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# Local adaptation, phenotypic plasticity, and species coexistence

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Understanding the mechanisms of species coexistence has always been a fundamental topic in ecology. Classical theory predicts that interspecific competition may select for traits that stabilize niche differences, although recent work shows that this is not strictly necessary. Here, we ask whether adaptive phenotypic plasticity could allow species coexistence (i.e., some stability at an equilibrium point) without ecological differentiation in habitat use. We used individual-based stochastic simulations defining a landscape composed of spatially uncorrelated or autocorrelated environmental patches, where two species with the same competitive strategies, not able to coexist without some form of phenotypic plasticity, expanded their ranges in the absence of a competition–colonization trade-off (a well-studied mechanism for species diversity). Each patch is characterized by a random environmental value that determines the optimal phenotype of its occupants. In such a scenario, only local adaptation and gene flow (migration) may interact to promote genetic variation and coexistence in the metapopulation. Results show that a competitively inferior species with adaptive phenotypic plasticity can coexist in a same patch with a competitively superior, non-plastic species, provided the migration rates and variances of the patches' environmental values are sufficiently large.

## KEYWORDS

adaptive plasticity, competitive interactions, eco-evolutionary dynamics, gene flow, spatial correlation

## 1. Introduction

Spatial variation in the direction and strength of natural selection may often lead to eco-evolutionary dynamics. Local selection for the optimum phenotype could be hindered not only by gene flow but also from competitive interactions with other species; interactions which, in turn, could also be affected by the dual processes of gene flow and divergent selection (Blondry, 2017). Furthermore, theoretical models have shown that phenotypic plasticity, the ability of organisms to express different phenotypes depending on environmental conditions (Bradshaw, 1965; Schlichting, 1986), readily evolves when selective conditions are variable, whether in time or space (Blondry, 2017; Pfennig, 2021). In particular, spatial environmental variation where selection favors different phenotypes in each environment facilitates the evolution of adaptive phenotypic plasticity given some movement between environments (Via and Lande, 1985; Gomulkiewicz and Kirkpatrick, 1992; Schinner, 1998). Since phenotypic plasticity occurs within an ecological context—e.g., a normal or helmet morph in water fleas depending on the absence or presence of predators (Agrawal et al., 1999), or quorum sensing in bacteria according to surrounding bacterial cell density (Miller and Bassler, 2001)—much current interest focuses on how variation in phenotypic plasticity can affect the dynamics of interacting populations or species

# Phenotypic Plasticity And Local Adaptation In Tadpoles

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