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Intermittent hydrology, macrofauna activity and litter size drive leaf litter decomposition in lotic ecosystems

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The shift from perennial to intermittent flow regimes in rivers and streams deeply modifies abiotic and biotic characteristics of benthic systems, changing the structure and functioning of benthic communities. Among others, leaf litter retention and processing are expected to be altered by long lasting droughts followed by flash flows. In streams, leaf litter breakdown is facilitated by feeding activities of shredders, that play a key role in nutrient recycling and energy transfer along the food web. Furthermore, litter decomposition can be affected by its size which control microbial and fungal colonization, e.g. by modifying either the volume to surface or the surface to perimeter ratios.

In this study we tested the hypothesis that drought affects the benthic macrofauna involved in organic matter processing, alters decomposition rate, and control ecological interactions between shredders and microbial community, resulting in different nutrient recycling.

To this purpose, a laboratory experiment was performed using 45 PVC microcosms. We tested 9 conditions, each with 5 replicates in which we incubated 0.5 grams of leaf disks (*Populus nigra*) of two different dimensions (1 and 5 cm as diameter), in presence and absence of larvae of *Potamophylax cinculatus* (Trichoptera, Limnephilidae), under permanent and intermittent conditions (dry phase followed by rewetting). Microcosms were maintained for nearly 40 days in a 200 L incubation tank containing well-mixed and aerated stream water and periodically underwent a short (6 hours) dark incubation. At the end of the experiment, we measured the net leaf biomass loss and the elemental composition of both leaves and resulting debris.

Our specific aims were to measure benthic metabolism (respiration and nutrient regeneration - NH_4^+, PO_4^{3-} and SiO_2) before and after drought, to quantify organic matter decomposition rates, and nutrient recycling and stoichiometry.

Results showed a decrease in litter mineralization under intermittent conditions, since drought slowed biological processes and benthic respiration, whereas rewetting phase increased NH_4^+ release. In permanent submerged conditions the undecomposed litter and debris became N- and P-enriched, likely due to microbial and fungal colonization and uptake, whereas intermittent conditions changed leaves stoichiometry, resulting in lower organic matter quality, and lowered nutrient content in debris. The activity of *P. cinculatus* had a strong effect on leaves elemental composition and increased mineralization rates. *P. cinculatus*, through feeding activity, also stimulated nutrient mobilization as organic particulate, increasing C, N and P content in debris. Our findings also showed different decomposition dynamics in leaves with different surface to perimeter ratio. In fact, leaves with the greatest surface to perimeter ratio displayed higher respiration, higher NH_4^+ regeneration rates and slightly higher biomass loss, compared to smaller leaf disks.

Under predicted global change scenarios, which are expected to increase the frequency and intensity of drought events, our findings suggest that hydrological drought could change streams ecosystem functioning by altering benthic communities and in turn ecosystem processes.

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