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Oxygen consumption and labile dissolved organic carbon uptake by benthic biofilms

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Biogeochemical activity in streams is often magnified at interfaces, such as in the case of biofilm growth near the surface of the stream sediments. The objective of this study was to evaluate the relative importance of surficial biofilms versus the biofilm in the hyporheic zone to the processes of biodegradation of a labile dissolved organic carbon (DOC) and to oxygen consumption.
Experiments were conducted in a recirculating flume, equipped with a drainage system that enables the control on losing and gaining fluxes. A surficial biofilm was developed over a sandy streambed with dune-shaped bed forms, by providing labile DOC (sodium benzoate) and nitrate. Homogeneously distributed biofilm was obtained by the same feeding strategy but with mixing the sediments manually on a daily basis. After the biofilm growth period, transformation of the labile DOC under different overlying velocities and losing or gaining fluxes was studied after spiking with sodium benzoate and by monitoring the decrease in DOC concentration in the bulk water over time using an online UV/Vis spectrophotometer. In addition, oxygen profiles across the water-streambed interface were measured at different locations along the bed form using oxygen microelectrodes.
Preliminary results showed that the rate of labile DOC degradation increased exponentially with increasing overlying water velocity, regardless of the type of biofilm. Gaining and losing conditions did not play a critical role in the DOC degradation regardless of the type of biofilm, because the labile DOC was quickly utilized close to the surface. Under losing conditions, complete depletion of oxygen was observed within the top 5 millimeters, regardless of the biofilm type. In contrast, oxygen profiles under gaining condition showed an incomplete consumption of oxygen followed by an increase in the concentration of oxygen deeper in the sediments due to the upward flow of oxygenated groundwater.
The results suggest that the transformation of labile DOC occurs in the upper millimeters of the streambed, and the size and shape of the hyporheic flow paths are less important for aerobic activity. In addition, the effect of overlying water velocity on labile DOC transformation was shown to be more influential than losing and gaining fluxes.