Optimal host choice by the parasitic wasp *Aphidius colemani* Viereck: influence of host, host plant and predators.

Thesis submitted for the degree of PhD

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Submitted to the senate of the Hebrew University of Jerusalem

July, 2006

Abstract

Parasitic wasps foraging for hosts face a series of decisions that will determine their reproductive success and the fate of their offspring. The host selection process by parasitic wasps is complex: the parasitoid must first locate the host's habitat, find the host itself, and then choose to accept or reject it. To increase its own fitness, the parasitoid is expected to choose the host which is most suitable for the development of its offspring. At the same time, many factors may influence host selection, including learning and previous experience, age and egg load of the parasitoid, genetic variation among populations, conditioning to the host on which wasp developed, availability of hosts of adequate quality, and complex interactions among the wasp and other natural enemies and mutualists of the hosts.

Interactions between natural enemies with shared hosts are termed intraguild interactions. They can take the form of competition for a common resource, mutual or unilateral interference, or intraguild predation (IGP). IGP occurs when one predator species feeds upon another species belonging to the same predatory guild. This type of interaction can have a decisive effect on the population of herbivore prey, and can, in some cases, interfere with effective biological control of the herbivore. While the degree of symmetry in relations between predators may be system-specific, the relationship between predator and parasitoid is by nature asymmetrical, usually resulting in the death of the parasitoid. This is true because many predators feed indiscriminately on both unparasitized and parasitized prey. In the presence of predators, parasitoids that serve as intraguild prey are expected to adopt behavioral strategies that reduce the risk of predation.

Aphidius colemani, which served as the model organism for this research, is a solitary wasp belonging to the family Aphidiidae. *A. colemani* parasitizes at least 39 species of aphids on a wide variety of host plants. The central aims of this research were 1) to evaluate the effect of plant, aphid-host plant combination and the presence of intraguild predators on host selection by *Aphidius colemani*;

and 2) to quantify the wasp's ability to reduce the aphid population in the presence and absence of the intraguild predator *Coccinella undecimpunctata*. Additional goals included assessment of a) the preference of predator larvae to feed on parasitized versus unparasitized aphid prey, b) the ability of the predator to consume different developmental stages of the parasitic wasp within the aphid, and c) the suitability of parasitized prey for the development of the predator, in comparison with unparasitized prey. These questions are central to understanding the degree and nature of predation pressure exerted on the wasps by intraguild predators.

The wasps chose to return to the host aphid upon which they developed, with the exception of those reared on *Rhopalisiphum padi* on wheat, which preferred to parasitize the aphid *Myzus persicae* on radish or pepper plants. Uninfested, aphid-free plants were not observed to affect host-habitat selection, while the aphid-host plant combination did prove to have a significant effect. Of all the combinations tested, *M. persicae* reared on radish plants produced the largest *A. colemani* offspring.

The presence of intraguild predators on the preferred host plant did not cause the wasps to alter their choice of host, and wasps reared on *M. persicae* on radish returned to that combination for oviposition while ignoring the presence of predators. An encounter between a coccinellid larva and adult wasp did not cause the wasp to abandon the plant, even when additional hosts were offered nearby on a predator-free plant.

Feeding on parasitized aphids hindered the development of *C. undecimpunctata* larvae. The rate of predation decreased with increasing developmental stage of the wasp and predator larvae could not feed on mummified aphids. Predator larvae that were offered aphid mummies with broken shells showed longer developmental time and they molted to pupae and adults of reduced weight compare to those fed on unparasitized aphids. *C. undecimpunctata* larvae did not, however, avoid consuming parasitized aphids when both parasitized and unparasitized aphid prey were provided.

In the short-term, the presence of predators had a negative effect on parasitoid population, expressed as a reduction in the number of mummies produced. Activity of the predators led to dispersal of aphid colonies and disturbed aphids fell from the plants. These effects decreased the number of wasp-aphid encounters per unit time, and caused a reduction in biological control. In the long term, however, the greatest reduction in aphid populations was attained by the combined action of predators and parasitoids, despite the increase in intraguild predation.

The results of this study indicate that the factors tested have an important effects on host selection by *A. colemani*. The plant-aphid complex upon which the wasp was reared had greater influence on the adult wasps than did the plant alone, and most wasps were positively conditioned to prefer the combination on which they developed. Host quality also affected host selection by parasitoids: wasps that were unfamiliar with the offered hosts chose the host that was most suitable for the development of their offspring, *M. persicae* on radish. Contrary to expectations, the presence of predators did not alter the host-selection behavior of parasitoids: adult wasps attacked preferred hosts even when predators posed a real threat to the survival of their offspring. Parasitized aphids were suboptimal prey for *C. undecimpuctata*, as demonstrated by increased developmental time and decreased pupal and adult weight. This negative effect on the predator reduces the asymmetry of these predator-parasitoid interactions. It is noted, however, that the coccinellid larvae fail to avoid feeding on parasitized prey, and in the long run the most efficient control of the aphid population was achieved by the combined activity of both types of natural enemies. Three mechanisms may explained this apparent contradiction: 1) under field conditions, the parasitoid may prefer to remain on a given plant in spite of the presence of predators because the probability of finding host patches without predators is low; 2) the parasitoid is vulnerable to predation only during part of its development because the predators cannot feed on the mummies. This may reduce the selection pressure that favors female wasps that leave predator-harboring plants; and 3) as the size of the aphid colony increases, the probability that a predator will

encounter a parasitized aphid decreases, thus reducing the threat of intraguild predation. This may lower the selection pressure placed on the parasitoids to avoid encounters with predators, as well as the pressure on coccinellids to differentiate between parasitized and unparasitized prey. Elucidation of these possible mechanisms will require further research.