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Heatwave Occurrences, Bleaching in Sponges was Reported on Temperate Mesophotic Reefs

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Abstract

Extreme climate change-related occurrences, such Maritime Heatwaves (MHWs), can have a significant negative influence on ecosystems. Thermal stress frequently causes localised die-offs and observable evidence of damage, as organism bleaching. While these effects are frequently reported in shallower habitats, deeper Mesophotic Ecosystems (MEs), where data collection is more expensive, have received less attention. However, these deeper ecosystems frequently exhibit biodiversity and serve crucial ecological functions, making it crucial to comprehend how climate change will affect these depths. Here, we investigate bleaching in a cup sponge' morphospecies' (i.e., morphologically different animals easily detected in imaging) in MEs across eastern Tasmania, an area undergoing fast ocean warming, using benthic imagery taken as part of a large-scale monitoring programme. We observe a rise in the frequency and there is currently no proof of widespread death as a result of bleaching, despite signs of bleaching in surveys following MHWs.

Keywords: Mesophotic reefs • Ecosystems • Morphologically • Bleaching • Marine heatwaves

Introduction

Our findings imply that this cup sponge morphospecies may be valuable for monitoring the effects of climate change on MEs in the area. Future work should focus on gaining a deeper knowledge of this morphospecies' physiological range limits and timing surveys to more closely monitor MHW episodes. Since sponges are a significant and prominent part of temperate MEs, it should be a continuing priority to monitor how climate change is affecting sponges throughout these ecosystems. Due to the increased frequency and severity of extreme oceanographic events linked to climate change, coastal marine ecosystems are undergoing significant changes. This is especially true in areas where thermal regimes have been drastically altered as a result of altering oceanographic conditions. "Marine heatwaves" are a phenomenon that can occur when warmer temperatures persist for a long time. In recent decades, these occurrences have become more frequent and severe, with a yearly increase in MHW days of, on average, 50% worldwide. The communities that make up shallow-water temperate habitat are changing as a result of the increased frequency of MHWs, which may have an impact on both the ecosystem's structure and function as a whole as well as the human populations who depend on it.

Programs of long-term, extensive monitoring are very useful for comprehending the reaction. Understanding the reaction of complex and nutrients. Under scenarios of future climate change, sponges in tropical locations may benefit because several species have been found to be more tolerant of warming and acidity than other dominant benthic species, such as corals. However, like corals that have symbiotic algae, many sponges contain Due to heat stress, symbiotic zooxanthellae may be more prone to increases in bleaching, necrosis, illness, and mortality. As a part of larger research looking at coral bleaching events, the majority of studies looking at the effects of temperature stress on sponges have concentrated on shallower tropical locales. Research in temperate regions are less common, and there are currently no studies covering broader latitudinal extents in temperate regions where temperature gradients exist across time.

Monitoring sentinel species, which may provide early warnings of consequences, is especially important in areas where ocean surface temperatures have changed quickly and are expected to do so in the future. One such area is the waters off Tasmania's east coast, which are regarded as a global hotspot for marine climate change. The deeper encroachment of the Extreme occurrences has increased due to the East Australian Current's (EAC) deepening penetration, and a 2°C - 4°C change between 1990 and 2060 has been anticipated. A range-extending urchin species' overgrazing in this region has had profound effects on shallower kelp-dominated ecosystems. However, because it is expensive to obtain monitoring data at these depths, effects on organisms in nearby MEs are less thoroughly documented. In MEs, the environment is often more stable and has the ability to offer protection against MHWs or long-term refugia. On the other hand, communities in MEs can be more vulnerable because to a lack of prior exposure to similar catastrophes. Understanding how MHWs affect MEs It is crucial to comprehend how MHWs affect MEs because these ecosystems frequently sustain lucrative fisheries and frequently contain undescribed biodiversity. Because it is currently difficult or impossible to taxonomically identify many species in MEs from imagery, scientists frequently concentrate on "morphospecies." These visually identifiable, morphologically distinctive organisms are known to correlate well with true taxonomic diversity.

