Coral preference of the polychaete Spirobranchus giganteus in the Belize Barrier Reef

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INTRODUCTION

On coral reefs, there are numerous symbiotic relationships among reef organisms (Goldberg 2013). Many of these symbioses are commensalisms, in which one participant (the commensal) benefits while the other participant (the host) is unaffected. However, there are some instances of reef commensalisms in which the host inadvertently benefits (Glynn and Nochs 2011). For example, xanthid crabs that carry coral fragments as protection can potentially help these fragments become established in different areas (Lamberts and Garth 1977). Spirobranchus giganteus (the Christmas tree worm) is a polychaete that commonly burrows in corals in what is likely a commensalistic relationship (Gibbs 1969). The polychaete may offer benefits to the coral host, such as greater water circulation from filter-feeding and nutrients from its waste (Ben-Tzvi et al. 2006). Further, coral colonies in the immediate vicinity of the polychaete may be protected from coral-feeding fish, facilitating coral colony regrowth after heavy predation (DeVantier et al. 1986). This polychaete-coral relationship occurs in only certain species of coral, because of the settlement preferences of the polychaete larvae (Marsden 1987).

The Christmas tree worm reproduces by mass spawning. Larvae are not sessile like adults and swim until they find a suitable coral colony for settlement (Qian 1999). In a laboratory preference study, Marsden (1987) demonstrated larval settlement preference on the coral species Acropora prolifera. Populations of the genus Acropora have been severely reduced in the Belize Barrier Reef over the last 30 years because of extreme weather and disease (Aronson et al. 2002). A field study of coral preference performed in Barbados (Conlin 1988) determined that the coral genus Diplora was the most preferred by S. giganteus. Hunte et al. (1990) demonstrated that S. giganteus individuals thrive and grow larger on Diplora when compared to other coral substrates.

Goldberg (2013) hypothesized that S. giganteus host preference may vary within large geographical areas. In addition, coral preference by S. giganteus could result from preference of larvae for a particular coral substrate color. Little is known about the abundance of S. giganteus color morphs, but investigations on color morph spatial patterns in other genera of polychaetes have been published. Crisp and Ekaratne (1984) noted that the distribution of Pomatoceros triqueter color morphs was correlated with latitudinal gradients, but found no spatial pattern in P. lamarckii. Rankin (1946) determined that the distribution of color morphs in Clymenella torquata was related to environmental conditions, with flesh-colored individuals associated with sandy substrates and green individuals associated with muddy areas.

The purpose of this study was two-fold. We investigated (1) whether S. giganteus prefers a specific coral host in the Belize Barrier Reef (the second largest barrier reef system in the world), thus testing Goldberg’s (2013) hypothesis that geographic variations exist in host preference behavior of this polychaete. The Conlin (1988) study in Barbados was used for comparison. In addition, we investigated (2) whether S. giganteus color morphs are associated with coral preference.

METHODS

Data was collected from two patch reefs: Whale Shoals (16° 46’ 39.39”N 88° 06’ 53.41”W) and Long Reef (16° 46’ 43.78”N, 88° 04’ 44.09”W), in May 2013 along the Belize Barrier Reef south of Carrie Bow Cay. To assess coral composition, six 10 m length transects
were placed parallel and at regular intervals within a 100 by 100 m study area at each site. We identified all mounding corals to the level of genus including Diplora, Porites, and Montastraea. Five 0.5 by 0.5 m quadrats were placed at 1.5 m intervals along each transect. In each quadrat, an estimate was made of the percent composition of each genus. To determine S. giganteus settling patterns, an investigator searched the study area in each site by moving at a constant pace along parallel transects. We searched for S. giganteus individuals for the duration of 40 min at each site. For each individual, we recorded the color of the stalk of the worm’s branchial crown and coral substrate on which it was found. Color was classified as red, white, or yellow (Fig. 1).

To calculate the expected number of S. giganteus per coral species, the total number of worms found for each site was multiplied by the percent cover of each coral species. Chi-squared tests were used to test for patterns of substrate preference and for color morph association with coral genera.

RESULTS

In both sites, S. giganteus preferred Diplora to the genera Porites and Montastraea (Fig. 2). At Whale Shoals, despite making up a small percentage of the overall coral cover (7.7%), Diplora hosted a significantly higher ($\chi^2 = 150.29, \text{df} = 2, p < 0.0001$) percentage of S. giganteus. Porites, even though it was the most abundant coral (80.5% of coral cover), hosted a significantly lower percentage ($\chi^2 = 12.12, \text{df} = 2, p = 0.0023$) of S. giganteus. The number of S. giganteus found on Montastraea was insufficient for proper analysis, despite having a similar percent coral cover (11.9%) to Diplora. The S. giganteus individuals exhibited similar preferences in Long Reef; the majority of the coral composition was Porites (77.9%), but fewer than predicted S. giganteus were observed on the coral ($\chi^2 = 9.75, \text{df} = 2, p = 0.0076$). Diplora made up slightly more of the coral composition at Long Reef (18.2%), and more worms than expected were observed there ($\chi^2 = 50.01, \text{df} = 2, p < 0.0001$).

