DENDROGYRA CYLINDRUS MONITORING UPDATE
1724 Guadalupe Underwater Archaeological Preserve (GUAP)
Bayahibe, Dominican Republic
November 17–19, 2023

Submitted to:
Pedro Morales, Technical Director
Dirección General de Patrimonio Cultural Subacuático (DGPCS)
Santo Domingo, Dominican Republic

Jimmy Garcia**,** President
ANAMAR

Submitted By:
Charles D. Beeker, Director
Center for Underwater Science, Indiana University

Author:
Hannah-Marie Lamle
Center for Underwater Science, Indiana University

Participants

Indiana University: Hannah-Marie Lamle
ANAMAR: Jenette Paola Morales Gomèz

Site Information

General Location: Offshore of Viva Wyndham Dominicus Beach Resort, Bayahibe, Dominican Republic.
Construction: A replica shipwreck as an underwater museum exhibit of historic artifacts from the 1724 Guadalupe including one anchor from Isla Saona, seven cannons, cemented and uncemented ceramics, cannonballs from the 1781 Scipion, and one dead eye. Also included are two plaques, 7 unused buoy blocks, and the historic marker buoy mooring line.
Site Visitation: "one of the most dived upon sites in the Dominican Republic," very busy, many boats overhead
Assessment Dates: 17-19 November, 2022

Diving Conditions

Depth: 20-30 ft
Accessibility: by boat, 776 feet from shore
Current Direction and Strength: moderate current from East to West
Wind Direction and Strength: no wind
Visibility: 10-35 ft, depending on the day
Hazards to Divers: Boats overhead, fishing line, visibility

Stony Coral Tissue Loss Disease (SCTLD)

Stony coral tissue loss disease (SCTLD) is a relatively new coral disease wreaking havoc on Caribbean Reefs. It was first noted in Virginia Key, off the coast of Miami, FL, in September 2014 (Precht et al., 2016). After almost a year after documenting the disease, it had radiated out 130 km, spreading three times farther in the north than the south (Precht et al., 2016). A comprehensive study of 24 coral species over 5 years (from 2012, before SCTLD outbreak, to 2016, two years after outbreak) in the Southeast Florida Region showed that 11 total species were affected. In addition, the number of species affected increased from two in 2013, six in 2014, nine in 2015, and seven in 2016 (Walton et al., 2018). This study showed that SCTLD preferences a wide range of species, unlike other white plague diseases that targeted specific genera of species (such as the white band disease epidemic that decimated the Acroporid corals in the 1980's) and could indicate that the disease can jump from one species to another. There is speculation that SCTLD was introduced via the Port of Miami dredging project of 2013 – 2015, however this theory is highly debated (Cunning et al., 2019; Gintert et al., 2019; Precht, 2021).

Coral diseases are extremely hard to understand due to the nature of studying microbial communities in a marine environment. Even the most senior studied diseases, including White Band, Black Band and Dark Spot Disease have significant gaps in the literature, including if the disease is bacterial or viral and the vectors in which the disease is transmitted. According to a 2018 study of coral tissue, water and sediment samples, SCTLD is believed to be a bacterial pathogen of two orders, *Rhodobacterales* and *Rhizobiales*, that work together during a SCTLD infection. It was noted that these two bacterial orders were also found in the water samples and sediment samples, although they were more commonly found in the sediment (Rosales et al). In terms of SCTLD virology, little is also known about the mechanisms of the disease and how it impacts coral cells. A study from Landsberg et al. concluded that SCTLD causes a disruption between the relationship between the coral animal cell and zooxanthellae, the plant cells that live inside the corals and supply it with nutrients (2020). More research is needed into coral pathogenesis to further understand how SCTLD is causing coral death.

