Methanogens and methanotrophs distribution in the hyporheic sediments of a small lowland stream

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Abstract: Distribution of microbial activity, methanogenic archaea and type I and II methanotrophs were studied in a small lowland stream Sitka in Czech Republic. The methanogens and methanotrophic bacteria were detected using FISH with 16S rRNA-targeted oligonucleotide probes. The highest microbial density was obtained in the upper sediment layer 0–25 cm; this zone corresponded also to that of the highest metabolic activity, as indicated by the methanogenic potential, methanotrophic activity, INT and FDA profiles. Both methanogenic archaea and aerobic methanotrophs were found at all localities along the longitudinal stream profile. The proportion of these groups to the DAPI-stained cells was quite consistent and varied only slightly but a higher proportion to the DAPI-stained cells in the deeper sediment layer 25–50 cm was observed. On average 23.4% of DAPI-stained cells were detected by FISH with a probe for methanogens while type I methanotrophs reached ~21.4% and type II methanotrophs 11.9%, respectively. The percentage of DAPI-stained cells hybridizing with methanotroph-specific probes was generally higher for type I than type II. Our data show that the methanogenic archaea and aerobic methanotrophs can be numerically dominant components of the hyporheic biofilm community and affect CH₄ cycling in river sediments.

Key words: methane, hyporheic sediment, methanogenic archaea, methanotrophs, FISH.

Introduction

The hyporheic zone, the volume of saturated sediment beneath and beside streams containing some proportion of water from surface channel, plays a very important role in the processes of self-purification because the river bed sediments are metabolically active and are responsible for retention, storage and mineralization of organic matter transported by the surface water (Hendricks 1993, Jones & Holmes 1996, Baker et al. 1999, Storey et al. 1999, Fischer et al. 2005). The seemingly well-oxygenated hyporheic zone contains anoxic and hypoxic pockets ("anaerobic microzones") associated with irregularities in sediment surfaces, small pore spaces or local deposits of organic matter, creating a ‘mosaic’ structure of various environments, where different microbial populations can live and different microbially mediated processes can occur simultaneously (Baker et al. 1999, Morrice et al. 2000, Fischer et al. 2005). Moreover, hyporheic-surface exchange and subsurface hydrologic flow patterns result in solute gradients that are important in microbial metabolism. Oxidation processes may occur more readily where oxygen is replenished by surface water infiltration, while reduction processes may prevail where surface-water exchange of oxygen is less, and the reduc-