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Strong stoichiometric control of heterotrophic, assimilatory nitrate and phosphate uptake by DOC in a laboratory experiment

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Diffuse nitrate and phosphate pollute aquatic ecosystems worldwide, and measures to retain them are urgently needed. Empirical studies and models indicate that in-stream uptake of nitrate and phosphate may be controlled by dissolved organic carbon (DOC). Especially the DOC:nitrate ratio seems to control nitrate uptake in stream waters. However, there is little detailed experimental-based information on the links between DOC and nitrate uptake and even less information on the links between DOC and phosphate uptake. Laboratory experiments were done by us to study the effect of DOC:nitrate and DOC:phosphate ratios on nitrate uptake with waters taken from four stream sites (Bode catchment area, Central-East Germany) using two realistic catchment DOC sources (Alder leaf leachate and a soil DOC extract). , we investigated whether the type of DOC controls the temporality of nutrient uptake over 30 days, the relationship between nutrient uptake and DOC:nutrient stoichiometry and, via spectroscopic measurements, whether specific molecular moieties of the DOC were preferentially consumed. During the experiments, we measured DOC and nutrient bioavailability under permanent weak ($\sim$ 100 rpm) shaking to ensure oxygenation in small bottles at 16 °C in the dark, using a bacterial inoculum from each of the streams.

We found a fast nitrate and phosphate removal with a maximum uptake after three days. An exponential decay model best explained the relationship between nitrate and phosphate uptake and DOC:nitrate (R^2 = 0.84) and DOC:phosphate (R^2 = 0.83) ratio, which was independent on the source of the water or bacterial inoculum. For reasons unknown, we found a re-release of the nitrate as ammonium and of the phosphate after 10 to 20 days. Currently, we are analyzing the spectroscopic DOC data, to assess changes in DOC composition during the experiments. We will show the results of this analysis during the conference. During the experiments, we used waters, and bacterial inoculates from independent hydrologic catchments. Despite these site-specific differences, the clear site-independent response of nitrate and phosphate uptake to catchment DOC sources shows the likely importance of DOC for in-stream nitrate and phosphate uptake, which hints towards the potential of restoring DOC catchment sources as an additional measure to reduce diffuse nitrate and phosphate loads in streams.