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Infaunal communities of the sponge *Aplysina fistularis*

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Abstract: The yellow tube sponge, *Aplysina fistularis* , is an important shelter, substrate, and food source for many micro- and macroscopic marine organisms. We tested the hypothesis that the communities this sponge species harbors vary with depth. We counted small invertebrates from sponges collected at 35 and 60 ft (11 and 18 m), and found that invertebrate density did not change with depth. We also surveyed the macrofaunal composition of these sponges at shallow and deep depths. In accordance with our predictions, gobies and brittle stars were more abundant on sponges at shallow depths. Sponges with more gobies and more brittle stars had significantly larger atrium volumes. Gobies and brittle stars were more frequently observed within the atrium than on the outer surface of the sponge. We conclude that *A. fistularis* harbors a complex community of micro- and macrofauna, which create a unique system that is affected by both the depth and the physical attributes of the sponge.

Key Words: brittle stars, depth effects, gobies, polychaetes, yellow tube sponge

INTRODUCTION

Sponges play an important role in coral reef ecosystems by providing both food and shelter to a wide variety of micro- and macrofauna (Westinga and Hoetjes 1981). Many species use sponges as refugia while others derive energy either from direct consumption of the sponge or from particulate organic matter being filtered through the sponge. A variety of polychaetes and crustaceans live within the sponge canals. Macroscopic organisms such as fish and echinoderms inhabit sponge atria and cling to the exterior sponge surfaces.

Several previous studies have looked at the relationship between infaunal communities and their sponge hosts, specifically in the loggerhead sponge (*Spheciospongia vesparia*) and the pineapple sponge (*Ircina strobilina:* Pearse 1932, Hoetjes et al. 1976, Campbell and Lovette 1990). They examined the correlation between the infaunal community structure, sponge size and sponge depth, with varying results. Pearse (1932) and Westinga and Hoetjes (1981) found that the abundance of infauna increased with depth, while Hoetjes et al. (1976) and Uebelacker (1977) argued that there was no relationship between these two factors. The disparity indicates that this subject warrants further investigation.

The yellow tube sponge, *Aplysina fistularis*, is a common and conspicuous member of Caribbean coral reef communities. In our study, we characterized the micro- and macro-infaunal communities of the yellow tube sponge. We hypothesized that the communities associated with this sponge vary with depth. We predicted that microfaunal and macrofaunal communities would have more individuals at shallower depths where more particulate organic matter is available (Westinga and Hoetjes 1981). Additionally, we predicted that there would be more macrofauna in larger sponges because they provide better refugia. Within the sponges, we observed the location and size of the macro-organisms. Specifically we examined the location of gobies (*Gobiosoma* spp.) and brittle stars in (*Ophiothrix suensonii*), as well as size of brittle stars on, host sponges. We predicted that gobies and brittle stars would be found more often on the inside of sponges, utilizing the atria as refugia. We also predicted that larger brittle stars would be found in larger sponges because large atria provide more refugia and have greater flow rates.

METHODS

Microfauna: On 5 March 2003 we collected six yellow tube sponges from

Dairy Bull dive site, Discovery Bay, Jamaica, W. I. Three sponges were taken from each of two depths — 35 ft and 60 ft. Each sponge was cut off at the base and collected in a plastic bag along with seawater to prevent loss of microfauna. In the laboratory, we preserved the microfauna found in each sponge. We first filtered the seawater from the plastic bag through a 211 mm screen. The sponge was then rinsed with a solution of half fresh water, and half 95% EtOh. We cut each sponge vertically in half with a razor, and measured the osculum height and width. The sponges were then cut into 2 cm segments and left to fix for 3 hrs in ethanol solution. We then filtered the solution, rinsed the sponges with fresh water, and filtered a second time. We calculated sponge volume by displacement (ml) in a beaker. The sponges were then placed in the sun to dry for 24 hrs and then placed in a drying oven for 24 hrs at approximately 60 degrees Celsius to get dry weight measurements. We examined the infauna of the six samples under a dissecting microscope. All invertebrates were classified by order. We examined differences between number of individuals per ml of sponge at the different depths using student's t-tests for all taxa, as well as for total individuals.