A report generated by the National Oceanic and Atmospheric Administration (NOAA) in 2018 classified common Caribbean coral species as Highly susceptible to SCTLD, Intermediately susceptible, Presumed susceptible, and Low susceptible. *Dendrogyra cylindrus* is classified as a Highly susceptible species, meaning that it will be one of the first species affected during an outbreak. *D. cylindrus* will also undergo rapid progression of SCTLD and total mortality typically within 1-2 months for larger colonies (NOAA, 2018). Monitoring of SCTLD has typically been conducted via the determination of sites of interest and frequent trips to these sites to obtain data in the form of photos and in some cases tissue samples. Antibiotic pastes using amoxicillin has been shown to be effective in the field on the speices *Colpophyllia natans*, *Orbicella faveolata*, *diploria labyrinthiformis*, *pseudodiploria strigosa,* and *Montastraea cavernosa* (Neely et al., 2020). More information is needed to understand the frequency in which applying the antibiotic paste would be successful.

Dendrogyra cylindrus **Monitoring Update**

The colonies of *Dendrogyra cylindrus* being impacted by SCTLD was first brought to the attention of IU faculty by ANAMAR representative Jeanette Morales. FUNDEMAR had documented the reach of the disease to the Southern coast of Dominican Republic in mid-late August, 2022. In response to this information, IU established a collaboration with Jeanette Morales and ANAMAR to send her to document the spread of the disease on the largest colony at the GUAP site, *D.cyl* #3, Emma's colony. Jeanette took two visits to the GUAP site on September 2 and October 4, 2022. From those visits, she gathered qualitative data that was processed in the form of a photogrammetric model that shows the extent of tissue death due to SCTLD on the October visit (Figure 8). Having seen the extent of tissue loss in just one month's time, IU decided to send associate researcher Hannah-Marie Lamle to Bayahibe in order to survey all 14 IU studied colonies as well as create another photogrammetric model of Emma's colony in mid-November, 2022.

From IU's visit, a qualitative health analysis was conducted for all 14 colonies of *D.cyl* along Guaraguao reef, adjacent to the GUAP site. These colonies are shown on a map included in appendix a (figure 1). The notes from the qualitative health analysis is included in appendix B, table 1. It was noted that some colonies had extremely high levels of tissue loss when compared to May photos, while others had little to no tissue loss. Colonies that suffered the most included colony #3 (Emma), #7, #12, #13, and #14. These should be of highest importance to document upon IU's return to the GUAP site in May of 2023 to confirm colony death. Colony #3, Emma's colony, which had been documented extensively, is the largest colony and has multiple photogrammetric models made of it. Figures 2 through 5 show the spread of the disease from September, October, and November of 2022. It can be seen through the photographs that from October to November the disease progressed considerably, to engulf almost the entire colony. The photogrammetric model from November of 2022 is still being processed by IU researchers, and once completed will be used as another tool to quantify the amount of tissue loss from September to November 2022.

It is important to note potential trends in which colonies suffered more tissue loss than others, and two main trends have emerged from the visual data collected. One trend is that these colonies were already under stress in May, but signs of the disease were not yet present. In May, the colonies farther Northwest from the GUAP site (#12, #13, #14) all had polyps that were retracted, which is unusual for this particular coral species, who keeps their polyps fully extended all throughout the day. Now, apart from colonies #3 and #7, these three were also suffering the most from SCTLD. There could potentially be a connection between these two phenomena, as retracted polyps could have indicated a stressed state for these corals, which made them more susceptible to SCTLD. Perhaps that is the way that the virus had travelled along the reef, reaching from the Northwest to Southeast, however this theory does not seem plausible because currents in the area flow the opposite direction. Another potential theory is that colonies that were larger and protruded higher in the water column became effected first. Due to other studies conducted on how SCTLD spreads, we know the virus is found in the water, and thus could impact those colonies in the water column first. This is true for all colonies with the highest percentage of tissue loss except for colony #7, which does sit very close to the bottom. However, it is extremely hard to understand why these colonies were effected first and most severely, while other colonies of *D.cyl* appear to be unaffected. Figures 5-7 show the extent of tissue death of colonies #12, #13 and #14.

