 and 30.0°C.

We placed a single sea urchin into the middle of the tank and recorded the percent of aboral surface covered and the percent of covering material consisting of turtle grass or coral rubble after 15 minutes. We tested the light-blocking capacity of grass versus coral rubble by placing each covering material over the light meter to see how much light was blocked.

We analyzed the effects of species and habitat on percent aboral surface covered and percent turtle grass making up the total covering material using two-way ANOVA. We ran each of these tests on both our experimental and observational data. We arcsine-transformed our proportion data to meet homogeneity of variance assumptions and used JMP 5.0.1 for all analyses.

RESULTS

Observational and experimental data showed similar trends. *L. variegatus* had a higher total percent aboral surface cover than *T. ventricosus* (Fig. 1, Table 1). Habitat did not affect total percent cover for either species. *T. ventricosus* used turtle grass for more of its total covering material than *L. variegatus* (observational: $F_{1,138} = 36.13$, $P < 0.0001$; experimental: $F_{1,30} = 5.39$, $P = 0.03$). Only *L. variegatus* displayed a difference in percent turtle grass cover of the total covering material across habitat, covering with the highest percentage of turtle grass in the mostly turtle grass habitat, and the lowest percentage of turtle grass in the mostly coral rubble habitat (observational: $F_{2,138} = 5.86$, $P < 0.01$; experimental: $F_{2,30} = 3.46$, $P = 0.04$). When used as a covering material *T. testudinum* blocked 82% of ambient light, while coral rubble (rocks and shells) blocked 99% of ambient light.

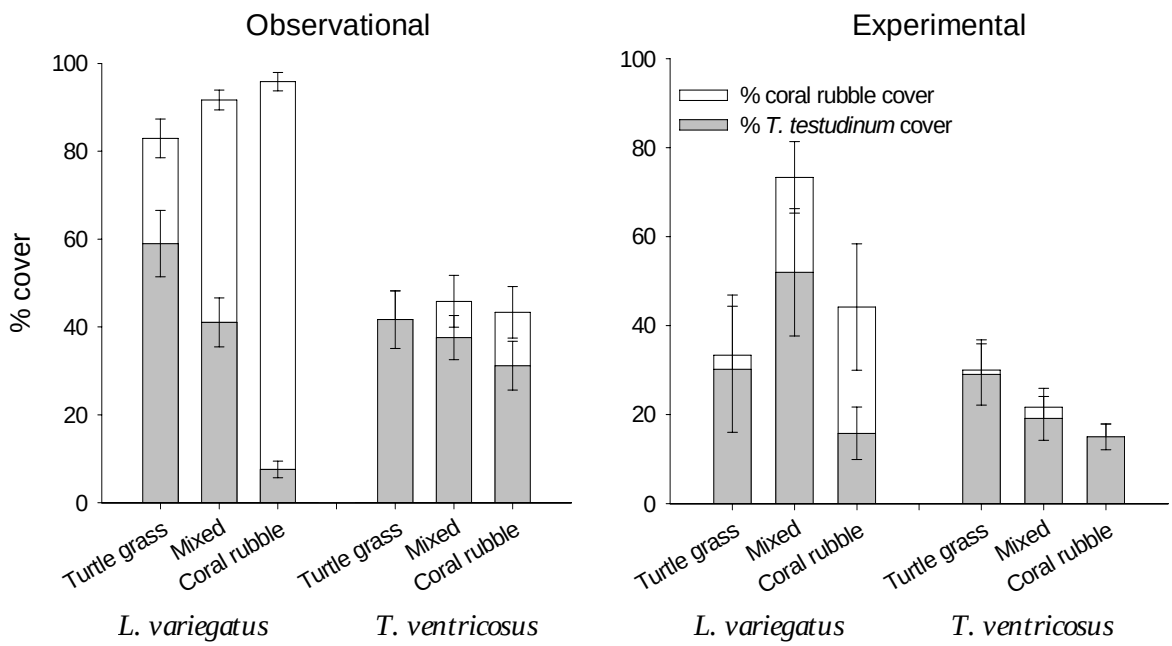

Fig. 1. Covering behavior of *T. ventricosus* and *L. variegates* across three habitats (mostly turtle grass, mostly coral rubble, and 50:50 turtle grass and coral rubble), based on observational and experimental studies (in tanks with equal amounts of turtle grass and coral rubble) at Discovery Bay Marine Lab, Jamaica. Total bar height represents total percent cover of aboral surface (mean ± SE). Stacked bars (mean ± SE) represent percent of total cover made up of turtle grass (gray) and percent of total cover made up of shells (white). See Table 1 for statistical analysis.

Table 1. Observational and experimental data: ANOVA showing the relationships between habitat and percent total covering, and habitat and percent turtle grass covering, for two species of sea urchin at Discovery Bay, Jamaica.

	Percent Total Covering			Percent Grass Covering		
Observational	DF	F	P	DF	F	P
Species	1, 30	10.02	0.004	1, 30	5.39	0.03
Habitat	2, 30	1.82	0.18	2, 30	0.38	0.69
Species * Habitat	2, 30	1.74	0.19	2, 30	3.46	0.04
Experimental	DF	F	P	DF	F	P
Species	1, 138	132.63	<0.0001	1, 138	36.13	<0.0001
Habitat	2, 138	1.60	0.2	2, 138	15.16	<0.0001
Species * Habitat	2, 138	1.14	0.32	2, 138	5.86	0.004

DISCUSSION

L. variegatus covered more than *T. ventricosus* and used coral rubble more than turtle grass, demonstrating that covering behavior depends on species. Species' covering material preferences may be related to urchin pigmentation and the ability of covering materials to block light. Lees and Carter (1972) demonstrated that UV radiation can cause mortality in *Lytechinus anamesus.* Kehas et al. (2004) demonstrated that sea urchins with less pigmentation cover more in response to UV radiation. Because *L. variegatus* is lighter colored and appears less pigmented than *T. ventricosus*, its covering behavior (heavier materials and greater percent covered) may indicate greater susceptibility to UV radiation.

Holding covering materials to the aboral surface requires energy, and may also reduce sea urchin respiration by reducing the number of aboral podia available for gas exchange (Kehas et al. 2004). Urchins often drop their covering material at night and cover less in low light intensities (Kehas et al 2004; Millott 1955), so the benefit of increased cover must outweigh these costs.

Coral rubble blocked more light than turtle grass. For *L. variegatus,* the benefits of extra UV protection may outweigh the combined costs of holding coral rubble: decreased respiration and increased energetic demand. If *T. ventricosus* is less susceptible to UV radiation, it may preferentially cover with turtle grass because it incurs a lower energetic cost. An experiment testing each species' relative susceptibility to UV radiation would effectively test this hypothesis.

Although sea urchin species had the greatest effect on covering behavior, *L. variegatus* covering behavior in the experiment corresponded with its original habitat. This may be due to a behavioral acclimatization to original habitat. We also observed in the field that *L. variegatus* covering behavior corresponded to the covering materials available in its immediate habitat. This suggests that the costs and benefits of covering with certain materials change according to habitat. *L. variegatus'* costs of searching for heavy coral rubble in a turtle grass bed may outweigh the benefits of increased protection. Investigating the costs of searching for covering materials and relative benefits offered by each material would test this hypothesis.

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