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Tansley review

Rapid climate change and the rate of adaptation: insight from experimental quantitative genetics

Author for correspondence:
Ruth G. Shaw
Tel: +1 612 624 7206
Email: shawx016@umn.edu

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Ruth G. Shaw[1] and Julie R. Etterson[2]

[1]Department of Ecology, Evolution and Behavior, University of Minnesota-Twin Cities, 1987 Upper Buford Circle, St Paul, MN 55108, USA; [2]Department of Biology, University of Minnesota-Duluth, 207 Swenson Science Building, 1035 Kirby Drive, Duluth, MN 55812-3004, USA

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Summary

Evolution proceeds unceasingly in all biological populations. It is clear that climate-driven evolution has molded plants in deep time and within extant populations. However, it is less certain whether adaptive evolution can proceed sufficiently rapidly to maintain the fitness and demographic stability of populations subjected to exceptionally rapid contemporary climate change. Here, we consider this question, drawing on current evidence on the rate of plant range shifts and the potential for an adaptive evolutionary response. We emphasize advances in understanding based on theoretical studies that model interacting evolutionary processes, and we provide an overview of quantitative genetic approaches that can parameterize these models to provide more meaningful predictions of the dynamic interplay between genetics, demography and evolution. We outline further research that can clarify both the adaptive potential of plant populations as climate continues to change and the role played by ongoing adaptation in their persistence.

I. Introduction

Over >4 billion years, biological evolution has proceeded through periods of considerable change in climate, atmospheric composition and many other aspects of environment. Plants have evolved in response to these changes, as reflected in macroevolutionary patterns of divergence that are congruent with climate change (e.g. Edwards *et al.*, 2010; Franks *et al.*, 2012) and in predictable relationships between biogeography and plant functional traits (Reu *et al.*, 2011). Such evidence illuminates climate-influenced evolution in deep time, with changes in climate greater and more rapid during some periods than in