<u>**Implications of SCTLD to Guaraguao Reef**</u>

As mentioned previously in this report, *Dendrogyra cylindrus* is classified as a highly susceptible species to SCTLD, meaning that once the virus reaches a reef, it will be one of the first to be affected. This has been seen on Guaraguao reef, as nine out of fourteen colonies of *D.cyl* had suffered tissue loss due to SCTLD. Therefore, it is likely that in the coming months/years, we will see other less susceptible species become infected with SCTLD, which tends to decimate whole reefs over the course of 1-2 years. It was noted on IU's November trip that many large bouldering species of corals, most notably brain corals, had died on the artifacts of the GUAP. All of these colonies were healthy in May, however it is difficult to attribute their death to SCTLD. There is little preventative measures which can be taken to prevent coral death due to SCTLD, however some actions in other areas of the Caribbean have shown to slow the spread of SCTLD. These actions include more stringent enforcement of scuba diving gear washing after a dive, in order to potentially scrub the bacteria off gear to not transport it to another dive site. Also encouraging boats to be wary of when/where they fill up and let out their ballast, as that can also transport the bacteria. Actions to mitigate the amount of coral death would be the application of antibiotics to colonies that are fighting SCTLD, however this tactic takes a dedicated team that would be able to return to the reef daily to reapply the medicine on colonies and is not the most sustainable solution.

Appendix A: figures

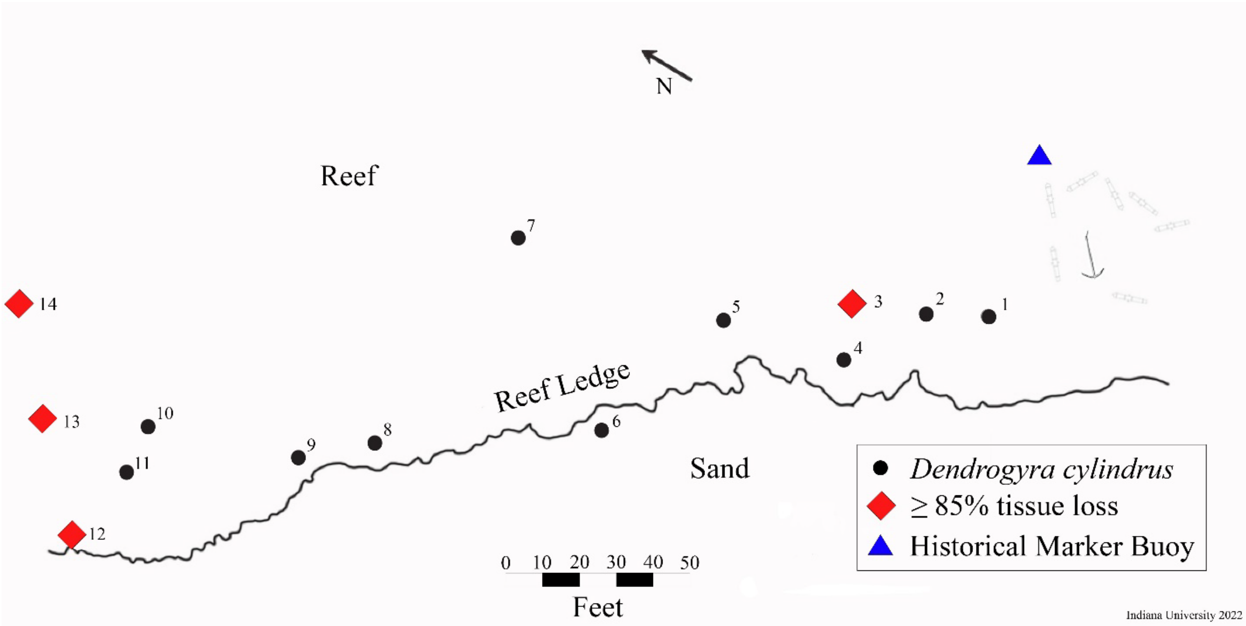

Figure 1: Map of Guaraguao Reef with healthy and diseased *D.cyl* colonies marked.

