Warming tolerance across insect ontogeny: influence of joint shifts in microclimates and thermal limits

Sylvain Pincebourde*[1] and Jerome Casas†

[1]Institut de recherche sur la biologie de l'insecte (IRBI) – CNRS : UMR7261, Université François Rabelais - Tours – Av Monge 37200 TOURS, France

Abstract

The impact of warming on the persistence and distribution of ectotherms is often forecasted from their warming tolerance–inferred as the difference between their upper thermal limit and macroclimate temperature. Ectotherms, however, are thermally-adapted to their microclimates, which can deviate substantially from macroscale conditions. Ignoring microclimates can therefore bias estimates of warming tolerance. We compared warming tolerance of an insect across its ontogeny when calculated from macro- and microclimate temperatures. We used a heat balance model to predict experienced microclimate temperatures from macroclimate, and we measured thermal limits for several life stages. The model shows a concomitant increase in microclimate temperatures and thermal limits across insect ontogeny despite they all share the same macroclimate. Consequently, warming tolerance, as estimated from microclimate temperature, remained constant across ontogeny. When calculated from macroclimate temperature, however, warming tolerance was overestimated by 7-10∘C depending on the life stage. Therefore, errors are expected when predicting persistence and distribution shifts of ectotherms in changing climates using macroclimate rather than microclimate.

Keywords: biophysical ecology, temperature, microclimate, thermal tolerance

*Speaker

†Corresponding author: jerome.casas@univ-tours.fr