Session: Biofilm ecology and ecotoxicology

Hydraulic control of biofilm diversity and function in streams

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Biofilms are an important component of aquatic ecosystems. They integrate key primary and secondary producers and represent a main food source for higher trophic levels of the food web. In small streams, epibenthic biofilms are the main drivers of essential ecosystem functions, such as nutrient uptake. The functional significance of stream biofilms depends on biofilm attributes, particularly community composition and morphology as well as on nutrient supply from the water column. In field studies, biofilm attributes have shown to be affected by the spatio-temporal heterogeneity of near-bed hydraulics. However, due to the complexity of natural aquatic systems and the variability of environmental conditions, it is difficult to separate the effects of hydraulics on biofilm attributes. We conducted experiments in streamside mobile mesocosms (the UFZ mesocosm platform MOBICOS) equipped with hydraulic flumes designed and constructed for investigating interactions of near-natural flow conditions and biofilm diversity and functioning. Biofilms were cultivated for several weeks under constant conditions on unglazed ceramic tiles before measuring near-bed flow velocity, oxygen fluxes together with biofilm thickness, diversity and nitrogen uptake rates. Our results show that the nitrogen uptake rates were directly controlled by local flow conditions as well as biofilm biomass and thickness. There were also indications that mean (temporarily averaged) flow velocity was more important for determining biofilm biomass and diversity than velocity fluctuations. Furthermore, flow velocity explained the richness of SAR (Stramenopiles, Alveolates and Rhizaria) operational taxonomic units (OTUs, dominated by diatom OTUs) and cyanobacteria OTUs by 30% each. Interestingly, cyanobacteria richness was positively correlated with mean flow velocity and nitrogen uptake efficiency (i.e. biomass normalized uptake rate), whereas SAR richness showed the opposite trend to mean flow velocity and no correlation to nitrogen uptake efficiency. Taken together, local flow conditions affect biofilm attributes and mass transfer processes, with nitrogen uptake efficiency being related to group-specific diversity within the stream biofilm community.