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From Forest Nursery Notes Winter 2013

**116. © Rapid climate change and the rate of adaptation: insight from experimental quantitative genetics.** Shaw, R. G. and Etterson, J. R. *New Phytologist* 195:752-765. 2012.



## Tansley review

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

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Received: 7 April 2012

Accepted: 5 June 2012

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## Summary

*New Phytologist* (2012) **195**: 752–765  
doi: 10.1111/j.1469-8137.2012.04230.x

**Key words:** adaptive evolution, additive genetic variation in fitness, geographic range, phenotypic plasticity, resurrection biology.

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