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Microbial biodiversity of the vanishing cryosphere in the Alps

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Glacial retreat occurs at unprecedented pace worldwide. Despite this rapid retreat, many mountain glaciers still nurture headwaters, the smallest in alpine fluvial networks. In these streams, glacial runoff dynamics is known as a major control of algal and macroinvertebrate ecology. While glaciers are increasingly recognized to harbor active microbial communities, possible implications of glacial retreat for the microbial ecology of glacial streams and particularly for their biofilms — the major players in stream processes — remain elusive. Here we provide a first systematic survey on microbial community structure and biodiversity, based on massive 454-pyrosequencing of the 16S rRNA gene, in the glacial ice, runoff and in stream benthic biofilms at the terminus of 26 Alpine glaciers. Our results suggest strong differences in microbial diversity and community composition in the ice and both stream habitats. Streamwater microbial diversity significantly decreased with elevation, whereas biofilms did not. Environmental parameters, such as streamwater conductivity, pH and temperature, explained much of the variation in community composition in biofilms, while space and time were insignificant. Conductivity and pH, but not temperature, even influenced the relative occurrence of certain bacterial phyla (e.g. Nitrospira) in biofilms. Our results underscore the sensitivity of microbial communities to environmental change as glacial retreat is induced. This adds a new dimension to our understanding of glacial ecosystems as part of the vanishing cryosphere.