# *SPIROBRANCHUS GIGANTEUS* CORAL MORPHOLOGY PREFERENCE

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*Abstract.* Past studies have found that *Spirobranchus giganteus*, the Christmas-tree worm, is more likely to be found on some coral species than others. We hypothesized that adult Christmas-tree worms are more likely to inhabit mound and knob shaped corals than corals of other morphotypes because this smooth contour shape may allow the worms to filter feed most efficiently. We compared percentages of worms found on different coral morphotypes to the percent of total coral cover contributed by each of these morphotypes at four sites to determine whether worms preferred some coral morphologies to others. Results showed that knob and blade shaped corals were more heavily colonized than all other morphotypes. Worms were associated with knob corals at deep depths, probably because these smooth contoured corals allow worms to filter feed efficiently in an environment where ambient flow is low. In contrast, worms were strongly associated with blade shaped corals at shallow depths, possibly because this morphotype provides worms with some shelter from drag in an environment where current velocities are high, but still allows them access to sufficient ambient flow to feed efficiently.

*Keywords*: Acropora palmata, *Christmas-tree worms, coral morphotypes,* Millepora *sp.*, Montastrea annularis

## INTRODUCTION

The Christmas-tree worm, *Spirobranchus giganteus* (Serpulidae), is found on coral heads all over the Caribbean at depths from 2 to 30m. These colorful polychaetes build calcareous tubes on living coral surfaces and extend their tubes as the coral polyps grow up the sides of the tubes (Hunte et al., 1990a). Worms circulate water through their two spiraled crowns of radioles to feed on filtered plankton. Since their radioles are so close together in compacted spirals. worms are forced to refilter water when there is no ambient current and thus can not feed as efficiently as other filter feeders. Therefore, these worms depend on sufficient ambient current to prevent inefficient feeding (Strathmann et al., 1984). Certain coral morphologies may allow worms to take full advantage of ambient currents while other morphologies may block flow to worms.

Past studies have found the distribution of Christmas-tree worms on different species of corals to be non-random. In the Barbados, *Diploria strigosa, Porites astereoides* and *Millepora complanata* harbored more worms than other species, and *Montastrea annularis* was moderately colonized (Hunte et al., 1990a). All of these "preferred" host coral species, except for *Millepora complanata* , share a common mound or knob shaped morphology. In contrast with the Barbados study, worms in Discovery Bay were more frequently associated with *M. annularis* than with any other species of coral (Damién, 1978). At that time, *M. annularis* was also the most prevalent coral on the reef at a 10 m depth, making up 82.4% of the coral cover at LTS (Damién, 1978., Bond, 1978). Since the Discovery Bay studies in 1978, two hurricanes have wrecked havoc on the reef and decimated coral populations. Because coral cover is probably much lower in abundance at present (Hughes, 1994), substrate may be limiting for worms and they may exhibit less preference for host coral species. We hypothesized that coral morphotype, rather than coral species, determines host suitability for adult Christmas-tree worms. We predicted that Christmas-tree worms would be found inhabiting mound and knob shaped corals more often because the smooth contour of these morphotypes should allow sufficient current flow for the worms to feed. We also predicted that distribution of worms across species of mound/knob shaped corals will vary with abundance of these corals at different sites and depths.





## METHODS

We surveyed the abundance of Christmas-tree worms on the west fore-reef of Discovery Bay, Jamaica on 6 to 10 March, 1998. We collected data at two sites, M1 and LTS, at depths of 2m, close to the fore-reef, and 10m, adjacent to the mooring. We completed two dives at each of the 10 m depths and one dive at the 2m LTS site. All other data collection at the shallow depths was done by snorkeling. In all, we compiled 10.4 scuba hours and 6 hours snorkeling.

To survey worm abundance, we performed four 10 min transects by swimming west in two parallel lanes for the first transect, moving 5 m north, and returning east in the same manner for the second transect. We then repeated this procedure east of the starting point to complete the third and fourth transects. For each worm seen, we recorded the species, color, and morphology of the coral where it was found, and the worm's size and color. We categorized sizes of worms as small (<5mm), medium (5-15mm), or large (>15mm). We classified corals into 8 morphotypes: mound, knob, blade, branching, encrusting, plate, fan, and spire (Humann, 1993).

To survey coral abundance, we completed nine 10 m transects using a string weighted down with bolts at both ends and marked off in 0.5 m increments. The transects were made at all four sites in areas near coral heads where worms had been surveyed. We recorded the species, morphotype and color of all corals touching the string, and the length of string contacting each coral. Proportion of species making up coral cover was calculated as total length of string contacting that species divided by total length of string contacting all coral.

