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The influence of dissolved organic carbon on bacterial phosphorus uptake and bacteria-phytoplankton dynamics in two Minnesota lakes

Stets, Edward G., James B. Cotner

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ABSTRACT: The balance of production in any ecosystem is dependent on the flow of limiting nutrients into either the autotrophic or heterotrophic components of the food web. To understand one of the important controls on the flow of inorganic nutrients between phytoplankton and bacterioplankton in lakes, we manipulated dissolved organic carbon (DOC) in two lakes of different trophic status. We hypothesized that labile DOC additions would increase bacterial phosphorus (P) uptake and decrease the response of phytoplankton to nutrient additions. Supplemental nutrients and carbon (C), nitrogen (N, 1.6 μmol NH_4Cl L^{-1} d^{-1}), P (0.1 μmol KH_2PO_4 L^{-1} d^{-1}), and DOC (glucose, 15 μmol C L^{-1} d^{-1}) were added twice daily to 8-liter experimental units. We tested the effect of added DOC on chlorophyll concentration, bacterial production, biomass, and P uptake using size-fractionated ^{33}P-PO_4 uptake. In the oligotrophic lake, DOC additions stimulated bacterial production and increased bacterial biomass-specific P uptake. Bacteria consumed added DOC, and chlorophyll concentrations were significantly lower in carboys receiving DOC additions. In the eutrophic lake, DOC additions had less of a stimulatory effect on bacterial production and biomass-specific P uptake. DOC accumulated over the time period, and there was little evidence for a DOC-induced decrease in phytoplankton biomass. Bacterial growth approached the calculated μ_{max} and yet did not accumulate biomass, indicating significant biomass losses, which may have constrained bacterial DOC consumption. Excess bacterial DOC consumption in oligotrophic lakes may result in greater bacterial P affinity and enhanced nutrient uptake by the heterotrophic compartment of the food web. On the other hand, constraints on bacterial biomass accumulation in eutrophic lakes, from either viral lysis or bacterial grazing, can allow labile DOC to accumulate, thereby negating the effect of excess DOC on the planktonic food web.

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