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ADAPTATION OF A QUANTITATIVE TRAIT TO A MOVING OPTIMUM

Abstract :

Does adaptation occur primarily through small or large mutational steps?

- For sudden environmental changes, it has become clear that evolution to a new optimum involves larger and fewer steps than previously thought. However, little is known about adaptation in gradually changing environments. Here, we address this issue using a simple population genetics model.

Under the assumption that the optimal value of a quantitative trait increases at constant rate, we calculate the expected time to fixation of mutant alleles with different phenotypic effects, the order in which they become fixed during short bouts of adaptation, and the effect distribution of fixed mutations over longer timescales. We find that mutations are most likely to contribute to adaptation if they have intermediate size. This is because small mutations are only weakly selected for, whereas large mutations initially overshoot the optimum and become beneficial only at a later time. The exact value of the preferred effect size decreases with the mutation rate and the selection strength and increases with the rate of environmental change. Depending on these parameters and the distribution of new mutations, we distinguish cases in which the pattern of adaptive substitutions is determined primarily by either genetic or environmental factors.