A Study of the Abundance of *Diadema antillarum* in Relation to Coral Abundance at Champagne Reef, Dominica, W.I.

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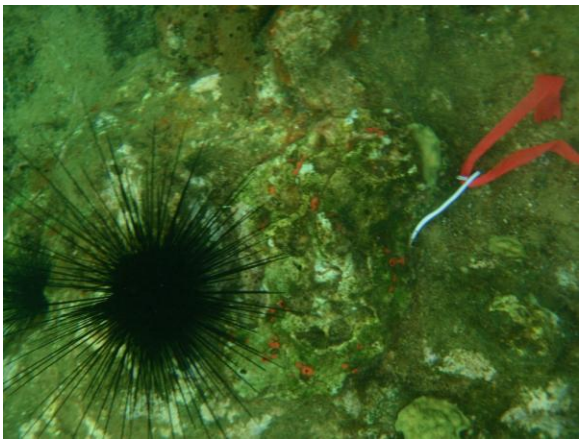
Abstract:

Diadema antillarum, more commonly known as the long-spined black sea urchin, is one of the most important herbivorous species on Caribbean reefs. My project was centered on looking at abundance levels of *Diadema* in relation to abundance levels of coral reefs. To do this I used transects to count organisms, and used the data to see if any such relationship was evident. The data showed that areas on the reef with greater numbers of *Diadema* also had greater numbers of coral polyps.

Introduction:

Diadema antillarum, more commonly known as the long-spined black sea urchin, is one of the most important herbivorous species on Caribbean reefs. It is responsible for keeping macroalgae and other plant species from out-competing coral polyps for space and nutrients. Over the past 20 years however, many reefs in the Caribbean have been transitioning from a coral dominated to macroalgal dominated reef system (Edmunds and Carpenter, 2001). This is in part because of population declines of *Diadema* in the early 1980's due to disease, which caused mass mortalities of the organism.



Benthic algae are the main source of food for *Diadema*. Most algae require a hard substrate to settle on which usually consists of coral skeletons. Studies show that grazing by *Diadema* removes the algae from hard surfaces and makes room for coral spat to settle and grow, thus creating healthier populations (Ogden and Carpenter, 1987).

Site Characterization:

Dominica is located in the Lesser Antilles volcanic arc at 15.25 N, 61.20 W. Champagne Reef is located on the southwest side of the island near the town of Soufriere at 15.245 N, 61.373 W. The reef itself is about the size of a football field, supporting many types of coral such as brain, finger, fan, and fire coral. Many other organisms also call the reef home such as parrotfish, eels, damselfish, squid, sea urchins, and many others. The reef is named after the thermal vents on the reef floor that release warm air bubbles that float to the surface, much like a glass of champagne.

Methods and Materials

On May 29, 2009 I began my project on how the abundance of the sea urchin *Diadema antillarum* reflects coral abundance. To do this, I laid three transects that were 27.432 meters (90 ft) long at three different locations along the reef using an underwater measuring tape. Transect 1 was laid furthest from shore along the main portion of the reef. Transect 2 was laid slightly closer to shore, along less abundant reef patches. Transect 3 was laid closest to shore, with the least amount of coral evident. Each transect was marked every 9.14 m (30 ft) with a flag marker that was left until the end of the study. There were a total of four flags for each transect. Once the transects were placed, I took depth measurements at each flag to determine average depths, as well as an estimated topography of the reef bottom.

Next, I counted the number of *Diadema* within one meter along each transect and separated those counts into adults and juveniles. Adults were those that had test diameters greater than 3 cm, indicating sexual maturity. Juveniles were those that had a test diameter less than 3 cm (Ogden and Carpenter, 1987). I also recorded the date and times that counts were taken to determine if the time of day played a role in abundance levels. This procedure was repeated three times on different days, May 29, May 31, and June 3.

Coral counts were then taken along transects. To do this I counted the number of live corals within a one-meter diameter around each flag at all three transects to get an average. A total of 12 coral samples were taken.

