Pollen provisioning in orchard systems and its effect on intraguild interactions among omnivorous mites and their pestiferous prey

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Abstract

The structure of ecological systems can be viewed as a collection of food chains characterized by trophic interactions among consumers and their food sources. Although food chains are traditionally described as having distinct trophic levels, many ecological communities include omnivorous species that feed on resources found at more than one trophic level. It has become evident that many terrestrial arthropods are in fact omnivores that obtain nutrients from both prey and plant sources. The ability of omnivores to feed on both sources makes them ideal candidates for biological control agents. Their unique nutritional ecology allows them to persist in the habitat and maintain populations by consuming plant food sources when prey is scare. Pollen is a well-known food source that supports and sustains omnivorous populations that are natural enemies of pests, and improves pest suppression. However, concomitant with the increase in natural enemy population levels, intraguild predation also increases, potentially affecting the net survival of both individual predator species and prey populations.

The present study focused on phytoseiid mites (Acari: Phytoseiidae) and their pestiferous mite prey. The overall objective of the study was to explore the effects of pollen availability on prey suppression by omnivorous consumers when they act alone or together with other intraguild consumers. Toward this objective, two different agroecosystems were studied: 1) avocado orchards with a simple predator–prey interaction between a single predator—*Euseius scutalis*, and a single pest prey—*Oligonychus perseae* (Acari: Tetranychidae; persea mite); 2) citrus orchards, with more complex multi-predator–prey interactions between several predators—*Amblyseius swirskii*, *Iphiseius degenerans*, *Typhlodromus athiasae*, *Euseius stipulatus*, *Euseius victoriensis* and *E. scutalis*—and a single pest prey, *Phyllocoptruta oleivora* [Acari: Eriophyidae; citrus rust mite (CRM)]. For both systems, experiments were conducted on three spatial scales: leaf discs, seedlings, and mature trees in commercial orchards. Study results are reported in three chapters.

In the first chapter, the effect of pollen provision on predator and pest populations was evaluated in the simple system with a single predator species and single prey species and no intraguild predation (IGP) (avocado), and in the complex system with multiple predator species and a single prey species, and potential IGP (citrus). Both laboratory and II field results in this chapter showed that significant

suppression of the persea mite and CRM could be achieved using specialized pollen-feeding phytoseiids (*Euseius* and *Iphiseius* species), provided that pollen is available. Furthermore, results in the first chapter suggested that none of the predator species were able to persist without pollen, regardless of experimental spatial scale.

In the second chapter, the effect of pollen supplementation on intraguild interactions among phytoseiid predators and their pest prey was studied in systems with a single predator species and a combination of two predator species. The results indicated that pollen supplementation does not act to reduce IGP and as a result, the combination of two predator species did not improve pest suppression compared to the single predator system. Activity of two predatory species did not have an additive effect on pest suppression and in some cases, the combined activity even disrupted pest suppression. The latter effect could be attributed to intraguild interactions and their impact on predator density: the presence of some species disrupted the establishment of others. In the third chapter, the effects of pollen provisioning on pollen-feeding and generalist predators (type IV and type III phytoseiids, respectively) and their ability to suppress populations of shared prey were compared. A prevalent assumption concerning possible tradeoffs between omnivorous and intraguild predatory abilities was tested. Results showed that IGP has significant effects on predator survival in all pairing combinations and that pollen does not improve these negative intraguild interactions. Furthermore, pollen-feeding predatory species tended to be more aggressive than the generalist predators.

In summary, results of the current study demonstrate the advantages of using omnivores as biological control agents, and the ability to enhance their suppression of pests by manipulating pollen availability. While a significant 'bottom-up' effect through pollen supplementation was evident in both systems (with a single and multiple predators), species assemblage in the latter did not improve pest control significantly. Furthermore, the natural enemies that best utilized pollen were superior in intraguild interactions and most effective as biological control agents. In addition, IGP negatively affected population levels of natural enemies and in some cases, negatively impacted pest suppression. It therefore appears that in the agro-ecosystems used in the present study, III biodiversity has a negative or no effect on pest suppression. From a practical perspective, this work suggests that augmentation or conservation of a single effective omnivorous predatory species may be more

beneficial for pest control than trying to enhance the biodiversity of natural enemies in the cropping system..