Figure 1: *Dendrogyra cylindrus* #3 in September 2022. Note the tip of tallest pillar is dead, with ring of diseased white tissue.

Figure 2: *D.cyl* #3 in August 2022, close up of tallest pillar.

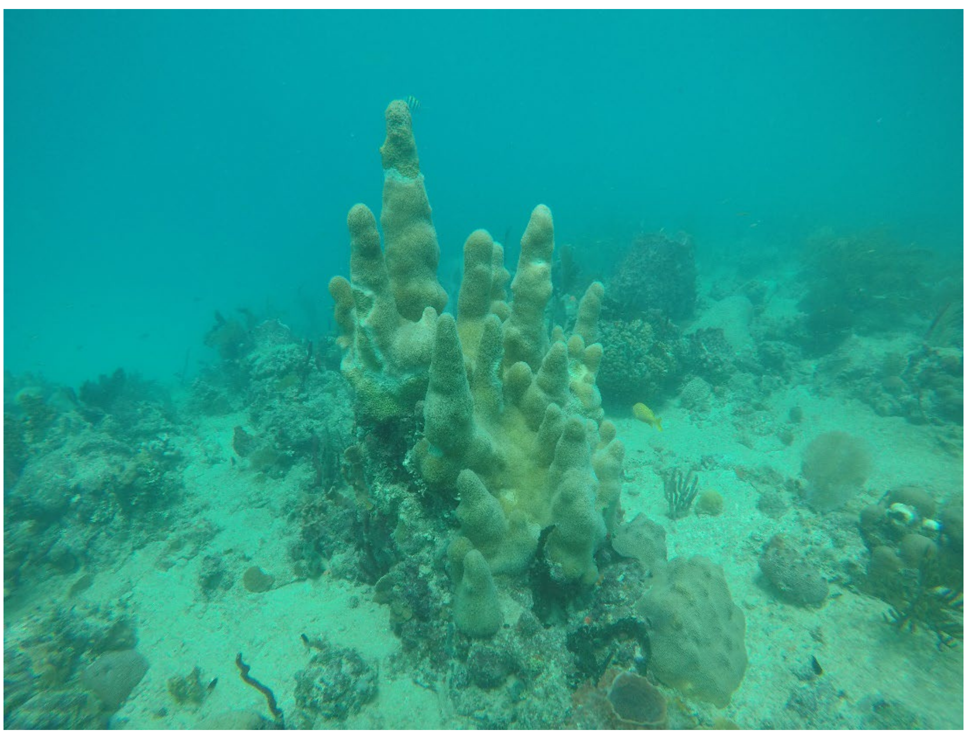

Figure 3: *D.cyl* #3 in October 4, 2022 with dead tissue reaching farther down on tallest pillar, and left side of colony diseased.

