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A procedure to characterize physical and chemical molecular properties of individual organic matter particles

Edurne Estévez[1], Sophia Mützel[1], Rubén del Campo[1], Roland Stalder[2], and Gabriel Singer[1]
[1]Institute of Ecology, University of Innsbruck, Innsbruck, Austria (edurne.estevez-cano@uibk.ac.at)
[2]Institute of Mineralogy and Petrology, University of Innsbruck, Innsbruck, Austria

Rivers are important contributors to the global carbon cycle as they actively transform terrestrial organic matter (OM) during transport to the oceans. The efficient OM processing results from a diverse assemblage of consumers including heterotrophic microbes (i.e., fungi, bacteria and protists) and macroinvertebrates, which interact with an equally diverse pool of OM. Ecologically, OM can be understood as forming a multidimensional resource space for consumers, whose understanding, however, requires an advanced capability to describe relevant dimensions (i.e., traits of OM) at a level that matches the resolution of consumer diversity, where significant advancement is generated by molecular biological means (i.e., DNA sequencing). This implies moving beyond proxy-based indirect descriptors (e.g., indices derived from absorbance or fluorescence spectroscopic analyses), integrative bulk property measures (e.g., C, N, P, lignin, tannins and fibre content) or bulk amounts of operational size fractions (e.g., dissolved, fine and coarse particulate OM). Recent technological advances such as size-exclusion, liquid or ion chromatography coupled to mass spectrometry have allowed to describe dissolved OM (DOM) on a molecular species level, setting a great step forward in the highly resolved description of DOM properties. However, particulate OM (POM) characterization remains behind significantly. Here, a per-particle basis description with regard to physical features and macromolecular composition is needed. We propose a procedure to asses both physical and chemical molecular properties of individual POM particles by combining (i) photometrical techniques, which are based on image processing and particle analysis (e.g., ImageJ) of pictures obtained with microscopes or cameras, and (ii) attenuated total reflectance infrared spectroscopy (ATR-FTIR) to measure particle-specific chemical composition. We apply this method to POM samples collected along large-scale environmental gradients in river networks.