Macrofauna: On the mornings of 6 – 10 March 2003 we surveyed *Aplysina fistularis* at five dive sites in Discovery Bay, Jamaica W. I. The sites, in chronological order, were Caricomp, Mooring 1, East Forereef, Dancing Lady and Dairy Bull. We conducted two surveys following a compass bearing at each site, one at shallow depths (30 – 40 ft) and one at a deeper depth (45 – 65 ft). Each survey was approximately 40 minutes long. Large ranges in depth were due to different depth gradients and different sites. We measured the height and osculum width of each atrium of each yellow tube sponge encountered. We counted each atrium as a separate sponge, or replicate. We also recorded the number of brittle stars

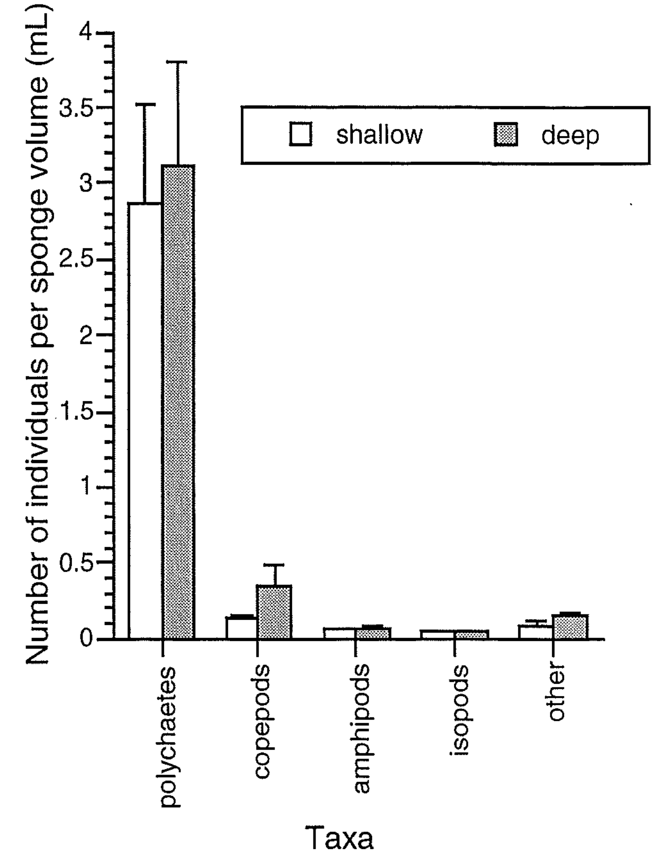

FIG. 1. Number of individuals of various taxa per unit sponge volume (mL; mean ± SE) at Discovery Bay, Jamaica.

and gobies in or on each sponge, the location of each individual (inside the atrium or on the outer surface) and estimated the size of each brittle star as the diameter across, including the arms. We classified brittle star size as small (approximately < 5.0 cm), medium (5.0 – 10.0 cm) and large (> 10.0 cm).

We analyzed the affects of depth, location, and the interaction of depth and location, on sponge size using one- and 2-way ANOVA, on number of brittle stars using Kruskal-Wallis Rank sums test (because number of brittle stars was not normally distributed) and on number of gobies using a student's t-test. To test if sponges with a greater number of brittle stars and gobies had a larger atrium volume we used the non-parametric Kruskal-Wallis Rank Sums test because the volumes were not normally distributed. To determine if larger

brittle stars were located on sponges with larger atrium volumes we used ANOVA. We used a Chi-square test to find where brittle stars and gobies preferred to reside (inside or outside the sponge). To determine if sponges with a brittle star outside were more likely to have one inside, we used a Chi-square test. We used a G-test to examine if the size of a brittle star was related to its location on the inside or the outside of the sponge.

Results

Microfauna: We found no significant differences between the density of microfaunal inhabitants of sponges at 35 ft and 60 ft (11 and 18 m; $t = -0.86$, $df = 4$, $P = 0.44$). The density of individuals for all taxa, as well as the number of taxa, were not different between depths (Table 1; Fig. 1). Polychaetes were the dominant taxa in all sponges surveyed, but copepods, amphipods, isopods and several other orders were also observed (Table 1).

Macrofauna: We found a higher density of gobies and brittle stars on yellow tube sponges at shallower depths (Fig. 2; $t = -1.74$, $df = 234$, $P = 0.08$ for gobies; Kruskal-Wallis, $c^2 = 6.48$, $df = 1$, $P = 0.01$ for brittle stars).

