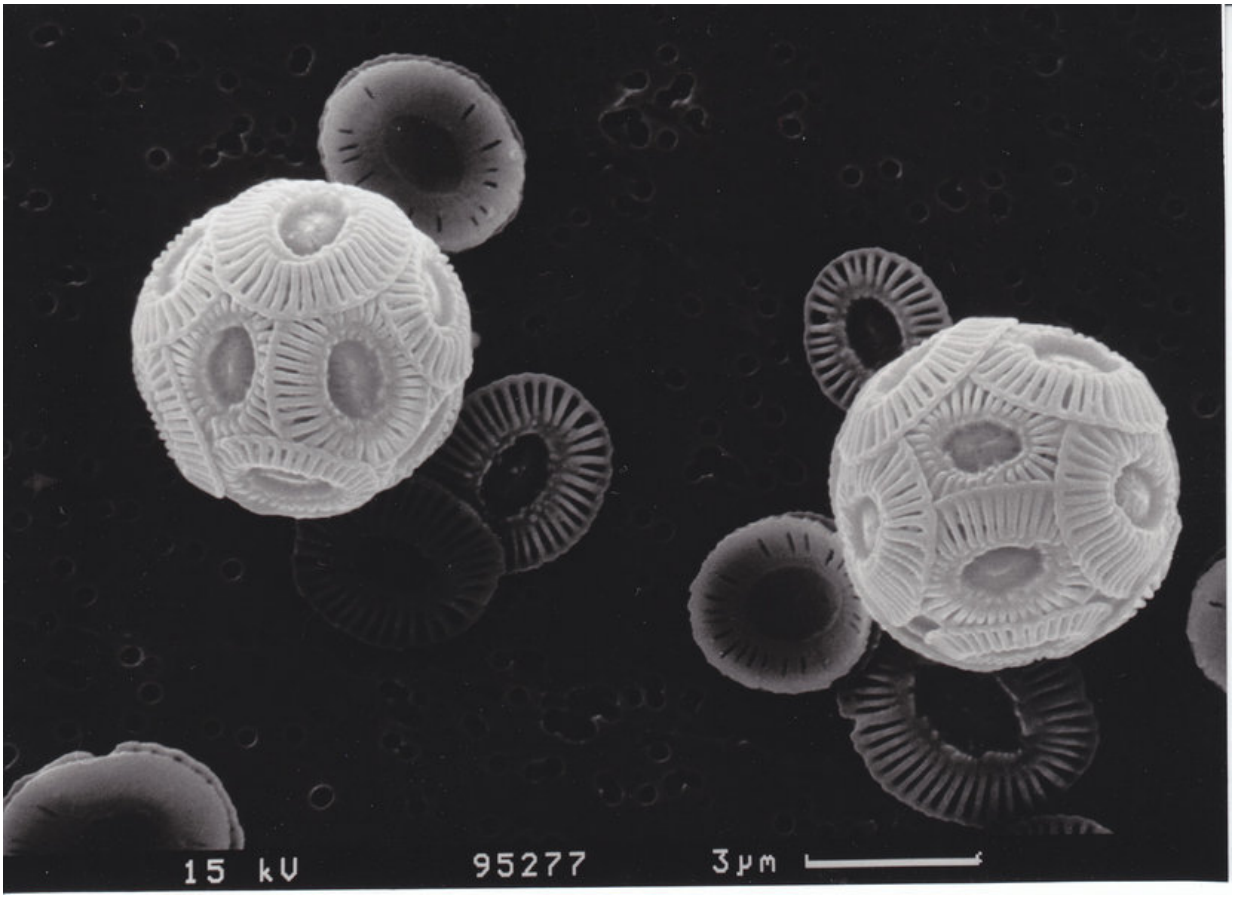
Rapid evolution of a calcareous microalgae

February 15 2018



Emiliania huxleyi cells in an electron microscopic picture. Credit: Lennart Bach, GEOMAR

When simulating future environmental conditions, researchers confront a problem: Laboratory experiments are easy to control and to reproduce, but are insufficient to mimic the complexity of natural ecosystems. In

contrast, experiments under real conditions in nature are much more complicated and difficult to control. Scientist of the GEOMAR Helmholtz Centre for Ocean Research Kiel have combined both approaches to investigate the response of a major plankton species to increasing ocean acidification. The results have now been published in the international journal *Nature Ecology and Evolution*.

The concentration of carbon dioxide (CO2) in the atmosphere increases continuously. As a consequence, an increasing amount of CO2 dissolves in the ocean, where it reacts to carbonic acid and acidifies the seawater. As ocean acidification progresses steadily, scientists aim to assess the implications of this process for marine ecosystems.

A team of researchers from the GEOMAR Helmholtz Centre for Ocean Research Kiel has for the first time examined the adaptability of the calcified alga Emiliania huxleyi to ocean acidification in a combination of laboratory and field experiments. "Some of the algae lineages in the experiment showed an extremely rapid change in their ecological fitness. We did not expect that to happen," says lead author Dr. Lennart Bach from GEOMAR. The study has been published recently in the international journal *Nature Ecology and Evolution*.

The current experiments were preceded by years of laboratory tests with Emiliania huxleyi at the GEOMAR in Kiel. Dr. Kai Lohbeck, co-author of the new study, had been keeping the algae under increased CO2 concentrations. Three years later, it became apparent that Emiliania huxleyi coped better with acidification than at the beginning of the experiment. "For us, that was a clear indication for the adaptability of the algae. But the experiment took place under laboratory conditions. Therefore, the question remained whether the evolutionary adaptation during an isolated lab experiment would bring an advantage also under natural conditions," says Lohbeck.

The opportunity to investigate this question emerged in the spring of 2013. The research group of Professor Ulf Riebesell conducted experiments with the Kiel Offshore Mesocosms in the framework of the collaborative project BIOACID (Biological Effects of Ocean Acidification) on the influence of ocean acidification on natural communities in Gullmarsfjord in Sweden. From the laboratory in Kiel, some of the already adapted algae cultures as well as the associated control groups were taken along to Sweden. There, they were added to the plankton communities which were acclimated to high CO2 levels in the field experiments.

"To our surprise, we found that the algae lineages that had already been adapted to ocean acidification in the lab did not cope any better at lower pH levels than the control groups that had never experienced acidification before," says Dr. Bach. An equally surprising finding: Although all algal lineages had the same ancestors, they differed significantly in their ability to compete in the natural plankton community after only three years. While some lineages proliferated rapidly, others tended to be excluded from the natural community, regardless of whether or not they were previously adapted to ocean acidification. "This demonstrates Emiliania huxleyi's ability to evolve rapidly," Bach resumes the results of the study.

Prof. Riebesell, co-author of the study and coordinator of the BIOACID project, sees this as an indication of how little we understand the long-term effects of ocean acidification: "The organisms' ability to adapt to new environmental conditions surprises us again and again. However, it does not change the fact that as ocean acidification progresses, many species will be unable to maintain their ecological niches. The loss of biodiversity is therefore inevitable."

More information: Lennart T. Bach et al, Rapid evolution of highly variable competitive abilities in a key phytoplankton species, *Nature*

Ecology & Evolution (2018). DOI: 10.1038/s41559-018-0474-x