For species of coral found at every depth and site, 2-way ANOVAs were used to find effects of site and depth on abundance of these species. Distribution of worms across coral species and morphotypes at all sites, as well as differences in worm size between depths were assessed using Chi-square statistics. The null hypotheses for between site and between depth comparisions were that proportions of coral morphologies and species did not differ between sites or depths. The null hypothesis for distribution of worms was that their disitribution on coral morphologies or species would not differ from the proportion of that species in coral cover at each site.

## RESULTS

We found a total of 553 Christmas-tree worms on 8 coral species at the four sites. Coral composition varied with depth. *Acropora palmata* was only found at 2m, *Millepora* sp. and *Sideastrea* sp. made up a higher percentage of the total coral coral cover at 2m than at 10m ($F_{1, 21}$= 9.73, $F_{1,8}$= 7.60; P= 0.005, 0.02 for *Millepora* sp. and *Sideastrea* sp. respectively), and *M. annularis* made up a higher percentage of the total coral cover at 10m than at 2m ($F_{1, 30}$= 6.44; P= 0.02). There was also an effect of site on abundance of *Sideastrea* sp. ($F_{1, 8}$= 10.80; P= 0.01).

Worms were distributed non-randomly with respect to coral morphology at three of the four sites ($\chi^2$= 260.74, 220.89, 207.25; P<0.001 for LTS 2m, LTS 10m, and M1 2m repsectively). Christmas tree worms settled primarily on corals with knob-shaped and blade morphotypes (Table 1). These "preferred" morphotypes differed with depth; blade morphotypes were most commonly colonized at 2m and blade and knob-shaped morphotypes were most commonly colonized at 10m depths.

Worms also were non-randomly distributed on coral species at three of the four sites ($\chi^2$=595.8, 211.19, 202.68, 12.49; P<0.001, P<0.001, P<0.001, P<0.1 for LTS 2m, LTS 10m, M1 2m, and m1 10m respectively). At 2 m depths, worms were most commonly found on *A. palmata* and *Millepora* spp. (Table 2: Figures 1a and 1c). At 10m depths, worms were most commonly found on *M. annularis, Millepora* spp., and non-coralline substrates (other) (Table 2: Figures 1b and 1d). Not all coral species found at the four sites were colonized by Christmas-tree worms and 7 coral species were not colonized at any site (Table 3).

Depth affected the crown sizes of worms ($\chi^2$=271.05, df=2, P<0.001 and $\chi^2$=180.0, df=2, p<0.001 at LTS and M1 respectively). Large worms were primarily found at 10m depths while small worms were usually found at 2m depths. There was also an effect of site on the distribution of differently sized worms ($\chi^2$=16.48, df=2, P<0.001 and $\chi^2$=6.00, df=2, p<0.001 at 2m and 10m depth respectively). Overall, there were more worms at the LTS site than at the M1 site.

Color pattern distributions of five predominant worm color patterns (black/white, black/yellow, rose, yellow, yellow/white) were similar across species of coral in three of the four

sites ($\chi^2$ = 10.64, 10.41, 8.30; df = 12; P = 0.56, 0.58, 0.76 for LTS 2m, LTS 10m, and M1 10m respectively). There were only two coral species with these color patterns at M1 2m, the site with significantly different color pattern distributions ($\chi^2$ = 8.77; df = 3; P = 0.03). Color pattern distributions between depths across both sites were similar as well ($\chi^2$ = 11.94, 12.80; df = 12; P = 0.45, 0.38 for 2m and 10m respectively).

TABLE 1. Compilation of morphotypes colonized markedly more than and less than expected.

| Site | Most Colonized Morphotypes | | Least Colonized Morphotypes | |
|---|---|---|---|---|
| | Morphotype | Partial Chi Square[a] (Obs/Exp)[b] | Morphotype | Partial Chi Square[a] (Obs/Exp)[b] |
| LTS 2m | Blade | 157.8 (2.51) | Mound | 35.2 (0.14) |
| | | | Knob shaped | 33.7 (0.03) |
| | | | Plate-like | 2.24 (0) |
| | | | Encrusting | 31.8 (0) |
| LTS 10m | Knob shaped | 163.25 (3.03) | Plate-like | 12.4 (0) |
| | Blade | 1.47 (1.82) | Spire | 7.7 (0) |
| | | | Encrusting | 6.7 (0) |
| M1 2m | Blade | 133.66 (2.76) | Mound | 42.12 (0.02) |
| | | | Knob shaped | 17.4 (0) |
| | | | Plate-like | 3.7 (0) |
| | | | Encrusting | 6.7 (0) |
| | | | Spire | 3.3 (0) |
| M1 10m | Knob shaped | 1.85 (1.27) | Fan | 0.8 (0) |
| | | | Blade | 0.4 (0) |
| | | | Plate-like | 2.2 (0) |
| | | | Spire | 0.8 (0) |
| | | | Encrusting | 0.4 (0) |

[a] Partial chi square represents contribution to total chi square value.
b Ratio of observed / expected > 1 indicates a morphotype colonized more than expected. A value of < 1 indicates a morphotype colonized less than expected.

