Understanding sargassum brown tide and its effect on corals in Barbados

Comprender la marea marrón del sargazo y su efecto en corales de Barbados

Comprendre la marée brune des sargasses et ses effets sur des coraux à la Barbade

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EXTENDED ABSTRACT

INTRODUCTION

Sargassum is a brown pelagic seaweed that has been seasonally inundating the windward coasts of Caribbean islands and mainlands over the last 15 years. During large sargassum influxes, sargassum can settle within the nearshore where it decomposes resulting in an increase in nutrients and organic matter referred to as sargassum-brown-tide (sbt). One of the major effects of sbt is a decrease in water quality which negatively affects marine life (Carrillo et al. 2016). Several studies in Mexico found that areas covered in sbt experienced increases in organic material, turbidity, ammonium and phosphorus and decreases in illuminance, pH and dissolved oxygen (DO) (van Tussenbroek et al. 2017; Cabanillas-Terán et al. 2019). Sbt results in eutrophication due to increases in nitrogen and phosphorus, which is one of the major threats to coral reef and seagrass ecosystems (van Tussenbroek et al. 2017; Pérez-Gómez et al. 2020; Camacho-Cruz et al. 2022). Due to the proximity of some coral reefs to the nearshore, sbt can extend over them, which is concerning as corals require oligotrophic water for optimal health. To better understand how sbt affects water quality and identify any related adverse effect on corals, water quality in the nearshore and on top of coral reefs was monitored along with two species of corals on select Barbadian coral reefs.

METHOD

Eight coral reef sites around Barbados were selected to be monitored based on the level of exposure to sargassum influxes: high sargassum exposure (one on the east coast), medium (three on the south coast), low (two on the south coast) or no exposure (two on the west coast). The overall aim is to have four rounds of data collection at each site: two during the low sargassum season (winter) and two during the peak sargassum season (spring/summer) to examine how water quality and coral health changes with the presence of sbt. Currently, two rounds of data collection have taken place, once during the low sargassum season (Jan/Feb 2024) and once during the peak sargassum season (June/July 2024). To determine the level of sargassum exposure experienced before and during each survey period, satellite imagery, beach monitoring cameras, word of mouth and personal experience were used. During each survey, the water quality in the nearshore and on top of reefs at each site was monitored using a handheld probe. The main parameters tested for were turbidity, dissolved oxygen (DO), and fluorescent dissolved organic matter (fDOM). To determine how sbt affected coral health, coral surveys were conducted. Two species of corals, *Porites astreoides* and *Pseudodiploria strigosa,* were monitored at each site. The health (healthy, bleached, pale, diseased) of the coral colonies was visually determined and documented. Abundance and live coral cover were also recorded but preliminary analysis focused just on health. To monitor changes in nutrient origin and content, three samples of macroalgae (*Dictyota sp.*) were collected from each site during each round of data collection and tested for C^{13} and N^{15} isotopes. Generalized Linear Mixed-Effects Models with survey sites as a random effect and sbt exposure as a fixed effect were used to determine if there was any statistically significant relationship between the changes in water quality, coral health and macroalgae nutrient origin and content, and the level of sbt exposure.

RESULTS AND DISCUSSION

The GLMMs showed that turbidity and fDOM increased significantly ($p < 0.05$) with sbt exposure. As sbt decomposes it releases leachate and causes discoloration, which explains the results seen. Interestingly, DO showed no significant difference with the presence of sbt. There was also no significant difference in the C^{13} isotope across sites and periods; however, there was a significant difference in the N^{15} isotope (Figure 1). Higher exposure to sbt led to a decrease in N^{15} isotope (Figure 1). This means that when sargassum decomposes it releases the lighter N^{13} isotope which is then taken up by the macroalgae. Even though nutrient enrichment was expected, there was no significant difference in the C:N ratio. In relation to changes in coral health, the two species differed in the temporal pattern of healthiness. *P. strigosa* was healthier

