DIFFERENTIAL EFFECT OF DEPTH ON MICROHABITAT SELECTION IN POLYCHAETE TUBE WORMS

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Abstract: An appropriate microhabitat is particularly important to sessile filter-feeding organisms such as polychaete tube worms. Both Christmas tree and fanworms use cilia to filter water from the abfrontal to the frontal side of each radiole. Unlike the single layer of radioles posessed by fanworms, the radioles of Christmas tree worms are stacked in a spiral conformation and filter efficiently only when ambient current displaces water perpendicular to the axis of coiling and prevents re-filtration. Feeding efficiency in both species may be negatively affected by strong currents that could bend or damage their radioles. We hypothesized that polychaete worms are selecting microhabitats on substrata based on current velocity, which changes with depth and height from the benthos. We then examined the height distribution of Christmas tree worms and fan worms across depths at the west forereef of Discovery Bay, Jamaica and confirmed our prediction that relative height of Christmas tree worms would be positively related to depth, while relative height of fan worms be lower and would not change with depth. This suggests that larvae of Christmas tree worms may be able to control the height at which they settle on a coral surface, thereby maximizing their feeding efficiency.

Key Words: Christmas tree worm, fanworm, Spirobranchus giganteus

INTRODUCTION

Polychaete tube worms are common on the surface of rocks and live corals in the forereef at Discovery Bay, Jamaica. These filter feeders extend their radioles and use cilia to create a feeding current. Suspended particulate food is intercepted by the radioles and transported to the mouth. Most of these worms have one fan-like layer of radioles that take in water on their undersides and expel it above, separating incurrent from excurrent and thus preventing the inefficient re-filtration of water. The Christmas tree worm, *Spirobranchus giganteus*, is exceptional in that in still water, the stacked spiral arrangement of its radioles causes excurrent flow passing through proximal whorls to be taken up and re-filtered by distal whorls. Although it has a large filter area, it requires external current roughly perpendicular to its whorl of radioles to make full and efficient use of its feeding capacity (Strathman 1984).

The need for external current at least partially drives the distribution of *S. giganteus*, with Christmas tree worms most commonly found on corals in exposed areas with high current velocity (Waters and Smith 1987) and generally absent from depths below 24 m (Fouts and Woodson 1994). Excessive water movement may bend and compress the worms' spirals, however, reducing surface area and preventing efficient feeding (Strathman 1984). Christmas tree worm larvae should thus seek out sites with sufficient current to prevent re-filtration, but not so much current

as to interfere with the functioning of the filters.

As water velocity generally decreases with increasing depth (Waters and Smith 1987), we hypothesized that Christmas tree worms in deep water would be found at or near the exposed tops of coral masses, while at shallower depths they would be found further down the sides in locations more shielded from the surge and less exposed to potential predators. Fanworms, which do not require external current for efficient feeding, should at all depths be located lower down on non-living substrates where they are hidden from predators and shielded from disruptive currents. We thus predict a positive relationship between depth and relative height on corals for *S. giganteus*, while relative height of fanworms should not change with depth and should be lower on average than the mean relative height of Christmas tree worms.

METHODS

We sampled polychaete tube worms on the west fore reef of Discovery Bay, Jamaica from 2 - 9 March 2005. Using SCUBA, we sampled worms along north-south transects near the Caricom mooring at depths ranging from 20 to 2 m. We measured the depth at which each worm was found and recorded its type (Christmas tree or fan). We also measured height (cm) from the sea floor to the opening of the worm's tube, as well as the total height of the coral or substratum the worm was inhabiting. We used these two heights to calculate relative height (height of worm / height of substratum) of each worm. We sampled worms evenly across all depths. Relative height data were arcsine-transformed to meet the assumptions of normality and homogeneity of variance for parametric tests. For the two worm types, we analyzed the relationship between depth and relative height on coral using an indicator variables regression. The regression model was:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_1 X_2 + \varepsilon$$

where Y is the response variable (relative height), X_1 is depth, X_2 is a binary indicator variable that codes for worm type (christmas tree or fan), β_0 is the intercept, β_1 is the slope, β_2 is the change in intercept between worm types, and β_3 is the change in slope between worm types. Data were