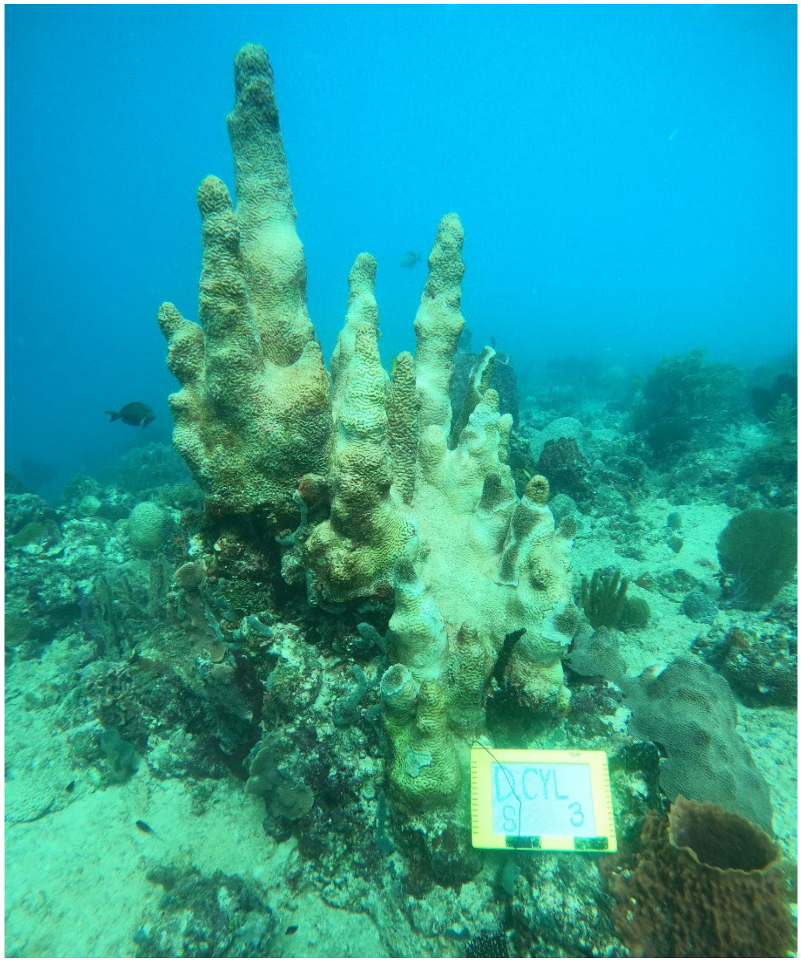

Figure 4: *D.cyl* #3 on November 20, 2022. Almost two months after last inspection colony is almost completely dead, tissue sloughing off skeleton.

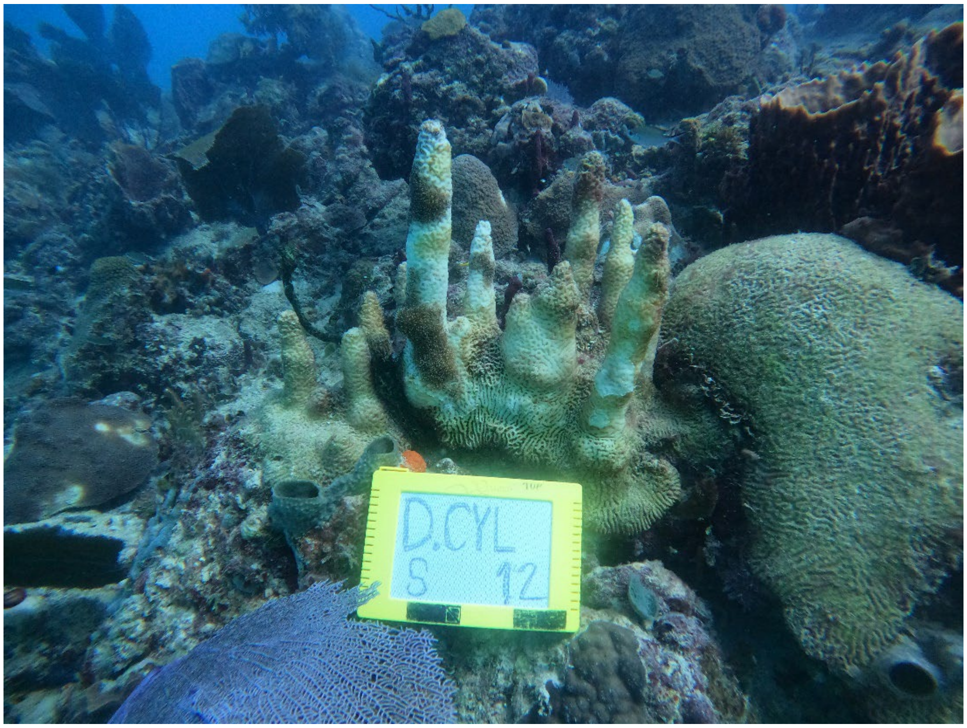

Figure 5: *D.cyl* #12 on November 20, 2022. Small patches of dark tissue remain on colony.