Water quality measurements using the Hydrolab were also taken each day and averaged to determine if conditions at Champagne Reef were ideal to support healthy populations of *Diadema*.

A HOBO data logger was also placed in the reef to measure continuous temperature over a five-day period. It was placed on May 29, and removed on June 3.

Results:

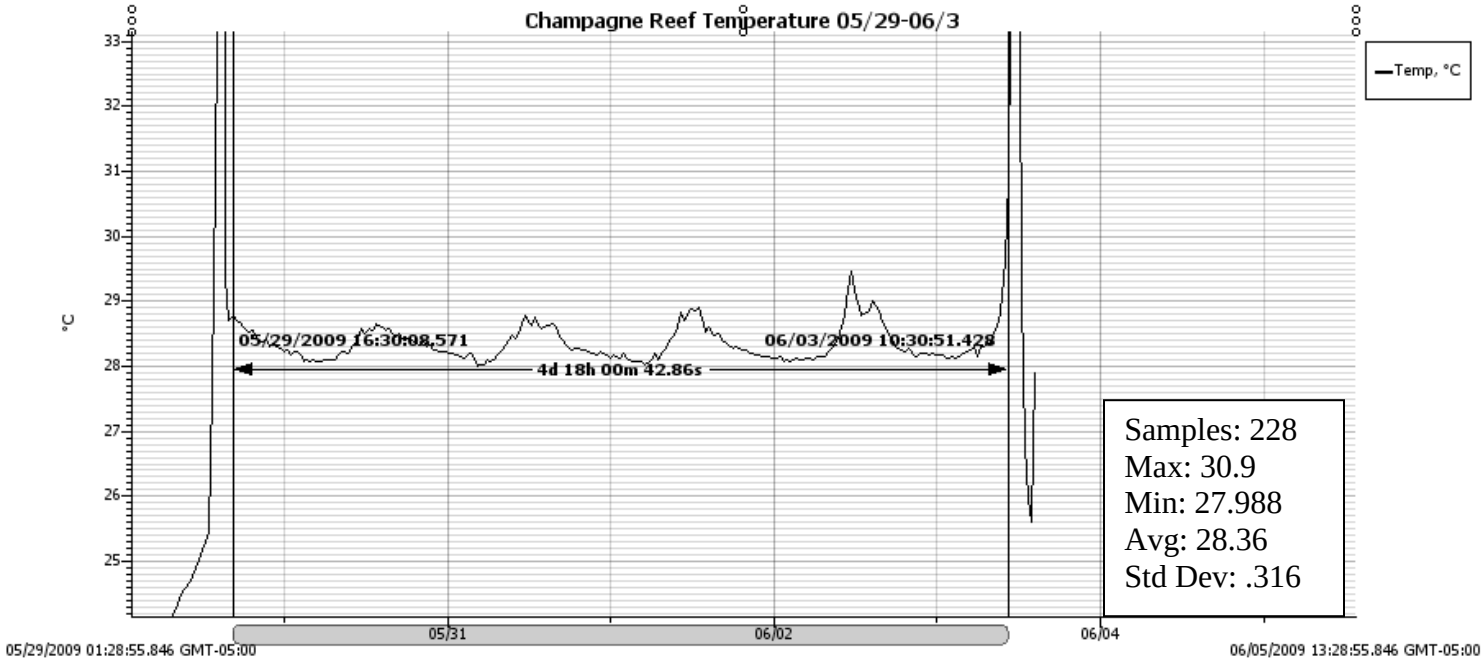
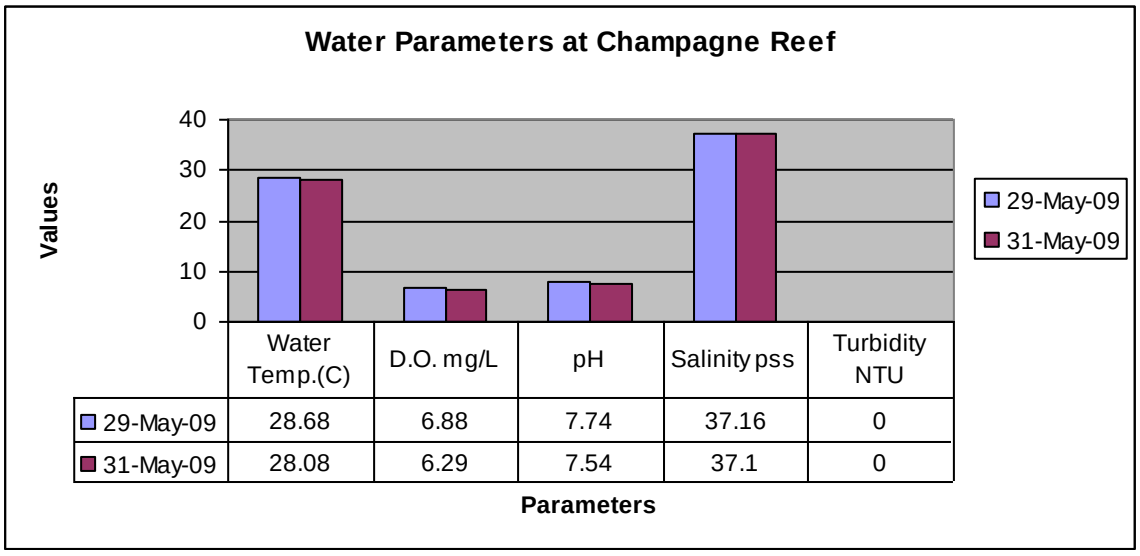


