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SHORT COMMUNICATION

USE OF *DIADEMA ANTILLARUM* SPINES BY JUVENILE FISH AND MYSID SHRIMP

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Introduction

The long-spined sea urchin (*Diadema antillarum* Phillipi) is an important element in the structure and function of coral reef communities. Regarded as a key herbivore in reef communities, grazing by *D. antillarum* shifts community dominance from macroalgal cover to live coral (Lessios 2005, Tuya et al. 2004). *Diadema antillarum* is primarily found in shallow coral reef and seagrass environments but can reside in a wide variety of habitats (Lessios 1998). This animal generally remains in sheltered areas during the day and moves to grazing sites during the evening. Its activities can create grazing halos around reefs (Ogden et al. 1973). Additionally, urchins represent potential biogenic structure and refugia for fish and invertebrates.

The availability of shelter influences the survivorship and recruitment of juvenile reef fishes (Shulman 1985). Structurally complex habitats allow prey to escape predation as they utilize small spaces for refuge (Caley and St. John 1996). Literature suggests that the urchin spines represent a complex three-dimensional structure in which small fish can evade predators. Consequently, the utilization of urchin spines as a structural habitat has been shown to increase survival of juvenile fish (Hartney and Grorud 2002). Studies have also noted that swarms of mysid shrimp (*Mysidium* sp.) associate with *D. antillarum* as a source of protection against fish predation (Twining et al. 2000). Additionally, urchin size may affect how frequently fish use this complex biogenic habitat (Hartney and Grorud 2002). Some fish have been shown to associate with urchins which possess spines that are proportionate to fish body size (Lissner 1978), and *D. antillarum* have the unique ability to regulate body size in response to resource availability (Levitan 1988, 1989). Therefore, exploration of how urchin test size correlates with the presence of juvenile fish and invertebrates may be important for assessing the urchin-fish/invertebrate relationship.

This research has the following objectives: 1) identify the size structure of *D. antillarum* among 3 coastal bays of St. John, United States Virgin Islands and 2) determine relationships between urchin presence and spine utilization by fish and mysid shrimp.

Study Site

Field studies were conducted at 3 coastal bays in St. John, United States Virgin Islands including: Hurricane Hole, a fringing mangrove and seagrass community; Greater Lameshur Bay, a predominantly hard substrate-coral reef community; and Little Lameshur Bay, a hard substrate-coral reef community interspersed with seagrass and unvegetated habitats.

Methods

To assess how *D. antillarum* size influenced fish and invertebrate presence, urchins were counted and measured and associated mysids and fish were recorded in 2 surveys. First, 410 *D. antillarum* were counted and test diameter was measured and classified into size categories (0–30 mm, 30–60 mm, 60–70 mm, 90–20 mm, 120–150 mm, > 150 mm). Data were recorded in the field, and all measurements were taken on individual days at each site to eliminate the possibility of measuring the same urchin twice. Urchin size-frequency data were analyzed using a non-parametric Kruskal Wallis Rank Analysis to determine whether urchin size differences existed among sites. When present, samples of fish were collected using a slurp gun, then enumerated and identified to species. An additional 628 urchins were surveyed in Little Lameshur Bay to determine the utilization of *D. antillarum* spines by mysids and fish. Fish and mysid presence was then tabulated to propose utilization of spines as refuge/biogenic habitat. In some cases, surveys did not identify certain fish species during sampling *a priori*, therefore they were not included within tabulated results.

Results and Discussion

The *D. antillarum* size-frequency distributions found in Greater Lameshur and Hurricane Hole indicate a relatively normal size distribution, with a modal test diameter

