SPATIAL PARTITIONING OF *RHIZOPHORA MANGLE* ROOTS BY SESSILE EPIBIONT COMMUNITIES IN WALSINGHAM POND

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Abstract The epibiont communities living on submerged Red Mangrove (*Rhizophora mangle*) roots were analyzed for spatial differentiation by depth. Eight genera of epibionts, including four common Metazoans and four common algae, were measured using video quadrats. Average depth and zonal depth (depth as a percentage of total root depth) were considered as environmental variables. Significant differences were found in the depth, distribution and zonation of algal and metazoan genera. These results provide potential evidence for resource partitioning via vertical stratification in epibiont communities, especially among algae.

Key Words: epibiont, community, mangrove roots

Introduction

In tropical and subtropical salt ponds, mangrove prop roots provide an important habitat for many sessile invertebrate and algal species. These prop roots provide a substantial amount of surface area on which epibiont communities may develop. Mangrove epibiont communities are most species rich in the Carribean and associated waters, which includes Bermuda (MacIntyre 2000; Farnsworth 1996) In Walsingham Pond, a Bermudan sinkhole with limited oceanic exchange, the red mangrove (*Rhizophora mangle*) and the black mangrove (*Avicennia germinans*) form a tight band around the shore of the pond (Thomas et al. 1992). The pond's bottom consists mostly of detritus and sediment, with scattered rocky outcrops and human trash (Eakins 1990); therefore, rock walls and mangrove roots provide by far the largest substrate for epifaunal communities. Of the two mangrove species, *R. mangle* roots seem to provide the majority of surface area as they are distributed closer to the center of the pond, and therefore their prop roots tend to extend deeper into the water (Hegeman unpub. data).

Niche differentiation is a well studied aspect of ecology which drives species competing for the same resource into separate ecological niches. Spatial partitioning may be especially important for sessile organisms, due to their stationary positioning and limitation to finite patches of habitat (Osman 1977). Multiple studies have shown that larval abundance is a key factor in distribution of marine epibionts (Osman 1977; Sutherland 1980; Bingham 1992; Hsieh 1995; Farnsworth 1996).

As there is a finite number of mangrove roots in Walsingham Pond, root surface area as a substrate is a competitive resource for epibionts. Root surfaces facing open water at the front of the mangrove root system were found by Farnsworth et al. (1996), to be the most speciose. As such, front roots must have a relatively high competition rate among epibiont genera.

This study focused on spatial differentiation between epibiont genera with regard to depth and root zonation. Eight abundant and easily recognizable genera were chosen: *Aiptasia, Amanthia, Biemna, Boodleopsis, Caulerpa, Clavelina, Rhizoclonium* and *Sabella*. Figure 1 illustrates a hypothetical single mangrove root community, with all members collected by Eakins (1990) present. Only the labeled species were considered in this study. The objective of this study was to establish whether mangrove epibiont communities have some amount of vertical stratification, whether in depth or zonation. This is a fundamental first step in determining whether epibiont communities partition spatial resources by occupying various depths or zones of each mangrove root, or whether certain epibionts are more subject to competitive exclusion.



FIGURE 1. Visual representation of a mangrove epibiont community

A schematic diagram depicting a typical mangrove root in Walsingham Pond with horizontal scale exaggerated. Roots in this survey did not tend to be this species rich and positioning in this diagram does not necessarily reflect that found in this paper (Adapted from Eakins1990).

Materials and Methods

The study occurred over a period of three mid-tidal afternoons at Walsingham Pond, Bermuda. Video transects of individual red mangrove roots were taken in the pond. Roots were selected from along the entirety of the pond edge. Roots that were more than three feet into the mangrove edge were not considered. Roots with no cameravisible epibionts were not considered, and roots under 20cm in depth were not considered (these tended to be epibiont poor). The survey was conducted using a Canon Powershot Digital Camera and a weighted waterproofed case. The camera was