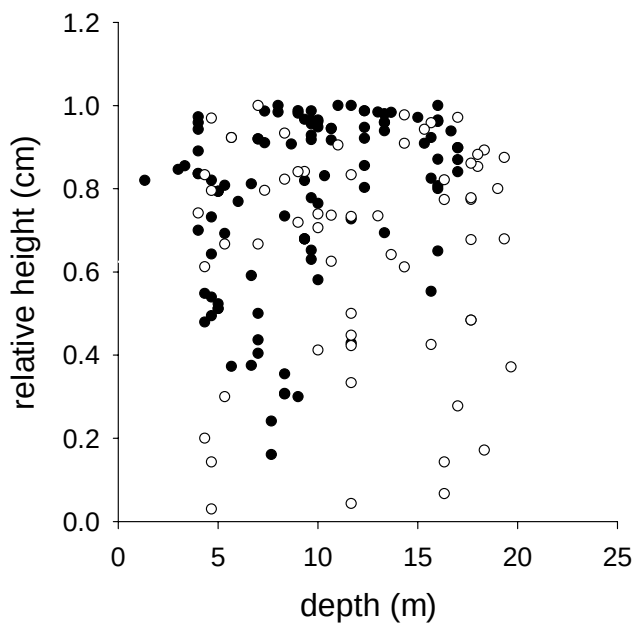

Figure. 1. Relative height on substratum of Christmas tree worms (closed circles) and fanworms (open circles) as a function of depth. For Christmas tree worms, there is a positive relationship between relative height and depth. The relative height of fan worms is independent of depth.

analyzed using JMP 5.0.1. All tests were performed on the transformed data.

RESULTS

As we expected, Christmas tree worms were always found on living coral and *Millepora*. Fanworms, however, were found on both living and non-living substrates. Variegated feather dusters (*Bispira variegata*) and yellow fanworms (*Notaulax occidentalis*) were only observed on non-living surfaces, while social feather dusters (*Bispira brunnea*) and star horseshoe worms (*Pomatostegus stellatus)* were most often found on live corals.

There was no relationship between water depth and the relative height on coral for fan worms ($Y = 0.001X + 0.745$; $r^2 < 0.00$, df = 1, 58, P for slope = 0.84, P for intercept < 0.01), but there was a positive relationship for Christmas tree worms ($Y = 0.010X + 0.705$; $r^2 = 0.12$, df = 1, 106, P for slope < 0.01, P for intercept < 0.01).

The rate at which relative height on substrata changed with depth (Fig. 1) was significantly different between fan worms and Christmas tree worms ($F = 5.04$, $P = 0.03$), and the y-intercept of the regression between depth and relative height was higher for fanworms than for Christmas tree worms ($F = 17.80$, $P < 0.01$).

DISCUSSION

As we predicted, relative height of *Spirobranchus giganteus* on coral masses increases with depth. In deep water, these polychaetes were found predominantly on promontories of knobby coral, where their spiraled radioles have maximum access to the relatively slow currents. As the water became shallower and currents became stronger, Christmas tree worms were found more frequently in sheltered areas lower on the sides of corals where they are less likely to be flattened by the surge. We informally observed there to be no *S. giganteus* in the back reef or lagoon, likely due to excessive surge and high sedimentation. Additionally, none were found deeper than 20 m, where water velocity probably is too slow for efficient filtration. Fanworms were most often found low on the sides of corals at all depths, avoiding areas of high water velocity and possibly decreasing their exposure to predation.

We found a number of exceptions to these general patterns of distribution in both Christmas tree and fanworms. Although most *S. giganteus* observed in shallow water occurred in relatively low positions, some occurred near the tops of coral formations where one would expect that their filter feeding would be continuously disrupted by high surge. These worms had much smaller filters than their low-current counterparts, however, and were found on bladelike pieces of *Millepora* coral that may act as a shield against moving water (Fierce and Campbell 2004). In deeper water, certain fanworms were observed growing on top of promontories in contrast to their apparent preference for protected areas. These sabellid fanworms, most likely *Bispira brunnea*, occur in clusters and are known to prefer areas with some water movement (Humann 1992). The clustering

of these worms could result in the overlap of their radiole crowns and lead to re-filtration, which may cause them to choose microhabitats similar to those preferred by *S. giganteus*. Additionally, the close proximity of other worms may help to reduce the disruptive impact of current on each individual.

S. giganteus is a broadcast spawner whose larvae swim in the plankton for 9 - 12 days before settling down to a sessile life on the surface of a live coral (Hunte et al. 1990). In the lab, these larvae exhibit an active preference for the coral species on which they most commonly occur (Hunte et al. 1990), suggesting that they select the coral substrate on which conditions for growth are likely to be best. Studies have also shown that *S. giganteus* larvae select corals with different morphologies at different depths, possibly due to the varying hydrodynamic properties of these corals (Dickenson and Douzinas 1998). Our results suggest that, in addition to differentiating between coral types and morphologies, larvae may be able to control the height at which they settle on the coral surface, therefore maximizing their feeding efficiency. Alternatively, it is possible that larvae settle on all areas of an appropriate coral surface and the ones that establish themselves in unfavorable positions simply die before reaching maturity. Further study is required to determine the nature and sensitivity of the mechanisms that generate the patterns of distribution and abundance for *S. giganteus*.

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