Here, we assess the prevalence of bleaching in a noticeable and widespread cup sponge morphospecies between 2007 and 2016 using benthic imagery from an Autonomous Underwater Vehicle (AUV) that spans a latitudinal gradient of about 350 km (from 40.46 to 43.62° South). Additionally, we look at the frequency and timing of MHW events over this as a potential catalyst for bleaching occurrences. employing a Bayesian spatial modelling technique, where images serve as the basis for the analysis and spatial correlation between images is taken into account for more information see, the proportion of bleaching over time can be determined. The number of bleached people in an image represents the number of "successes," while the overall number of people represents the number of trials. We handled the response as a binomial. Depth was considered as a continuous covariate while the survey year was treated as a categorical variable. The intercept estimate represents the initial survey for each site. To estimate changes in abundance, a second model with a Poisson response was provided for the combined bleached and unbleached counts of the target cup sponge morphospecies.

All of the modelling was done and statistics package's Integrated Nested Laplace Approximation method was used for all modelling. The identical Bayesian were applied. The posterior distributions for each effect are provided because the model fixed effect estimates are Bayesian. Evidence for an effect is defined as the distributions that do not include zero in the 95% credible range and greater effects are distributed further from zero. The posterior distributions for each pairwise comparison's linear combinations were looked at in order to perform post hoc comparison

for the survey year. Since there were just two sampling events in Flinders Northwest, this comparison was not made. Estimates of the model coefficients are on the logit scale, and bleaching probabilities were determined by computing the inverse logit. Coefficient estimates for the count-based model are on the log scale and multiplicative variations in mean counts per image. From the Eastern Tasmania Ocean Circulation Model (ETAS), which provides 3D records for the time period, daily ocean temperature records at depth were recovered. The closest grid cell (about 20 km–30 km distant) had to be used as a stand-in for the temperature record for these sites because the ETAS model did not cover the Flinders AMP sites. Though similar patterns were found in the shelf waters and sites included in this region, an exploratory analysis revealed them. Between the surveys in 2013 and 2017, bleaching increased at both Flinders sites. This was due to a significant MHW episode in 2014, during which temperatures peaked at more than 1.0C over the 90% seasonal threshold and persisted for 16 days. At both Flinders sites, the likelihood of bleaching about doubled between surveys. The sole summers MHWs at Freycinet happened before the initial survey, although this location had the highest overall risk of bleaching.

Between the first 2011 survey and the survey in 2014, there was noticeably less bleaching, and the likelihood of bleaching in 2016 was comparable to that of 2011. Between 2009 and the poll in 2010, the likelihood of bleaching nearly quadrupled. Between these two surveys in the summer of, MHW took place. In comparison to MHW happening in the summer of 2013, a larger likelihood of bleaching was maintained in 2014. The occurrence of bleaching in a cup sponge morphospecies throughout MEs on Tasmania's east coast for the first time. Surveys conducted after MHW episodes revealed increased bleaching, indicating that this may be the cause of the bleaching that has been seen. Coral bleaching has been shown to last for more than a year; however, sponge bleaching after warming events has not been as well documented, and it is unclear how long our cup sponge morph species will continue to bleach. This suggests that surveys need to be to be more closely coordinated with MHW events. This area is recognised as a "hotspot" for marine global warming, with warming events expected to become more severe and frequent in the decades to come. Changing oceanographic conditions and global warming's effects on shallow reef systems in that present what appears to be an early warning indication of the impacts of MHWs on deeper MEs. Impacts of warming and changing oceanographic conditions on shallow reef systems in the region have historically been recorded. From a conservation standpoint, our findings are significant since these deeper reefs are known to be biodiverse and are probably home to species that have not yet been fully characterised by science. Given that it can be reliably identified, is widespread, and is somewhat abundant, our target cup sponge morphospecies may serve as an indicator for continued monitoring of the effects of warming events throughout MEs in the south-east marine park network. Clearly, further research is needed to determine the minimum temperatures and maximum exposure times needed for bleaching to occur.

There have been reports of large-scale sponge deaths during periods of extremely warm water. The abundance estimates growing concurrently with an increase in bleaching at both Flinders locations, and no obvious connections between bleaching events and abundance at the other sites, suggest that mass mortality in our target cup sponge morphospecies has not occurred due to the bleaching. It will take constant monitoring and manipulative experiments to determine the fate of the cup sponge morphospecies individuals, how long bleaching lasts, and effects on health and reproductive output. Surprisingly, at three of our four sites, we discovered a tendency for deeper bleaching. Because of the current lack of clarity regarding this pattern, more research is needed to fully understand these findings. There are no records from nearby diver-based surveys for this cup sponge morphospecies, which appears to only be present in mesophotic ecosystems (>30 m) in our region. Therefore, depth is unlikely to serve as a refuge for this morphospecies if MHW events are capable of having an impact on these ecosystems.

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