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Responses of auto- and heterotrophic nanoplankton to photochemical transformation of DOM

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Solar radiation-induced photochemical reactions decompose natural biologically recalcitrant but photoreactive dissolved organic matter (DOM) into inorganic constituents (CO_2, NH_4^+) and low molecular weight biologically labile substrates. Numerous bioassays carried out in darkness following exposures to solar radiation have revealed that photochemically produced biologically labile substrates and nutrients can stimulate heterotrophic food webs. The biologically labile nutrients and substrates can be expected to stimulate also primary producers under conditions where bioavailable nutrients limit primary production. For example, photochemically produced ammonium from biologically recalcitrant DON could serve as nutrient source for phytoplankton. However, little experimental evidence is available for the importance of photochemically generated nutrient to the plankton community, which includes primary producers.

This study addresses the importance of photochemically produced labile substrates to the nitrogen-limiting nanoplankton community of Baltic Sea. In the first part of experimental work, an indigenous nanoplankton community of Baltic Sea under PAR-irradiance and P-replete conditions consumed the biologically labile dissolved nitrogen. Then the resulting biologically recalcitrant DOM was exposed to natural solar radiation for 14 days to decompose a part of photodegradable DOM and to generate bioavailable substrates and nutrients. In the final part of the experiment, bioassay, an indigenous community of nanoplankton was introduced to the solar radiation exposed waters and correspond dark control waters to test the response of an indigenous nanoplankton community to the solar radiation exposed DOM.

The photochemical transformation of DOM stimulated both hetero- and autotrophic plankton. On day 4 of the bioassay, the biomass and production of bacterioplankton peaked and was over three-times larger in the water exposed to solar radiation than in the dark control. Phytoplankton biomass and production peaked on day 6 and was up to four-times larger in the solar radiation exposed water than in the dark control. The particulate organic nitrogen content of plankton community was 2.5-times larger in the solar radiation-treated than in the dark control water. This indicates that photochemical reactions released bioavailable nitrogen from biologically recalcitrant DON and stimulated the growth of N-limited phytoplankton. The grazers of bacterio- and phytoplankton (heterotrophic nanoflagellates) had a secondary response to the primary photochemical stimulus. Heterotrophic nanoflagellates gained up to 6-fold higher biomass in the solar radiation treated than in the dark control water. These results indicate that the photochemical transformation of DOM can stimulate both bacterio- and phytoplankton and that this primary stimulus can be transferred also to higher trophic levels.