OVIPOSITION PREFERENCES OF *EPISYRPHUS BALTEATUS*

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ABSTRACT

A crucial aspect of predator oviposition behaviour is host plant choice, especially in hover-flies where the newly hatched offspring are unable to move a great distance to search for the appropriate prey. Such offspring must generally feed on the host plant aphids previously selected by the mother. Some factors involved in the selection of the oviposition site of *Episyrphus balteatus* De Geer include aphids associated to chemical stimuli, aphid colony size and host plant characteristics. Here we tested the hypothesis that there will not only be a rank order hierarchy of preference for aphid prey species reared on the same host plant but that a similar hierarchy of different host plant of one aphid species could be established. Therefore we compared the number of eggs laid on different combinations of host plant and aphid species. *Vicia faba* L., secondary metabolites free, *Brassica napus* L. and *Sinapis alba* L., containing low and high levels of glucosinolates respectively were used. The latter compounds are well known allelochemicals from Brassicaceae having a strong influence on specialist and generalist insects from both phytophagous and entomophagous levels. These experiments enhance the importance of tritrophic interactions in biological control of pests by underlining the host plant influence on aphidophagous predators, either directly or through the odours emitted by the phytophagous prey.

INTRODUCTION

Episyrphus balteatus is one of the most abundant and most efficient aphid predators found in different crops (Latteur 1991;Tehnumberg, 1995, Vidal, 1997) and is extremely generalist (Rotheray & Gilbert, 1989). Nevertheless, when offered different aphid and host plant complexes, the females do have ovipositional preferences (Sadeghi & Gilbert, 2000a). Their host choice is crucial in syrphid species where the larvae cannot move any great distance to search for an appropriate prey. The female selection is guided by several factors including visual and olfactory stimuli (Chandler 1968 a,b,c; Budenberg & Powell, 1992) The latter are aphid-associated compounds present on leaf surface such as honeydew together with both polar and non-polar compounds extractable from aphid surface (Bargen *et al*, 1998). As the host plant influences aphid chemical content (Francis *et al*, 2001), as well as the development of *E. balteatus* (Vanhaelen *et al* 2001, submitted), we tested the hypothesis that there would not only be a rank order hierarchy of preference for aphid prey species reared on the same host plant but also that there is a hierarchy of different host plant of one aphid species. In order to assess this oviposition preference, the eggs deposited on each aphid and plant complex were counted. The host plant and aphid complexes consisted in three specialist aphids, namely *Megoura viciae* Buckton, *Acyrthosiphon pisum* Harris reared on *Vicia faba* or *Brevicoryne brassicae* L. reared on *Brassica napus* L.. The generalist *Myzus persicae* Sulzer was reared on glucosinolate free *V. faba*, *B. napus* and *Sinapis alba* L. containing low and high levels of glucosinolates respectively. The Brassicaceae were chosen due to their secondary metabolite content and the presence of related degradation products (mainly isothiocyanates), which are known to display either attractive or repulsive and toxic effects on insects of both second and third trophic level (McCloskey & Isman, 1993; Huang & Renwick, 1994; Reed *et al*, 1995; Hopkins *et al*, 1998 and; Francis *et al*, 2000).

MATERIALS AND METHODS

Plant and insect rearing

Broad beans (*Vicia faba*) were grown in 20×30 cm trays including a mixture of perlite and vermiculite (1/1) in a controlled environment room at 20±2 °C and 16 h daylight photoperiod. White mustard (*Sinapis alba* containing high GLS level) and oilseed rape (*Brassica napus*, containing 6 fold less GLS than *S. alba*) were raised in 10cm diameter plastic pots containing ordinary compost in separated rooms with the same controlled conditions. While *Acyrthosiphon pisum*, and *Megoura viciae* were reared on broad beans, *B. napus* was used as *B. brassicae* host plants. *Myzus persicae* was reared on the three plants. Each aphid species had been reared in the laboratory for several years.

The first generation of *E. balteatus* was provided by PK Nützlingzuchten (Welzheim, Germany). Adults were reared in 100×60×60 cm cages and fed with pollen, honey and sugar. Hoverfly larvae were mass-reared in aerated plastic boxes of 11×14×4 cm and were daily fed *ad libitum* with *M. viciae* as standard diet.

Oviposition preference

Equal number of females and males were reared together for one week. When most females contained mature eggs, they were transferred individually in 60x30x30 cm cages. These naïve females were then offered aphids on a newly cut section of their host plant. The aphids were presented every two days in a randomised sequence. Each presentation lasted 30 minutes. Aphid host plant combination was then replaced by another one until all combinations had been offered. When removed from the cages the eggs laid in each case were counted.