TABLE 2. Compilation of coral spp. colonized markedly more than and less than expected.

| Site | Most Colonized Corals | | Least Colonized Corals | |
|---|---|---|---|---|
| | Spp. | Partial Chi Square[a] (Obs/Exp)[b] | Spp. | Partial Chi Square[a] (Obs/Exp)[b] |
| LTS 2m | *Acropora palmata* | 497.9 (6.41) | *Montestrea annularis* | 47.42 (0.02) |
| | *Millepora* spp. | 2.87 (1.24) | Other | 45.63 (0.11) |
| LTS 10m | *Montestrea annularis* | 79.13 (2.18) | *Agaricia agaricites* | 18.28 (0.13) |
| M1 2m | *Acropora palmata* | 52.07 (2.93) | *Porites astreoides* | 11.08 (0.08) |
| | *Millepora* spp. | 74.94 (2.48) | Other | 64.60 (0) |
| M1 10m | Other | 5.03 (2.28) | *Agaricia agaricites* | 3.68 (0.18) |
| | *Millepora* spp. | 1.07 (1.67) | | |
| | *Montestrea annularis* | 1.64 (1.24) | | |

[a] Partial chi square represents contribution to total chi square value.
b Ratio of observed / expected > 1 indicates a coral sp. colonized more than expected. A value of < 1 indicates a coral sp. colonized less than expected.





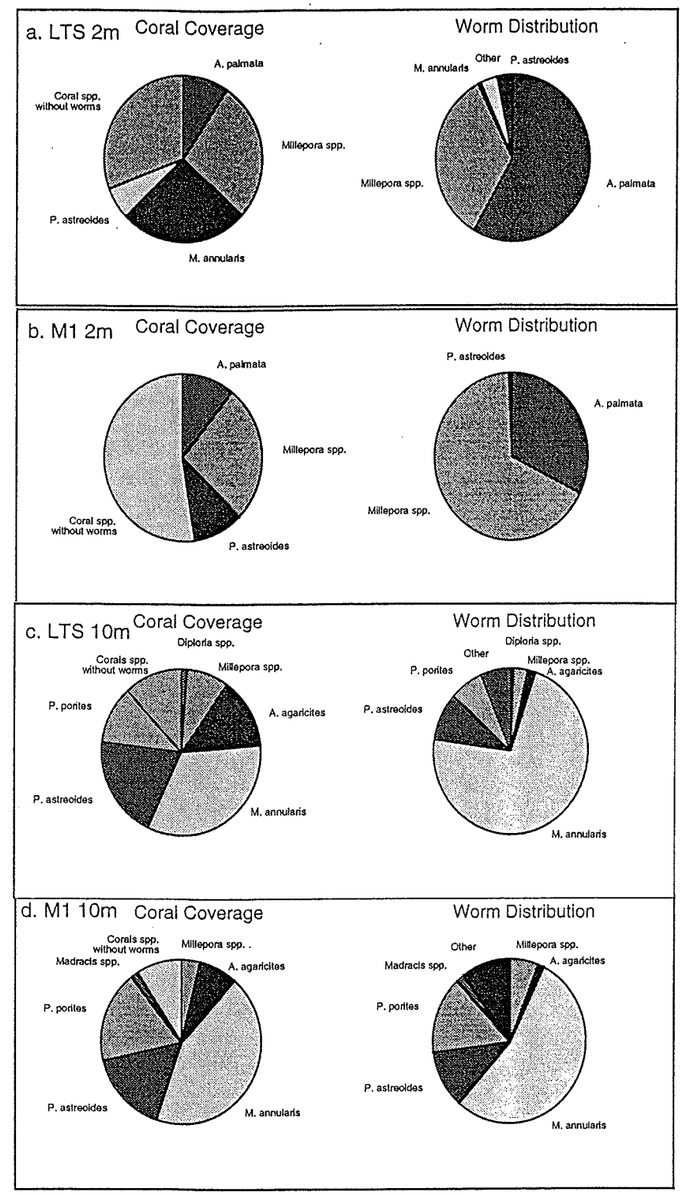


FIG. 1. Proportion of coral species with christmas-tree worms and proportion of them contributing to total coral cover.

