The Effect of Temperature on Species Composition in Subtidal Rocky Reef Zones on Champagne Reef

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Introduction

Coral reefs are home to a multitude of species. The reefs provide shelter, food and breeding grounds for many species of fish, worms, crustaceans, mollusks and algae. The type of reef observed in this study was a subtidal rocky reef. This type of reef is located below the intertidal zone which means that the water line is as low as the lowest tide. Subtidal reefs have little fluctuation in the water line due to this reason. The evidence of this can be seen in the patterns of zonation. Zones are areas of grouping or banding of certain species adapted to the conditions that occur in that zone. These conditions are called gradients. Many gradients affect what can inhabit each zone. These gradients are light, temperature, substrate, water movement, and competition between species (MITZI, 1999; Holmes, 2002). This study focused on the temperature gradient in relation to species composition in each zone.

Champagne Reef contains geothermal vents that pump hot air from the sea bed into the surrounding waters. This causes the temperature to rise in the area around the vents (Virtual Dominica, 2004). Zones in subtidal rocky reefs are more compact than zones in intertidal rocky reefs. This occurs because there is less variation in water lines than in reefs with vast changes in water lines due to tides (MITZI, 1999). The goal of this study was to test the hypothesis that zone species composition on the subtidal rocky reefs of Champagne Reef is affected by the surrounding water temperature.

Materials and Methods

This study was conducted over three weeks at Champagne Reef in Dominica. A wetsuit was used for skin protection from rocks and corals since the sampling occurred close to the rocky surfaces. A snorkel, mask and flippers were also used for visibility under water and in order to move around freely. Sites were chosen at both ends of the reef. One site was located northwest up the reef and the other was further southeast down the reef near the geothermal vents. In order to be a candidate for a test site, the rocky surface had to extend out of the water and to the sea floor. This was for the convenience of getting an overall sample of zonation at each site. These sites were labeled as being below 30ºC and above 30ºC, respectively.

A rope marked off in intervals of 10cm was used measure to the rocky reef face. It was thrown to the top most point of the rock face and then the slack was released to the sea floor, allowing the rope to be in a straight line. Next, specific zones were measured out by listing the depth of the transition into the next zone. An area qualified as a zone when an overall change in species occurred as the rope descended. This data was then written on an underwater tablet. Species richness of corals, algae, fish, worms, crustaceans and mollusks in each zone was also recorded within a 1m width of the rope and the scientific name of each species was identified using a field guide at the Archbold Tropical Research and Education Center (ATREC). This sampling method was used at all six sites. Water temperature readings were also taken at each site with a LaMotte thermometer.

Results

Table 1 shows the temperature readings for each site. The mean temperature for the sites below 30ºC was 27.3ºC and the mean temperature for the sites above 30ºC was 34.5ºC. Table 2 shows the depth of each zone marked at the end of each zone before the transition into the next. Lastly, Table 3 shows the number and mean of species per each zone for each site.

Table 1:

Temperature (ºC) Per Site		
	Below 30ºC	**Above 30ºC**
Site 1	27.5	33
Site 2	27	34
Site 3	27.5	36.5
Mean:	27.333333	34.5

Table 2:

Depth (cm) of Zones									
	Below 30C:					Above 30C:			
	Site 1	**Site 2**	**Site 3**	**Mean Depth**		**Site 1**	**Site 2**	**Site 3**	**Mean Depth**
Zone 1	80	30	70	60		40	80	50	56.66667
Zone 2	140	130	170	146.667		60	140	160	120
Zone 3	240	200	210	216.667		170	120	190	160
Zone 4	800	840	750	796.667		620	630	680	643.3333

Table 3:

Number of Species Per Zone							
	Below 30ºC				Above 30ºC:		
	Site 1	**Site 2**	**Site 3**		**Site 1**	**Site 2**	**Site 3**
Zone 1	2	2	1		1	1	2
Zone 2	1	2	2		1	2	1
Zone 3	5	4	5		2	1	2
Zone 4	5	6	5		1	2	2
Mean:	3.25	3.5	3.25		1.25	1.5	1.75
Overall Site Mean:	3.33				1.5		

