The thermal breadth of temperate and tropic freshwater insects supports the Climate Variability Hypothesis

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Abstract

Climate change involves increases in mean temperature and changes in temperature variability at multiple temporal scales. Research on species response to climate change has focussed on changes in mean temperature. Thus, there is a need to consider how species will respond to changes in temperature variability. The Climate Variability Hypothesis (CVH) provides a conceptual framework for exploring potential effects of annual scale thermal variability across climatic zones. The CVH predicts ectotherms in temperate regions tolerate a wider range of temperatures than those in tropical regions in response to greater annual variability in temperate regions. However, various other aspects of thermal regimes (e.g. diel variability), organisms' size and taxonomic identity may also influence thermal tolerance. Indeed, high temperatures in the tropics have been proposed as constraining organisms' ability to tolerate a wide range of temperatures, implying that high annual maximum temperatures would be associated with tolerating a narrow range of temperatures. We measured thermal regimes and critical thermal limits (CTmax and CTmin) of insects in the orders Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) along elevation gradients in streams in temperate and tropical regions of eastern Australia and tested the CVH by determining which variables were most correlated with thermal breadth (Tbr = CTmax - CTmin). Consistent with the CVH, Tbr tended to increase with increasing annual temperature range and increasing body size. Tbr was generally wider in Plecoptera than in Ephemeroptera or Trichoptera. We found no evidence that higher annual maximum temperature constrained individuals' abilities to tolerate a wide range of temperatures. The support for the CVH we document, suggests that temperate organisms may be able to tolerate wider range of temperatures than tropical organisms. There is an urgent need to investigate other aspects of thermal regimes, such as diel temperature cycling and minimum temperature.

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