In both sites, red was the dominant color morph, regardless of coral substrate (Fig. 3). The two study sites showed different trends in S. giganteus color morph in relation to coral genus distributions. In Whale Shoals, there was no significant color morph association with coral genus. In Long Reef, there was a significant positive color association between Diplora and red color morphs ($\chi^2 = 10.01, \text{df} = 2, p = 0.0067$) (Fig. 1), and a significant negative association between Diplora and yellow color morphs ($\chi^2 = 9.33, \text{df} = 2, p = 0.0094$).
Figure 2. Percent coral composition and percent *S. giganteus* individuals found on coral substrate at Whale Shoals (A) and Long Reef (B)

A. Significantly fewer *S. giganteus* were found on *Porites* and significantly more *S. giganteus* on *Diplora* at Whale Shoals. The number of *S. giganteus* found on *Montastraea* was insufficient for proper analysis. B. The *S. giganteus* individuals exhibited similar preferences in Long Reef; *Porites* made up the majority of the coral composition, but more worms were found on *Diplora*.
Figure 3. Percentage of color morphs per coral genus at Whale Shoals and Long Reef

A. Data from Whale Shoals shows a random distribution of color morphs on *Porites*, but non-random trends on *Diplora* for yellow and red color morphs. B. Long Reef had a slightly different distribution, with significant negative association with yellow and positive association with red morphs. The white color morph displayed no significant association in either site. We did not observe *S. giganteus* on *Montastrea* coral on Long Reef.
DISCUSSION

*S. giganteus* were most frequently found on corals in the genus *Diplora*. This settlement preference for *Diplora* in the Belize Barrier Reef matches a similar pattern found by Conlin (1988) in Barbados and therefore does not support the Goldberg (2013) hypothesis that there is likely to be geographical variation in substrate preference. *Diplora* made up a small percentage of the overall coral composition, yet settlement rates were significantly higher than on *Porites* or *Montastraea*, so it is evident that *S. giganteus* were not randomly distributed among corals. The non-random distribution may be a result of larval preference or differential mortality (Conlin 1988). Data regarding settlement on *Montastraea* was inconclusive due to the rarity of the coral at the two study sites. The limited *S. giganteus* settlement could be related to the depth at which the coral is found within the study site (Conlin 1988).

Although there were site-specific associations between worm color and coral substrate, there were no significant overall trends between the two sites. The random distribution of color morphs may reflect density-independent pressure from predation and habitat constraints. Previous studies in the Red Sea have shown that a wide variety and even distribution of different color morphs prevents predators from forming an association of *S. giganteus* with a certain color morph (Grassle 1973). Further, the Indo-Pacific region hosts a variety of *S. giganteus* colors not found in the Caribbean, such as blue, brown, and purple. The cause of these regional effects is unclear. Even in our small-scale study, the color morphs varied greatly between the two sites. Environmental stress and other abiotic factors, such as depth and temperature, may also contribute to varying color morph distribution (Etter 1988). Whether these factors relate to *S. giganteus* settlement preferences is an area of future research.

While our data and that of Conlin (1988) suggests *S. giganteus* preference is strongly linked with *Diplora* in the Caribbean basin, studies on the Great Barrier Reef (Marsden 1988) and in Taiwan (Dai and Yang 1995) demonstrated that *S. giganteus* is not solely dependent on one species of coral for survival. Many factors influence *S. giganteus* larval preference, including depth, prevalence of light, and percent coral cover (Marsden 1984). It is likely that the larval preference towards *Diplora* is due to the expansive size and surface area of *Diplora* colonies, as well as the relative depth of *Diplora* in the Belize Barrier Reef (Conlin 1988).

In reef ecosystems, mutualistic and commensalistic relationships among organisms are common (Goldberg 2013). This interdependence between species makes them vulnerable to the loss of either partner (Kohl et al. 2004). Corals are especially vulnerable to environmental threats such as acidification, bleaching, extreme weather, eutrophication, or disease. Each coral species has a different susceptibility to these threats (Burke and Maidens 2004). *Diplora* coral have been shown to be less susceptible to coral bleaching in the Caribbean as compared to species in other coral genera (van Hooidonk et al. 2012). Our results show a strong preference by *S. giganteus* towards *Diplora* as a coral substrate. If this commensalism is a result of the resilience of *Diplora* to environmental pressures, *S. giganteus* may be showing a preference towards coral types that are less susceptible to bleaching. However, if this preference is obligatory, a future decline in *Diplora* could cause a decline in *S. giganteus* abundance. Our study was located in the Caribbean region, which contains some of the most endangered reef systems in the world (Burke and Maidens 2004). In the two coral reefs we studied, we found a lower density of polychaete worms (fewer than five per square meter) than seen in previous studies of other systems (Conlin 1988).
Whether *S. giganteus* abundance is linked to coral decline is a question that is worthy of future study in the Caribbean region.

**LITERATURE CITED**


