



Response to Stony Coral Tissue Loss Disease outbreak with antibiotic treatment.

Progress Report: August 2022 – October 2023

DRNA Permit #2021-SCTLD-002 (O-VS-SCT01-00002-22042021)

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Executive summary

Stony coral tissue loss disease (SCTLD) was detected in Puerto Rico around September 2019. Since then, different governmental and non-governmental agencies, accompanied by NGOs and private companies, have joined efforts to respond to this event. This report summarizes the efforts made by Sea Ventures Marine Response Unit (MRU) in responding to this disease between August 2022 to October 2023 with the support of NOAA Restoration Center and other partners. To date, a total of 2,705 colony treatments (Amoxicillin + Base2B) have been applied at least once during field efforts. To monitor the effect of the treatment in this reporting period, 80 colonies were tagged across two sites (40 colonies in Pinaculos and 40 Colonies in Turrumote). By October 2023 survival rate of treated *O.faveolata* colonies was 100% in Pinaculos and Turrumote, compared to 30% survival in control *O.faveolata* colonies. The survival rate of treated *C.natans* colonies was 90% in Pinaculos and 100% Turrumote, compared to 0% survival in controls for both sites . By the last visit, 83% were healthy, 3 % dead, and 15% disease. These 15% of diseased colonies needed reapplication of treatment due to the progression of previously treated lesions or the appearance of new lesions. Collaborative work has been key to carrying out the different efforts to apply treatment and detect the disease at the sites. It is recommended to continue visiting the reefs mentioned in this report since the disease persists, and many colonies whose lesions stopped may be reinfected again. A mass bleaching event occurred in late summer-fall 2023. Most colonies that have survived the SCTLD event are now bleached. It is important to keep track of the recovery of the bleaching condition and the potential increase in tissue loss lesions.

Study sites

Between November 2020 – October 2023, a total of 13 sites have been visited for treatment application (Figure 1a). During this period of work, some of these sites have been visited only once due to multiple factors such as time, logistics, budget, and disease dynamics. In the last year (August 2022 -October 2023) our approach was in 3 priority sites within La Parguera Natural Reserve: Pinaculos, Turrumote and San Cristobal (Figure 1b). These sites were selected due to the disease prevalence, accessibility, and the high abundance of large colonies of SCTLD susceptible species. This report is centralized in these sites, where 80 tagged colonies have been fate-tracked.



Figure 1. a) All sites visited since 2020, some of these sites have been visited only once due to multiple factors such as time, logistics, budget, and disease dynamics. b) Priority sites visited between August 2022 and October 2023 for SCTL treatment.

Research Permit

These field operations were carried out under DNER emergency permit No. #2021-SCTLD-002 (O-VS-SCT01-00002-22042021).

Treatment application

During the period of this report, antibiotic treatments were applied to diseased colonies in 3 priority reef sites with known SCTL D outbreaks: Pinaculos, Turrumote I and San Cristobal in La Parguera where an ongoing outbreak of SCTL D has been confirmed by various coral disease experts based on several logistical and biological criteria including accessibility, exposure to wave action, abundance and size of diseased colonies, and disease prevalence. Treatments consist of a mixture of human-grade Amoxicillin and the silicon-based paste Base2B following protocols by Neely et al (2020).

As part of the collaborative response efforts to SCTL D in Puerto Rico treatment material was provided to the PR-DNER as requested to expand the number of sites and colonies treated across sites.

Monitoring treatment effectiveness

To evaluate the effects of the treatment a total of 40 colonies were tagged in Pinaculos and 40 in Turrumote I, for a total of 80 tagged colonies. In each site, 10 *C. natans* and 10 *O. faveolata* were treated (treatment group) and 10 colonies of each species and site were not treated (control group).