Discussion

After all the data was collected and analyzed, it was found that the species richness contained in each zone did correlate to the temperature of the surrounding waters. The three sites that had a mean water temperature below 30ºC sustained zones with a higher number of species than the zones of the sites with a mean water temperature above 30ºC. Excluding Zone 1, the species at each site and in each submerged zone can be contrasted to see the definite differences in richness. There was a mean of 3.33 species per zone in the below 30ºC sites not located next to geothermal vents and a mean of 1.50 species per zone in the above 30ºC sites located near geothermal vents. Zone 1 at each site contained the same types of species. These species include Sally Lightfoot Crabs (*Grapsus grapsus*) and Nerite Snails (*Nerita sp.*) This may be due to the fact that only spray from waves can reach this zone, so temperature might not matter much in this case. However, the differences in the remaining zones at each site must be noted. Zone 2, which is just under the water's surface, shows similar species at each site, regardless of temperature. The species include the Fuzzy Chiton (*Acanthopleura granulate*) and the Little Striped Barnacle (*Balanus amphitrite*). The little variance between sites may also be explained by the limited water submersion of this zone to due waves (Littler et al., 1989; Humann, 1998).

The next two zones are the most different for the two sets of sites. Zone 3 at the sites that were without geothermal vents contained multiple species of worms, corals and fish. The species identified in Zone 3 were Christmas Tree Worms (*Spirobranchus giganteus*), Star Horseshoe Worms (*Pomatostegus stellatus*), Bearded Fireworms (*Hermodice carunculata*), Lesser Starlet Coral (*Siderastrea radians*), Redlip Blennies (*Ophioblennius atlanticus*), Hairy Blennies (*Labrisomus nuchipinnis*) and Sergeant Majors (*Abudefduf saxatilis*). Zone 3 at the sites with geothermal vents contained only species of algae. These species included Green Algae (*Ulva Lactula, Bryopsis plumose*) (Littler et al., 1989; Humann, 1998).

Zone 4 at the sites without geothermal vents showed many species of fish, algae, corals, worms and urchins. These species included Magnificent Feather Duster (*Sabellastarte magnifica*), Social Feather Duster (*Bispira brunnea*), Long-Spined Urchin (*Diadema antillarum*), Rock-Boring Urchin (*Echinometra lucunter*), Symmetrical Brain Coral (*Diploria strigosa*), Ocean Surgeonfish (*Acanthurus bahianus*) and Brown Algae (*Padina sanctae-crucis*). Zone 4 at the sites located near geothermal vents contained mostly algae with some sea anemones and fish. These species included Green Algae (*Ulva Lactula, Bryopsis plumose*), Pink-tipped Anemones (*Condylactis gigantean*), Sun Anemones (*Stichodactyla helianthus*), Bluehead Wrasses (*Thalassoma bifasciatum*) and Yellow Goatfish (*Mulloidichthys martinicus*) (Littler et al., 1989; Humann, 1998).

Even though the data supported my hypothesis there was still much room for error. Errors could have occurred in species identification, measurements and biases. In order for the results to be more accurate in regards to species composition per zone, the gradients of substrate, water movement, and competition between species should be observed. Hopefully, this project will benefit the study of temperature's effect on zonation in Champagne Reef and throughout the Caribbean.

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Works Cited

Holmes, Jan. 2002. Seashore Players Most Successful When They're in Their Zone. Washington State University Beach Watchers. < http://www.beachwatchers.wsu.edu/island/essays/zonation.htm>.

Humann, Paul. 1993. Reef Coral Identification: Florida, Caribbean, Bahamas. New World Publications, Inc. Jacksonville, Florida.

Humann, Paul. 1992. Reef Creature Identification: Florida, Caribbean, Bahamas. New World Publications, Inc. Jacksonville, Florida.

Humann, Paul. 1994. Reef Fish Identification: Florida, Caribbean, Bahamas. New World Pulications, Inc. Jacksonville Florida.

Littler, Diane Scullion *et al*. 1989. Marine Plants of the Caribbean: A Field Guide From Florida to Brazil. Smithsonian Institute Press. Washington, D.C.

Maine InterTidal Zone Investigation. 1999. Subtidal Zone. Zonation. Bigelow Laboratory for Ocean Sciences. < http://www.bigelow.org/mitzi/lib_sub.html>.

Virtual Dominica. 2004. Scott’s Head Soufriere Marine Reserve. <http://www.avirtualdominica.com/ssmr/index.html>.