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Declining silica availability – a challenge in the North Atlantic region?

Kriste Makareviciute-Fichtner[1,2], Birte Matthiessen[1], Heike K. Lotze[3], and Ulrich Sommer[1]
[1]GEOMAR Helmholz Center for Ocean Research Kiel, Marine Ecology, Germany (kmakareviciute@geomar.de)
[2]HOSST Research School, GEOMAR Helmholtz-Centre for Ocean Research Kiel, Wischofstraße 1-3, 24148 Kiel, Germany
[3]Department of Biology, Dalhousie University, Halifax, Canada

Understanding how changes in limiting nutrient availability affect life in the oceans requires interdisciplinary efforts. Here we illustrate this with an example of silicon, one of the most common elements on land which bioavailable form, silicic acid ($Si(OH)_4$), is a limiting nutrient for silicifying primary producers, such as diatoms.

Silicic acid concentrations in the pelagic polar and subpolar North Atlantic have declined by 1-2 µM during spring pre-bloom conditions over the past 25 years. Many coastal areas of the North Atlantic region also face decreased relative availability of silicon due to increased riverine supply of nitrogen and phosphorus and stable or declining loads of silicon. Both declining silicic acid concentrations and declining silicon to nitrogen (Si:N) ratios limit the growth of diatoms, which are major primary producers contributing up to a quarter of global primary production.

To assess the effects of declining silicon availability on phytoplankton communities we conducted a mesocosm experiment manipulating Si:N ratios and copepod grazing pressure on phytoplankton communities from the Baltic Sea. Declining Si:N ratio affected not only diatom abundance and relative biomass but also their species composition and overall plankton diversity. Our results illustrate the importance of silicon in structuring community composition at the base of temperate marine food webs. Changes in silicic acid concentrations and Si:N ratios, therefore, may have far-reaching consequences on oceanic primary production and planktonic food webs.

The decline in silicon concentrations in polar and subpolar North Atlantic waters is attributed to natural multi-decadal variability but is likely amplified by reduced ocean mixing due to increased water temperatures, illustrating the need of international efforts to curb global climate change. The decline in Si:N ratios in coastal oceans also highlights the need for further reduction of nutrient pollution and improved river basin management. This may require interdisciplinary and international approaches to manage anthropogenic perturbations of the silicon cycle.