During each visit, the number of lesions was annotated, and treatment was reapplied if there was the presence of active lesions only in the colonies of the treatment group. Tagged colonies were visited at variable frequencies ideally every 14-20 days after the initial treatment, but this depends on the weather conditions. For this reporting period, a total of 23 visits were conducted in Pinaculos, 22 in Turrumote and 10 in San Cristobal. Treatment effectiveness in the tagged colonies is presented here based on survival %. Other metrics to evaluate treatment effectiveness, such as disease prevalence per visit and changes in recent tissue mortality, can be extracted and analyzed in the project database.

Photos of each tagged and treated colony were taken and arranged in a time series sequence for analysis of the progression (or not) of the lesions so that before and after photos of each lesion were used to compare the tissue loss and obtain percent tissue mortality estimations. Effectiveness was defined as the cessation of disease progression at the treatment line. Meanwhile, ineffectiveness was defined as the lesion continuing unimpeded across the colony. An analysis of tissue mortality over time is underway as part of Yanelle Silva's UPR Department of Marine Sciences master's thesis project.

All the data and pictures generated from the treatment application were delivered to the DNER Coral Program staff and shared with different researchers from Puerto Rico through the monthly meetings convened by the DNER to update and discuss SCTL D status in Puerto Rico.

Data access

All SCTL D treatment interventions and roving diver survey data have been compiled into a unified database custody of Sea Ventures MRU. A copy of the treatment data has been shared with the PR-DNER monthly. The data matrix is accessible online in a google drive link:

<https://docs.google.com/spreadsheets/d/1VmQY27CBX9iIQE7gEAt7iXeRYJBdWMCgQVUP7qFXwKA/edit#gid=1037068128>

Results

In August 2022 Treatment of rare *O. faveolata* giant colonies has been successfully started at Pinaculos and Turrumote I (Figure 2). These colonies have a diameter and height of between 2 and 5 meters. In August 2022 these colonies presented the first SCTL D lesions and thanks to constant monitoring in collaboration with the UPR-Department of Marine Sciences. Treatment efforts were started before the disease lesions spread through these colonies.

In this reporting period (August 2022 - October 2023) a total of 2,705 colony treatments have been applied during 55 site visits across the 3 priority sites (23 visits at Pinaculos, 22 at Turrumote, and 10 at San Cristobal) by joint efforts between Sea Ventures and the Department of Marine Sciences University of Puerto Rico (Table 1). The total amount of applied treatment in this period was 200 Base2B treatment jars and 100 amoxicillin jars. The results of treatment efforts are detailed next.