Result analysis

The relative oviposition preference were expressed as the mean percentage of eggs laid in response to each aphid and host plant complex expressed on a per cycle or overall per female basis. The Kruskal-Wallis test was used for detecting differences among relative preferences. Kendall's coefficient of concordance, W, was used to measure the consistency of the rank order preference either between female or between cycles for each female. Minitab software (vs 11.2) was used for the data analysis.

RESULTS

In the first part of this study we assessed the impact of different aphid species on the oviposition preferences of the female. Therefore *M. viciae* was chosen as control prey which was used for the hoverfly mass rearing., *A. pisum* that had already been shown to be highly attractive for *E. balteatus*, *M. persicae*. The three latter aphid species were reared on broad beans whereas the cabbage aphid was reared on rape seed (Figure 1). The syrphid female did significantly prefer *M. persicae* and *A. pisum* (more than 30 % each) when compared to the other two species (H = 10.15 and P = 0.017).

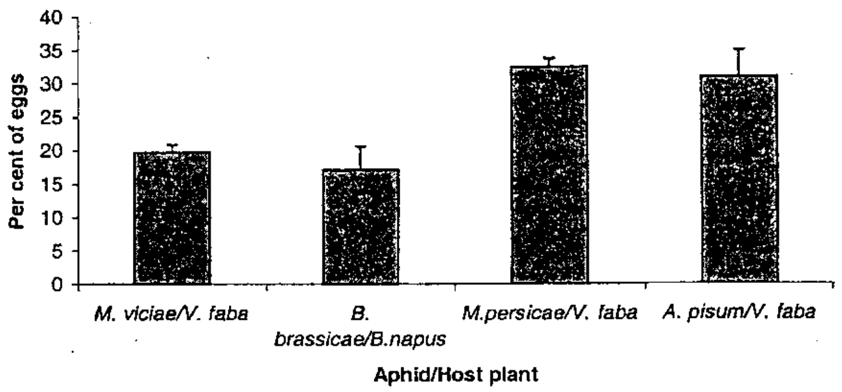

Figure 1: Lifetime fertility percentages of female *Episyrphus balteatus* (± SE) in response to particular aphid species.

There was a significant level of agreement among females in their overall ranking of preference (W = 0.65, χ^2 = 11.80 and P = 0.004). All the females preferred *M. persicae*, the peach aphid followed by *A. pisum*, the pea aphid. There was some variation for the rank of the two other considered aphids. The percentage of eggs laid on the most and least preferred aphid in successive oviposition cycles is shown in Figure 2.

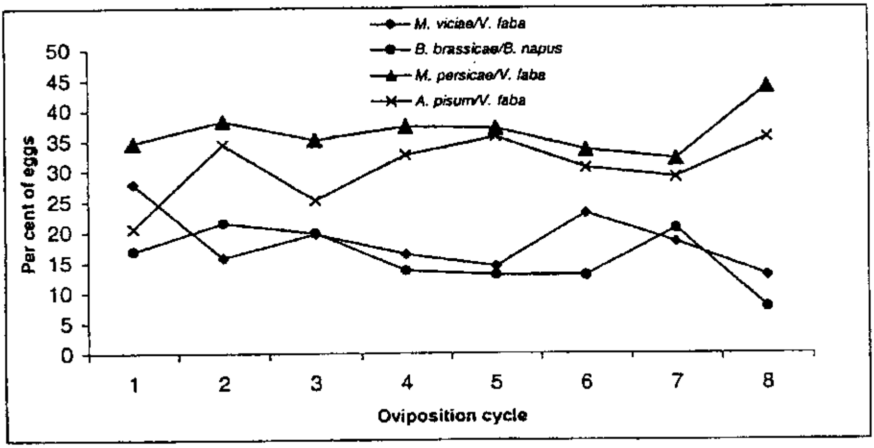

Figure 2 : Percentages of total eggs deposited by *Episyrphus balteatus* females during each oviposition cycle

In order to assess the agreement in the ranking of aphid species throughout the oviposition period by individual females, Kendall's coefficient of concordance was calculated across the cycles. The resulting values of W (from 0.34 to 0.73, χ^2>5,33 and P<0,064) were significant except for one female, which had irregular oviposition cycles.

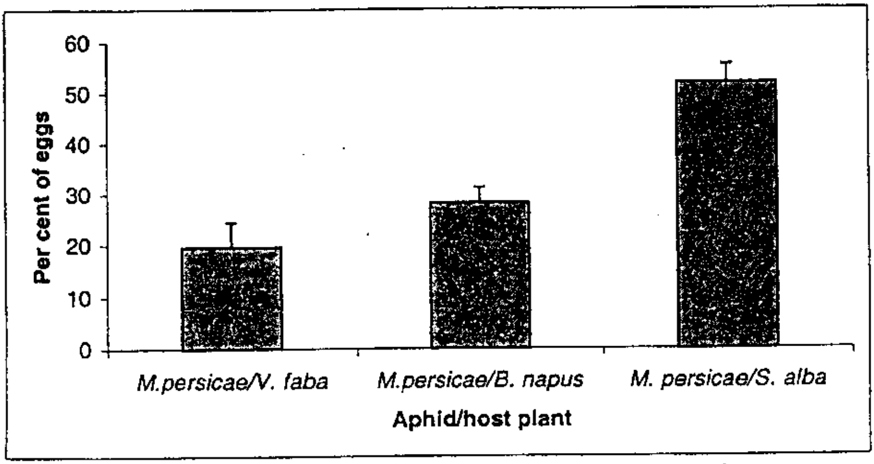

Figure 3 : Lifetime fertility percentages of female *Episyrphus balteatus* (± SE) in response to particular host plant.

