Relationship between sediment organic matter, bacteria composition, and the ecosystem metabolism of alpine streams

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ABSTRACT: We tested whether sediment bacteria abundance (4',6-diamidino-2-phenylindole-stained cell counts) were related to sediment organic content (ash-free dry mass [AFDW]) in 11 nonforested streams of three different Alpine catchments during summer 2003. We used terminal restriction fragment-length polymorphism (T-RLFP, a molecular genetic technique) to test for seasonal and spatial differences in bacterial composition in these same streams. We then related the above parameters, in conjunction with periphyton biomass and hyporheic respiration, to whole stream estimates of gross primary production (GPP) and ecosystem respiration (ER) in a glacial and nonglacial stream, representing environmental extremes, in one of the catchments. The percentage of organic matter of sediments was 4-14% (0.01-0.04 g AFDW ml sediment^{-1}), and counts of bacteria cells per millimeter of sediment averaged 2 x 10^6-4 x 10^6. Bacteria counts correlated with sediment AFDW only for streams in the catchment with highest sediment AFDW levels. Bacteria composition (based on the presence and absence of terminal restriction fragments from T-RFLP analysis) changed seasonally in the different streams and differed between glacial- and groundwater-fed streams. In the one catchment, hyporheic respiration averaged 0.0004 and 0.0003 g O_2 h^{-1} kg sediment^{-1} and was positively correlated with AFDW (r^2 = 0.23). Ecosystem metabolism displayed a strong seasonality, with GPP averaging 4.5 and 8.4 and ER averaging 5.4 and 9.9 g O_2 m^{-2} d^{-1} for the two sites, respectively, thus indicating a predominance of heterotrophy (P :R < 1) in these high-elevation, open-canopied systems. Bacteria play a strong role in the trophic dynamics of alpine streams.