Arctic phytoplankton assemblages in coastal waters remain productive, despite variable environmental conditions

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Credit: Paolo Verzone/Alfred Wegener Institute

Even when Arctic water becomes more acidic and the available light or temperatures change, phytoplankton assemblages in the ocean

demonstrate undiminished productivity and biodiversity. They form the basis of the Arctic food web—and are extremely tough. This was the main finding presented in a study by researchers at the Alfred Wegener Institute, released jointly with their Canadian colleagues in the journal *Nature Climate Change*. Yet much more research is required to determine whether phytoplankton, a source of food for seals, whales and commercially harvested fish species in the Arctic, can ultimately cope with global climate change.

Phytoplankton living in the coastal waters of the Arctic have to cope with extreme and highly variable environmental conditions, including constant darkness under metre-thick ice, sunlight 24 hours a day, variably salty seawater, and occasional murky freshwater from rivers; and all this at icy temperatures. Though these pose serious challenges, in an era characterised by global transformation, they can also be advantageous—because they have helped Arctic phytoplankton adapt to variable environmental conditions in the course of their evolution. That is one possible explanation for the fact that some phytoplankton assemblages can more successfully acclimate to global change than their counterparts from regions with more stable environmental conditions, as the first author of the study, biologist Dr. Clara Hoppe from the Alfred Wegener Institute, Helmholtz Centre for Polar and Marine Research (AWI) explains.

"We were able to demonstrate that some phytoplankton, the most important primary producers in the Arctic, are extremely robust. For instance, they demonstrate less sensitivity to ocean acidification than what we are used to seeing in assemblages from the Southern Ocean or the temperate latitudes," says Clara Hoppe. In a range of experiments with naturally occurring phytoplankton assemblages, she varied the temperature, available light and pH value, and measured the phytoplankton's productivity. Our oceans are becoming more acidic because, due to the combustion of fossil fuels, more carbon dioxide is

being released into the atmosphere. CO2 reacts with water to produce carbonic acid and reduces the water's pH level, which, at the cellular level, can influence organisms' metabolism, and with it, their productivity.

In nine out of 10 experiments, the productivity remained unchanged; only the experiment with the lowest temperature (1.8 degrees Celsius) did increased acidification result in significantly decreased productivity; at the other temperatures tested (from three to eight degrees Celsius), ocean acidification produced no measurable effects during the one- to three-week experiments. The authors write, "Phytoplankton are apparently capable of tolerating the higher proton levels that underlie sinking pH values, provided the temperature doesn't drop below a certain threshold."

The team attributes the general ability of phytoplankton from coastal regions to remain productive despite highly variable environmental conditions to a number of mechanisms. First, the individual phytoplankton seem capable of acclimating to a diverse range of conditions in a flexible way, as the AWI team was able to demonstrate in further laboratory experiments. Secondly, many diatom species produce spores, which can survive for several years on the ocean floor. If the environmental conditions are advantageous for certain spores, they hatch and subsequently initiate phytoplankton blooms. As such, there is a "seed bank" which provides a high degree of inter- and intraspecific diversity, which allows those species and strain that are suited best for many combinations of environmental conditions to come up and thrive.

"Primary production in the Arctic is an essential ecosystem service, which the increasingly commercially important fishing grounds will also depend on. In our lab experiments, we were able to demonstrate that these producers are surprisingly resistant in terms of the ocean acidification levels we expect to see by the end of the century—and

that's good news," says AWI biologist Clara Hoppe. Nevertheless it is important to understand the limits and costs of this resistance, to which the study has made a valuable contribution. Whether the outcomes can also be used to draw conclusions regarding the complex food web in nature is something that only further research can tell us.

More information: Clara Jule Marie Hoppe et al, Compensation of ocean acidification effects in Arctic phytoplankton assemblages, *Nature Climate Change* (2018). DOI: 10.1038/s41558-018-0142-9

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