Effects of field spatial scale and predator colonization behavior on pest suppression in an agroecosystem: a modelling approach

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ABSTRACT

Ecological field studies and theory over the past several decades have demonstrated that the spatial scale at which heterogeneous habitats are deployed can have a profound effect on the growth, movement, reproduction, and mortality of resident plants and animals. Increasing evidence from studies in agroecosystems, however, has revealed that landscape complexity affects different organisms in different ways. Very little is known about the underlying mechanisms driving such differences in species responses, creating challenges for determining how best to manage landscapes in order to maximize environmental services such as biological control/pest suppression. Diversifying agroecosystems by establishing or retaining natural vegetation in and around crop areas has long been recognized as a potentially effective means of bolstering pest control by attracting more numerous and diverse natural enemies, though outcomes are inconsistent. We address here gaps in our understanding of the link between non-crop vegetation in field margins and pest suppression by using a system of partial differential equations, which include population-level predator-prey interactions as well as spatial processes, to capture the dynamics of crop plants, herbivores, and two generalist predators. We focus on differences in how these two predators (a carabid and a ladybird beetle) colonize crop fields where they forage for prey, examining differences in how they move into the fields from adjacent vegetation as a potential driver of differences in overall pest suppression. Furthermore, we examine how differences in colonization behavior may interact with spatial scale in determining the ability of predators to suppress prey in diversified agroecosystems. We show that predator colonization behavior and spatial scale are important factors in determining pest suppression, and discuss the implications of our results in terms of habitat management for biological control in agroecosystems.