Impacts of ocean warming on echinoderms: A meta-analysis

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Abstract

Rising ocean temperatures are threatening marine species and populations worldwide, and ectothermic taxa are particularly vulnerable to warming. Echinoderms are an ecologically important phylum of marine ectotherms and shifts in their population dynamics can have profound impacts on the marine environment. The effects of warming on echinoderms are highly variable across controlled laboratory-based studies. Accordingly, synthesis of these studies will facilitate the better understanding of broad patterns in responses of echinoderms to ocean warming. Herein, a meta-analysis incorporating the results of 85 studies (710 individual responses) is presented, exploring the effects of warming on various performance predictors. The mean responses of echinoderms to all magnitudes of warming were compared across multiple biological responses, ontogenetic life stages, taxonomic classes, and regions, facilitated by multivariate linear mixed effects models. Further models were conducted which only incorporated responses to warming greater than the projected end-of-century mean annual temperatures at the collection sites. This meta-analysis provides evidence that ocean warming will generally accelerate metabolic rate (+ 32%) and reduce survival (– 35%) in echinoderms, and echinoderms from sub-tropical (– 9%) and tropical (– 8%) regions will be the most vulnerable. The relatively high vulnerability of echinoderm larvae to warming (– 20%) indicates that this life stage may be a significant developmental bottleneck in the near-future, likely reducing successful recruitment into populations. Furthermore, asteroids appear to be the class of echinoderms that are most negatively affected by elevated temperature (– 30%). When considering only responses to magnitudes of warming representative of end-of-century climate change projections, the negative impacts on asteroids, tropical species and juveniles were exacerbated (– 51%, – 34%, and – 40% respectively). The results of these analyses enable better predictions of how keystone and invasive echinoderm species may perform in a warmer ocean, and the possible consequences for populations, communities, and ecosystems.

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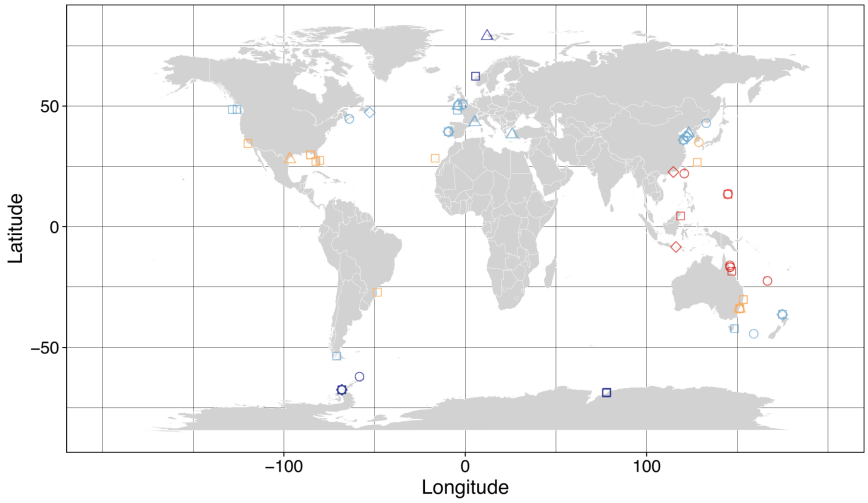

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