We found an average of approximately one goby per sponge. However, the

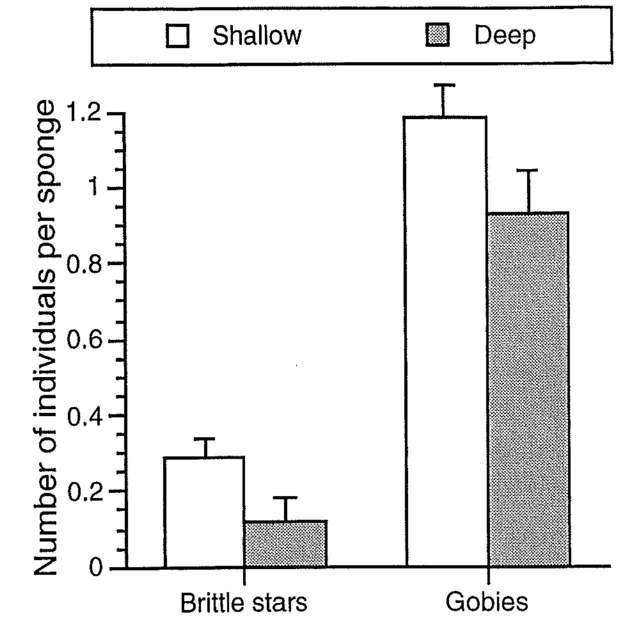

FIG. 2. Number of individuals of brittle stars and gobies (mean ± SE) on the yellow tube sponge at shallow (30 - 40 ft) and deep (45 - 65 ft) depths at five sites at Discovery Bay, Jamaica.

density of brittle stars on the sponges was < 0.25 (Table 2). Sponges with more gobies had significantly larger atrium volumes (Fig. 4; Kruskal-Wallis; $\chi^2 = 49.70$, $df = 6$, $P < 0.0001$). Similarly, sponges with more brittle stars had significantly larger atrium volumes (Fig. 4; $F = 2.66$, $df = 2, 50$, $P < 0.08$). We also found that sponges with larger brittle stars had significantly larger atrium volumes (Figs. 3, 4; Kruskal-Wallis, $\chi^2 = 11.53$, $df = 4$, $P = 0.02$).

We found that there were more gobies and brittle stars located in the atrium

TABLE 1. The volume and number of individuals from various infaunal taxa found in sponges collected at 35 and 60 feet at Dairy Bull, Discovery Bay Marine Laboratory, Jamaica.

Sponge	Depth (ft)	Volume (ml)	Total infauna	Polychaetes	Copepods	Amphipods	Other
1	35	280	529	459	33	22	15
2	35	330	1158	1059	59	13	27
3	35	150	612	567	14	11	21
Mean ± SE	35	253 ± 53.6	766 ± 197	695 ± 184	35 ± 13	15 ± 3	23 ± 2
4	60	170	773	725	16	4	27
5	60	130	344	248	70	6	21
6	60	150	580	480	63	15	22
Mean ± SE	60	150 ± 11.5	565 ± 124	484 ± 137	49 ± 16	8 ± 3	21 ± 3

TABLE 2. Percent of sponges with various numbers of macrofaunal inhabitants. 0 = the percent of sponges without any brittle stars/gobies, 1 = the percent of sponges with one brittle star / goby, ≥ 2 = the percent of sponges with two or more brittle stars / gobies, and Mean = mean number of brittle stars and gobies per sponge sampled at Discovery Bay, Jamaica.

	0	1	2	Mean	± SE
Brittle stars	81.5	15.5	3.0	0.24	0.04
Gobies	28.2	52.1	19.7	1.07	0.07

than the outer surface of the sponge (χ^2 = 25.20, df = 1, P = 0.001 for gobies; χ^2 = 8.38, df = 1, P < 0.01 for brittle stars). When we looked at sponges with brittle stars on the outside, we found that there was not a greater tendency for there to be brittle stars on the inside (χ^2 = 2.98, df = 1, P > 0.05). Finally, brittle star size was not related to location on the sponge (χ^2 = 0.19, df = 2, 55, P = 0.91).

DISCUSSION

Microfauna: Depth was not a significant driver of microfaunal abundance. It is possible that the 25 ft (7.5 m) depth difference or the small sample size was not enough to reflect differences in microfaunal community structure. Alternatively, while the amount of suspended organic matter at shallow depths might positively influence microfaunal abundance, this effect could be negated by the impact of increased wave action. Previous studies have found that shallow sponges exposed to heavy wave action are more dense, contain more spicules, and have more tightly constricted canals than sponges experiencing less stress from wave action (Palumbi 1984, 1986). We propose that these shallow sponges provide less habitable space per unit mass for invertebrates. Therefore, even if there is more particulate organic matter in shallow waters that could provide more nutrients for suspension feeding invertebrates, microfauna cannot increase in abundance because space is limiting.