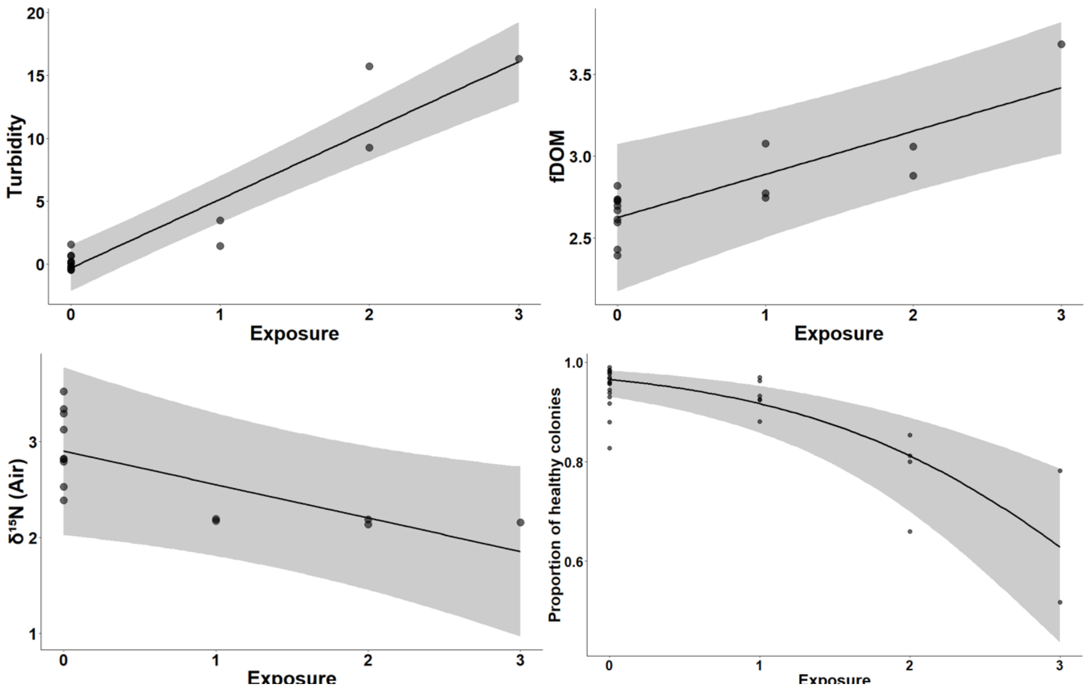

Figure 1. The effect of sbt exposure (0-3; 0 = no exposure, 3= high exposure) on turbidity, fDOM, N15 isotope, and the proportion of healthy colonies

in the summer, but *P. astreoides* was healthier overall (Figure 2). It is important to note that bleaching and SCTLD likely drove some of these patterns particularly during winter 2023 which was a bleaching year. When it came to sbt, the model showed that sbt exposure was negatively associated with healthiness of coral colonies ($p < 0.05$) (Figure 1).

Given that sbt led to an increase in turbidity and fDOM, and corals require oligotrophic water for optimal health, it is likely that sbt significantly contributed to the decrease in coral health. Moving forward, two more rounds of data collection will take place again in the winter (Dec 2024/ Jan 2025) and the summer (Jun/Jul 2025) to have a

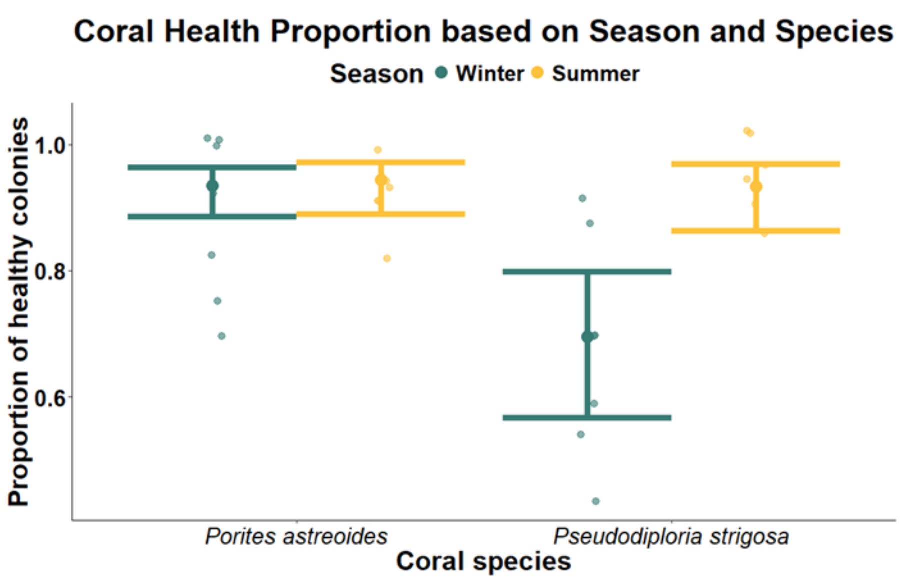

Figure 2. Residuals based on GLMM model showing the interaction between season and species in model1.1 after accounting for the effect of exposure

larger dataset so that a definitive conclusion can be made. Additionally, more water quality data will be collected on top of reefs using the handheld probe when sbt is present so that there is a better understanding about the diffusion of sbt towards the reefs and how the water quality is affected. This will also help with determining any relationship between coral health and sbt exposure. At the end of the last survey period, DO, Photosynthetically Active Radiation and salinity loggers were installed at three sites to monitor the changes in water quality over time. This was done to examine how water quality changes as sbt forms as well as to see if there are any other changes in water quality unrelated to sbt that can affect coral health. During the upcoming winter survey, the data from these loggers will be collected to see how water quality changed in the past six months. The loggers will then be reinstalled at the same sites. Recognising that bleaching is becoming a more prevalent issue for the region, it is important to determine if changes in coral health are a result of sbt, bleaching or both and one way to accomplish this is by monitoring SST using these loggers. Satellite products will also be used to help fill in gaps and gather more information about water quality in the nearshore.

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