Landmark global scale study reveals potential future impact of ocean acidification on species' distribution

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Credit: University of Plymouth

Ocean Acidification and the extent to which marine species are able to deal with low pH levels in the Earth's seas, could have a significant influence on shifting the distribution of marine animals in response to climate warming.

This is one the findings of a landmark new study that has taken a first-ever global scale integrative approach to the topic, bringing together population genetics, growth, shell mineralogy and metabolic data for marine snails found in the North Atlantic.

Published in this month's *Nature Communications*, the report, Regional adaptation defines sensitivity to future ocean acidification, reveals that populations at the northern and southern range edges are the most sensitive to ocean acidification, and the least likely to be able deal with significant implications for biogeography and diversity.

Scientists at the University of Quebec in Rimouski (UQAR), Canada, the University of Plymouth, the Plymouth Marine Laboratory, and the University of Birmingham, launched the project in 2010 with funding from a number of sources, including the Natural Environment Research Council's UK Ocean Acidification Research Programme.

Project lead Dr Piero Calosi, from the Department of Biology, Chemistry and Geography at UQAR, said: "It is well established that an organism's physiological response to temperature is a major determinant of species distributions, which in turn can dictate the sensitivity of populations and species to global warming. In contrast, little is known about how other major global change drivers, such as ocean acidification, will help shape species' distributions in the future."

The team sampled the common periwinkle Littorina littorea - an intertidal snail that has a wide latitudinal distribution - from six populations living along the European coastline of the North Atlantic, including warm temperate, cold temperate and subpolar regions.

Specimens were transported to the Marine Biology and Ecology Research Centre at the University of Plymouth and kept in aquaria containing either sea water representing current (pH 8.0) levels, or low pH predicted to occur for the year 2100 (pH 7.6).

Upon analysis, the scientists discovered a range of impacts including markedly higher rates of shell dissolution and degradation across all of the specimens maintained in the low pH condition, caused by the corrosive water conditions. This was particularly marked in the snails from the subpolar region, which have genetically adapted to the colder waters.

Where populations exhibited clear differences was in their metabolic responses to low pH conditions. The snails from warm temperate populations were found to decrease their metabolism as a trade-off between maintaining their physiological systems and their ability to grow, ultimately limiting the latter. Snails from the subpolar populations maintained their metabolic rates, but increased the amount of energy they put into shell mineralization. And the snails taken from the cold temperate waters were able to increase their metabolic rate, fuelling the maintenance of their growth and of their physiological systems to a better level than the other populations.

Dr Simon Rundle, from the School of Biological and Marine Sciences at University of Plymouth, said: "Such latitudinal differences in the metabolic 'strategies' may, in part, help explain the observed reduced growth towards range edges. Exposure to ocean acidification was shown to cause a reduction in the energy metabolism of the snails, and such reductions can lead to a reallocation of the energy budget away from fundamental fitness-related functions."

Professor Stephen Widdicombe, Head of Science in Marine Ecology and Biodiversity at Plymouth Marine Laboratory, said: "Together, the findings of this study suggest that the relative sensitivity of different populations of L. littorea to future ocean acidification are likely to vary considerably across its geographical range of extension in the North East Atlantic through local and regional adaptation, with populations closer to the range edges being most sensitive."

Dr Lucy Millicent Turner, from the University of Plymouth, added: "If ocean acidification selects against sensitive, range-edge genotypes, it could cause a reduction of genetic diversity levels that could have far-reaching consequences for the ability of these populations to respond and further adapt to other local and global stressors."

The results, say the authors, also demonstrate the risks of using single population studies when aiming to predict species' and community responses to global environmental drivers.

"We may be currently over- or underestimating the impact of different environmental changes in different climatic regions," concludes Dr Calosi, "with this having important implications for the development of directives and policies to promote the preservation of marine biodiversity under the ongoing global change."

More information: Piero Calosi et al, Regional adaptation defines sensitivity to future ocean acidification, *Nature Communications* (2017). DOI: 10.1038/NCOMMS13994

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