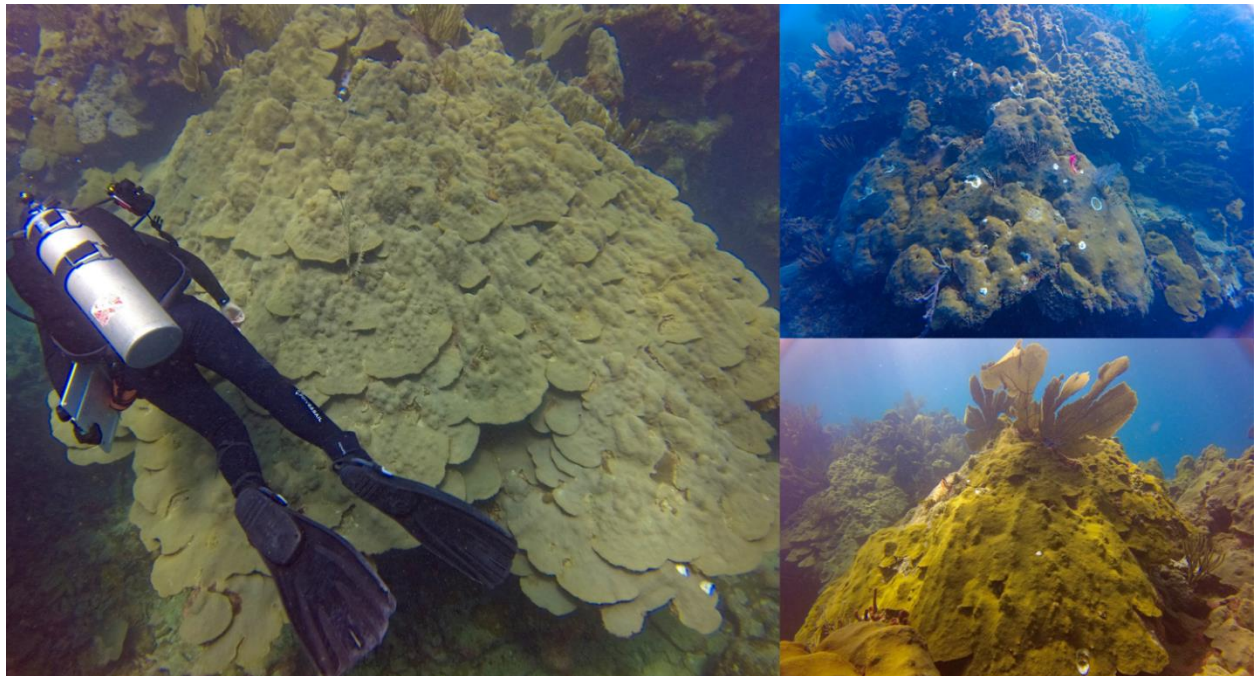


Figure 2. Example of *O. faveolata* giants at Pinaculos with initial lesions of SCTL D.

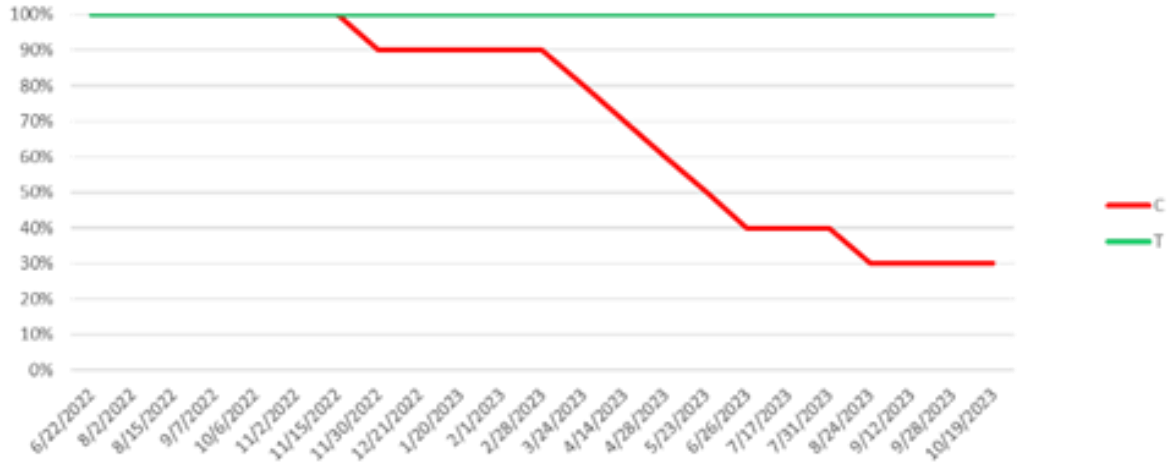
Treatment monitoring:

- By October 2023 survival rate of treated *O.faveolata* colonies was 100% in Pinaculos and Turrumote, compared to 30% survival in control *O.faveolata* colonies (Figure 3a).
- By October 2023 survival rate of treated *C.natans* colonies was 90% in Pinaculos and 100% Turrumote, compared to 0% survival in controls for both sites (Figure 3b).
- Changes in the percent recent mortality between treated colonies were indicative of disease progression in these two species. The mortality percent of *O. faveolata* colonies was 0% in both sites. In *C.natas* colonies was 0% in Turrumote but 10% in Pinaculos (Figure 3a and 3b). This suggests that the treatment helped halt the lesions in most colonies (Figure 4 and 5).
- Changes in the percent recent mortality between control colonies were indicative of disease progression in these two species. The difference in recent tissue mortality (between the most recent and the first visits) showed that 100% of the *C.natans* and 70% of *O.faveolata* control colonies died in both sites (Figure 3a and 3b). In *C.natas* colonies it is possible that the connectivity between polyps given the meandroid morphology causes rapid progression of the disease, causing faster mortality than *O.faveolata* (Figure 6).
- The proportion of tagged colonies that had visible active lesions (“diseased”), no active lesions (“healthy”), and to live tissue (“dead”) was annotated per visit to evaluate treatment effectiveness.
 - Controls: By the last visit, an average of 13% healthy, 85% dead, and 3% diseased.
 - Treated: By the last visit, 83% healthy, 3 % dead, and 15% diseased.
- However, many colonies without active lesions have been found bleached on the last date of the visit, with 98% either partially or totally bleached across the 45 tagged colony survivors that remained.
- Monitoring of tagged colonies allowed us to detect new lesions that appear even after several months after a colony was treated with success (Figure 4 and 5). This highlights the importance of continuous monitoring to increase the success of this treatment method.
- In the shallow area of the San Cristobal reef, treatment was constantly applied to *Pseudodiploria strigosa* giant colonies (Figure 7). Even though we don’t have marked colonies on this reef, the Sea Ventures team has observed that the treated lesions of these colonies have stopped.
- 10 visits have been made to San Cristobal with the intention of applying treatment to the giant *P.strigosa*.

a)

