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Altitudinal distribution limits of aquatic macroinvertebrates: an experimental test in a tropical alpine stream

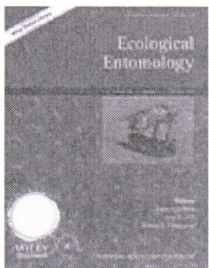
1. PHILIP B. MADSEN¹,
2. ANDRÉS MORABOWEN²,
3. PATRICIO ANDINO²,
4. RODRIGO ESPINOSA²,
5. SOPHIE CAUVY-FRAUNIÉ³,
6. OLIVIER DANGLES³ and
7. DEAN JACOBSEN^{1,2,*}

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Author Information

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1

Freshwater Biological Laboratory, University of Copenhagen, Copenhagen, Denmark

2

Escuela de Biología, Facultad de Ciencias Exactas y Naturales, Pontificia Universidad Católica del Ecuador, Quito, Ecuador

3

IRD, Institut de Recherche pour le Développement, UR 072, Laboratoire Evolution, Génomes et Spéciation, Centre National de la Recherche Scientifique (CNRS), France and Université Paris-Sud 11, France

* Correspondence: Dean Jacobsen, Freshwater Biological Laboratory, Department of Biology, University of Copenhagen, Universitetsparken 4, 2100 Ø, Copenhagen, Denmark. E-mail: Djacobsen@bio.ku.dk (<mailto:Djacobsen@bio.ku.dk>)

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Keywords:

Benthic macroinvertebrates; Ecuadorian High Andes; glacier-fed stream; locomotory activity; oxygen saturation

1. Temperature and oxygen are recognised as the main drivers of altitudinal limits of species distributions. However, the two factors are linked, and both decrease with altitude, why their effects are difficult to disentangle.
2. This was experimentally addressed using aquatic macroinvertebrates; larvae of *Andesiops* (Ephemeroptera), *Claudioperla*, (Plecoptera), *Scirtes* (Coleoptera) and *Anomalocosmoecus* (Trichoptera), and the amphipod *Hyaella* in an Ecuadorian glacier-fed stream (4100–4500 m a.s.l.). The following were performed: (i) quantitative benthic sampling at three sites to determine altitudinal patterns in population densities, (ii) transplants of the five taxa upstream of their natural altitudinal limit to test the short-term (14 days) effect on survival, and (iii) *in situ* experiments of locomotory activity as a proxy for animal response to relatively small differences in temperature (5 °C vs. 10 °C) and oxygen saturation (55% vs. 62%).
3. The transplant experiment reduced survival to a varying degree among taxa, but *Claudioperla* survived well at a site where it did not naturally occur. In the *in situ* experiment, *Scirtes* and *Hyaella* decreased their activity at lower oxygen saturation, whereas *Andesiops* and *Anomalocosmoecus* did so at a low temperature. The decrease in activity from a high to a low temperature and oxygen for the five taxa was significantly correlated with their mortality in the transplant experiment.

4. Together the present experiments indicate that even relatively small differences in temperature and oxygen may produce effects explaining ecological patterns, and depending on the taxon, either water temperature or oxygen saturation, without clear interacting effects, are important drivers of altitudinal limits.

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