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Effects of inorganic nutrients, glucose and solar radiation treatments on bacterial growth and exploitation of dissolved organic carbon and nitrogen in the northern Baltic Sea

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Factors controlling bacterial growth and degradation of dissolved organic carbon (DOC) and nitrogen (DON) in the productive surface layer were investigated during the main post-spring-bloom stages of phytoplankton growth in the Gulf of Finland. The effects of different combinations of ammonium, phosphate, glucose and sunlight pre-exposure treatments were studied. Bacteria degraded the indigenous labile DOC and DON pools within 1 week. The labile shares of total DOC and DON were <1-5%, and 13-21%, respectively and their depletion showed no important treatment effects. Nevertheless, photochemical transformations of DOC and DON (sunlight pre-treatment over a day) resulted in significant bacterial production increase at 0.1-0.2 m depth.

The phytoplankton system was N-limited in early summer, but showed a shift towards combined P and N deficiency during the late summer bloom of filamentous, N2-fixing cyanobacteria. Bacterial production was consistently C-limited in the surface layer, with N or both N and P as the secondary limiting nutrients from spring to early summer and in late summer, respectively. Ambient labile DOC:DON ratios were low, increasing from <1-3 (mol/mol) in early summer to 3-7 in late summer. Thus, it appears that bacteria were consistently limited by the low availability of labile DOC, while phytoplankton exhausted the available free mineral nutrient pools, thereby creating a situation combining C-limited bacterial growth with mineral nutrient-limited phytoplankton growth. C-limitation of heterotrophic bacteria has important implications for plankton ecosystem structure and function, including reduced negative feedback on atmospheric CO2, and channelling of inorganic nutrient inputs to conspicuous blooms of toxic filamentous cyanobacteria in late summer.