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The future for microplankton in the Baltic Sea
Effects of SWS and climate change

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Abstract

The Baltic Sea is located between 53°N to 66°N and from 10°E to 30°E and is the second largest brackish water body in the world. It consists of several basins where the Baltic Proper is the major water mass. Around 85 million people live in the catchment area of the Baltic Sea, which subjects it to a range of environmental pressures, such as increased nutrient inputs from human activities (eutrophication), shipping, over-fishing, acid rain and trace metals released from anti-fouling paint. All these stressors, combined with low alkalinity, variable salinity and limited water exchange, makes the Baltic Sea a very sensitive area that may be less resilient to future stressors such as climate change or increased shipping activities. Microplankton communities consist of small heterotrophic bacteria, picoplankton, phytoplankton, cyanobacteria and smaller grazers, such as ciliates and zooplankton. In the Baltic Proper, there is a succession of blooms, within the microplankton community, from diatoms and dinoflagellates in the early spring to cyanobacteria during summer and ending with a second diatom and dinoflagellate bloom in the autumn. The cyanobacteria of the Baltic Proper bloom every summer and are dominated by *Aphanizomenon* sp. and *Nodularia spumigena*. *Dolichospermum* spp. is present but is less abundant. The effects of climate change were tested on a natural microplankton community, as well as on isolated cyanobacteria species from the Baltic Sea. To simulate effects of climate change, the temperature was increased from 12°C to 16°C, salinity decreased from 6-7 to 3-4 and atmospheric pCO_2-levels was increased from 380 ppm to 960 ppm. The biovolume of *Aphanizomenon* sp. and *N. spumigena* increased when temperature was increased by 4°C. When salinity was decreased by three units, both the growth and photosynthetic activity of *N. spumigena* were reduced while *Aphanizomenon* sp. was unaffected, and the growth of *Dolichospermum* sp. was increased. Furthermore, present-day salinities were beneficial, in terms of increased biovolumes, of diatoms, dinoflagellates and ciliates, compared to reduced future salinity. Increased atmospheric pCO_2 had no effect on any of the species in the microplankton community. These results show that the future microplankton community may be positive, in terms of increased biovolume, for the cyanobacteria species *Aphanizomenon* sp. and *Dolichospermum* spp. An increase of cyanobacteria blooms may open up to the possibility to grow and/or harvest these species as a source of biofuel or fatty acids (FA). *Dolichospermum* sp. yielded higher total FA content per biovolume, compared to the other two cyanobacteria species in phosphorus-depleted medium and *Aphanizomenon* sp. in nitrogen-depleted medium. Natural nutrient levels in the Baltic Proper are low both in nitrogen and phosphorus, which indicates a possible future market for biofuel and FA technologies.

Additionally, the effects of seawater scrubbing (SWS) were tested on a natural summer-bloom microplankton community. Three different concentrations of scrubber water were added; 1%, 3% and 10%. To elucidate effects of decreased pH alone, water acidified with H_2SO_4 was added in equal concentrations. The six treatments were compared to a control without acidifying substances. SWS or the corresponding pH treatments, did not have a direct effect on microplankton species composition and biovolume. However, the increased amount of Cu and Zn in the scrubber water, combined with significant decrease in pH and alkalinity already at the 1% scrubber water treatment calls for precaution when implementing scrubber units on the shipping fleet of the Baltic Sea. The accumulated effects of long-term repeated addition constantly throughout the year, i.e. in a shipping lane, are yet to be elucidated.