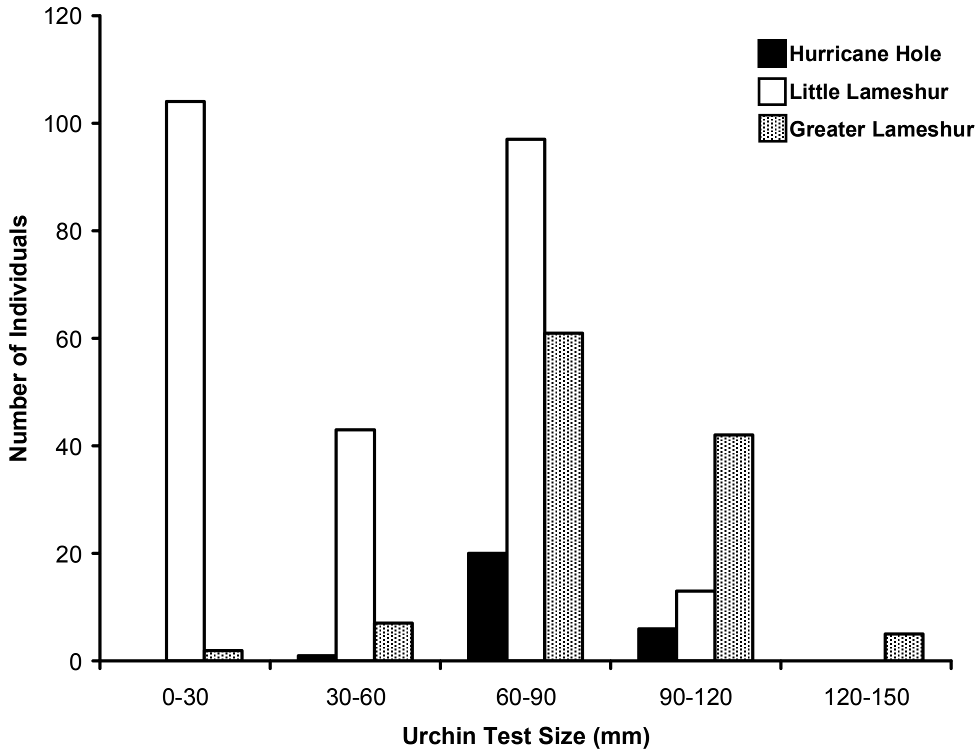

Figure 1. *Diadema antillarum* size frequency distribution. Bars represent total number of urchins within each test diameter size class (mm) at each of the 3 study sites.

within the 60–90 mm size class (Figure 1). The Little Lameshur site differed, however, with a mode at 0–30 mm, which may reflect the presence of recently recruited juveniles and a different year class present in the samples. This disparity resulted in a significant difference in mean test size (H = 151, $P < 0.001$) between Greater Lameshur (sample mean = 85.5 mm) and Hurricane Hole (80.5 mm) compared to Little Lameshur (47.2 mm). Additionally, the largest size classes of urchins occurred only at Greater Lameshur (Figure 1).

Our exploration of the *Mysidium* sp. and *D. antillarum* association suggests that urchin test diameter influences mysid presence. Whereas swarms occurred over groups of smaller urchins, they were only observed over individual urchins in the 90–120 mm size class. *Mysidium* sp. swarms were found over urchins at all sites, with frequencies of occurrence of 3.8% at Hurricane Hole, 6.8% at Greater Lameshur, and 2.8% at Little Lameshur (Table 1). *Mysidium* sp. is known to occur in swarms just off the bottom of the sea floor near structurally complex, three-dimensional substrata, including *D. antillarum* (Hahn and Itzkowitz 1986). In a previous study on the homing behavior of *M. gracile*, it was found that mysids swarm at given sites during the day and disperse during the night. It was suggested that mysid shrimp use some type of homing behavior to re-coalesce into discrete schools after nocturnal dispersal (Twining et al. 2000).

The most abundant fish associated with sea urchin spines was *Haemulon flavolineatum* (French grunt). This species was only collected from urchins of a test size > 60–90 mm and only in Little Lameshur Bay (Table 1). This does not mean that they were not present in the other

Table 1

Mysid shrimp and fish utilization of *Diadema antillarum* spines. (NA = not assessed during specific site survey).

Sites	*Diadema antillarum* (*N*)	*Mysidium* sp. Schools	*Haemulon flavolineatu* Schools (mean#/school)	*Canthigaster rostrata*	*Pareques acuminatus*
Hurricane Hole	26	1	0	0	0
Greater Lameshur	117	8	0	NA	0
Little Lameshur East	628	17	NA	10	0
Little Lameshur West	259	8	9 (11.2)	NA	1