Orbicella faveolata

TURRUMOTE I
Survival %
Treatment vs. Controls



Pinaculos
Survival %
Treatment vs. Controls



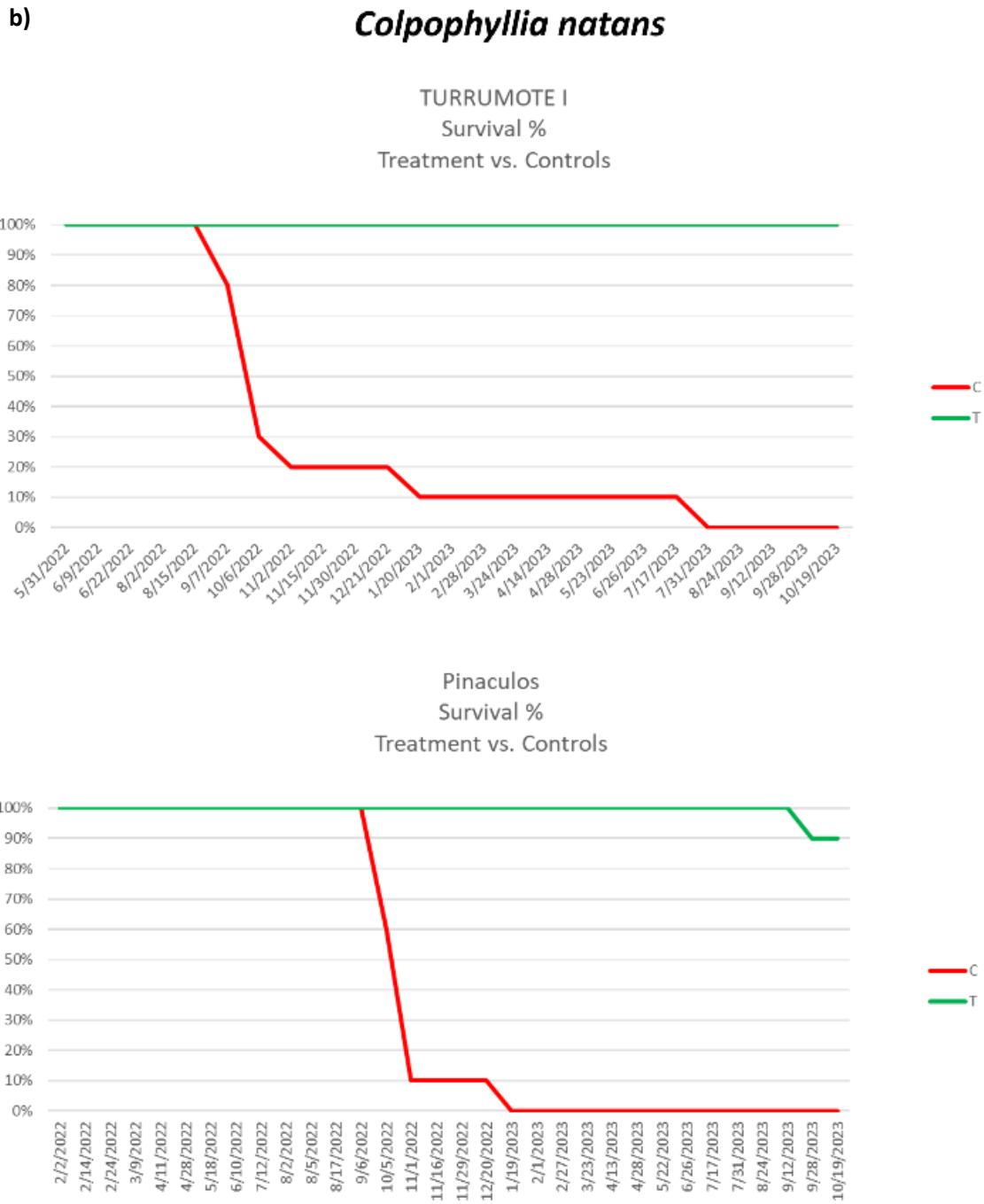


Figure 3. Survival rates over time for a) *Orbicella faveolata* and b) *Colpophyllia natans*. Green line represents colonies treated during each visit when active lesions were present. Red line represents control colonies, infected but never treated. N = 80 (10 colonies tagged per species, per treatment group, per site).

Table 1. Colony treatments and data of tagged colonies for treatment fate-tracking.

Site	# treated colonies (No tagged)	Ofav Surv. % Treated colonies	Ofav Surv. % Control colonies	Cnat Surv. % Treated colonies	Cnat Surv. % Control colonies	# Treatment Visits
Pinaculos	1103	100	30	90	0	23
Turumote I	1144	100	30	100	0	22
San Cristobal	458	n/a	n/a	n/a	n/a	10
Average / Sum	2705	100	30	95	0	55

