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Marine invertebrate responses to temperature-related stressors and their interactions

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As the global climate adjusts to anthropogenic high levels of CO₂, marine organisms have to cope with multiple changing environmental stressors that influence their performance. Marine metazoan hard limits to temperature and chronic anoxia have long been known. However, interactions between stressors, such as synergies between temperature and both low oxygen levels and acidification, have emerged relatively recently as concordant across many experiments and organisms. Understanding interactions is critical because stressors rarely occur singly. Multiple temperature related stressors (TRS) have been implicated at most, if not all, past extinction crises, although their geographical distributions may be relevant to their impact. We present a meta-analysis of experiments involving multiple TRS and their interactions. Results have implications for the interpretation of patterns in fossils in regard to ancient impacts of TRS. We show interactions to be wider than previously reported within TRS, and to vary by response type and organism ontogenetic stage. Forecasting the effects of TRS on marine organisms by modelling single stressors, such as temperature, is unlikely to reveal more than a low estimate of the severity of response. Geographical context is also likely to be important, although general trends are evident. Cross-checking biological responses between fossil and current evidence is recommended as best practice.

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