Effects of global warming on species interactions: editorial comment on the Highlight Article by King and Sebens

Fabio Bulleri^{1,2}

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Anthropogenic climate change is among the major threats to biodiversity (Pecl et al. 2017). Concerns over potential consequences on the functioning of ecosystems and their ability to provide goods and services to humans have prompted research in both terrestrial and aquatic systems. Within this context, the potential for climatic stressors to interact among them, as well as with non-climatic stressors (i.e., multiple stressor scenarios), is widely recognized (Crain et al. 2008). In marine environments, a plethora of studies has, thus, assessed how combinations of different climate stressors—in particular, ocean warming and acidification—can influence species physiology, phenology and behavior (e.g., Byrne et al. 2009; Nowicki et al. 2012; Iniguez et al. 2016; McQueen and Marshall 2017; Preziosi et al. 2017; Davis et al. 2018, to cite a few). Often, climate-induced modifications at the individual level, scale up to that of the community, through the filter of species interactions (Post and Pedersen 2008; Russell et al. 2009; Ockendon et al. 2014). Nonetheless, indirect effects of climate changes have received less attention than direct effects. For instance, only recently species interactions have been incorporated into models aiming to forecast species distribution under future climate scenarios, despite the long-standing view of their role to be relevant only at local scales being amply discredited (Wisiz et al. 2013).

By means of a mesocosm experiment, King and Sebens have assessed how air and water warming influences the growth rates of the barnacle *Balanus glandula* and of the dogwhelk *Nucella ostrina*, as well as whelk predation rates. The

growth of barnacles increased following the warming of both air and water, while that of whelks decreased in warmer air conditions and was not influenced by water warming. Whelk predation rates decreased by 35% under warmer air conditions, although these negative effects were, to some extent, mitigated by warmer water. Under these circumstances, benefits of warming for barnacles might be twofold: increased growth and lower predation pressure. It is, therefore, evident that a robust estimate of the effects of warming on this simple prey–predator system requires integration between air and water and between each species performance and their interaction.

As the authors themselves point out, the net effects of water and air warming on the species investigated might be influenced by other factors, such as whelk behavioral responses and air humidity during emersion. Nonetheless, this study provides solid information for generating hypotheses to be tested through more complex experimental setups, possibly including a field component. As impacts of increased climatic variability and extremes on physiological and ecological processes are likely to be as important as increments in average values (Vázquez et al. 2017), the temporal heterogeneity of physical drivers is an important component of climate change that should be formally incorporated into future studies.

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✉ Fabio Bulleri
fabio.bulleri@unipi.it

¹ Dipartimento di Biologia, Università di Pisa, Via Derna 1, 56126 Pisa, Italy

² CoNISMa, Consorzio Nazionale Interuniversitario per le Scienze del Mare, Piazzale Flaminio 9, 00196 Roma, Italy

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