Is terrestrial carbon degradation in stream hyporheic zones stimulated by nutrients?

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The stream hyporheic zone (HZ) represents the interface between streams and groundwater. Due to the mixing of organic matter and nutrients from groundwater and surface waters it is a hot spot of microbial activities and carbon processing within a stream network. The magnitude of terrestrial carbon degradation by microorganisms in the HZ influences the quantity and biochemical quality of terrestrial carbon as well as greenhouse gas concentrations in streams. One of the factors controlling microbial activities and terrestrial carbon degradation in the HZ are nutrients. However, major knowledge gaps exist regarding the control of nutrients on terrestrial carbon processing in the HZ among different streams.

We investigated the role of algal DOM (DOM\textsubscript{alg}) and phosphorus (P) on the degradation of soil DOM (DOM\textsubscript{soil}) by hyporheic microorganisms in a lab- and a field-based experiment. In the lab-based experiment, we focused on the influence of different DOM\textsubscript{soil}:DOM\textsubscript{alg} ratios on the DOM degradation at similar carbon concentrations in microcosms mimicking the HZ. One batch was incubated at ambient P concentrations and a second batch at increased P concentrations adapted to the highest levels found in the pure DOM\textsubscript{alg}. We assessed microbial respiration and changes in DOM optical properties to examine quantitative and qualitative changes of the DOM pool. In the field-based experiment, we determined microbial respiration rates of HZ-sediments from 20 streams in Austria with differing ambient nutrient and organic carbon concentrations. The sediments were incubated with DOM\textsubscript{soil} with and without additional P.

Results from the lab-based experiment show that microbial respiration in the HZ decreased with increasing soil DOM fractions. When P levels were adapted to DOM\textsubscript{alg} concentrations, microbial respiration rates were comparable between the different DOM mixtures and DOM\textsubscript{soil} was degraded. However, in the field-based experiment, P addition only stimulated microbial respiration rates in one out of 20 HZ-sediments, suggesting that microbial respiration rates are not solely controlled by P.

In conclusion, nutrient pulses can stimulate microbial activities and thus terrestrial carbon degradation in the HZ. However, when using different stream HZ-sediments, it becomes evident that the nutrient stimulation is not a ubiquitous mechanism and terrestrial carbon degradation in
the HZ is controlled by a multitude of factors.