

## **DROUGHT AND REWETTING: DRIVERS OF RIVER ECOSYSTEM MATTER CYCLING**

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A main function of river ecosystems is the recycling of organic matter. The rates and efficiencies of organic matter accumulation, transport, biogeochemical transformation and microbial use depend on river hydrology. Organic matter use and transport might be especially affected during transition from wet to dry and dry to wet conditions. In Mediterranean intermittent streams there is typically a summer drought period, when channel areas become discrete pools where sediments and organic detritus accumulate and cannot be exported. Carbon limitation for the microorganisms during these dry periods has been described, favoring autotrophic production. Severe drought periods can be followed by intense rainfall, often leading to major floods. The transport of materials through the stream after drought might be strongly affected by the nature of the organic matter accumulated during drought. In the interphase periods between dry to wet episodes, nitrate and dissolved organic carbon (DOC) mobilize. Abrupt hydrological fluctuations are responsible for shifting connections between benthic, hyporheic and flowing water compartments. Infiltration/exfiltration at the surface/groundwater interface are related to the variable hydrology in intermittent streams, and determine major biogeochemical changes. Varying hydrological conditions determine temporal variability of microbial processes, their rates, and chemical conditions (Dahm et al. 2003). The predicted changes in the discharge pattern in temperate regions will determine higher frequency of floods and droughts, and a substantial change in leaf fall patterns, organic matter accumulation and processing (Sabater et al. 2008). Thus, understanding the effects of extreme hydrologic patterns on the biogeochemistry of organic matter and on carbon cycling in Mediterranean streams is increasingly relevant.

Previous studies in Mediterranean temporary streams have shown drastic changes in the content and composition of dissolved organic carbon during rewetting. Associated to this change, the increase in dissolved and biodegradable DOC during rewetting increases microbial activity. Results show that a dry-wet shift favors the retention of up to 60% of total DOC that flows across the stream-riparian interface (Vázquez et al. 2007). Retention efficiency also varies according to DOC molecular size. More than 70% of high molecular weight DOC fractions (> 10KDa) are retained, while the smaller fraction (<1 KDa) is nearly conservative (Vázquez et al. 2007). Temporality of the discharge pattern affects the magnitude and bioavailability of the peaks of dissolved and particulate organic matter. Variations in the extracellular enzyme activities by the microbial community evidence that the changes in organic carbon determine relevant variations in the biota.

This study aims to characterize the changes in benthic organic matter quantity and quality in an intermittent Mediterranean stream during transition from wet to dry and dry to wet conditions. Organic matter was analyzed in different compartments: the

accumulated material (biofilm grown on rocks and cobbles, leaves and plant material, sand sediment), the flowing water (dissolved and particulate fractions), and the groundwater. Samples were collected during the pre-drought period (May-June, until the stream was completely dry), and, immediately after the flow was re-established after 2 months of drought (September-November), and compared to the conditions of basal flow recovery (December). Organic matter composition was analyzed for total amino acid, fatty acid, and polysaccharide content. Microbial biomass, as bacterial density and chlorophyll content, was further analyzed. Bioavailability and biodegradability of organic matter was analyzed by extracellular enzyme activities and biodegradable DOC (BDOC) measurements.

During wet to dry conditions, the benthic biomass accumulated especially on rocks. Total polysaccharide, amino acid and fatty acid content per dry weight of epilithic organic matter also accumulated during the wet-drought process. The decrease in leucine aminopeptidase and the increase in  $\beta$ -glucosidase activity during this transition suggests a decrease of peptides availability and a major use of polysaccharides. This indicates that microbial heterotrophs might use a lower quality organic matter source (polysaccharides, providing only C) when peptides are not available (providing N and C sources).

The first rains after drought caused a fast recovery of the microbial activity (increase in the percentage of active bacteria), together with a peak of DOC and DON (dissolved organic carbon and nitrogen) as well as BDOC and most of the extracellular enzyme activities. Increasing DOC and DON in the ground water indicated the fast recharge of this compartment during rewetting. However, this first response lasted for a few weeks and values decreased again to basal values, due to the fast and efficient microbial use of available labile fresh material transported during rewetting. The flow recovery also determined changes in the quality of the benthic organic matter, as shown by the decrease in the polysaccharide, amino acid and fatty acid content in the three benthic compartments analyzed. The leaf and plant material showed a major loss of polysaccharides (from 97.1 to 17.5 mg/gDW) while the epilithon mainly lost amino acid and fatty acid content (from 3.6 to 0.9 mg/gDW and from 9.3 to 1.7 mg/g DW, respectively). Such decrease in the epilithon might be mainly due to washing off the biofilm biomass (chlorophyll content changed from 23.6 to 5.8 mg/m<sup>2</sup>). Polysaccharide decrease in leaves may be due to lixiviate loss. The sediment was the benthic compartment with the smallest decrease in polysaccharide, amino acid and fatty acid content. This compartment therefore experienced the lowest cleaning effect due to rewetting. The differential changes in benthic organic matter quality related to the hydrological river conditions also affected the meio and macrofauna feeding on it.

The obtained results suggest that are two linked effects related to abrupt hydrologic fluctuations: 1- changes in downstream organic matter loss dynamics, and 2- Changes in the microbial use of available organic matter.

#### References

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