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Terrestrial origin of transparent exopolymer particles (TEP) and particulate organic carbon (POC) in boreal freshwaters

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Transparent exopolymer particles (TEP) are a class of organic particles that are ubiquitous in aquatic ecosystems. They can represent more than half of the standing stock of particulate organic carbon (POC) and contribute to biogeochemical processes such as the sedimentation of organic matter in oceans and freshwaters. Earlier studies, mostly done in marine ecosystems, indicate that the formation of TEP is related to the in situ activity of phytoplankton or bacteria. However, the sources and driving factors of TEP in inland waters were rarely investigated and terrestrial sources of TEP and TEP precursors were usually not considered.
We investigated TEP concentration and explored the influence of environmental factors as drivers of TEP concentrations in boreal freshwaters. We hypothesize that large amounts of TEP and TEP precursors can enter freshwaters via terrestrial inputs. In a field survey, we measured TEP concentrations and other environmental factors across 30 aquatic ecosystems in Sweden. In a mesocosm experiment, we further investigated TEP dynamics over time after manipulating terrestrial dissolved organic matter (DOM) inputs concentrated from a stream via reverse osmosis and light conditions with a shading cloth.
We found high TEP concentrations in all sampled systems ranging from 83 to 4940 μg Gum Xanthan equivalent per liter, which was comparable to other studies in freshwaters whereas marine systems show about an order of magnitude lower concentrations. The carbon fraction of TEP in the sampled boreal freshwaters is much higher than the phytoplanktonic carbon, in contrast to previous studies in northern temperate and Mediterranean regions. Boreal TEP concentrations were mostly related to POC and dissolved organic carbon (DOC) concentrations, as well as DOM optical indices of terrestrial influence with minor influence of bacterial abundance, bacterial production and chlorophyll-a. Additionally, one day after the addition of terrestrial DOM to the mesocosms, TEP concentrations increased in these treatments, whereas chlorophyll-a and bacterial abundances showed no differences to the control, suggesting that abiotic factors also play a role in TEP dynamics.
Our results point towards a high terrestrial input of TEP and its precursors and explains the high concentrations we found throughout the boreal aquatic continuum. Thus, a strong aquatic-terrestrial coupling might increase TEP concentrations in the freshwater aquatic continuum. This may facilitate flocculation, including the co-precipitation of TEP with colored organic matter of terrestrial origin and potentially increase terrestrial carbon sequestration by burial in boreal inland waters.