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TITLE: Marine Heatwave Hotspots in Coral Reef Environments: Physical Drivers, Ecophysiological Outcomes, and Impact Upon Structural Complexity

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ABSTRACT:

A changing climate is driving increasingly common and prolonged marine heatwaves (MHWs) and these extreme events have now been widely documented to severely impact marine ecosystems globally. However MHWs have rarely recently been considered when examining temperature-induced degradation of coral reef ecosystems. Here we consider extreme, localised thermal anomalies, nested within broader increases in sea surface temperature, which fulfil the definitive criteria for MHWs. These acute and intense events, referred to here as MHW hotspots, are not always well represented in the current framework used to describe coral bleaching, but do have distinct ecological outcomes, including widespread bleaching and rapid mass mortality of putatively thermally tolerant coral species. The physical drivers of these localised hotspots are discussed here, and in doing so we present a comprehensive theoretical framework that links the biological responses of the coral photo-endosymbiotic organism to extreme thermal stress and ecological changes on reefs associated after MHW hotspots. We describe how the rapid onset of high temperatures drives immediate heat-stress induced cellular damage, overwhelming mechanisms that would otherwise mitigate the impact of gradually accumulated thermal stress. The warm environment, and increased light penetration of the coral skeleton due to the loss of coral tissues, coupled with coral tissue decay support rapid microbial growth in the skeletal microenvironment, resulting in the widely unrecognised consequence of rapid decay and degeneration of the coral skeletons. This accelerated degeneration of the coral skeleton on a reef scale hinders the recovery of coral populations and increases the likelihood of phase shifts towards algal dominance. We suggest that MHW hotspots, through driving rapid heat-induced mortality, compromise reefs' structural frameworks to the detriment of long term recovery. We propose that MHW hotspots be considered as a distinct class of thermal stress events in coral reefs, and that the current framework used to describe coral bleaching and mass mortality be expanded to include these. We urge further research into how coral mortality affects bioerosion by coral endoliths.

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