When does environmental change lead to selection on phenotypic plasticity?

Phillip Gienapp[1], Thomas E. Reed[1,2]

[1]Netherlands Institute of Ecology, [2]University College Cork

Introduction Environmental change can lead to selection on phenotypic plasticity if it alters the relationship between the 'cue environment' (E_1) that determines the phenotype and the 'selective environment' (E_2) that determines the optimal phenotype. Since climate change is heterogeneous in time and space, it may be likely that E_1 and E_2 change at different rates. Using individual-based models and the well-understood great tit-caterpillar system as a 'template' we here tested under which circumstances climate change can lead to selection on (linear) reaction norms.

Results The correlation between E_1 and E_2 and the variation in E_2 relative to E_1 affected selection on slopes (Fig.1).
When E_2 increased by 0.02°C/a (corresponding to IPCC SRES A1B scenario) and E_1 only at half that rate, phenotypic plasticity evolved towards a steeper slope (Fig.2). Interestingly, this was also the case when temperatures increased at equal rates (Fig.3) because the 'caterpillars' have a steeper reaction norm slope than the 'birds'.
Temporal autocorrelation could affect selection on slopes because it would lead to subsequent years being more (positive) or less (negative autocorrelation) similar but this did not seem to be the case (compare Fig.4 with Figs.2&3).

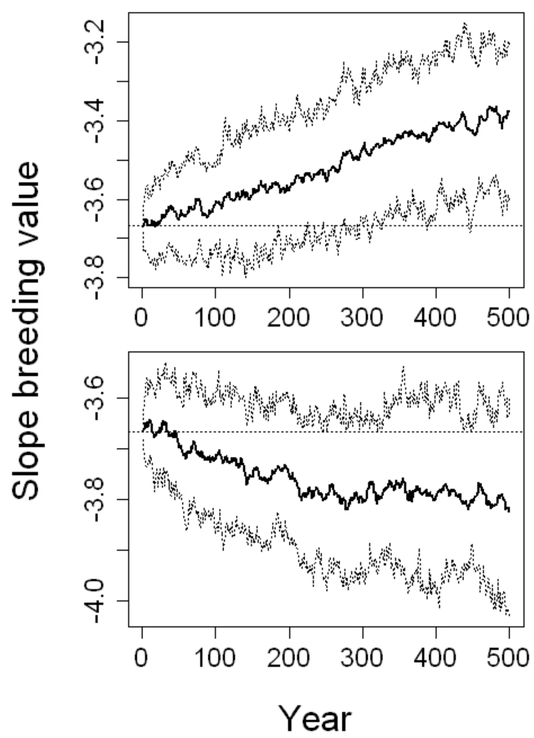

Fig.1 Evolution of reaction norm slopes when correlation between E_1 and E_2 is reduced (top) and variation in E_2 (but not E_1) is increased (bottom).

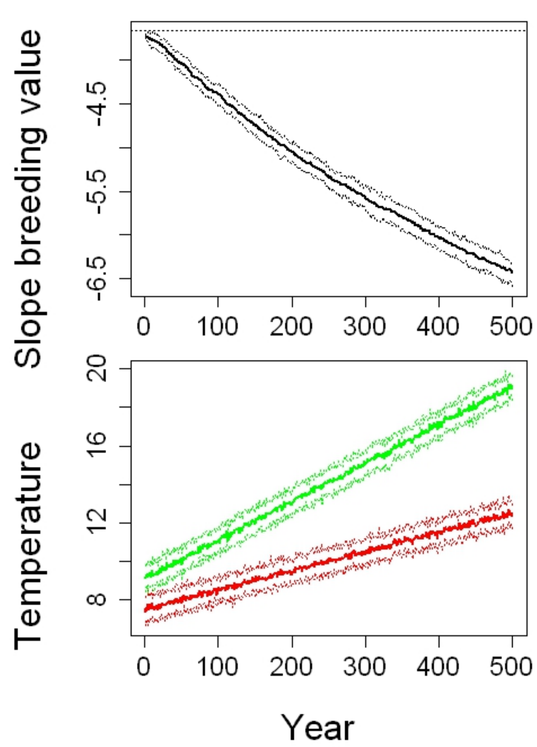

Fig.2 Evolution of reaction norm slopes (top) under differential increase in E_1 and E_2 (bottom).

