On evolutionary stability in predator–prey models with fast behavioural dynamics

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ABSTRACT

Question: Does optimality in predator–prey models with plastic traits evolving on a fast time-scale imply evolutionary stability?

Mathematical methods: Predator–prey models of population growth described by differential equations with controls and feedback regulation, G-function.

Key assumptions: Plastic responses of organisms to changes in environment are adaptive in the sense that they maximize individual fitness. Population dynamics are deterministic and described by the Lotka-Volterra type dynamics.

Predictions: Adaptive plastic responses do not necessarily lead to evolutionary stability. Mutants with a different strategy can invade a monomorphic resident population, but they cannot replace residents.

Keywords: adaptive foraging, evolutionarily stable strategies, G-function, game theory, ideal free distribution, population dynamics, predator–prey games.

INTRODUCTION

A central challenge in ecology is to develop models that faithfully capture those important mechanistic details of natural systems that are required to make reliable predictions about population community structure and dynamics. This requires integration of processes that run on three different time-scales: individual, population, and evolutionary. The individual time-scale comprises phenotypic plasticity that produces behaviourally flexible phenotypes as a response to changing environment (Miner et al., 2005). The population time-scale is concerned with population dynamics that manifest on a slower time-scale than behavioural responses. The evolutionary time-scale focuses on slow trait changes due to mutation and selection processes. This trichotomy led to separation of these three research programmes that currently correspond to behavioural ecology, population ecology, and evolutionary
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