TABLE 3. Coral spp. not colonized by *Spirobranchus giganteus*, and their abundance rank at each site.

| LTS 2m | Rank | LTS 10m | Rank | M1 2m | Rank | M1 10 | Rank |
|---|---|---|---|---|---|---|---|
| *Siderastrea* spp.* | 3 | *Siderastrea* spp.* | 6 | *Montastrea annularis* | 2 | *Diploria* spp. | 5 |
| *Diploria* spp. | 4 | *Dendrogyra cylindreus** | 7 | *Agaricia agaricites* | 3 | *Gorgonia ventalina** | 8 |
| *Madracis* spp. | 7 | *Meandrina meandrites** | 10 | *Diploria* spp. | 5 | *Dendrogyra cylindreus** | 8 |
| *Agaricia agaricites* | 8 | *Gorgonia ventalina** | 11 | *Porites porites* | 7 | *Siderastrea* spp.* | 10 |
| | | *Pseudoplexaura sp.** | 12 | *Porites astreoides* | 7 | *Acropora cervicornis** | 10 |
| | | | | *Dendrogyra cylindreus** | 9 | *Eusmilia fastigiata** | 12 |
| | | | | *Siderastrea* spp.* | 10 | *Meandrina meandrites** | 13 |

*Coral spp. not colonized at any site.

## DISCUSSION

Christmas-tree worms were most abundant on corals of two distinct morphotypes. At deep depths (10 m) knob corals were more heavily colonized by Christmas-tree worms than other coral morphotypes as we predicted. However, at shallow depths, blade morphotypes were most heavily colonized. We noticed that most promontories in the reef at 10m were formed of mound and knob corals and that worms were often found on these promontories. By inhabiting smooth knobs located above most of the other coral in the area, worms are exposing themselves to the highest ambient flow rates present at deep depths and thus probably minimizing refiltration (Strathmann, 1984). At 2m, current velocities are generally much higher than those at deeper depths and may bend tentacles too much for worms to filter feed effectively (Strathmann, 1984). This could explain why blade corals harbored worms at 2m depths. Since blade morphotypes are generally promontorial on the shallow fore-reef, they could provide some shelter from current velocities by dissipating wave energy through grouped vertical arrays of coral matter. By inhabiting blade corals at shallow depths, worms are still located high enough above the substrate to have access to ambient flow but also gain protection from drag. This theory is strengthened by the observation that worms at shallow depths were smaller overall than worms at deep depths. Short tentacles in worms at shallow depths may be an adaptation to deal with high flow because longer tentacles would be bent more at high current velocities and lead to inability to feed (Strathmann et al., 1984). Small crown size may allow worms to feed sufficiently at shallow depths, but not at deep depths. Therefore, if worms can control their tentacle length, worms would invest the mimimal amount of energy in their tentacles to obtain a sufficient amount of food. However, if tentacle size is genotypic, differential mortality may select for small worms at shallow depths and large worms at deep depths, because they are best suited to their respective environments.

*Acropora palmata, Millepora complanata,* and *Montastrea annularis* were the three coral species most heavily colonized by adult Christmas-tree worms. Although worms do not seem to exhibit as strong a preference for *M. annularis* as they did in 1978, it was still the most preferred coral species of the knob/mound morphotype. While these three preferred corals do not share the same morphotype, they have other common characteristics that may make them superior Christmas-tree worm hosts; All three have small polyps that may not extend up high enough to compete with worms for plankton, all three lack deep grooves that could inhibit worms from filter-feeding effectively, and all three tend to be found on promontories. Future studies should try to address the effects of these coral characteristics on Christmas-tree worm distribution.

Coral morphology seems to be more important than coral species in determining Christmas-tree worm host preference. We could not assess whether distribution of worms on coral species of the knob morphology varied with abundance of these species at different sites because at both deep sites, *M. annularis* was the most abundant knob-shaped coral and the coral most colonized by worms. At both shallow sites, *Millepora* was the most abundant of the preferred blade-shaped coral and the most colonized by worms at M1 2m. However, at LTS 2m, *A. palmata* was the coral most colonized by worms suggesting that worms at this site may prefer this species over others of the same morphology. If worm larvae settle on corals where adults are already present, as Hunte





suggested (Hunte et al., 1990b), a chance difference of adults found on *A. palmata* and *Millepora* sp. during a period of high larval abundance could have caused more larvae to settle on one, thus giving the illusion that this species is a more suitable Christmas-tree worm host .

