Ecological consequences of the rapid spread of the Stony Coral Tissue Loss Disease in Cozumel

Consecuencias ecológicas de la rápida dispersión del Síndrome Blanco en Cozumel

Conséquences écologiques de la propagation rapide de la maladie de la perte de tissu corallien à Cozumel

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EXTENDED ABSTRACT
Coral reefs have shifted away from coral dominance over the past few decades compromising the ecosystem stability, hence reducing their capacity to support important ecosystem services and biodiversity (Hughes et al., 2017; Perry & Alvarez-Filip, 2019). Particularly for the Caribbean, disease outbreaks have emerged as significant drivers of coral mortality, over the years, these events have increased in frequency and intensity and have been often related to multiple pressures, such as rising sea surface temperatures and decreased seawater quality (Van Woesik & Randall, 2017). The Stony Coral Tissue Loss Disease (SCTLD) is a novel and unprecedented white plague disease first observed off the Florida coast in 2014, affecting >20 coral species (Precht et al., 2016; Kramer, Roth & Lang, 2019; Alvarez-Filip et al., 2022). The exact putative agent is still unknown, although virus viruses of the algal symbionts have also been reported in recent studies (Work et al., 2021) and sediments have been identified as possible sources of transmission (Aeby et al., 2019; Muller et al., 2020; Rosales et al., 2020). For the Mexican Caribbean, the onset of the SCTLD occurred in the summer of 2018 for mainland reefs, changing the structure of coral communities and decreasing their physical functionality (Estrada-Saldívar et al., 2020; Alvarez-Filip et al., 2022). But in December 2018, the SCTLD was first observed on the western coast of Cozumel Island, one of the healthiest reef systems in the Caribbean. In this study, we integrated data from multiple survey protocols conducted between July 2018 and April 2020 to track the progression of the outbreak in the SW Cozumel and to assess the impacts of the SCTLD on coral communities and the benthic composition of reefs, by quantifying changes in the cover of corals and algae. We also investigated whether the coral bleaching event from autumn 2019 further exacerbated coral mortality. We used three complementary approximations to assess the spread and impacts of the SCTLD outbreak. First, to track the spread of the disease across the MPA, we conducted prospective surveys during February and March 2019 in collaboration with Park Authorities and local dive shops. Where a diver trained in coral disease identification joined commercial drift diving trips to survey 10 sites. At each site all coral colonies found within 4 m across the field of vision of the diver were registered, recording species identity, presence of SCTLD, and mortality for each diseased colony. Second, to assess the impacts of SCTLD and bleaching, from July 2018 to April 2020, we surveyed the coral communities of six reef sites during different periods and four reef sites over a single period. To evaluate coral communities we used both bar drop and belt transect methods (Lang et al., 2012; Searle et al., 2014), for both methods the species identity, colony size (maximum diameter, diameter perpendicular to the maximum diameter, and height), percentage of bleaching, percentage of mortality (recent, transient, and old), and the presence of SCTLD or other diseases were registered (Lang et al., 2012). We also included colonies with 100% recent mortality which could be attributed to SCTLD. Using the data obtained from the coral surveys, we then calculated SCTLD prevalence for each site, time period, and coral species. To explore geographical and temporal trends we focused only on the most highly susceptible species, for which we only considered those with more than 10% prevalence. For the disease prevalence, we considered both diseased and recently dead colonies. Lastly, to estimate changes in the cover of corals, algae, and other benthic components, we conducted benthic surveys between July 2018 and July 2019 using the Mesoamerican Barrier Reef System protocol (Almada-Villela et al., 2003). We compared the coral and algae cover between July 2018 and July 2019 for each reef. We also tested for possible changes in dominance between coral and macroalgae cover between July 2018 and April 2020. To test significance a univariate comparison of coral and algae cover was performed. We also tested for possible changes in dominance between these two benthic components, for which we estimated the ratio between the percentage cover of coral and algae, always using the lowest value of these two coverages as the denominator and the highest value as the numerator, thus we could always yield the proportion in relation to the dominant group. Our findings showed that the SCTLD spread throughout the SW coast of Cozumel in only two months and reached a peak in five months. Species of the families Meandrinidae, Faviinae, and

Montastraeidae reached between 33%-95% of mortality. The overall coral cover of the six reefs surveyed decreased significantly from 26.35±2.21 in July 2018 to 14.71±1.49 in July 2019, whereas algae cover increased from 40.92±2.74 to 50.64±2.23. Chankanaab was the only site that did not experience an increase in July 2019, whereas algae cover increased from 40.92±2.74 to 50.64±2.23. Chankanaab was the only site that did not experienced an increased in algae cover, likely because the reef had very high algae cover, prior to the SCTLD outbreak. In July 2018, a clear dominance of algae over coral was not observed, but some transects in some reefs had between 2-10 fold more coral cover than algae. Unfortunately in 2019, the great majority of the transects had a higher proportion of algae than corals. Bleaching began to be observed in July 2019. Still, the effects of sustained thermal stress became evident between October and November 2019, when a rapid increase in the percentage of bleached colonies was observed. Despite widespread coral bleaching, coral mortality resulting from this event was low, even in colonies that were not affected by the SCTLD, presented 100% bleaching, and did not present tissue mortality. The increase in coral mortality left available substrate for other organisms to colonize and grow, and in this study, a significant increase in algae cover was found after the outbreak. The SCTLD is radically changing the ecology of coral reefs by decimating the populations of key-builders and reconfiguring the benthic assemblages. Although coral diseases have been widely related to thermal stress events (Randall & Van Woesik, 2017), our study showed that neither disease prevalence nor the rate of tissue loss in infected colonies increased as water temperatures warmed. In Cozumel, the SCTLD triggered a coordinated and dedicated collaborative effort between academics, MPA authorities, and the tourism sector to track the disease and raise awareness among the community. These collaborations are key to improving coral reef management, along with restoration actions that must be focused on fully addressing coral threats in order to improve ecosystem resilience

KEYWORDS: SCTLD, reef monitoring, coral mortality, coral disease outbreak

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