Annual dynamics of river bed clogging in a second order stream forms hyporheic community patterns

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Introduction: Colmation is the clogging of the interstices of river bed sediments. It is a natural and dynamic process affected by precipitation, surface run-off and river discharge patterns as well as characteristics of the catchment area. In intensively used landscapes the rate of erosion and stream colmation increases [1]. Colmation has strong impacts on benthic and hyporheic communities and the ecological state of rivers [1]. However, colmation is not considered for the assessment of the ecological state following the EU-Water Framework Directive (EU-WFD). The aim of this study is to assess the temporal dynamics of inner colmation and its effects on hyporheic communities during one year.

Methods: The annual change of inner colmation was assessed monthly, from Mai 2019 - April 2020, in a second order stream (Guldenbach) in Rhineland-Palatinate, Germany. The degree of colmation was measured quantitatively via the sediment permeability with a so-called Kolmameter® [2]. Colmation was measured by the reduction of water flow injected into the sediments, compared to the outflow directly above the sediment surface. Therefore, 10 measuring points were defined within a section of approximately 50 m length and the permeability was measured in 15 cm below sediment surface. Afterwards interstitial fauna and hyporheic water (2 L) were extracted using a vacuum pump.

Hyporheic fauna was determined on a higher taxonomic level, and community structure was analysed. Interstitial water and sediment were analysed for basic physico-chemical parameters, grain size, organic matter (OM) and pesticides. Furthermore, data for precipitation, turbidity, water level and discharge patterns were considered.

Results: The one-year study at the "Lower Guldenbach" reveals pronounced dynamics of colmation and hyporheic fauna which clearly responded to the sediment conditions: Based on the faunal pattern 3 stages of colmation could be identified: **1) Transition stage:** From April to August the sediments gradually became more and more clogged. Water level was usually low. A shift from crustaceans to oligochaetes and other fine sediment dwellers was observed. **2) Colmation stage:** From September to January colmation was strongest compared to the other sampling occasions. In accordance, hyporheic communities were dominated by taxa preferring fine sediments such as oligochaetes and nematodes. **3) Decolmation stage:** In February and March 2020 strong floods the decolmation of the hyporheic zone and flushed OM and fauna. Thus hyporheic animal density was comparatively low and fauna was dominated by crustaceans.

Discussion: We assume that the conditions observed at the Guldenbach are representative of many streams of similar size in Central Europe: The temporal changes in colmation were in accordance with the hyporheic fauna. This finding is plausible, indicating an increasing number of fine sediment dwellers with increasing amounts of fine sediment and thus increasing colmation. Hence, we conclude that 1) hyporheic fauna reflect sediment permeability and colmation. Therefore, they have to be considered as potential indicators for the biological evaluation of colmation. 2) The assessment of colmation is crucial due to the seasonality observed. Consequently, season and number of measures have to be carefully selected. Assessment in autumn probably will show a stronger colmation compared to spring. We have to take in account, that there are significant correlations between the results of the WFD evaluation and colmation [3]. This means 1) that the monitoring and assessment of streams should also consider colmation and 2) a sediment management is required, both for catchments and streams, in particular for the WFD management plans.

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