Figure 1. HOBO Data Logger temperature readings from 5/29/2009 to 6/3/2009



	Water Temp.(C)	D.O. mg/L	pH	Salinity pss	Turbidity NTU
29-May-09	28.68	6.88	7.74	37.16	0
31-May-09	28.08	6.29	7.54	37.1	0

Figure 2. Hydrolab Water Quality Monitoring System measurement averages from Champagne Reef.

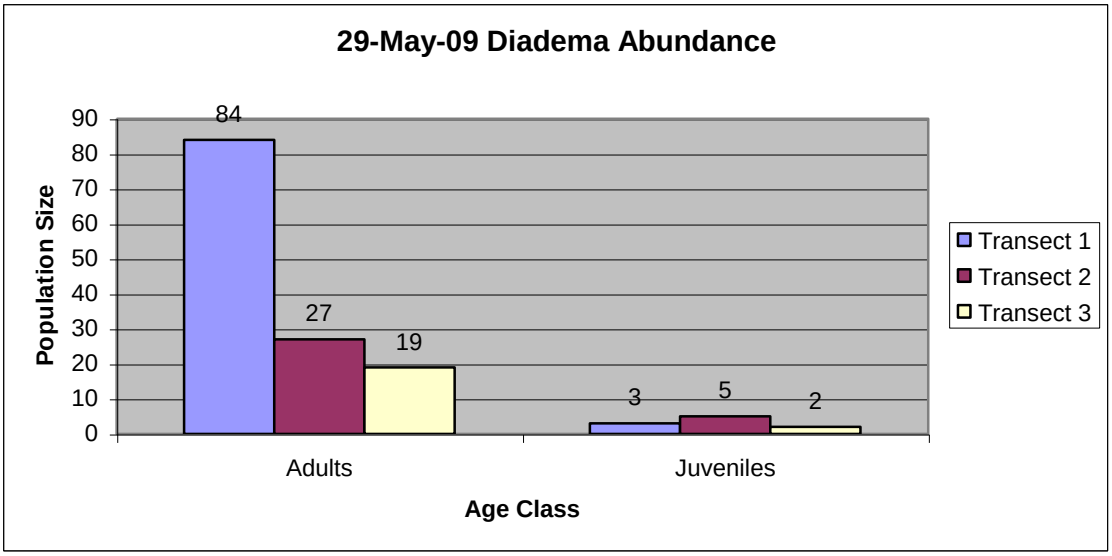


Figure 3. Abundance of adult and juvenile *Diadema antillarum* along three transects at Champagne Reef on May 29, 2009.