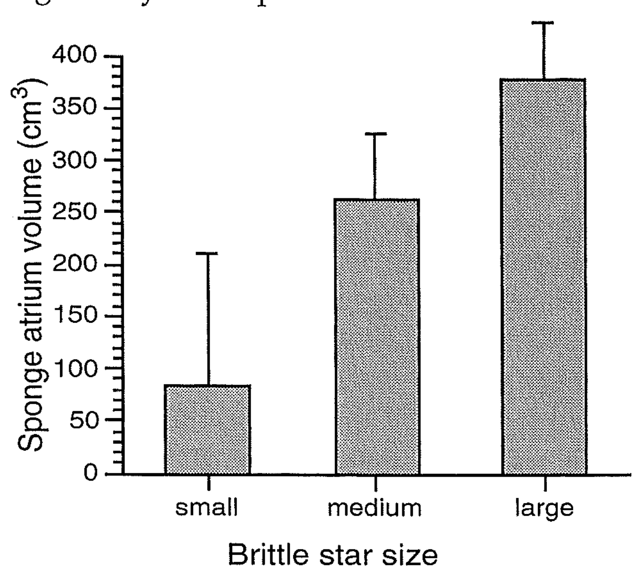

FIG. 3. Brittle star size by sponge atrium volume (cm^3; mean ± SE) for five sites in Discovery Bay, Jamaica.

Polychaete worms dominated the fauna in the sponges we collected at both depths. Campbell and Lovette (1990) found an unidentified parasitic polychaete worm in high densities inhabiting the *Ircina strobilina* they sampled from 35 ft (11 m). The polychaetes we found in our samples may be the same or a closely related species and may rely on the sponge for both sustenance and substrate. The obligate nature of these polychaetes may explain their abundance in comparison to the other, facultative taxa found in the sponges we sampled.

Macrofauna: Depth was an important factor affecting the abundance of macrofauna in yellow tube sponges. As predicted, we found significantly more macrofauna at shallower depths. Gobies and brittle stars may benefit from inhabiting sponges at shallow depths where there is increased productivity.

Sponge size was also an important factor determining the abundance of sponge macrofauna. We found more gobies and more brittle stars in larger sponges. Large sponges have deeper atria, which may

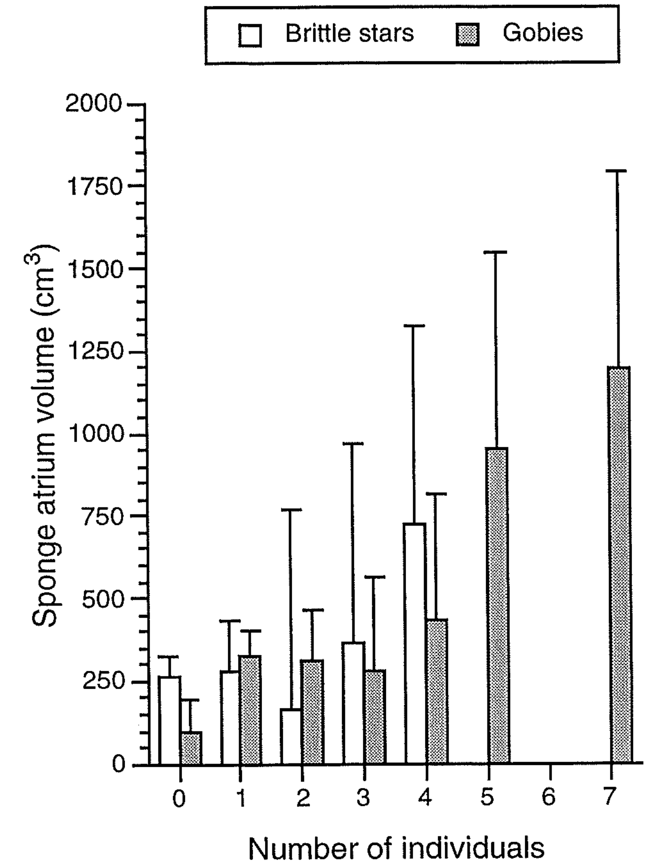

FIG. 4. Number (mean ± SE) of brittle stars and gobies by sponge atrium volume (cm^3) at five sites in Discovery Bay, Jamaica.

provide more spatial refugia for more individuals. Additionally, the increased flow of water through larger sponges may result in higher food availability for brittle stars.

When gobies and brittle stars were found in sponges, they were most frequently found inside the atria. Macrofauna may preferentially choose the inside of sponges because it provides better daytime refuge from predators. When we examined the behavior of brittle stars specifically, we found that when there was a brittle star on the outside of the sponge, it was no more likely that there would be a brittle star in the atrium, suggesting there may be advantages to being on the outside of the sponge. Also, we found no evidence of large brittle stars excluding smaller brittle stars from the sponge atrium. Because of the low density of brittle stars in yellow tube sponges, there may not be competition for space.

A. fistularis harbors a complex community of micro- and macrofauna. Our findings suggest that these organisms create a unique system that is affected by both the depth and the physical attributes of the sponge.

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