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Active response of freshwater invertebrates to hydro-and thermopeaking in a laboratory flume

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The increasing electricity demand on the one hand, and the need to decrease greenhouse gas emissions on the other hand, lead to a substantial increase in the construction of hydropower dams worldwide. This increase in green energy also comes along with significant ecological adverse effects, e.g. fragmentation of rivers and changes in habitats of organisms, thus further threatening freshwater biodiversity. For example, intermittent release of water from hydropower plants causes sudden variations in discharge that increase bed shear stress and dislodge benthic organisms. Release from high-elevation reservoirs can also affect the thermal regime of the river by causing sharp variations in water temperature. Since the hydrodynamic and thermal waves separate while propagating downstream, the benthic community is exposed to two distinct stressors that affect taxa differently based on their sensitivity and adaptations. However, because individual organism-scale processes are difficult to approach in field studies, evidence for behavioural response to flow and temperature changes has remained scarce. We investigated the effects of a sudden variation in discharge or in water temperature on the swimming behavior of a widespread species of cyclopoid copepod in a laboratory flume equipped with a camera system that allows the tracking of organisms both in the water column and inside a transparent sediment bed. We gradually varied the discharge or the temperature of the water to mimic the artificial changes caused by hydropower plants. We tracked copepods in three dimensions and quantified the kinematics of their motion. Copepods increased substantially their counter-current swimming effort in response to increasing flow velocity. This behavioural response resulted in a substantial reduction in their downstream transport and hence opposed drift. Copepods reacted differently to warm and cold variations in temperature. Increasing temperature enhanced resistance to drift, while decreasing temperature resulted in a decreased counter-current swimming effort and may hence enhance drift. Our study highlights the importance of understanding the behavioural traits that mediate the response of stream invertebrates to disturbances in the hydraulic and thermal regimes of their environment. It may help developing sustainable ways of implementing and operating hydropower dams.