A Comparison of Brain Coral Bleaching And Water Quality at Champagne Bay and Rodney's Rock

Lauren Divine, Carolyn Campbell, Ricci Loughridge, Travis Krause
June 8, 20006

Texas A&M University Study Abroad Dominica
Dr. Tom Lacher
Dr. Jim Woolley

Abstract

Surveys of brain coral bleaching and water quality tests were performed at Rodney's Rock (otherwise known as Tarou Point) and Champagne Bay. Sizes and damage of brain corals were recorded and related to water quality tests at each test area. A comparison was made of bleaching and water quality between Rodney's Rock and Champagne Bay. The study showed that Rodney's Rock contained a larger total percentage of bleached brain coral than Champagne Bay which was consistent with the results of our water quality tests.

Introduction

Coral reefs are found worldwide in tropical waters surrounding islands and continents. Corals are made by small animals called polyps that attach to the seafloor and secrete a calcium carbonate skeleton as protection ("Coral Reefs," 2006). The main type of reef encountered in the Caribbean is a fringing reef, which is described as a reef that " . . . grows out from the shore or [is] separated by a shallow lagoon"(Humann,1993). The reefs found in the waters of Dominica contain a large variety of corals including finger coral, fire coral, brain coral, common sea fans, and sea plumes. These reefs are experiencing various amounts of damage known as coral bleaching, a ". . . whitening of diverse invertebrate taxa . . ." (Buchheim, 1998). Bleaching results from various causes such as elevated temperature, excessive chemical input, solar irradiance, excessive algal formation in the water column, and other anthropogenic processes. Coral bleaching events have been increasing worldwide in extent and frequency for the past 20 years (Buechheim, 1998). Upon our first observation of Rodney's Rock, we noticed excessive bleaching on several brain coral species, leading us to focus our project on this type of

coral. Our goal for the experiment was to use water quality and counts of observed bleaching in correlation to compare the degree of degradation between Rodney's Rock and Champagne Bay. Based on our observations and bleaching counts, we hypothesized that water quality differences between the two sites would be linked to the magnitude of bleaching for each site.

Methods and Materials

Before any official surveys were taken, we observed the condition of the reef at Rodney's Rock on May 25, 2006. The most noticeable bleaching affected brain coral species; this led us to focus our experiment on brain coral. On May 31, 2006 we collected brain coral bleaching and dissolved oxygen data for Rodney's Rock. Each member was equipped with a mask, snorkel, fins, and an underwater writing tablet. We proceeded to swim north away from Rodney's Rock and designated an acceptable test area. Next we used a 25 meter rope and randomly choose a measurement of 13 meters by 15 meters. We dropped stones tied with surveyors tape to mark the boundaries of sample site one. The site was divided between three members; counts were done on the total number of coral and brain coral. The approximate size of each brain coral and bleach damage were recorded.
The second and third test sites for Rodney's Rock were the north and west sides of the rock, respectively. We randomly identified boundaries for each side of the rock and measured each with the meter rope. Test site two was 11 meters by 6 meters and test site three was 14 meters by 10 meters. Once measurements were made, the same process was used to count total coral, total brain coral, and bleaching damage on each brain coral. After all three sites were observed, the group compiled the information on each writing tablet and recorded it on paper (see Tables 1 and 2).

Collection of data for Champagne Bay was conducted on June 2, 2006. The type of reef found here was a scattered fringing reef (Humann, 1993). The group split into pairs and swam away from each other along the reef. One group swam northwest and one group swam southwest. The group swimming southwest identified two suitable test sites while the group swimming northwest identified a single site for a total of three areas. We used the same method for measuring each site at Champagne Bay as was used at Rodney's Rock. Test area one was 19 meters by 14 meters; test area two was 11 meters by 21 meters. The third test site in the northwest area of the reef measured 10 meters by 23 meters. After surveys for each area were complete, the data was compiled and recorded on paper.

A second trip to Rodney's Rock and Champagne Bay was made on June 5, 2006. On-site testing with fresh water samples was required for accurate results. We used a La Motte Saltwater Aquaculture Testing Kit for all water quality tests. Water samples were collected in Nalgene® 500 mL bottles from each of the 6 test sites and water quality tests were performed on each sample. Tests included nitrite, nitrate, ammonia, pH, alkalinity, and carbon dioxide. Salinity tests were discontinued after sites two and three at Rodney's Rock because of contamination of the reagent. All results were recorded and later averaged to be used with bleaching data for interpretation of each reef condition.

All data were put into a spreadsheet and interpreted in the lab. Brain corals were divided into categories based upon approximate size: 6 inches or less, 7- 12 inches, and 13 inches or more. Bleach spots were categorized as small to medium, large to full, faded, or non-bleached. Small to medium spots were considered to cover up to ½ the total size and

large spots to fully bleached covered greater than ½ to the total coral. Faded and non-bleached corals were also noted.

Results

The physical geography of each test site limited our sampling areas. Due to the fact that Rodney's Rock has a majority of coral occurring on the main face of the boulder and Champagne Bay is a shallow, fragmented reef, we were unable to survey identical test areas. The ratio of each category to total brain coral was determined by dividing total number of coral in each category by total number of brain coral. When each category was analyzed separately, they were within 2-6% of each other. We determined this was not a significant difference, allowing us to compare each category between Rodney's Rock and Champagne Bay. Coral measuring six inches or less composed 44.7% at Rodney's Rock and 46% of total brain coral at Champagne Bay. Rodney's Rock had 21% more small coral with large to full bleaching (Table 1). Champagne Bay showed 22% more fading on small brain coral than Rodney's Rock (Table 2). Brain coral of seven to 12 inches made up 31% total brain coral at Rodney's Rock and 36% at Champagne Bay (Tables 1 and 2). There were no significant differences between bleaching categories for this size. Large brain coral (13 inches or more) covered 23% of Rodney's Rock and 17% of Champagne Bay (Tables 1 and 2). Rodney's Rock also exhibited 21% more small to medium bleaching on 13 inch or larger brain coral (Table 1). Water quality test results are shown in Tables 3 and 4.

