Metal(loid) accumulation in organic-rich sediment: Effects of and on decomposing invertebrates

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Organic-rich sediments are known to be a significant sink for metal(loids) in contaminated ecosystems and metal(loid) accumulation has been shown to increase significantly during natural decomposition of organic material. We show how invertebrate shredders, grazers, and bioturbators determine metal(loid) fixation or mobilisation within organic-rich sediments and which effect metal(loid) accumulation has on the invertebrates themselves.

Net metal(loid) fixation was observed for both invertebrate shredders, e.g. *Gammarus pulex L.*, as well as invertebrate grazers, e.g. *Lymnaea stagnalis*. Bioturbators, e.g. *Chironomus plumosus*, affect element fixation or mobilization by influencing the redox potential of sediments due to bioturbation and bioirrigation. Experiments revealed three types of effects: 1) net mobilization by bioturbation (Mg, Ca, Sr, Mo, U), 2) mobilization by bioirrigation when larvae dig into sediments, followed by strong fixation with final concentrations in organic matter being higher than in treatments without invertebrates (net fixation) (Mn, Ni, As, Cd, Cs), and 3) strong mobilization by bioirrigation followed by fixation to concentrations as in control treatments (Al, Fe, Co, Cu, Zn, Ce) (no net change).

To investigate the reverse effect of metal(loid) accumulation on the decomposer community, we examined exemplarily the strategies of *G. pulex* to cope with arsenic. We found that half of the total arsenic was not even taken up by *G. pulex* but associated with the cuticle. X-ray absorption spectroscopy further showed that As speciation changed from 68 % arsenate and 29 % monomethylarsenate in the food (leaves) to 23 % of the more toxic arsenite, but also 46-56% of less toxic dimethylarsenate after ingestion into the gut system. Little transfer to the adjacent tissues was observed and the dominant species were mono- and dimethylarsenate (76-80 %), besides 10-21 % As(III) complexed to sulfur. Our results indicate that *G. pulex* as one member of the decomposer community in organic-rich sediments copes with arsenic accumulation in its natural habitat by minimizing uptake and translocation from the gut to other tissues and producing arsenic species that can effectively be excreted.