# The role of mutualism in marine benthic communities: Key species are affected by predicted warming but show resistance to ocean acidification

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## Abstract

The effects of climate change on coastal biodiversity are a major concern because altered community compositions may change associated rates of ecosystem functioning and services. While responses of single species or taxa have been studied extensively, it remains challenging to estimate responses to climate change across different levels of biological organisation. Studies that consider the effects of moderate realistic near-future levels of ocean warming and acidification are needed to identify scope for adaptation and evolution. Also, studies including different levels of biological complexity may reveal opportunities for amelioration or facilitation under changing environmental conditions. To test experimentally for independent and combined effects of predicted near-future warming and acidification on key benthic species, we manipulated three levels of temperature (ambient, +0.8 °C, +2 °C) and two levels of pCO2 (ambient at 450 ppm, elevated at 645 ppm) and quantified their effects on mussels and algae growing separately or together (to also test for inter-specific interactions). Warming increased mussel clearance and mortality rates simultaneously, which meant that total biomass peaked at + 0.8 °C. Surprisingly, however, no effects of elevated pCO2 were identified on mussels or algae. Moreover, when kept together, mussels and algae had mutually positive effects on each other's performance (i.e. mussel survival and condition index, mussel and algal biomass, and proxies for algal productivity including relative maximum electron transport rate [rETRmax], saturating light intensity [Ik], and maximum quantum yield [Fv/Fm]), independent of warming and acidification. Our results show that even moderate warming affected the functioning of key benthic species, and we identified a level of resistance to predicted ocean acidification. Importantly, we show that the presence of a second functional group enhanced the functioning of both groups (mussels and algae), independent of changing environmental conditions, which highlights the ecological and potential economic benefits of conserving biodiversity in marine ecosystems.

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