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ORIGINAL PAPER

Back-to-back bleaching events in Peninsular Malaysia (2019–2020) selectively affect hard coral taxa across- and within-reef scales

Sebastian Szereday[1] · **Christian R. Voolstra**[2] · **Affendi Y. Amri**[3]

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Abstract

The impacts of (repeat) bleaching events and the differential heat stress susceptibility of hard coral taxa are largely unknown in Malaysia, although it is part of the greater coral triangle. Here we determined bleaching trajectories of 46 hard coral taxa across- and within-reef scales based on data recorded during the first reported back-to-back coral bleaching occurrences in Malaysia between May 2019 and September 2020. Although the severity of coral bleaching in both years did not correspond to the rather small magnitude of heat stress observed, i.e., Degree Heating Weeks (DHW) of 1.05 °C-weeks and 0 °C-weeks in 2019 and 2020 respectively, we observed high levels of bleaching (55.21% and 26.63% of all surveyed colonies in 2019 and 2020, respectively). Notably, the bleaching response for both consecutive years was highly taxon-specific and significantly varied across- and within-reef scales. Mortality rates overall were low following the 2019 event, likely due to a rapid decrease in heat stress. Five of the 46 surveyed hard coral taxa exhibited more severe bleaching in 2020, despite a lower heat stress load. Interestingly, we observed low bleaching of ascribed susceptible taxa such as *Acropora* and *Montipora*, while we found taxa considered to be resilient, e.g. *Heliopora* and *Porites*, to exhibit severe bleaching, suggesting a reversal of bleaching hierarchies of taxa over time. Our findings provide a foundation for further coral bleaching studies in a region with few published records to enable more accurate regional assessments and to follow the trajectory of future coral bleaching events.

Keywords Coral bleaching · Malaysia · Climate change · Ocean warming · Coral reef · Mortality

Introduction

Coral bleaching refers to the whitening of coral tissue due to the disruption of the coral-Symbiodiniaceae relationship under heat stress. Although several stressors can induce bleaching (Jaap 1979; Lesser 2011; Rädecker et al. 2021), the association between the coral host and its specific algal endosymbiont assemblage is considered to contribute to bleaching susceptibilities of coral taxa (Baker et al. 2004; Hume et al. 2020). Under non-stressful conditions, photosynthetic Symbiodiniaceae algae provide the coral's energy requirements to build calcium carbonate skeletons, which in turn provide the backbone of the three-dimensional structure of coral reefs and habitat for one third of all described marine species (Muscatine 1990; LaJeunesse et al. 2018).

The spatial and temporal extent of thermal stress events are increasing in all ocean basins (Skirving et al. 2019; Eakin et al. 2022; Reimer et al. 2024), making the understanding of the cumulative and interactive impacts of repeat (i.e., back-to-back) bleaching events a critical component for accurately projecting the future of reef ecosystems and to implement active interventions (Hughes et al. 2021; Voolstra et al. 2021). It is no longer feasible to fully understand the impacts of coral bleaching by investigating isolated events, nor to assess ecosystem states without considering the legacy effects of previous disturbances (Hughes et al. 2019; Slattery et al. 2019; Johnston et al. 2020; Evensen et al 2022; Lachs et al. 2023). In particular, because coral species exhibit differential susceptibility to

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✉ Sebastian Szereday
sebastian@coralku.org

✉ Christian R. Voolstra
christian.voolstra@uni-konstanz.de

[1] Coralku Solutions, Non-Profit Organization for Coral Reef Research and Restoration, Kuala Lumpur, Malaysia

[2] Department of Biology, University of Konstanz, Constance, Germany

[3] Institute of Ocean and Earth Sciences (IOES), Universiti Malaya, Kuala Lumpur, Malaysia