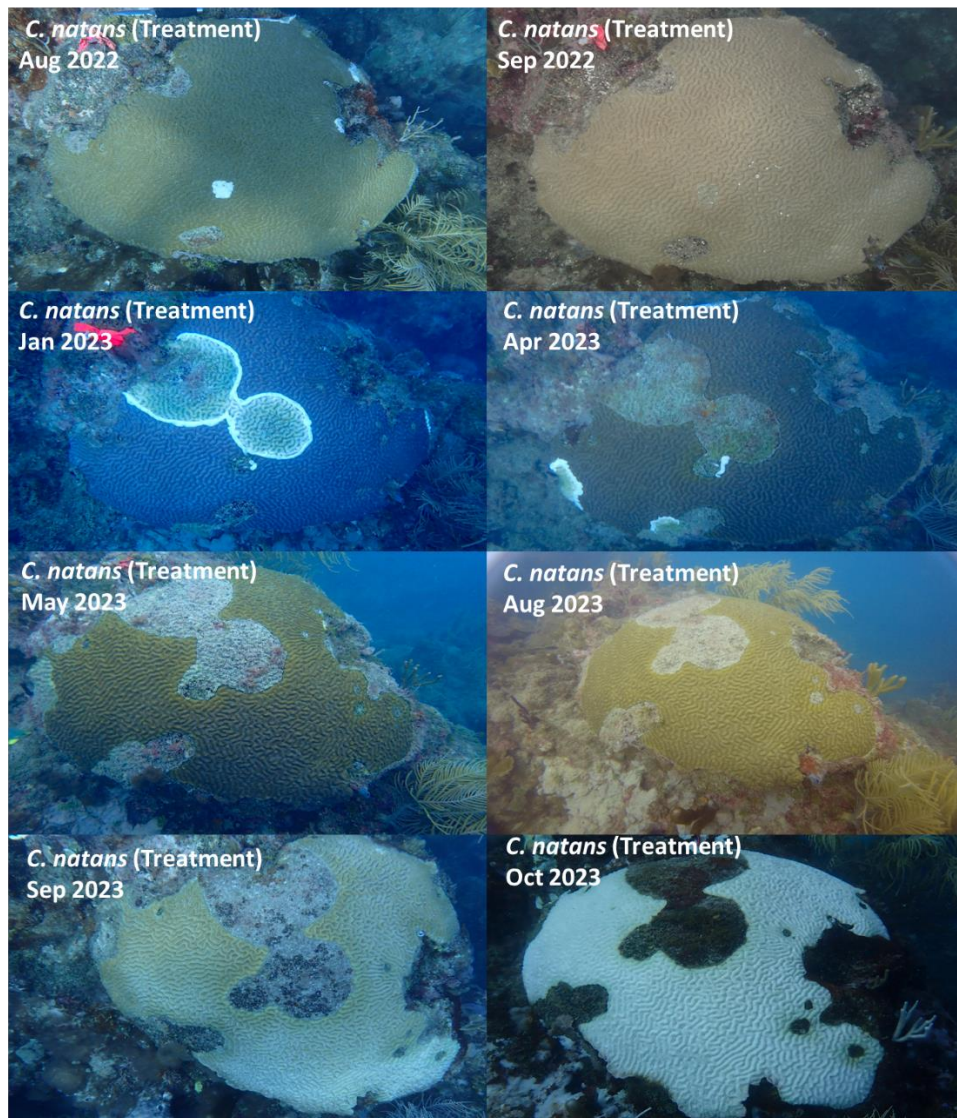


Figure 4. Example of lesion progression in a treated *C. natans* colony (tag# 793) at Pinnacles (La Parguera). Between August 2022 to October 2023 the treated lesions stopped but new lesions appeared, and in the last two months (Sep and Oct) the colony was bleaching.

