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Influence of bioturbation on sediment respiration in advection- and diffusion-dominated systems

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Ecosystem engineers are organisms, whose impact on ecosystem functioning is large compared to their abundance and biomass. Classic examples of ecosystem engineers are burrowing organisms whose activity is affecting the sediment matrix and pore solutes in aquatic sediments; this is called bioturbation. Constant reworking of the sediment matrix and transport of solutes caused by activities of sediment-dwelling organisms are modifying habitats and resource availability.

Despite that progress of studies on the interactions between the animal bioturbation and the sediment respiration was rather slow, mostly due to the existing methodological limitations. Conceptual framework, formulated by Mermelloid-Blondin and Rosenberg (2006) is suggesting that impact of bioturbation on the sediment biogeochemistry will be much larger in sediments with low hydraulic conductivities (diffusion-dominated) than in sediments with high hydraulic conductivities (advection-dominated).

In order to test this hypothesis in application to the sediment respiration, we have used the resazurin-resorufin bioreactive tracer system, which allowed us to decouple respiration of the sediment of microbiota.

Our work has shown that in diffusion-dominated sediments (organic rich lake sediments) bioturbator's (bloodworms, larvae of Diptera, Chironomidae) activity could increase sediment aerobic respiration by 300%. In addition to that, impact of the bioturbators on the diffusion-dominated sediments respiration is growing with increasing temperature. Total oxygen consumption (TOU) in such sediments is also increasing by about 50% in bioturbated sediments in comparison with uninhabited sediments. On the other hand, in advection-dominated sediments (sandy sediments from marine tidal flats, bioturbated by brittlestars) we have observed no increase in TOU, and only slight (25%) increase in aerobic respiration in the presence of bioturbators.

It became evident that due to the high hydraulic conductivity of advection-dominated sediments, alteration in solutes and nutrient distribution are minimal, hence no increase in TOU occurs. Still, presence of bioturbators has increased aerobic respiration of the system (probably due to animals' own respiration and the burrow-associated microbiota), thus not increasing but re-structuring TOU.