# Research finds multiple nutrients are required for phytoplankton to thrive

November 2 2017

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Phytoplankton, unicellular photosynthetic microbes, play a fundamental role in the global carbon cycle and fuel marine food webs. Globally, phytoplankton productivity is regulated by the availability of essential nutrients such as nitrogen and iron. Researchers at the GEOMAR Helmholtz Centre for Ocean Research, Kiel, have now been able to show that the growth of phytoplankton over large extents of the ocean is not limited by a single nutrient, but by multiple nutrients simultaneously. The study has been published today in the top scientific journal *Nature*.

Fluxes of nutrients to the surface ocean are changing. Such changes will almost certainly influence phytoplankton productivity and impact marine food webs and the carbon cycle. But how, exactly, will phytoplankton productivity be affected? In order to answer this question, it is important to know which nutrients limit phytoplankton growth in the ocean. Measurements of nutrient concentrations in the ocean have shown widespread depletion of multiple elements simultaneously. However, to date, no experimental studies have convincingly demonstrated so-called co-limitation of growth by more than one nutrient over large extents of the ocean.

An international research team led by the marine biogeochemist Dr. Thomas Browning from the GEOMAR Helmholtz Centre for Ocean Research, Kiel, has now shown that over broad regions of the South Atlantic, a combination of two nutrients was needed to stimulate any phytoplankton growth, while in some cases, three separate nutrients were required to maximize growth. The team has published its results in the scientific journal *Nature*. "Nutrient co-limitation has been proposed many times before. However, we were able to prove it experimentally over large oceanographic extents for the first time," says Dr. Browning.

The study is based on results from an expedition conducted as part of the International GEOTRACES Programme on the German research vessel METEOR off Southwest Africa in November-December 2015. At numerous sites along the 1000s of kilometers of cruise track, Dr. Browning took water samples for experiments in which nitrogen, iron, and cobalt were added in all possible combinations and incubated in an environment simulating the ocean.

"The experimental setup sounds quite simple. However, the technical implementation of these types of experiments is actually complex as we need to ensure absolutely no contamination of the experimental chambers with trace elements. This is a challenge because these elements are found almost everywhere on ships—even on new plastic surfaces," explains Dr. Browning. "Phytoplankton are also very sensitive to light and temperature so special care had to be taken when collecting and preserving these samples".

Spatial patterns in nutrients limiting phytoplankton growth were also found. While in some samples nearer the coastline a single nutrient significantly increased plankton growth, at least two nutrients were needed to stimulate growth in samples taken from the open ocean. "Another key finding was that we found these limitation regimes could be reconciled with the measured nutrient concentrations in the ambient seawater," says Dr. Browning.

This later result is significant as it suggests the potential for making larger-scale predictions about nutrient limitation using new data from programmes like GEOTRACES—a large international effort to map nutrient concentrations in the ocean. The results also have implications for global ocean models. "Many biogeochemical models do not yet adequately address the importance of nutrient co-limitation. Our study can help to improve representation of this," says Dr. Browning. He adds, "Of course, this is only the first step. Similar experiments should be conducted in other regions to assess how widespread the phenomenon is. Ultimately, combining such information with worldwide nutrient measurements and improvements in ocean biogeochemical models will enable us to make robust predictions about nutrient limitation and its response to change at a global scale. "

**More information:** Thomas J. Browning et al, Nutrient co-limitation at the boundary of an oceanic gyre, *Nature* (2017). DOI: 10.1038/nature24063

Provided by Helmholtz Association of German Research Centres