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Digest

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Digest: Plastic responses to warmer climates: a seminatural experiment on lizard populations

Josephine E. Robertson

Department of Ecology and Evolution, University of Chicago, Chicago, IL, United States

Corresponding author: Department of Ecology and Evolution, University of Chicago, 1101 E 57th St., Chicago, IL 60637, United States. Email: jerobertson@uchicago.edu

This article corresponds to Bestion, E., San-Jose, L. M., Côte, J., Calvez, O., Guillaume, O., & Cote, J. (2023). Plastic responses to warmer climates: A seminatural experiment on lizard populations. *Evolution*, 77(7), 1634–1646. https://doi.org/10.1093/evolut/qpad070.

Abstract

Determining whether a phenotypic change is the result of microevolution or plasticity can be challenging. Bestion et al. investigate the contributions of plasticity (both intragenerational and intergenerational) and selection to phenotypic changes in common lizards (*Zootoca vivipara*) in response to a warmer climate that mirrors projections for 2080. Their results suggest that plasticity plays a more important role than selection in governing many of the phenotypic responses to temperature change.

The potential for species to adapt to climate change is often explored through one of two lenses: evolution and phenotypic plasticity (Fox et al., 2019; Merilä & Hendry, 2014). Studies confirm that both can play a crucial role in mediating how species respond to environmental change (Stamp & Hadfield, 2020). However, it can be challenging to distinguish which mechanism underpins a given phenotypic change: Claims in support of evolution must be linked to discernible heritable changes, while evidence for phenotypic plasticity relies on decisively ruling out genetic modification (Merilä & Hendry, 2014). Moreover, even those studies that succeed in elucidating the underlying cause of phenotypic change frequently fail to empirically determine whether the observed changes confer some adaptive benefit (Merilä & Hendry, 2014). Given the potential for evolution and plasticity to also drive phenotypic changes that are nonadaptive, or even maladaptive, it is critical to quantify whether observed phenotypic changes are truly adaptive (Fox et al., 2019).

Aiming to disentangle the relationship between selection and plasticity (as well as adaptive and nonadaptive phenotypic changes), Bestion et al. (2023) investigated whether exposure to warmer temperatures resulted in behavioral and/or morphological change in populations of common lizards (*Zootoca vivipara*). As ectotherms, *Z. vivipara* were expected to have a suite of both behavioral and morphological traits that aid in thermal stress mitigation. To uncouple the effects of plasticity and selection on these traits, Bestion et al. (2023) established populations of *Z. vivipara* in mesocosms and manipulated average summer temperatures. Populations comprised of adults and juveniles were split between two temperature treatments: (a) Present day, with temperatures representative of current averages at the study site in Ariège, France, and (ii) warm, with temperatures an average of 2 C higher than the current averages at the site.

After a year, Bestion et al. (2023) evaluated the following traits in both adults and juveniles: body size, dorsal darkness, dorsal contrast, temperature preferences, and the covariation between these traits. The authors identified selection using differential survival based on trait values and linked these measures to evolution by quantifying trait heritability. Trait plasticity was determined by monitoring phenotypic changes within individuals during the year-long experiments. Additionally, offspring born to mothers who were pregnant during the warming experiments were used to assess the impact of maternal environment on juvenile traits (i.e., intergenerational plasticity).

After two sets of year-long experiments, Bestion et al. (2023) found that, relative to the present-day temperature treatment, adult lizards in the warm treatment were larger-bodied, tended to gravitate toward lower temperatures, and generally exhibited paler dorsal coloration with less contrast. Phenotypic plasticity, rather than evolution via selection, was identified as the driving force behind the observed changes in both thermal preference and coloration in adults. Intergenerational plasticity played a role in determining dorsal darkness and contrast in juveniles: for example, the offspring of warm-climate mothers developed darker, less contrasted coloration when they, too, were in the warm-climate treatment. The only significant selection gradient was one that favored larger body sizes in the warm treatment; selection gradients were nonsignificant in all other treatments for every other trait. Finally, warmer temperatures uncoupled positive covariation between temperature preference and darker dorsal coloration, decreasing covariation by 50% in the warm treatment.

With a focus on future studies, another result to note is an interesting, albeit nonsignificant, weak selection gradient in favor of darker coloration in warmer climates, which is antithetical to the trend toward paler coloration observed in warm climates driven largely by plasticity. Though the data

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in this study do not provide robust confirmation of this pattern, this result highlights an important consideration: plasticity and evolution may not always be working in the same direction. How often do selection and plasticity act antagonistically? How might antagonism between these two forces hinder adaptation as our climate changes? These are important questions to address in the future.

Conflict of interest: The author declares no conflict of interest.

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