Algal–bacterial competition for phosphorus from dissolved DNA, ATP, and orthophosphate in a mesocosm experiment

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ABSTRACT: We measured the turnover of phosphorus (P) from radioactive-labeled dissolved deoxyribonucleic acid (dDNA), adenosine triphosphate (ATP), and orthophosphate, and the partitioning of P from these sources into different size fractions of algae and bacteria in nutrient-manipulated mesocosms. There was a transition from uptake dominated by larger organisms during balanced enrichment toward uptake dominated by smaller organisms during nitrogen (N) enrichment (P starvation). Contrary to expectation, this effect was counteracted by glucose enrichment, probably because bacterial cells increased in size in a glucose-amended mesocosm. During P starvation, estimates of biomass-specific affinity for all substrates were consistent with uptake becoming limited by molecular diffusion transport toward the cells. Dissolved organic phosphorus (DOP) turnover times (T) fell to ~5 min for ATP and ~1.5 h for dDNA (compared to 1.1 and 15.6 h, respectively, during balanced enrichment), coincided with little inorganic P liberated from DOP in the water, and reflected a tight coupling between hydrolysis and uptake in this situation. At one time during the experiment, the ability of algae and bacteria to compete for P was also assessed by the combination of isotope dilution experiments and affinity estimates. High affinity and low values of the term $K + S_n$ (the half saturation constant + the natural concentration of bioavailable substrate) when the 1-0.2-μm size fraction was compared to the >1-μm size fraction for all substrates indicated bacterial supremacy while in competition for both inorganic and organic P. No significant shift in algal-bacterial competition for DOP relative to dissolved inorganic phosphorus (DIP) was found.