The effect of biofilm age and composition on dissolved organic matter processing in low-order streams

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Streams and rivers form an inherent component of the global water, sediment and carbon cycle. Additionally, these ecosystems are recognized as an important source of CO_2 to the atmosphere by the most recent assessment of global CO_2 emissions (IPCC 2013). Low-order streams often account for more of the surface area than higher order streams. Within this context, especially low-order streams are considered as net-heterotrophic ecosystems and are fuelled by a steady supply of terrestrial derived organic carbon (Hotchkiss et al. 2013). However, in a recently published study, we have shown the DOM transformation along a drought gradient (see Fig. 1). In short, we found that streams might export considerable amounts of in-stream produced DOM moieties downstream during droughts and this labile DOM fuels high respiration rates. In this study, we have used fluorescence spectroscopy and PARAFAC modelling in combination with high frequency absorbance and oxygen measurements. We related the protein-like component to the metabolic activity of mesocosms. These mesocosms, the "LunzerRinnen" consist of six flumes, with 40m of length each and fed by a subalpine stream as a continuous water source that can be distributed to the six flumes as required. This setup provides excellent conditions to study changes in environmental conditions on carbon and nutrient cycling in small streams.

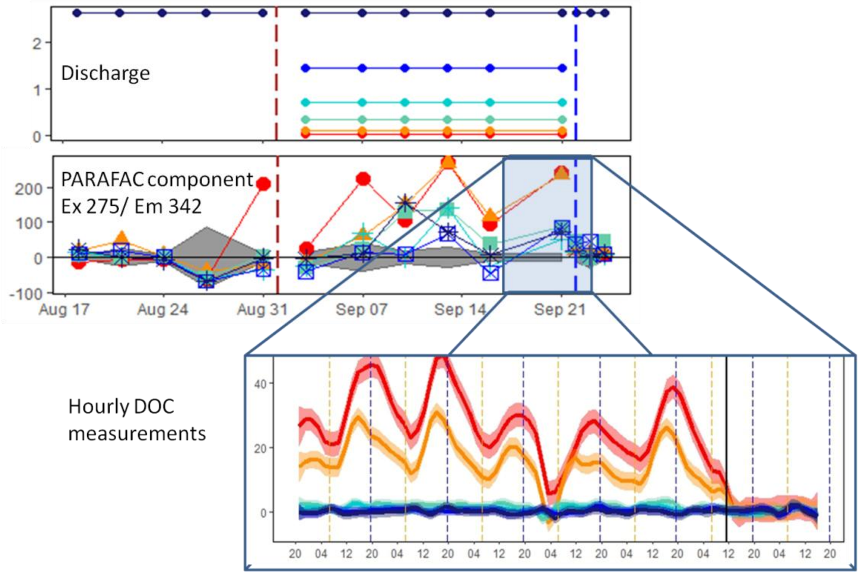

Fig 1: Results of the drought experiment in the LunzerRinnen mesocosm experiment from Harjung et al. (2018). The PARAFAC component related to protein-like, aquatic origin and the hourly DOC absorbance measurements are shown in a percentage change between the source water of a pre-alpine stream and the outlet of each mesocosm.

In our current experiment at the "Lunzer Rinnen", we investigate the impact of hillslope runoff and soil microbes flushed during storm events into streams. The ecosystem functioning of first-order streams, besides allochthonous dissolved organic matter (DOM) inputs, is controlled by the assembly and composition of stream microbial biofilms because small streams have the highest streambed to stream surface area ratio. Biofilms are responsible for a considerable amount of organic carbon breakdown within the streams (Battin et al. 2008). To understand how biofilm assembly and composition affect DOM transformation, we have performed an experiment with biofilm of different age and investigated the biofilm community and DOM transformation before and after soil addition. This approach is coupled with in-situ absorbance measurements and stable carbon isotopes. We expect that the colonization with soil microbes will increase the microbial diversity in the biofilm and will thereby enhance the capacity of the biofilm to take up more complex DOM components. Indeed, fluorescence spectroscopy shows that the soil addition provoked a shift in preferential uptake along the mesocosms from the protein-like small component before the soil addition towards the humic-like terrestrial component after the colonization by soil microbes. Furthermore, we found that this uptake pattern lasted less than three weeks after soil addition. This result is consistent with previous findings where species richness in biofilms decreased after two weeks of soil addition (Thuile Bistarelli, 2016). Hence, our experiment indicates that soil microbes can change the DOM uptake pattern of small streams, but only for a short period.

Fig 2.: On the left: Lucky project, the day of our planned artificial soil addition, a heavy storm event "did our job". On the right: Biofilm growing in the flumes.

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