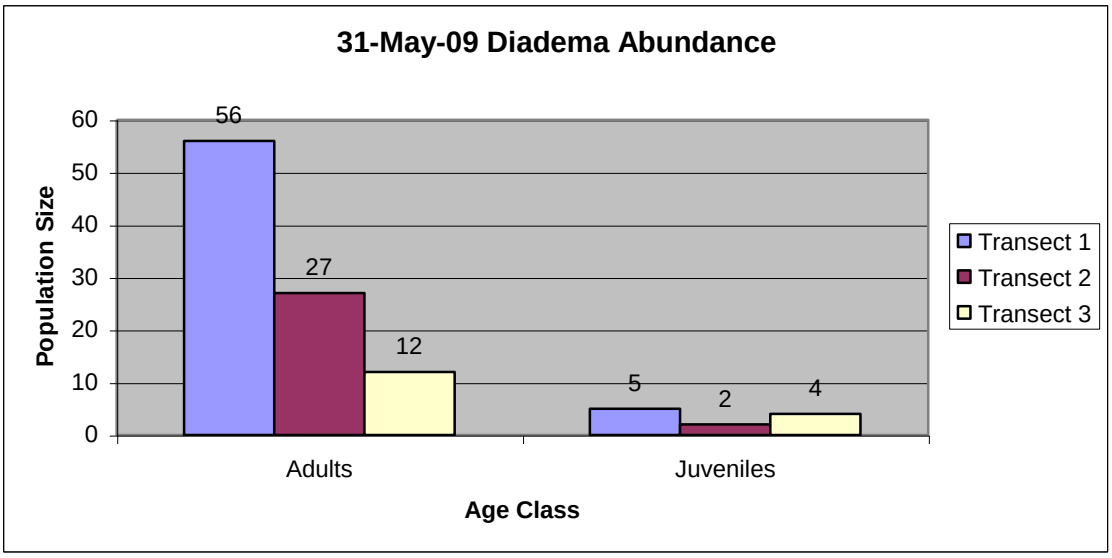


Figure 4. Abundance of adult and juvenile *Diadema antillarum* along three transects at Champagne Reef on May 31, 2009.

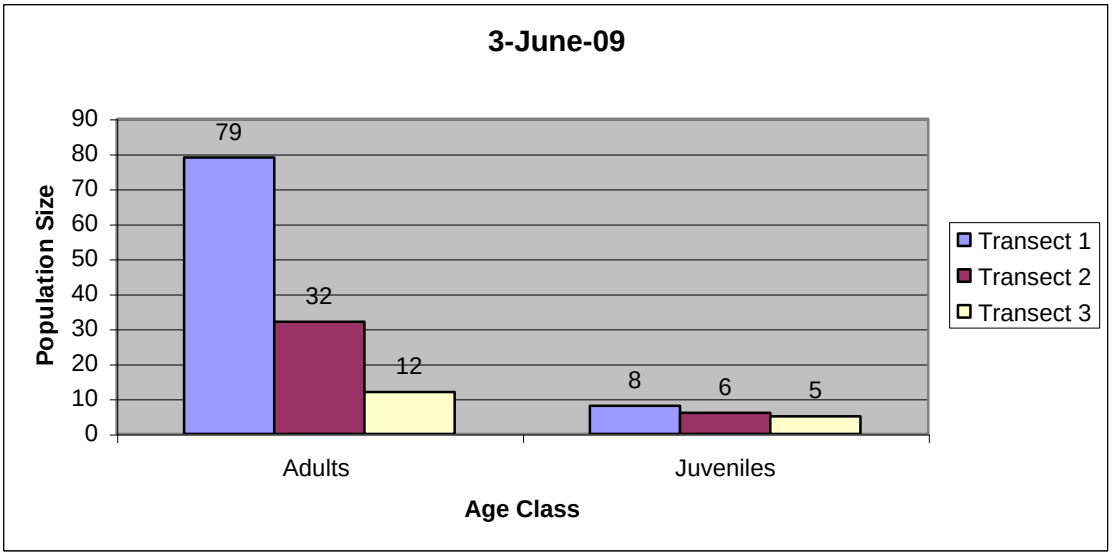


Figure 5. Abundance of adult and juvenile *Diadema antillarum* along three transects at Champagne Reef on June 3, 2009.

