Understanding the prevalence of coral disease in Curacao as a function of *Coralliophila abbreviate* density and the disease status of nearest neighbors

Abstract

The spread of diseases, such as White Pox and White Band Disease, is becoming an increasing threat to the life of corals in recent years. By understanding the route and dispersal methods of coral diseases, effective strategies of disease treatment and prevention could be developed. Several studies have centered on the spread of coral disease in Acropora species in Florida and have shown that disease can spread by healthy tissue coming into contact with fragments of infected tissue from other corals and the presence of vector, such as the snail *Coralliophila abbreviate*. This project analyzes the role those dispersal methods play in the prevalence of disease in the corals of Curacao. The frequency of disease spread via infected tissue contact will be analyzed by observing the disease status of an individual coral colony, the distance of the colony from its nearest neighbor, and the disease status of the nearest neighbor. The role of a vector in disease dispersal will be analyzed as a function of the density of the snail *Coraliophila abbreviate* and the disease status of a coral.

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Introduction

Coral reefs are often considered the hub of biodiversity in marine environments, providing food and shelter for a variety of organisms. In addition to their importance to biodiversity of marine environments, coral reefs buffer shorelines from erosion by storms. In addition to providing food and recreational economic value, reefs have medicinal value. Some organisms on coral reefs contain compounds that are used in treating diseases, such as cancer and malaria. With global temperatures expected to increase, corals have become more susceptible to disease and coral bleaching, endangering these valuable ecosystems (Rosenberg et. al. 2007).

Disease can be extremely devastating to coral communities. Some diseases can wipe out a significant portion of the local coral population. 88% of *Acropora palamata* was killed by White Pox Disease in the Florida Keys between 1996 and 2002 (Sutherland et. al. 2010). In addition to their virulence, many diseases are universal and can infect several species of corals. In 1995, White Plague Disease infected 17 species of coral in the Florida Keys (Dybas 2013). Identifying the causes and pathways of coral diseases can aid the development of treatment and preventive strategies.

A variety of diseases exist in the ocean; some include White Band Disease, Black Band Disease, Plague Type II. Each infect coral colonies differently. Yellow Band and Black Band disease spread from a starting point on a colony until the whole colony is infected. This spread can be distinguished by its namesake, a band. Figure 1 shows a colony infected by Black Band Disease.

**Figure 1.**



**Figure 1**. is an image of Black Band Disease spreading over a *Colpophyllia natans*, colony (Richardson 1998).

Within recent decades, coral diseases have been found to be caused by bacterial, viral, and fungal infections. *Aurantimonas coralicida*, a Gram negative bacteria, single-handedly caused the White Pox breakout in 2003 (Dybas 2013). Other diseases that have been identified are Black Band Disease, White Band Disease, Plague Type II. Various microorganisms occupy coral tissue and mucus under normal conditions; however, environmental stress triggers pathogenic organisms to induce infections. The stresses that can induce an infection include rising temperatures, water pollution, and overfishing (Rosenberg et. al. 2007).

Once a coral is infected, the disease can be transmitted via coral-to-coral contact or by a vector.

Corals are sessile organisms; however diseases have been found to be contagious, typically spreading to a diseased coral’s nearest neighbors. Coral disease can transmit to healthy coral when infected tissue fragments off of the coral and lands by healthy corals. A diseased coral’s nearest neighbors are the most susceptible to come into contact with these fragments (Williams et. al. 2005). An organisms nearest neighbors are identified as the organisms closest to the individual of interest. The larger the distance between the individual and its nearest neighbors, the more isolated the individual is (Clark et. al. 1954). The spread of White Pox Disease in *Acropora palmata* on Florida reefs has been observed as a prime example of this disease transmission through nearest neighbors. Between 1996 and 1997, White Pox spread from one colony of *A. palmata* in Florida to all *A. palmata* on Florida reefs (Patterson et. al. 2002).

Another factor contributing to the spread of disease is the presence of a vector, carrying the pathogen. One vector, the coral-eating snail *Coralliophila abbreviate*, has been found to transmit disease between *Acropora palmata* individuals. Snails typically only travel between coral individuals once their host coral dies. A snail, feeding on a diseased coral that eventually dies, transports disease when it travels to a new healthy coral, intensifying the spread of the disease (Williams et. al. 2005).