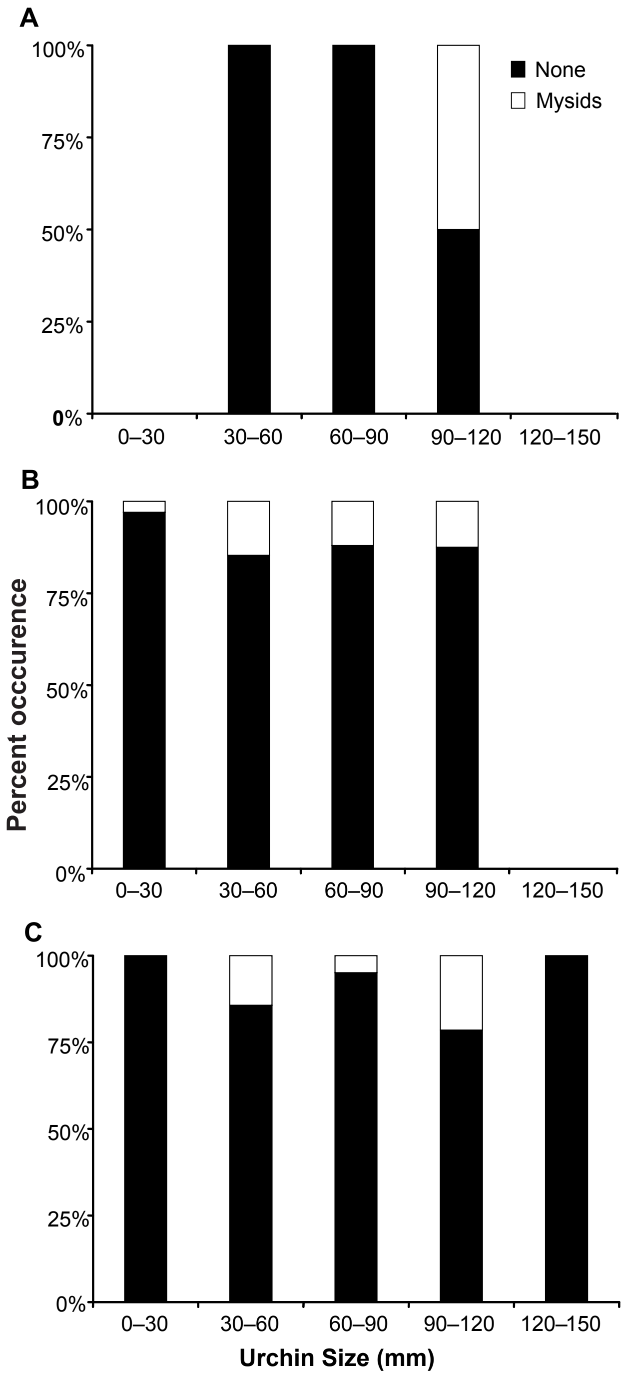

Figure 2. ***Mysidium*** **sp. utilization of** ***Diadema antillarum*** **spines. Bars represent percent frequency of occurrence of mysids among spines of urchins in each size class. A) Hurricane Hole. B) Little Lameshur. C) Greater Lameshur.**

bays, but rather that our survey did not identify utilization of *D. antillarum* in these bays. McFarland and Kotchian (1982) showed that *H. flavolineatum* commonly forms mixed schools with mysid shrimp (genus *Mysidium*). The schooling behavior of these different organisms into large complexes may relate to the morphological similarities that grunts have with mysid shrimp. The postulated benefits for the fish include protection (at smaller sizes) and use of mysids as food (at larger sizes).

In addition to *H. flavolineatum*, we observed 2 other species that have not been previously recorded from *D. antillarum* spines. We observed and collected *Canthigaster rostrata* (sharpnose puffer) from within the spines of urchins in Little Lameshur Bay (Table 1). The puffers were observed and collected deep within the spines of urchin groups comprised of 3–6 individuals (observation Bologna and Townsend). Previous studies of *C. rostrata* in St. Thomas, USVI indicate that this species is significantly more abundant where predators are more abundant, in comparison to other prey species (Shulman 1985). Sharpnose puffers are toxic and may survive in predator rich areas because they are not potential prey for piscivores (Hixon and Beets 1993). *Canthigaster rostrata* is, however, preyed upon by some bony fish, including *Sphyraena barracuda* (Randal 1967), which was frequently observed in Little Lameshur Bay (Bologna observation). Therefore, it is possible that juvenile sharpnose puffers utilize urchin spines as refuge from predators, enabling this species to co-exist in these reef communities. A *Pareques acuminatus* (high-hat) was also observed and collected from deep within the spines of *D. antillarum.* This fish was very cryptic, and its body form and pigmentation resembled urchin spines. Although we only collected one *P. acuminatus*, we believe that its presence and its cryptic appearance among the urchin spines may suggest Batesian mimicry between *P. acuminatus* and *D. antillarum*.

Through our research, we were able to identify 3 types of juvenile fish within urchin spines, as well as determine that urchin test size plays a role in juvenile fish/mysid shrimp utilization. Future investigations of the association between *H. flavolineatum*, *C. rostrata*, and *D. antillarum* are necessary to understand the relationship between these juvenile fish and urchins. Additionally, further studies with *P. acuminatus* need to be pursued in order to determine whether our observation was a random occurrence or if this species uses crypsis and mimicry of urchin spines as a predation refuge during early juvenile stages.

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