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APPENDIX 1. Proportions for each coral species of total coral cover and proportions for worms found on each coral species of total number of Christmas-tree worms at the four sites (see Figure 1).

| LTS 2m | Coral | Worms | LTS 10m | Coral | Worms |
|---|---|---|---|---|---|
| *A. palmata* | 0.09 | 0.58 | *A. agaricites* | 0.14 | 0.02 |
| *M. annularis* | 0.26 | 0.01 | *Diploria* spp. | 0.01 | 0.01 |
| *Millepora* spp. | 0.28 | 0.34 | *M. annularis* | 0.33 | 0.72 |
| *P. astreoides* | 0.06 | 0.04 | *Millepora* spp. | 0.09 | 0.03 |
| other | | 0.03 | *P. atreoides* | 0.20 | 0.09 |
| without worms | 0.31 | | *P. porites* | 0.11 | 0.07 |
| | | | other | | 0.06 |
| | | | without worms | 0.12 | |
| **M1 2m** | **Coral** | **Worms** | **M1 10** | **Coral** | **Worms** |
| *A. palmata* | 0.11 | 0.32 | *A. agaricites* | 0.08 | 0.02 |
| *Millepora* spp. | 0.28 | 0.67 | *Madracis* spp. | 0.02 | 0.02 |
| *P. astreoides* | 0.10 | 0.01 | *M. annularis* | 0.43 | 0.54 |
| without worms | 0.51 | | *Millepora* spp. | 0.04 | 0.05 |
| | | | *P. astreoides* | 0.16 | 0.12 |
| | | | *P. porites* | 0.18 | 0.15 |
| | | | other | | 0.10 |
| | | | without worms | 0.09 | |

APPENDIX 2. All of the color patterns of Christmas-tree worms found at four study sites. Patterns are listed as tentacle color/ tip color. Symbols indicate that a color pattern appeared at one site only.

| Color Pattern | # | Color Pattern | # | Color Pattern | # |
|---|---|---|---|---|---|
| Black | 10 | Brown/Yellow | 1‡ | Red/White | 22 |
| Black/Green | 4* | Fuschia/White | 1† | Red/Yellow | 6 |
| Black/Green/Pink | 1* | Green | 1† | Rose | 20 |
| Black/Green/Red | 2* | Green/Pink | 4 | Rose/Black | 8** |
| Black/Green/White | 1* | Green/Purple | 1† | Rose/Purple | 1** |
| Black/Orange | 9 | Green/Red | 1† | Rose/White | 7 |
| Black/Orange/White | 1* | Green/White | 2* | Rose/Yellow | 1** |
| Black/Pink | 10 | Green/Yellow | 1† | White | 11 |
| Black/Pink/White | 5* | Marroon/White | 4 | White/Black | 7 |
| Black/Purple | 4 | Orange | 9 | White/Black/Pink | 1* |
| Black/Red/White | 1** | Orange/Black | 1** | White/Blue | 1** |
| Black/Red | 9 | Orange/Red | 1** | White/Green | 1* |
| Black/White | 73 | Orange/White | 8 | White/Orange | 7 |
| Black/White/Orange | 1* | Orange/Yellow | 3 | White/Pink | 7 |
| Black/White/Yellow | 1‡ | Pink | 6 | White/Purple | 4** |
| Black/Yellow | 75 | Pink/Black | 1* | White/Red | 5 |
| Black/Yellow/White | 14 | Pink/Blue | 1† | White/Yellow | 6** |
| Blue | 2 | Pink/White | 7 | Yellow | 44 |
| Blue/Black | 1 | Pink/Yellow | 2 | Yellow/Black | 7 |
| Blue/Pink | 12 | Purple | 15 | Yellow/Green | 3 |
| Blue/Purple | 2† | Purple/Pink | 5 | Yellow/Orange | 1‡ |
| Blue/White | 3 | Purple/White | 9 | Yellow/Pink | 3 |
| Blue/Yellow | 4† | Purple/Yellow | 4 | Yellow/Pink/White | 1† |
| Brown/Orange | 1‡ | Red | 3 | Yellow/Purple | 6 |
| Brown/Red | 1** | Red/Orange | 1† | Yellow/Red | 1** |
| Brown/White | 2 | Red/Purple | 2 | Yellow/White | 28 |

* LTS 2m; ** LTS 10m; † M1 2m; ‡ M1 10m