The dynamics of adaptive response under strong selection regime in small populations

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Abstract

Climate changes are affecting plants at an incredible pace leading to major life-cycle shifts with complex consequences. The capacity of plants to cope with the rate of predicted climate changes will ultimately determine their survival. Here we investigate the rate of life-cycle shifts in maize using two independent divergent selection experiments (DSEs), conducted for more than 20 years under natural conditions in the Plateau de Saclay. Within each DSE, we applied a strong selection pressure (1%) for phenological shifts by choosing and selfing at each generation the 10 earliest- and 10 latest- flowering genotypes among thousand observed ones. The resulting Early and Late evolved populations exhibit pronounced phenotypic divergence for flowering, while preserving original characteristics of the initial inbreds. Using genetic markers and transcriptomic data, we identified a number of (epi)genetic differences. In order to address questions related to the role of new mutations versus standing variation in the response to selection, and to the rate and limits of adaptation, we have implemented a revised version of the animal model that explicitly accounts for new mutations. In this model, the observed response to selection is treated as a quantitative trait, driven either by shifts in average phenotype or plastic changes. From the dynamics of the selection response, we quantified the input of new mutations over generations, and indicated the most likely mutational events along the pedigrees. In addition, we implemented a population genetic model that describes the fate of a new mutation, in this high selection-high drift design. We discuss how, in these conditions, drift can accelerate fixation of adaptive mutations.

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