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Towards understanding dynamics of dissolved organic phosphorus in freshwater ecosystems

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Our traditional view of lake nutrient limitation typically builds upon the availability of the most bio-accessible form of phosphorus (P) – the inorganic orthophosphate molecule (Pi). However, Pi is often only a minor contributor to the standing stock of total phosphorus (TP), while the majority consists of compounds containing both carbon and P. In fact, dissolved organic phosphorus (DOP) may contribute more than 80% to TP in freshwater systems – but we know surprisingly little about its composition and significance for nutrient cycles and water quality. Conventional P inventories consider DOP as an entity, and attempts to further differentiate between major molecular groups and their biochemical function have not been made systematically because of analytical complications. Thus, DOP has largely remained a black box to nutrient biogeochemists for decades. Over the last years evidence has grown that DOP is not just a passive P pool. A wide range of aquatic microorganisms – autotrophs as well as heterotrophs – can utilize DOP compounds to meet P demands, especially when Pi is limited; using enzyme systems that harvest Pi from DOP by hydrolysis of phosphoesters, but also specific cross-membrane transport systems that enable microorganisms to incorporate organic P directly.

The ecological function of nutrient DOP in freshwaters is unclear, and has not been considered in concepts of lake management. It is impossible to predict the role of DOP in eutrophication and internal loading without detailed knowledge of its molecular characteristics.

In our contribution, we outline an analytical attempt to (1) apply simple and robust extraction/separation schemes to isolate DOP from lake water, (2) use a HPLC-MS/MS method framework for targeting key components of extracted DOP, and (3) obtain preliminary data of select DOP compounds in freshwater ecosystems with well-studied P dynamics and different trophic states.