Host selection for self-superparasitism by *Diaeretiella rapae* (M'Intosh) (Hymenoptera: Aphidiidae)

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Nae6742,d the solitary endoparasitoid

e brassicae, was studied in the laboratory. When given a choice

itised aphids, 70% of females made their attack on unparasitised

eady-parasitised aphids were less defensive to parasitoid attack

had shorter host-handling time. The female superparasitised

ack and the large hosts were superparasitised more often than

superparasitised hosts carried two to ve parasitoid larvae, only

an adult. The body size of parasitoid larvae, as measured 4 days

cted by the total number of larvae in the host. Superparasitism

cussed in the context of reproductive tness.

host defence, *Brevicoryne brassicae*, *Diaeretiella rapae*.

INTRODUCTION

Reproductive tness of female parasitoids depends on their ability to assess the suitability of hosts as resources for successful development of their larvae. Superparasitism is a common phenomenon (Van Alphen & Visser 1990; Jaramillo et al. 2006) in which female parasitoids lay egg(s) in already-parasitised hosts, and the larvae developing inside the host compete for the

In gregarious parasitoids where more

are not readily available (Van Alphen & Visser 1990). Superparasitism may also increase the chance of survival of at least one larva, as two or more larvae probably depress the host defence system more effectively than one (Mackauer & Chau 2001).

This study looked at the superparasitism strategy of *Diaeretiella rapae*, a solitary endoparasitoid of cabbage aphid *Brevicoryne brassicae* and several other aphids of cruciferous and non-cruciferous plants (Pike et al. 1999). There is little information on superparasitism in this cosmopolitan wasp, although Lester & Holtzer (2002) suggested superparasitism in *D. rapae* occurs at low host density. Previous studies on *D. rapae* showed that females prefer larger hosts for oviposition, when given a choice of different sizes of hosts (Kant et al. 2008). It is important to understand the superparasitism behaviour in terms of fitness consequences for the parasitoid, as this may improve biological control programmes at the level of mass rearing and/or during augmentative release (Hamelin et al. 2007). The following questions were addressed in the present study to understand the superparasitism strategy of *D. rapae*: (1) Is the female able to distinguish between unparasitised and parasitised hosts? (2) Does the female show any preference for host size during superparasitism? (3) Does defensive behaviour of already-parasitised and unparasitised aphids differ during parasitoid attack? (4) What are the effects of superparasitism on growth of parasitoid larvae?

MATERIALS AND METHODS

Insect culture

Cultures of *D. rapae* and its host, *B. brassicae*, were established from individuals collected in a cabbage field in Palmerston North (Manawatu, New Zealand). Aphids were maintained on 8-week-old cabbage *Brassica oleracea* var. *capitata* (cv. Summer Globe Hybrid) at 20±2°C under 65% RH and 16 h light regime. *Diaeretiella rapae* were reared on large (5-7 days old) cabbage aphid nymphs.

Discrimination between parasitised and unparasitised host

In order to get parasitised aphids, 1-day old mated *D. rapae* females were each offered five cabbage aphid nymphs in a Petri dish. There were two groups of females (n=35 in each group), and these were offered either small (1-2 days old) or large (6-7 days old) nymphs. Two sizes of aphids were used in order to make easy visual reference of unparasitised versus already-parasitised aphids when recording behaviour. Parasitism was observed and the parasitised aphids were transferred to cabbage leaves for 1 h for later use in the host discrimination test; the unparasitised aphids were discarded.

The discrimination ability of *D. rapae* females was examined in a two-part experiment. In the first part, each of the 35 females previously used to parasitise 1–2-day-old aphids was offered a small (1-2 days old) self-parasitised aphid nymph and a large (6-7 days old) unparasitised nymph in a Petri dish. In the second part of the experiment, the other 35 females (those used to parasitise 6–7-day-old nymphs) were each offered a large self-parasitised aphid and a small unparasitised aphid. The first encounter of the female (with unparasitised or already-parasitised host) and defensive behaviour of aphids were recorded. After parasitism or superparasitism, the aphids were transferred to cabbage seedlings for their development, for 4 days, and subsequently dissected under a stereomicroscope (Olympus SZX12). The number of larvae found in each host was recorded and the larval body lengths were measured using Motic imaging software (version 2.0).

Host size preference for superparasitism

The host size preference for superparasitism was tested by offering four aphid nymphs: 1, 3, 5 and 7 days old (age of aphid nymphs is directly correlated to their size, Kant et al. 2008) to a 1-day-old mated *D. rapae* female in a small Petri dish. The female was allowed to oviposit for 20 min and the behavioural responses of the female and the hosts were recorded for that period. Twenty-five females were tested in this experiment.

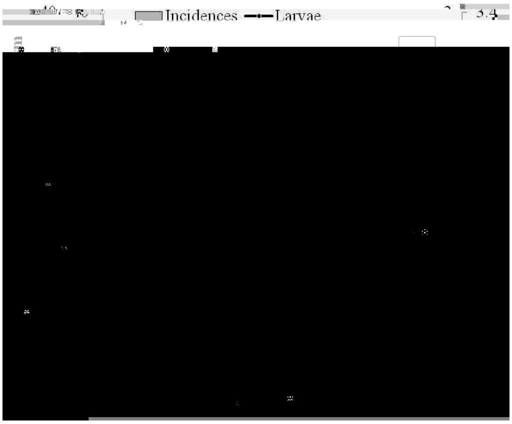

Figure 1

Table 2 Size of *Diaeretiella rapae* larvae in single larva and multiple larvae hosts. Same letter within a column indicates no signi cant difference (•=0.05).

Development condition of the *D. rapae* larvae	Larval size (µm)	
	Larger host	Smaller host
Single larva	841±56 a	581±41 a
Multiple larvae	549±19 b	505±46 a

different (P=0.07). However, when smaller (1 and 3 days old) hosts and larger (5 and 7 days old) hosts were grouped together, the difference in the mean number of eggs laid in larger and smaller hosts was signi cant (P<0.03). The number of parasitoid larvae found in superparasitised hosts varied from two to ve per aphid.

The size of *D. rapae* larvae found in the dissected aphids 4 days after oviposition, was positively correlated with the size of aphid in which they developed (P<0.0001) (Figure 2).

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