Effect of Aphid Predators on Oviposition Behavior of Aphid Parasitoids

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Accepted November 12, 1997; revised November 22, 1997

KEY WORDS: aphid; parasitoid; Aphidius ervi; Coccinellidae; oviposition behavior.

INTRODUCTION

Most herbivores and many other insects are subject to attack by both parasitoids and predators. Members of these two guilds of natural enemies thus compete for resources (Rosenheim et al., 1995). However, competition is usually asymmetric because insects attacked by parasitoids are often as vulnerable to predation as unparasitized hosts (e.g., Lawton and Hassell, 1981). In such cases, we might expect parasitoids to evolve to avoid areas where predators are present.

Aphids are attacked by large guilds of parasitoids and predators (Dixon, 1985: Minks and Harrewijg, 1988). Primary aphid parasitoids develop endo-parasitically, pupating within the mummified remains of their host. Predators such as Coccinellidae appear not to distinguish between aphids with or without parasitoid larvae (Hagen and van den Bosch, 1968) and frequently consume mummified aphids.

We studied the oviposition behavior of the parasitoid Aphidius ervi (Braconidae, Aphidiinae) attacking the pea aphid Acyrthosiphon pisum (aphididae, Macrosiphoninae). We predicted that the parasitoid would be less willing to attack aphids in patches where a major predator, the coccinellid Coccinella septempunctata, was present or in patches which contained recent traces of predators.

METHODS

Aphids and parasitoids were collected from the field at Silwood Park, Berkshire, in the south of England. The aphid and parasitoid were cultured in the

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laboratory using broad beans, *Vicia faba* var. Sutton Dwarf, as the host plant. Adult and larval predators were collected from the field shortly before the experiments and fed on another species of aphid, *Microlothium barnosum*, prior to use. All parasitoids used in the experiment had prior experience of oviposition, but no previous contact with predators. Aphids and parasitoids were used only once in the experiments. *Acyrthosiphon pisum* is not an ant attended species of aphid.

We compared the foraging behavior of individual *A. ervi* females in patches that did or did not contain predators or traces of predators. A patch consisted of a single potted bean plant on which 25–35 *A. pisum* (2–5 apterous adults with nymphs of different ages) had been placed 1 h before the start of the experiment. There were four treatments: (i) no predators, (ii) a larval *C. septempunctata* placed in the patch 10 min before the parasitoid, (iii) an adult *C. septempunctata* placed in the patch 10 min before the parasitoid, and (iv) a larval *C. septempunctata* placed in the patch for 20 min but removed 10 min before the start of the experiment. Treatments i and iv were replicated 20 times, and the other two treatments 10 times. At the start of the experiment there was no difference in the number of aphids in patches of the different treatments. We recorded (a) the total time spent in the patch by each female; (b) the number of contacts between wasp and aphid; (c) the fraction of contacts that led to oviposition and (d) the "rest time," the time the wasp spent in the patch not searching, either sitting motionless or grooming. Statistical analysis was performed using ANOVA, with variances stabilized where necessary using logarithmic or angular transforms.

**RESULTS**

Compared to the control, female parasitoids spent less time on the patch if there were adult or larval coccinellids present or if there had recently been a coccinellid in the patch (Fig. 1). The patch residence time was higher in the control than in the three experimental treatments (*F*$_{1,56}$ = 19.00, *P* = 0.0001) and there were no differences among the latter three values (*F*$_{2,56}$ = 0.64, *P* = 0.53). The proportion of time in the patch spent resting did not differ among the four treatments (*F*$_{3,56}$ = 1.82, *P* = 0.15).

There were significantly more contacts between wasps and aphids in the experimental treatments compared with the control (Fig. 2) (*F*$_{1,56}$ = 20.66, *P* < 0.0001), with no significant heterogeneity among experimental treatments (*F*$_{1,56}$ = 0.30, *P* = 0.74). A more complicated picture is found for the fraction of contacts that led to ovipositions. There is significant heterogeneity among the control and experimental treatments (Fig. 3) (*F*$_{3,56}$ = 13.43, *P* < 0.0001) with