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Design of laboratory microcosms to study stream biofilms and their environmental impact

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Stream biofilms, growing at the sediment-water interface, are multispecies microbial communities with complex relationships to the surrounding environment resulting in distinct structural and functional properties. Their location at the interface of flowing water and stream bed surface renders biofilms biogeochemically important ecological compartments deciding on the fate of inorganic nutrients and dissolved and particulate organic matter. In order to understand the environmental impacts of microbial biofilms across scales thorough mechanistic understanding of their structure and function is vital.

We designed laboratory microcosms to study undisturbed biofilms under controlled flow, light and temperature conditions and to facilitate the use of complex microbiological techniques and experimental setups. Microflumes were constructed from plexiglas (length 1.3 m, width 0.02 m), and were filled with standardized, unglazed ceramic tiles (1 x 2 cm) as quasi-natural substrates for biofilm growth. Water flow (raw stream water in a recycling mode) was adjusted to yield a constant flow environment with specific velocity, depth and bulk flow Reynold´s number. Single tiles serve as easily retrievable samples and all measurements can be replicated within each flume, between 4 flumes sharing the same body of water, and between 3 separate stream systems (4 flumes each) with differing water bodies. In total 3 setups (12 flumes each) with 3 different adjusted flow "treatments" enable data analysis in a simple ANOVA-approach.

A pilot study proved the reproducibility within flumes, between flumes and between stream systems for basic biomass parameters and genetic community composition.

A General Linear Model-analysis identified significant variance components within and among flumes, as well as a significant flow treatment effect. Our results demonstrate the applicability of microcosms for the cultivation and investigation of stream biofilms.