Table 1. Brain coral and bleach sizes recorded for Rodney's Rock

Rodney's Rock

	brain coral sz. :		
	6" or less	7"-12"	13"+
bleach sz. : no	41%	27%	30%
sm-md	7%	9%	27%
lg-full	34%	22%	16%
faded	18%	42%	27%
Total brain coral	**107**	**76**	**56**

Total # of brain corals	**239**	
Total size	727	m^2
Total # of corals	1065	
Total % Bleached	38	

Table 2. Brain coral and bleach sizes recorded for Champagne Bay

Champagne Bay

	brain coral sz. :		
	6" or less	7"-12"	13"+
bleach sz. : no	36%	28%	48%
sm-md	12%	21%	6%
lg-full	13%	12%	14%
faded	39%	39%	32%
Total	**94**	**75**	**35**

Total # of brain coral	**204**	
Total size	401	m^2
Total # of corals	565	
Total % Bleached	27	

Table 3. Avg Water Parameters RR

Rodney's Rock		
Nitrite Nitrogen		0.1
Nitrate Nitrogen		4.67
Ammonia Nitrogen		0.02
Alkalinity ($CaCo_3$)		140
Dissolved Oxygen		4.5
PH		8.67
^oC		32.45

Table 4. Avg. Water Parameters CB

Champagne Bay		
Nitrite Nitrogen		0.07
Nitrate Nitrogen		3.67
Ammonia Nitrogen		0.26
Alkalinity ($CaCo_3$)		126.67
Dissolved Oxygen		3.73
PH		7.83
^oC		30.14

Discussion

At Rodney's Rock, 38% of total brain coral had some form of bleaching, whereas only 27% of the total brain coral was bleached at Champagne Bay (Tables 1, 2). Our water quality results are consistent with the observed data gathered at each site, projecting Rodney's Rock as a less healthy reef system, indicated by bleaching of brain coral. Rodney's Rock contained 0.03ppm more nitrites in the water than Champagne Bay. This presence of nitrites is not generally toxic, but even at low levels can contribute to the growth of algae that compete with coral for nutrients and space (SeaTest, 1994). Nitrites are reduced in marine systems into nitrates and eventually ammonia. Rodney's Rock exhibited 1.0ppm more nitrates than Champagne Bay; this higher presence of nitrates will lead to higher amounts of ammonia at Rodney's Rock. Ammonia is highly toxic to the marine invertebrates that colonize coral reefs and is a strong indicator of an unhealthy reef (Webber, 2004).

Alkalinity is an indicator of the presence of calcium, a critical building block for coral growth and regeneration (SeaTest, 1994). Both sites showed low amounts of calcium

carbonate, however, Rodney's Rock had over 13ppm more $CaCO_3$. This indicates coral at Rodney's Rock has more calcium available in the water column to use for regeneration.

Our results for pH at each site were also lower than recommended (Webber, 2004), although pH may fluctuate throughout a 24 hour period. These low levels could be a natural low in the daily fluctuation and remain in the neutral level for marine water. Coral species benefit from high levels of dissolved oxygen (D.O.) which varies as current flow changes in the system. Our D.O. levels at Rodney's Rock and Champagne Bay were also lower than recommended (Webber, 2004). Through our observations, we noticed a consistently stronger current at Rodney's Rock, which may explain higher D.O. levels at this site.

Reefs are temperature sensitive; a 1- 2^{o}C increase in temperature for longer than five weeks during warm months will usually induce bleaching (Buchheim, 1998). Although we only took temperature one day at each site, Rodney's Rock was more than 2^{o}C over the suggested maximum temperature a reef may function without being impaired. If water temperature remained this high for more than five consecutive weeks, it could be a factor of bleaching at Rodney's Rock. We did not include a thorough study of current flow through each site, but this could be a factor affecting temperature.

Faded coral may be a sign of regeneration of the polyps or a precursor to bleaching. Since we cannot interpret on an individual basis whether fading indicated regeneration or degradation, we simply noted it in our data.

Our study did not include analysis of phosphorus, current flow, salinity, or metals at each site. These data may or may not have a significant affect on our results. We also did not

take into account contributors to bleaching such as sedimentation, fresh water dilution, inorganic nutrients, sub aerial exposure, or xenobiotics. In the future, this experiment may be improved by studying these factors more thoroughly and conducting more tests over a longer period of time.

Acknowledgements

The group would like to thank Dr. Lacher and Dr. Woolley for transportation to each test site, editorial input, and overall enthusiasm for the students.

References

Buchheim, Jason. 1998. Coral Reef Bleaching. Odyssey Expeditions- Marine Biology Learning Center. http://www.marinebiology.org/coralbleaching.htm

"Coral Reefs." 2006. Pacific Whale Foundation. Maui, Hawaii. http://www.pacificwhale.org/childrens/fsreef.html

Humann, Paul. 1993. Reef Coral Identification. New World Publications, Inc.: Jacksonville, Fl. 19.

SeaTest. 1994. Reef Aquarium Test Kit: Multi- Kit. Aquarium Systems, Inc. Mentor, OH. 3.