Several studies have focused on the transmission of disease among acroporid corals. However, the transmission of disease in coral species of Curacao has yet to be analyzed. This project would involve the examination of two factors contributing to disease dispersal: distance from nearest neighbor and the presence of a vector, a coral-eating snail *Corallophila abbreviata*. It is expected that the closer the nearest neighbor is to a diseased coral, the more likely the neighbor is diseased. Conversely, the farther the nearest neighbor is from a diseased coral, the less likely that neighbor is diseased. Additionally, it is expected that diseased corals will have a high density of *Corallophila abbreviata* feeding on the remaining healthy tissue, while healthy coral individuals will have lower snail densities. This project involves minimal disturbance to the sites and minimal cost of equipment, and the results from this project can contribute to the development of treatment and preventive strategies of disease prevalence in Curacao coral populations.

Materials and Methods

To test these hypotheses two sites in Curacao will be analyzed. Twenty-five corals at each site will be examined for disease status, distance from nearest neighbor, disease status of nearest neighbor, and snail density on the coral of interest. Field data will be recorded on underwater paper. Disease status will be determined by the appearance of disease on the coral of interest. Distance from nearest neighbor will be measured with measuring tape in meters. Density of the snail, *Coralliophila abbreviata*, on a coral will be estimated using a quadrat.

The data will be combined from each site and presented in tables. One table will list the coral of interest, disease status, distance from nearest neighbor, disease status of nearest neighbor, and snail density on the coral of interest. To analyze the occurrence of disease status in nearest neighbors as a factor of distance, an ANCOVA test will be applied. To examine disease status and probability of nearest neighbor’s disease status, a Fisher’s Exact Test will be applied. A Fisher’s Exact Test will also be applied to analyze the presence of high or low snail density (the definition of high and low snail density is to be determined relative to the data collected) and the probability that the coral is diseased. An example table is below.

**Table 1**. This table represents the probability that a coral’s nearest neighbor will be diseased based on the diseased status of the nearest neighbor. This table shows that if the focal colony is healthy, there is an 80% chance its nearest neighbor is healthy and 20% chance the nearest neighbor is diseased, and if the focal colony is diseased, there is a 20% chance its nearest neighbor is healthy and 80% chance its nearest neighbor is diseased.

|  |  |  |
| --- | --- | --- |
|  | Focal Colonies |  |
| Nearest Neighbor | Healthy | Diseased |
| Healthy | 80% | 20% |
| Diseased | 20% | 80% |

Timeline

Day 1: Site One Examination

This day will be used to examine twenty-five corals at site 1, their disease status, distance from nearest neighbor, nearest neighbor’s disease status, and snail density.

The total time per coral is estimated to be eight minutes.

Finding coral to observe: 2 minutes

Identifying disease status of coral and coral’s nearest neighbor: 2 minutes

Measuring snail density on coral: 4 minutes

Total time per coral: 8 minutes

Total timer per site: 8 minutes X 25 corals = 3hrs and 20 minutes

Since the site will be available 9am-5pm, a total of 8 hours, there is enough cushion time for breaks to be taken and possible occurrences that may delay some parts of the procedure.

Day 2: Site Two Examination

This day will be used to follow the same procedure as Day 1 at site two.

Day 3: Data Organization, Analysis, and Interpretation

These tasks will most likely occur after the Curacao trip, if not during the trip, if time permits. The data will be organized into tables. The ANCOVA test and Fisher’s Exact test will be run. The results will then be interpreted.

Literature Cited

Clark, Philip J., and Francis C. Evans., (1954) Distance to nearest neighbor as a measure of

spatial relationships in populations. *Ecology,* **35.4**: 445-453.

Dybas, C. L., (2013) Caribbean Coral Mystery. *Oceanography*, **26**: 10

# Patterson, K. L., et. al., (2002) The etiology of white pox, a lethal disease of the Caribbean

# elkhorn coral, *Acropora palmata*. *Proceedings of the National Academy of Sciences,* 99.13: 8725-8730.

Rosenberg, E., Kellogg, C. A., Rohwer, F., (2007) Coral Microbiology. *Oceanography*, **20**: 146-

154

Sutherland, K. P., Porter, J. W., Turner, J. W., Thomas, B. J., Looney, E. E., Luna, T. P., Meyers,

M. K., Futch, J. C. and Lipp, E. K, (2010) Human sewage identified as likely source of

white pox disease of the threatened Caribbean elkhorn coral, Acropora palmata.

*Environmental Microbiology*, **12**: 1122–1131

Williams, D. E., and Margaret W. Miller, (2005) Coral disease outbreak: pattern, prevalence and

transmission in Acropora cervicornis. *Marine Ecology Progress Series,* **301**: 119-128

Budget

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| --- | --- |
| 0.5m X 0.5m Quadrat tape | $20 |
| 35ft Measuring tape | $15.98 |
| Underwater paper | $32.25 |
| Pencil | $1.00 |
| Clipboard | $6.00 |
| Total | $75.23 |