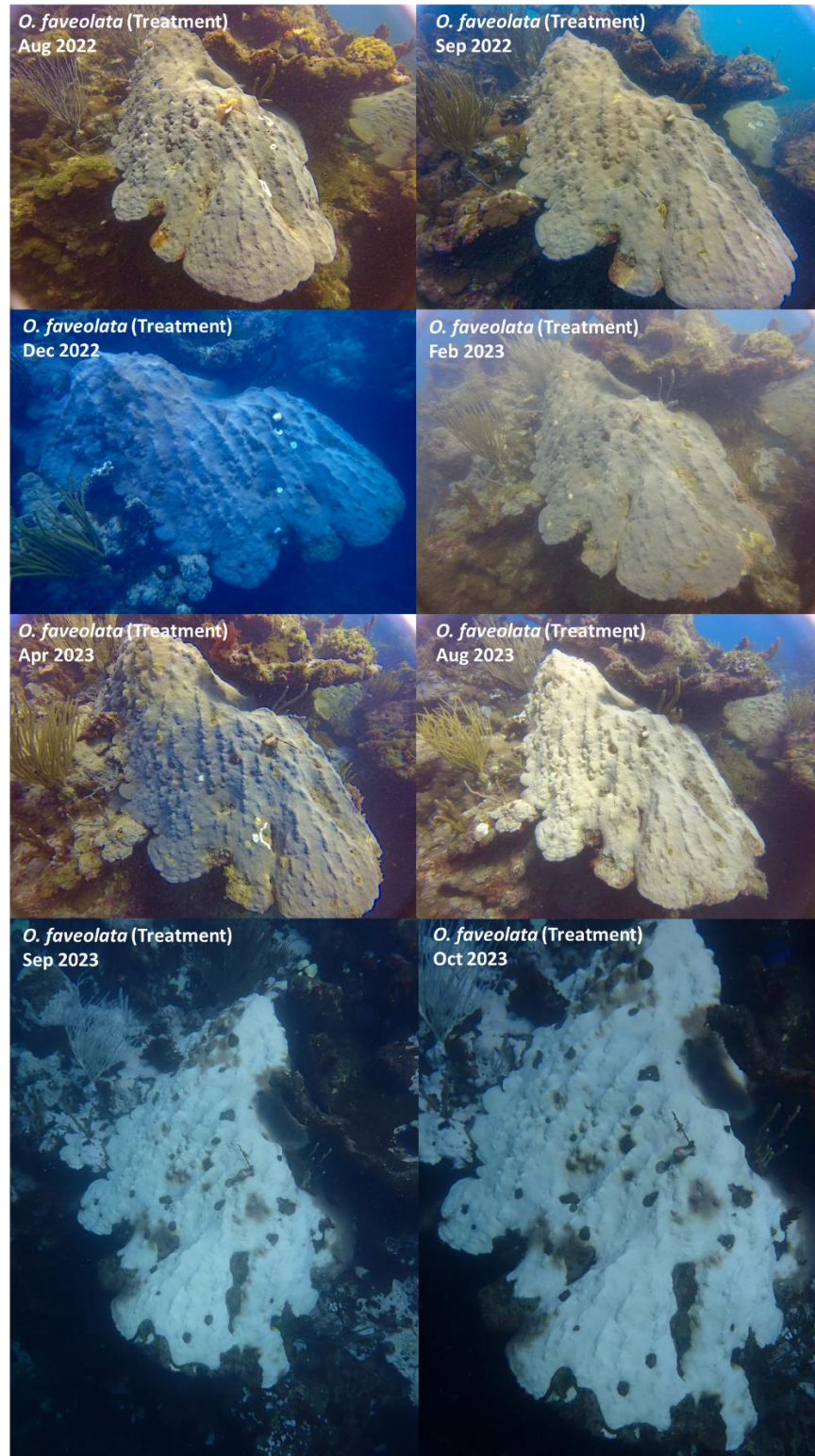


Figure 5. Example of lesion progression in a treated *O. faveolata* colony (tag# 385) at Pinnacles (La Parguera). Between August 2022 to October 2023 the treated lesions stopped but new lesions appeared, and in the last two months (Sep and Oct) the colony was bleaching.

