State-dependent habitat selection games between predators and prey: the importance of behavioural interactions and expected lifetime reproductive success

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ABSTRACT

The fitness of both prey and predators will be affected by the behaviour of conspecifics and other (predator or prey) species. However, little theory has considered the case where predators and prey respond to one another simultaneously. I present a framework that examines the impact of the predator–prey behavioural interactions (within and between species) in a state-dependent life-history context. I use multiple linked dynamic state variable game equations to predict the patch selection of prey and predators as a function of their energy reserves. When prey are expected to maximize their probability of survival, the individual predators and prey that are not at risk of starvation are predicted to be uniformly distributed among patches independent of the difference in resource input rates among sites. However, individuals near starvation cause more prey and predators to be found in high resource sites. In contrast, when predators and prey both maximize reproduction, predators and prey are predicted to show imperfect resource matching. The proportion of individuals at risk of starvation causes deviations from the perfect resource matching predicted by previous predator–prey games. The predicted patterns clearly illustrate the importance of recognizing that predators and prey will both respond concurrently to one another’s distributions. However, the models also illustrate that an organism’s state, competition among conspecifics and the life-history pattern of both predators and prey are key to understanding their distribution and behaviour. We can increase our understanding of these interactions and the distribution of predators and prey in space and time by combining the consideration of interactions within and between the species with knowledge of how foraging relates to lifetime expected reproductive success of both predators and prey.

Keywords: dynamic state variable model, game theory, habitat selection, life history, predator–prey interactions.

INTRODUCTION

Interactions between species are at the heart of many important ecological and evolutionary processes. Predator–prey dynamics are a classic and relatively well-studied example of
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