CORAL PREFERENCE, DISPERSION PATTERNS, AND COLORATION PATTERNS OF THE CHRISTMAS TREE WORM, *SPIROBRANCHUS GIGANTEUS*

SARAH E. KOPPLIN, CHRISTIE D. R. JACKSON, AND STASIA A. BEMBENEK

Abstract. Dispersion patterns, substrate preference, and color phenotype frequency were examined in the polychaete worm *Spirobranchus giganteus* at Discovery Bay, Jamaica. The dispersion of the worms was clumped on *Monstastrea annularis* and *Porites astreoides*,. *S. giganteus* preferred *Montastrea* spp. corals as a substrate over any other corals present (*P. astreoides*, *Agaricia agaricites*, *Porites porites*, *Diplora* spp., *Eusmilia fastigiata*, and *Siderastrea siderea*). Additionally, tan-colored worms were the most frequently found color on all coral types colonized by *S. giganteus*. Thus, the settlement habbits of these worms seems to be dependent on coral types available and is non-random.

Key words: S. giganteus, P. astreoides, A. agaricites, P. porites, Diplora *spp.*, E. fastigiata, M.annularis, S. siderea, *substrate preference, dispersion, coral reefs*

INTRODUCTION

Spirobranchus giganteus is a tropical, calcareous-tube dwelling, serpulid polychaete that lives as an obligate associate of live coral. These sessile organisms are easily noticed on coral heads throughout the Caribbean, for they extend radioles of a myriad of different colors in a spiraling "Christmas tree."

S. giganteus is a dioecious polychaete, which sheds its gametes into the water column for reproduction and dispersal. Upon larval settlement, *S. giganteus* secretes a calcareous tube on the coral surface and initiates a mutualistic relationship with the coral: the coral provides support and protection from space competitors, and the worm enhances water circulation, aids the subsequent arrival of food particles to coral polyps, and protects polyps near the tube from predators (Hunte et al. 1990a).

Personal observations suggested that *S. giganteus* exists in a clustered community among coral heads in the fore reef of Discovery Bay, Jamaica. *S. giganteus* larval preference for coral substrates is a major cause of its non-random distribution on corals (Marsden et al. 1990b). Among those species of coral preferred for colonization are: *Montastrea annularis*, *Porites astreoides*, *Agaricia agaricites*, and *Porites porites*.

We wanted to clarify the relationship between *S. giganteus* and corals by looking at substrate preference and dispersion patterns. We hypothesized that S. *giganteus* would prefer particular coral species as substrate. Although preference has been studied at Discovery Bay (Damien 1978), we questioned whether major hurricanes in 1980 and 1988 may have altered *S. giganteus* preference due to disturbed reef composition and differential coral survivorship. We predicted that boulder-type corals would be most abundant because of their ability to withstand extreme surge. Subsequently, we predicted that worms would prefer these corals because of their ability to withstand and facilitate currents necessary for worm survival.

Preliminary observations revealed interesting dispersal patterns. While passing through the reef, we noticed that most of the worms were clumped on various coral heads. We therefore hypothesized that spatial distribution within the community would be clumped as opposed to overdispersed or random.

Worm morphology, in particular radiole color patterns, may have an interesting correspondence to the colonization of different coral types. We hypothesized that a dominant color pattern would colonize a specific coral type. If the worms do have a clumped distribution, then perhaps selection for clumps of particular color morphs is most advantageous. We specifically predicted that if a tan coral type was most prevalent in the reef, worms with tan radiole patterns would be the most dominant throughout the worm population. Assuming that the worms are palatable and predation is a risk, this dominant color pattern would presumably be the least conspicuous to potential predators, probably fish.

METHODS

Observations of *S. giganteus* were made at Mooring 1 (M1) on the west fore reef of Discovery Bay, Jamaica from 1-8 March 1996. Waters and Smith (1987) found highest densities of worms at 18 m; thus, we completed eight dives (19.8 SCUBA hours) along buttresses at a depth of 18 m $\pm$ 2 m.

To accurately measure S. giganteus abundance and distribution and coral composition, we haphazardly selected transects of 120 m^2 (4 m x 30 m) on buttresses around M1. Each transect was surveyed by three divers (40 m^2 each), and the following data were recorded: number of coral heads, coral species, number of worms per coral head, number of patches of worms per coral head (patch => 1 worms within 10 cm^2), color pattern of worm, and planar dimensions (length x width) of coral head in cm. Although most corals are not flat, we used the planar measures to estimate percent coral cover.

To determine if worms preferred certain corals, we calculated their expected distribution on each coral species from the number of worms observed and the percent cover of each coral species. We then compared this distribution with the observed distribution using a X^2 test. To determine if the dispersion pattern of the worms on their preferred coral substrates was clumped, random, or overdispersed, we compared their observed distribution with that expected from a Poisson distribution. Poisson frequencies for all size categories of corals were grouped together for a X^2 analysis. We compared the distribution of worm color morphs on different coral species with a G-test of independence.

RESULTS

Live coral surface area was 134.58 m^2, representing 15.3% cover over 880 m^2 of transects (Table 1). Seven coral species were observed and occurred in most of the transects: *Montastrea*, *Porites astreoides*, *Agaricia agaricites*, *Porites porites*, *Diplora* sp.,*Eusmilia fastigiata*, and *Siderastrea siderea*. However, the amount of surface area coral covered varied greatly among species: *Monastrea* was 38 times more abundant than *E. fastigiata*.

