Submitted Abstract

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Abstract

The impact of global warming on mountain ecosystems is predicted to be high, and particularly in the tropical region. Geothermal streams have provided comprehensive evidence about how aquatic biodiversity changes across natural thermal gradients, but current knowledge is restricted to arctic and temperate zones. Thermal tolerances are different in tropical biological communities, resulting in high thermal sensitivity and low capacity to endure change in their thermal environments. This feature can change the response of aquatic organisms to warming, yet there is little empirical evidence to support this assumption.

In this study, we address this issue by evaluating how water temperature affects biodiversity, and the structure of primary and secondary producers of a high-elevation geothermal stream system (4,500 m above sea level) in the Bolivian Andes. We analysed multi-taxa responses to increased water temperature using benthic macroinvertebrate families, benthic algae and cyanobacteria, fishes, and macrophytes as study organisms. Different models were run to assess the response of aquatic biota to temperature. In addition, threshold indicator taxa analysis (TITAN) was used to identify changes in macroinvertebrate taxa distributions along the thermal gradient.

We found that macroinvertebrate richness decreased at 24–25°C due to the different taxon-specific responses to temperature. Threshold indicator taxa analysis identified 17 temperature thresholds for each family of macroinvertebrates. Changes in macroinvertebrate community composition were significantly associated with changes in water temperature. Similarly, changes in macrophytes were associated with temperature differences, and high macrophyte richness was found at 19–20°C. Chlorophyll-a concentration of green algae and diatoms was higher at intermediate temperatures 20–22°C, macroinvertebrates density peaked at 27°C, and fish body size reduced linearly with temperature.

Temperature increase in the geothermal stream resulted in a reduction of aquatic diversity and primary and secondary producers by simplifying the community structure to a few warm-adapted taxa and reduced body size. These patterns differed from those obtained in temperate/arctic geothermal streams, but are similar to other studies at high-elevation. In a context of increasing warming, the ecological structure of high-elevation streams might lose cold-adapted taxa, and change to smaller populations. Additional studies based on ecosystem functioning of geothermal streams could lead to a better understanding on how warming affects high-elevation streams.