Sediment-organism interaction as a control on hyporheic exchange flows: effect of body size of the organisms

Shivansh Shrivastava[1], Michael Stewardson[1], and Meenakshi Arora[1]

[1]University of Melbourne

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Abstract

Streambed inhabitants mix and mobilize sediments by actions such as burrowing, feeding, and excretion, a process referred to as sediment reworking. This sediment-organism interaction could modify the hydro-physical properties of streambeds and significantly influence the hyporheic flow regime in streams as highlighted by our recent research. In this work, we further advance the understanding of the sediment reworking process by investigating the influence of the organism size on the modification of streambed properties and hyporheic exchange. Laboratory experiments were conducted in long recirculating flumes to simulate streamflow environment and Lumbriculus variegatus of two different sizes (large worms were double the thickness of small worms) were used as model organisms. The organisms of both sizes were allowed to rework the sediment beds in their respective flumes for 10 days after which dye tracer tests were performed to characterize hyporheic exchange flows. Visual observations reveal that the burrow openings at the bed surface were readily visible in the flume reworked by larger organisms compared to the flume reworked by organisms of smaller size. The former also exhibits higher hyporheic flux and shorter residence times compared to the latter which could be attributed to the rapid exchange of solutes across the streambeds due to the presence of a dense network of voluminous burrows. The exchange depths in both the flumes were similar and a potential reason for this observation could be the reworking of sediment beds up to similar depths in the flumes. We suggest that further exploration must be done at both small and large scales to comprehend the role of sediment-organism interaction in modulating hyporheic exchange flows as it will have direct implications on critical stream ecosystem services such as natural processing of nutrients and contaminants.

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