Ocean warming and acidification impact the marine food web, study finds

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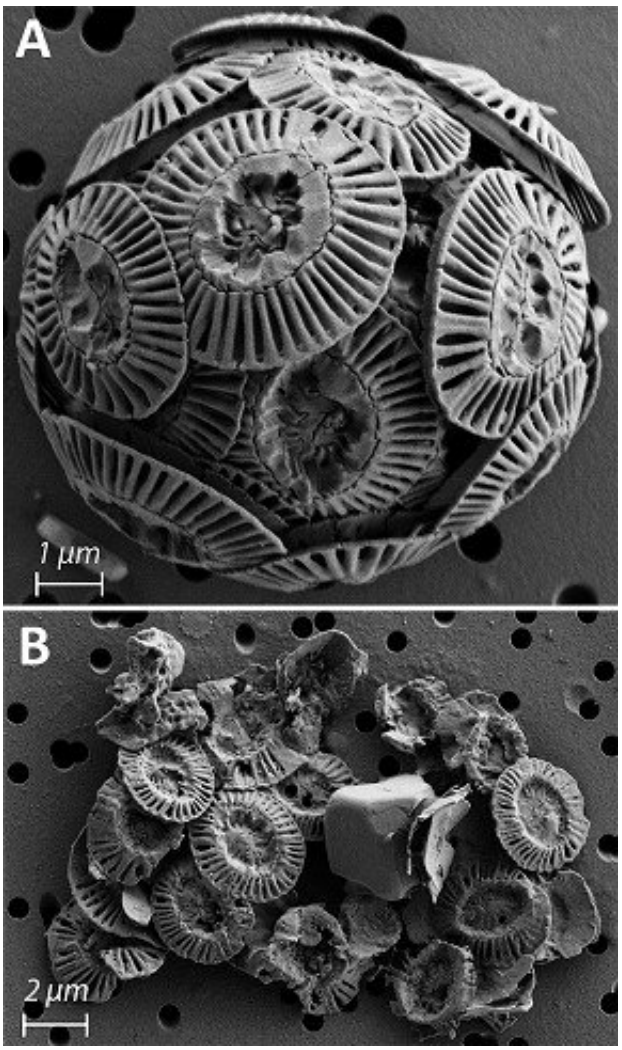

(A) A healthy coccolithophore. (B) A collapsed coccolithophore. Ocean acidification greatly increases the chance of the coccolithophore sphere to collapse. Credit: Roberta Johnson ICTA-UAB

Ocean warming and ocean acidification driven by climate change decrease the nutritional quality of some marine organisms, causing disruptions to the ocean food web.

This is the main conclusion of a study conducted by the Institute of Environmental Science and Technology of the Universitat Autònoma de Barcelona (ICTA-UAB) in collaboration with the Roscoff Marine Station (France) that analyzes the increase in temperature and ocean acidification on the nutritional content of coccolithophores, a unique and abundant type of phytoplankton able to calcify and cover the cell with elaborate calcite elements.

Ocean warming and acidification are the result of the rapid accumulation of carbon dioxide in the atmosphere. While ocean warming is predicted to cause changes in the distribution of species, which will have impacts on marine ecosystems, calcifying marine organisms are predicted to respond negatively to ocean acidification as it makes it more difficult for them to build their skeleton or shells. Although these impacts are expected to affect the marine food web, there is a lack of knowledge as to what these specific effects will be.

Coccolithophores are at the base of the marine food web and are a food source for many zooplankton species by providing energy to these organisms in the form of fats (lipids) and other nutrients. Like other marine organisms, acidification is expected to negatively affect their shells.

The study's experiment used simulated future climate conditions. Results showed an increase in the availability of lipids under ocean warming; however, this increase was reduced by ocean acidification. The coccolithophores also showed reduced nutritional content, indicating they will provide a lower quality food source for their consumers. Additionally, the shell of the coccolithophore was weakened, which will

likely be beneficial for their consumers as they will be easier to digest.

"Coccolithophores are a very important marine organism. Although they are microscopic, they play a large role in the carbon cycle, and they're an important food source in the ocean," says Roberta Johnson, ICTA-UAB researcher and lead author of the study. "We can see that these organisms are negatively impacted by climate change conditions, with reductions in energy and nutrients, and this will have varied impacts on the marine food web," she adds.

Patrizia Ziveri, Professor at ICTA-UAB and co-author of the study states that "this abundant group of unicellular organisms are particularly key in open ocean and conditions where nutrients are scarce. Our findings show that climate change might have a domino effect on the food web." It is important to note that the fact that nutritional quality of coccolithophores for consumers might decline under climate change has wide implications for the food web dynamics of our rapidly changing ocean.

The study concludes that coccolithophores may also shift to other regions with more favorable conditions, further affecting marine organisms that rely on them as a food source. This short-term experiment provides a small taste of the nutritional response of coccolithophores to climate change stressors; however, further work investigating the long-term impact of ocean warming and acidification as well as species and community interaction will be a key part of understanding the impacts of climate change on marine food web dynamics.

The research is published in *Limnology and Oceanography*.

More information: Roberta Johnson et al, Nutritional response of a coccolithophore to changing pH and temperature, *Limnology and*

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