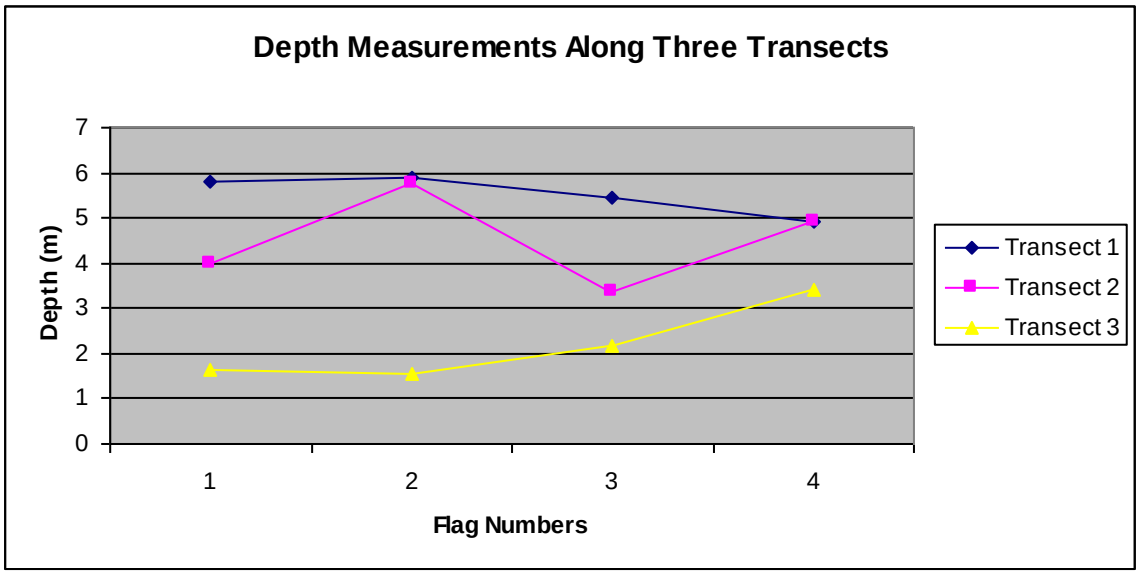


Figure 6. Depth measurements taken at four sites along three transects to determine bottom topography.