Figure 6: *D.cyl* #13 on November 20, 2022. Remaining tissue is almost all white, indicating diseased.

Figure 7: *D.cyl* #14 on November 20, 2022. Of what tissue remained alive in May, is now almost completely dead.

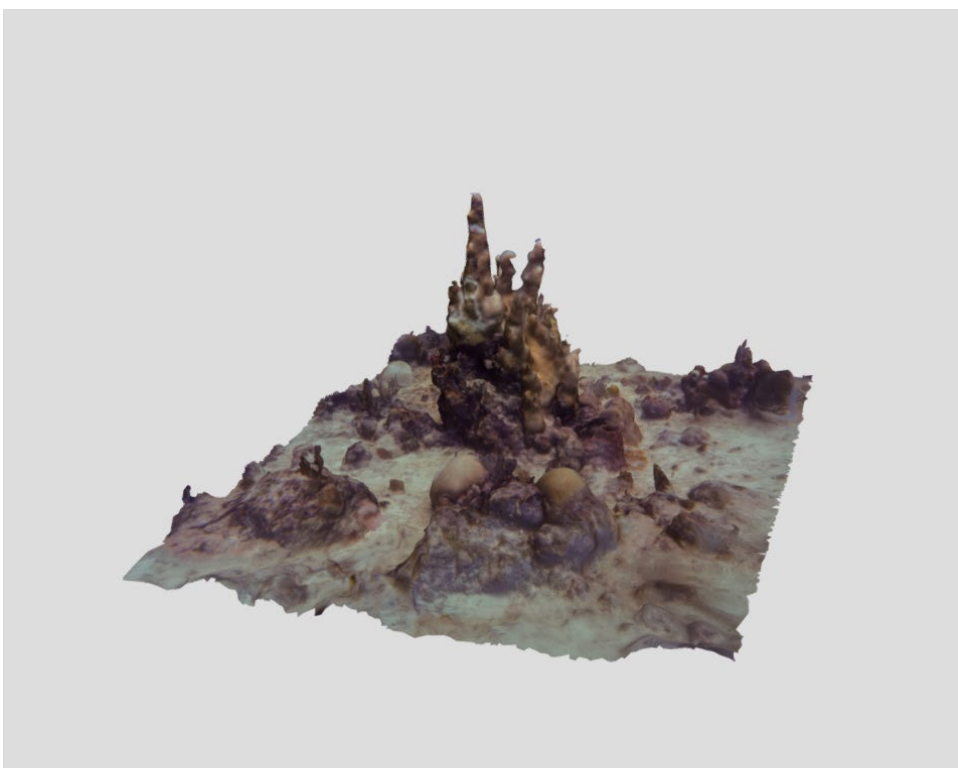

Figure 8: Photogrammetric model of Emma's Colony, created on September 30, 2022 showing small lesions of tissue loss.

Appendix B: Tables

Table 1: Qualitative Health Analysis

11/22 *D.cyl* Qualitative Health Analysis	
Colony	**Notes**
1	>5% tissue loss, slightly around edges of colony.
2	>5% tissue loss, no bleaching.
3	85% tissue loss. Flesh sloughing off skeleton.
4	>5% tissue loss, no bleaching.
5	35% tissue loss, spots with tissue are bleaching.
6	5% tissue loss, live tissue healthy.
7	65% tissue loss, live tissue healthy. Note polyps retracted close to dead tissue.
8	40% tissue loss, live tissue healthy.
9	>5% tissue loss. Broken cylinder. Small patches of bleaching.
10	60% tissue loss, live tissue healthy.
11	65% tissue loss, live tissue healthy.
12	90% tissue loss, live tissue healthy.
13	95% tissue loss, live tissue healthy.
14	90% tissue loss from May. Colony was already mostly dead. Live tissue healthy.

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