lowered parallel to the selected root while taking video. A small ruler was used for scale. For the purposes of this study, only one side of each root was considered. In total, thirty-seven (37) root transects were taken. Videos were analyzed and individual frames taken with VideoLAN VLC Media Player to create a full representation of the mangrove root, each root representing one discrete population. Figure 2 displays a contrast enhanced frame taken from root number eleven. ImageJ (rsb.info.nih.gov/ij) was used to collect spatial variables including depth (cm) as measured from current water level, and zonal depth, depth as a proportion of the total length of the root. For measurement, each frame was referenced to a known scale, present in one of the frames. The depth of each individual (for Sabella, Clavelina, Amanthia and Aiptasia) or the centroid of the colony (for Biemna, Rhizoclonium, Boodleopsis, and Caulerpa) was measured with reference to the known scale. The still pictured in Figure 2 exhibits minor haziness near the root tip, frames exhibiting minor haziness were compensated for using additional video frames. Of the thirty-seven original videos 5 were unusable due to absence of scale or hazy image quality (n=32). Rutzler and Feller (1999) found that for many epibiont phyla that utilize mangrove roots, many species are as yet undescribed. For the purposes of the study, only eight (8) major genera of epibionts were sampled in each quadrat and little identification was made to the species level. Keying was done using keys found in Fauchald (1977) and Eakins (1990). Using JMP (www.jmp.com), One-way ANOVA and Tukey-Kramer HSD tests were performed to determine significant differences between genera.



Figure 2. Video still illustrating typical organisms in Walsingham Pond

Typical organisms found on prop roots in Walsingham Pond.

Green Algae (1)- *Boodleopsis pusilla* Red Algae (2)- *Rhizoclonium sp*. Tube worms (3)- *Sabella melanostigma*

Results and Discussion

ANOVA revealed several differences in depth and zonation among taxa. Pairwise comparisons revealed a significant difference in depth between *Caulerpa* and *Rhizoclonium* (Table 1A). Significant results were also found in zonation between *Caulerpa* and *Rhizoclonium*, as well as *Biemna* and *Rhizoclonium* (Table 1B). All other genera were found to have varied mean depth and zonation but not significantly different mean depth and zonation (Table 1).

Table 1. Tukey-Kramer HSD comparisons between genera. Table 1 groups genera by significance found with Tukey-Kramer HSD (p value < .05). Table 1A displays results for depth and Table 1B displays results for zonation. Genera with common letters are not significantly different from one another (p > 0.05). A, Mean depth (level); B, Zonation.

А				В				
Level			Mean	Level			Mean	
Caulerpa	Z		55.99	Biemna	Х		75.14	
Amanthia	Z	Y	48.97	Caulerpa	Х		69.47	
Biemna	Z	Y	47.39	Amanthia	Х	W	64.95	
Sabella	Z	Y	45.00	Sabella	Х	W	64.84	
Boodleopsis	Z	Y	42.99	Aiptasia	Х	W	59.79	
Rhizoclonium		Y	38.32	Clavelina	Х	W	59.79	
Clavelina	Z	Y	33.80	Boodleopsis	Х	W	58.72	
Aiptasia	Ζ	Y	26.14	Rhizoclonium		W	53.87	

The differentiation between genera on *R. mangle* roots provides some indication of resource partitioning of available root space. Though species are not finely divided into layers on each root (*Sabella* especially grow within other epibionts), depths and zonation of these genera show that some amount of differentiation is present. Whether this differentiation is due to zonal/depth changes in water quality, available light, nutrient availability or larval supply at each depth is not explored in this study. Future research could serve examine the influence of these factors on the distribution of epibionts on red mangrove roots.

The results of this study provide evidence which suggests some factor of spatial differentiation between genera in the mangrove root community. Most genera, with the exception of *Clavelina*, were found in more than one zone and depth. Roots 6, 9, and 11

exhibit communities where the distribution of genera was contrary to the findings of the survey at large. This may be because of a founder effect, wherein spaces on roots are colonized according to larval availability, as found by Bingham (1992). Osman (1977) found that physical disturbance and larval supply together were the most influential factors in epifaunal communities on rocks. If this is also the case on mangrove roots, there should be seemingly random distribution and large patches of grouped algae on the root. This seems to agree with disturbance and larval supply as important factors in mangrove community growth. However, genera were still distributed non-randomly, as evidenced by significant differences between certain genera. It is feasible that over time genera observed on mangrove roots differed over time, and that members of mangrove root communities experienced high turnover rates even in absence of turtle grazing. Further study on a time component to mangrove roots could prove worthwhile.

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