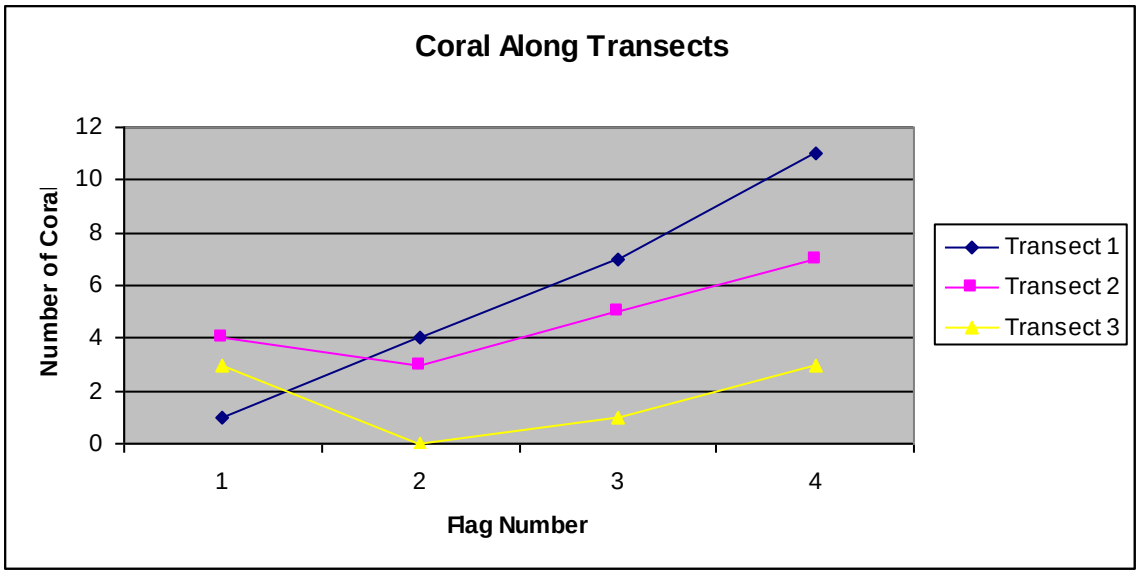


Figure 7. Coral counts taken at one-meter diameters around four locations along three transects to determine coral abundance.

Discussion:

The water quality readings taken by the Hydrolab showed average readings that are suitable to support *Diadema* populations. Temperature was fairly constant, with small fluctuations between day and night. D.O., salinity. pH, and turbidity also stayed constant.

Data taken on May 29 showed the highest abundance levels of *Diadema* at transect 1, with a total count of 87 organisms. Next was transect 2, with a total count of 32, followed by transect 3 with a total count of 21. This pattern was to be expected since *Diadema* have a direct relationship with coral reefs, and the latter two transects were farther from the reef. The total count of *Diadema* along all three transects was 140. Results followed the same pattern for the May 31 data. Transect 1 was most abundant with a total of 56 urchins. Transect 2 had 27, and transect 3 had 12. The total count of *Diadema* along all three transects was 106.

While the pattern of abundance levels was the same as on May 29, the overall numbers were much lower. This could have been due to the fact that the May 29 data was taken in the afternoon between 15:30 and 17:00. The May 31 data was taken in the morning between 9:12 and 10:10. Research shows that *Diadema* are most active beginning in the late afternoon and through the night (Ogden and Carpenter, 1987).

The June 3 data also followed the pattern of decreasing abundance away from the reef. Transect 1 had a total of 87 *Diadema*, transect 2 had a total of 39, and transect 3 had a total of 17. The overall total count for the day was 143.

Coral counts were higher at transect 1 than the other two transects as shown in Figure 7, even with the low count at flag 1. This low point could be because flag 1 on transect 1 was in a rocky valley on the reef and not directly on the main reef. While more study in this area would need to be done, data shows that areas in Champagne Reef with greater numbers of *Diadema* also had greater coral abundance.

Unfortunately, the scope of this project was limited by time and transportation. Having more days worth of data would have made for a more accurate and in depth study, and having more time at each site would have allowed for greater sampling. Future studies stemming from this project could be done by laying more than three transects, and sampling on more than three days at different times. It could go into even greater detail by sampling coral health and relating that to the abundance of *Diadema*.

This study was done to evaluate the abundance of *Diadema* and relate it to the abundance of coral on the reef. The decline of coral reefs all over the world is a huge concern, and one that only gets worse everyday. At one time *Diadema* covered coral reefs with populations of up to 20 individuals per m^2 (Moe, 2009). After disease decimated up to 98% of populations, coral health has been declining. It has been about 25 years since the mass mortality, but *Diadema* populations in many areas have still not recovered.

Studies like the one I conducted are important because they monitor urchin populations, and can hopefully be used in a grander scheme to try to prevent the loss of reef habitat in the Caribbean.

Acknowledgements:

I wish to acknowledge Dr. William Heyman for providing continual guidance and support coming up with a project idea as well as while I conducted my research. I would also like to thank Drs. Thomas E. Lacher Jr. and James B. Woolley for giving me the opportunity to study in such a unique environment, for purchasing equipment, for providing transportation to study sites, and for providing guidance when needed. I also wish to thank Nancy Osler and

ATREC for their hospitality and use of facilities while I conducted my research. A special thanks to Dr. Steve Davis for lending his Hydrolab water quality data collector at the last minute when our equipment fell through. Finally, I would like to thank Texas A&M University for supporting programs such as study abroad that allow students to gain experience in their given fields, while also learning about culture and diversity in other places throughout the world.

Works Cited:

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