BOOK OF ABSTRACTS

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Springs from cold rocky landforms: icy seeps in warming mountains

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Abstract

The decline of cold environments is among the major effects of climate change. In mountain areas, freshwater habitats have been warming as a result of increasing air temperature, reduction of the snowmelt period, and glacier recession. However, most high-mountain regions contain landforms composed of coarse rocky materials and often containing ice, that are thermally buffered, and sustain cold/cool habitats in otherwise unfavourable climatic conditions. These cold rocky landforms, often originate very cold springs (< 2 °C), termed icy seeps, that might represent climate refugia for cold-adapted aquatic organisms. Rock glaciers appear to be the most common source of icy seeps, but other mountain landforms including debris-covered glaciers, morainal deposits, talus slopes, and protalus ramparts can support similarly cold springs. Collectively, icy seeps have been understudied, and little is known about how their thermal regimes vary among types of icy seep and across major mountain ranges. We monitored summer water temperature (mostly 2021/2022) of 152 springs across 14 mountain areas of the Eastern and Western European Alps, Rocky Mountains, Great Basin Mountains, and Patagonian Andes. The monitored springs represented icy seeps from rock glaciers, morainal deposits, talus slopes, protalus ramparts, and debris-covered glaciers, plus reference springs originating from slopes composed of fine materials with diverse origins. Thermal conditions at the same spring types differed among mountain ranges, but icy seeps were consistently colder (by 0.5 – 6.0 °C) than reference springs located within the same catchments, and at comparable elevations. This thermal offset was positively correlated with spring elevation, slope aspect, and average clast size of the landform debris. Our results highlight that major geomorphological drivers are useful for identifying some mountain features as cold rocky landforms for aquatic habitats. Hydroecological research on these environments is needed to address management strategies for climate change adaptation.