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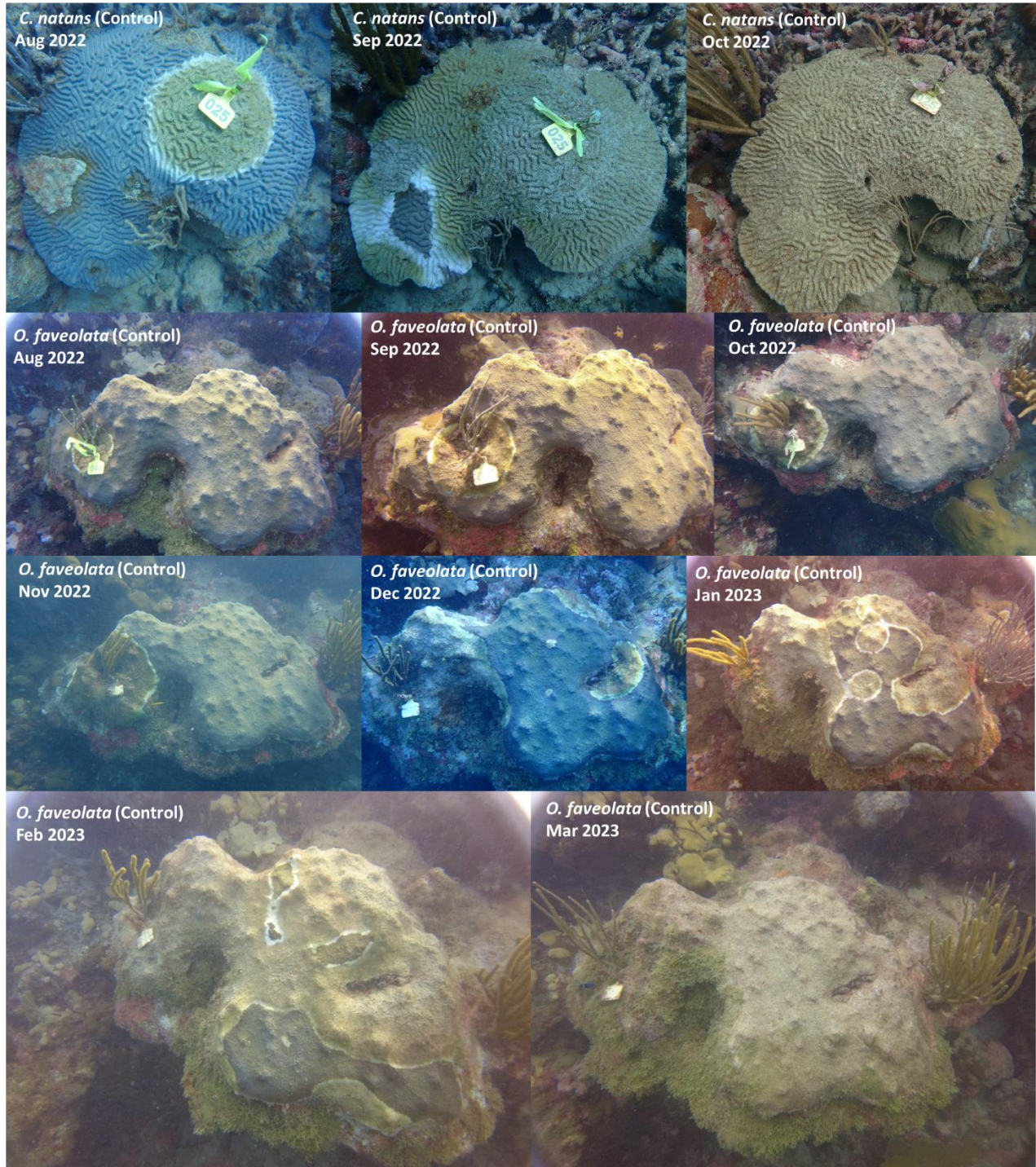


Figure 6. Example of control colonies of *C. natans* and *O. faveolata*. It can be seen that despite being of similar sizes and having lesions of equal sizes, *C. natans* died in 3 months vs *O. faveolata*, died in 8 months.



Figure 7. Example of *P.strigosa* giants at San Cristobal with initial lessons of SCTLD.

Conclusions and recommendations:

- B2B + Axicillin can be a very effective treatment option in *O.faveolata* and *C.natans*, given frequent monitoring and reapplication. To maximize the impacts of the treatments given the logistical and funding constraints to conduct this kind of response, resources should be focused on a few accessible sites where monthly to bi-monthly visits can be achieved.
- The time to repond to a disease outbreak in *C.natans* is much narrow than the time to repond to *O.faveolata* due to higher virulence of SCTLD in *C.natans*. However, in *C.natans* the treatment benefits are more evident than in *O.faveolata*.
- It is recommended to continue treatment and monitoring efforts in these important reefs with giant colonies where the bleaching has recently arrived. Monitoring giant *O.faveolata*, *C.natans* and *P.strigosa* colonies is very important since few places are found with this type of giant colony and is possible after bleaching event a high outbreak of SCTLD re-emerges.
- A mass bleaching event occurred in late summer-fall 2023. Most colonies that have survived the SCTLD event are now bleached. It is important to keep track of the recovery of the bleaching condition and the potential increase in tissue loss lesions.