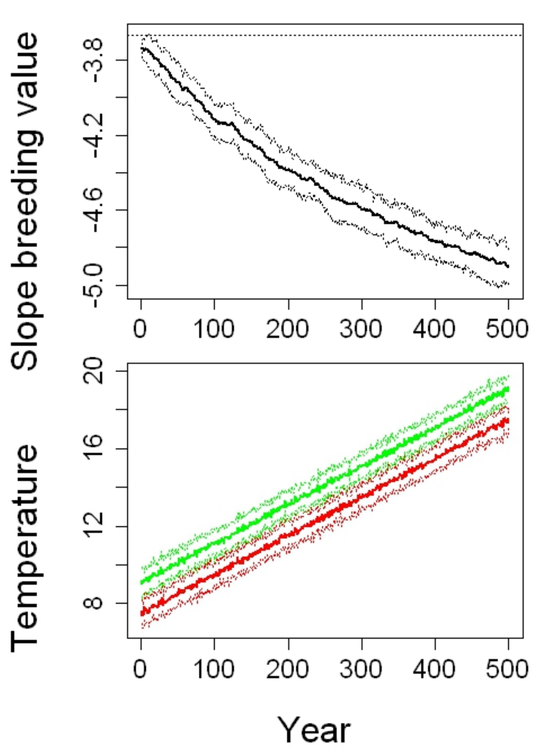

Fig.2 Evolution of reaction norm slopes (top) under equal increase in E_1 and E_2 (bottom).

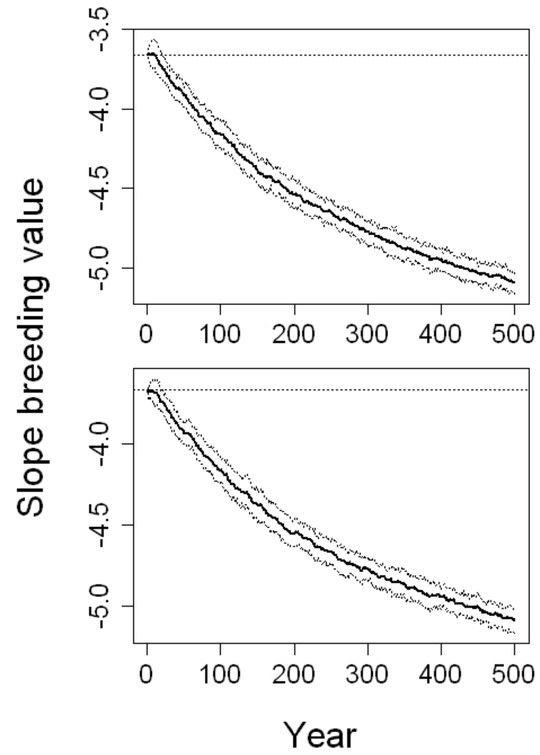

Fig.3 Evolution of reaction norm slopes under equal increase in E_1 and E_2 and positive (top) and negative autocorrelation (bottom).

Plotted are annual means (solid line) ± CI (dotted lines). Dotted horizontal line indicates initial mean breeding value. Since adult survival rate was 500 years correspond roughly to 250 generations.

Conclusion Climate change is likely to lead to selection on phenotypic plasticity, which may have consequences for successful adaptation as current evidence indcates that genetic variance in reaction norms slopes may be small or absent.

Netherlands Institute of Ecology (NIOO-*KNAW*)
Department of Animal Ecology
Wageningen, the Netherlands
p.gienapp@nioo.knaw.nl

School of Biological, Earth & Environmental Sciences
University College Cork
Cork, Ireland; treed@ucc.ie