Press Release

GEOMAR
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Remember Darwin!
Evolutionary adaptation might alter species' reactions to ocean acidification

January 28, 2014/Kiel. **Evolutionary adaptation to ocean acidification has to be taken into account when projecting the future of marine ecosystems, says a team of scientists from Canada, Australia, the United States, Great Britain, Sweden and Germany in a review published this week in the international journal "Trends in Ecology and Evolution" (TREE). The scientists revise studies published to date and give recommendations for exploring ocean life's capacity to adapt in response to ocean acidification. They point out the importance of this long-neglected aspect of projected changes in our ocean ecosystems, and suggest that future work should focus on important species, find models that represent taxonomic or functional groups and consider interdependencies within the food web. In addition, they advise to investigate responses to combined stressors and include factors such as rising water temperatures.**

Changing living conditions caused by climate change or ocean acidification – the decrease of ocean pH due to the uptake of human-induced carbon dioxide from the atmosphere – pose serious threats to marine organisms. To survive in a new environment, animals and plants respond via acclimation or adaptation. While "acclimation" describes variations in physiology, morphology or behaviour that do not enter the genetic code, "adaptation" means genetic changes and thus a heritable modification that improves an offspring's chance to cope with new living conditions. Scientists from six institutions leading in ocean acidification research summarized the current status of knowledge on evolution in the oceans: Which species are likely to evolve? How does their adaptive evolution alter ecological interactions in the oceans? And finally, are these reactions able to affect important ocean services such as carbon storage or food supply?

"Ocean acidification will definitely change marine ecosystems. If we want to foresee that change, it is absolutely necessary to understand how populations will adapt to it over time. If organisms adapt, their future reactions to ocean acidification might be different from what they are like today", says Prof. Thorsten Reusch. The Evolutionary Biologist at GEOMAR Helmholtz Centre for Ocean Research Kiel teamed with experts from Canada, Australia, the United States, Great Britain and Sweden to critically review previous studies and to give advice for future investigations. "Although Charles Darwin laid out his theory of evolutionary adaptation more than 150 years ago, this aspect has long been neglected in the context of ocean change."

The evidence for evolutionary adaptation to ocean acidification comes mainly from two approaches. First, in experimental evolution studies, scientists have recently begun to expose organisms to conditions projected for the future for many generations in order to directly test for "evolution in action". Such experiments are only possible in species that reproduce relatively rapidly, for example unicellular phytoplankton. One of the striking findings from laboratory experiments was that calcifying algae, which first suffer particularly in terms of growth and carbonate production from ocean acidification, can partly restore their functioning via evolution.

To estimate the evolutionary potential of multicellular organisms with generation times of one year or longer, the authors recommend measuring the heritable diversity among individuals in how they respond to ocean acidification today. "If some individuals are better at coping than others in a low-

pH environment, we need to know how efficiently that ability can be passed on to that individual's offspring and how quickly this trait will spread in the population", explains Dr. Jennifer Sunday, Post Doctoral Research Fellow at the University of British Columbia in Canada. The study summarizes recent findings that ample genetic variation exists for tolerating future acidity levels and that many fish and invertebrate species may adapt by natural selection. In future, more systematic studies might show which species may adapt fastest and if this rate of adaptation is fast enough to prevent the species' extinction.

"Understanding the impacts on single species is really only half of the story", Dr. Piero Calosi, Lecturer at the School of Marine Science and Engineering at Plymouth University summarizes. "We need to find out more about the evolutionary potential of organisms and at what price it comes. It is possible that other functions like growth, reproduction or longevity decrease when tolerance increases." The team of scientists also note that organisms go through different developmental stages with different possibilities to respond to a changing environment. They interact within complex communities and they are affected by a number of different stressors.

Because evolutionary potential cannot be assessed for all species, future work must strategically concentrate on ecologically or economically important ones or on those most helpful for model calculations, the international expert team advises. Dr. Sam Dupont, researcher at the University of Gothenburg: "All of this is by no means trivial. But we found good examples showing that adaptation is not just possible in principle – we are now poised to understand the process at a more detailed level."

Original publication:
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Images:
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