The highest worm density was present on *Montastrea* (Table 1). Although the mean density on *Montastrea* was 2.5 worms / m^2, dispersion between coral heads was not even: only 40% of the Montastrea coral heads were colonized. Only 22% of *P. asteoides*, 6.5% of *A. agaricites*, and 10.5% of *P. porites* were colonized.

Montastrea accounted for more than half of the worms; *P. astreoides*, *A. agaricites*, and *P. pontes* were colonized to a lesser degree, and *Diplora* spp., *S. siderea*, and *E. fastigiata* had no worms (Table 1). *S. giganteus* colonized Montastrea more than expected based on percent cover, but all other coral except *P. astreoides* were colonized less than would be expected (G = 57.23. df = 6, P<0.005).

In total, 642 corals were sampled with a range of 0 to 27 worms per coral head (Table 2). The Poisson analysis for *Monstastrea* and *P. asteoides* worm abundance per coral head showed that between expected and observed values there was a significance for each coral type (former, X^2 = 33.8, df = 3, P < 0.001) (latter, X^2 = 238.68, df = 3, P < 0.001). Only these two species analyzed for dispersion patterns due to the low colonization on *A. agaricites* and *P. porites*.

Analysis of color variation showed that 51.7% of *S. giganteus* were tan for all four colonized coral species (Table 3). The frequency of color morphs varied significantly among coral heads (G = 24.49, df = 24, P<0.05; Table 3).

DISCUSSION

Though coral cover at Discovery Bay decreased from 51% in 1981 (Woodley et al. 1981) to 15.3% in 1996, it appeared that the 1980 and 1988 hurricanes reinforced the dominance of *Montastrea* on Discovery Bay reefs. *Spirobranchus giganteus* showed a strong preference for *Montastrea* and *Porites astreoides*, and three of seven coral species were never colonized by *S. giganteus*. The *Montastrea* may be able to withstand destructive hurricanes which destroy more fragile branching corals; thereby acting as a substrate source when other fragile coral species have been destroyed.

S. giganteus may prefer *Montastrea* over *Porites porites* because *P. porites* lives only 4 - 5 years, while *Montastrea* may live 20 years under normal circumstances (Hunte et al. 1990c). A worm's life span, however, is limited by the life of the coral (Hunte et al. 1990c). A longer coral life may lead to higher potential *S. giganteus* longevity and fitness because worms can live only as long as the coral.

S. giganteus not only settled on particular coral species, but aggregated on coral mounds within a coral species. The clumped distribution of worms could have resulted from pre-colonization influences, and/or from differential mortality following settlement. A patchy distribution of *S. giganteus* larvae in the water column could have caused clumped colonization. The dispersion pattern may also have been the consequence of conspecific attraction which would further enhance reproductive success.

Table 1. Summary of *Spirobranchus giganteus* for most common coral species at M1 dive site in Discovery Bay, Jamaica

Coral Type	Surface Area (m^2)	% of Total Coral Cover	# of Coral Heads w/ Worms	# Worms	Worm Density on Live Corals (# worms / m^2)
Montastrea	76.9	57.2	85	190	2.5
P. asteoides	16.9	12.5	17	34	2.0
A.agaricites	10.4	7.8	10	10	1.0
P. porites	18.8	14.0	8	8	0.4
Diplora	3.5	2.6	0	0	0.0
S. siderea	6.5	4.7	0	0	0.0
E. fastigiata	1.8	1.3	0	0	0.0
Totals	134.58	100	120	242	1.8

Table 2. Dispersion of *Spirobranchus giganteus* among all coral heads.

Worms / Coral Head	# of Coral Heads
0	567
1	42
2	16
3-4	8
5-6	3
7-8	3
9-11	2
>20	1

are actively selecting against *S. giganteus* individuals whose colors differ most from their coral substrate. We also observed that coral heads tended to have similar color morphs. This suggested a color selection at settlement that was perhaps influenced by adult chemical cues. More likely, larvae may be attracted by chemical cues of adults of the same phenotype.

Future studies could compare survival of *S. giganteus* sizes across color morphs. Larger worms may be older worms that have escaped predation. If predators are exerting selection pressure on color morphs, we may expect the tan *S. giganteus* to be larger than aposematic worms. If color is found to be genetically

Table 3. Spirobranchus giganteus color variations among four coral species at MI dive site, Discovery Bay, Jamaica. Percent of color is for each individual coral species. (x) = number of worms with that coloration for each coral species. (n = 242)

Coral Type	Percent of each color on each coral species					
	Tan	Yellow or Orange	Brown or Black	Black and White	Pink	Maroon or Purple
Montastrea	48.4 (92)	4.7 (9)	9.5 (18)	7.9 (15)	13.7 (26)	15.8 (30)
P. asteoides	73.5 (25)	2.9 (1)	3.9 (2)	8.8 (3)	8.8 (3)	0.0 (0)
A.agaricites	50.0 (4)	0.0 (0)	0.0 (0)	37.5 (3)	0.0 (0)	12.5 (1)
P. porites	40.0 (4)	10.0 (1)	10.0 (1)	0.0 (0)	10.0 (1)	20.0 (2)
Totals	51.7	4.5	8.7	8.7	12.4	13.7

The *S. giganteus* population consisted of several coral morphs, yet the majority of individuals on all coral types were tan-colored. The mechanism behind this prevalence is indeterminate. Tan was the most cryptic of the color morphs. It may be that predators and / or environmentally determined through experimental larval settlement manipulations, much of what determines color morph distribution may be resolved.

It is interesting that the predators of *S. giganteus* are not known. Though the *S. giganteus* predators are

most likely fish, there are no observations or studies supporting this theory (Hunte et al. 1990c). A study examining the possible predators would further our understanding of the ecology of *S. giganteus*.

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