Impact of host plant on oviposition was considered using *M. persicae* reared on three different plants (Figure 3). White mustard, *S. alba*, was preferred for oviposition by *E. balteatus* females (H = 8.23 and P = 0.016). As already observed for the aphid species, the host plant preference was consistent among females (W = 0.79, χ^2 = 7.5 and P = 0.011). The percentages of eggs laid in successive cycle is shown in Figure 4. This rank order was consistent trough the time for each female (W = 0.46-0.77, χ^2 > 4.6, P<0.05).

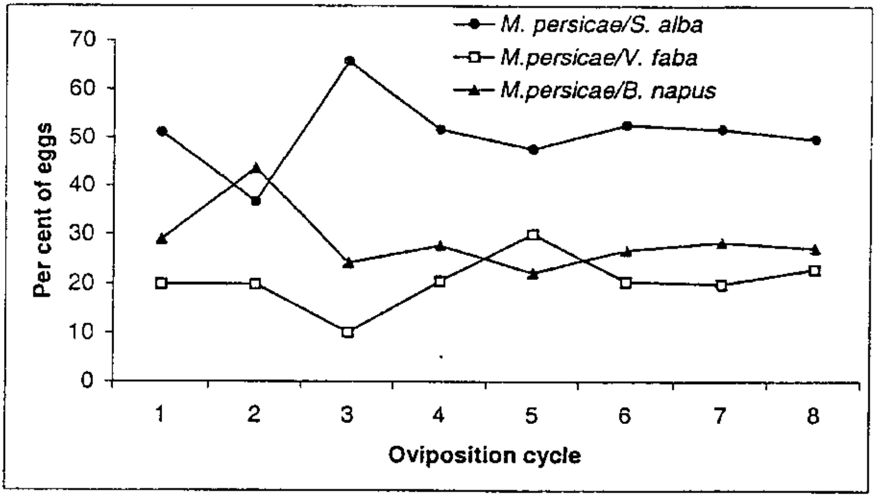

Figure 4 : Percentage of total eggs deposited by *Episyrphus balteatus* females during each oviposition cycle

DISCUSSION

In regard to the relative percentages of eggs laid on several aphid species reared on the same host plant, *M. persicae* and *A. pisum* aphids were the most preferred hosts of *E. balteatus* females. *M. viciae*, the vetch bean aphid and *B. brassicae*, the cabbage aphid, were the last preferred preys. The consistency in the ranking of aphids through the observation duration agrees with the prediction of the hierarchy threshold model (Courtney *et al*, 1989) that the rank order of hosts should not change with age. These results confirm some previous observations of Sadeghi & Gilbert (2000 a, b) that even in very generalist predator there are differences in the egg distribution among various prey species.

Although the role of aphid species in prey selection was already demonstrated for some taxa (Bargen *et al*, 1998), other factors such as chemical cues are effective actors in the prey-predator interactions. In response to herbivore attacks, plants such as tobacco, maize, broad beans and cotton systemically emit volatiles that attract parasitoïd or predators (Turlings *et al* 1990, Vet & Dicke, 1992, De Moraes 1998, Guerrieri *et al,* 1999). The interactions of aphid infested plants and natural enemies is more complex than only volatile release by plants. Whether the latter emit attractive compounds for entomophagous species, also depending on time and level of infestation (Guerrieri *et al,* 1999), other chemical cues such as from herbivore honeydew can act at short distance (Ayal, 1987). In this study we showed the impact of plant species on the oviposition preferences of the aphidophagous *E. balteatus*. The females clearly preferred white mustard as prey host plant followed by rape seed and broad beans at last preferred. This rank order is correlated with the plant allellochemical content: higher secondary metabolite levels are related to higher predator fecundity. Such an influence of glucosinolates and their breakdown products, isothiocyanates, has already been demonstrated for the parasitoïd wasp *Diaeretiella rapae* M'Intosh and its prey *B. brassicae* (Bradburne & Mithen, 2000) The oviposition activity of *E. balteatus* female and plant allelochemicals content needs further investigations. Do other molecules present in honeydew attract the females or is the attractiveness due to systemically released volatiles in response to herbivore attack?

These results underline the importance of tri-trophic interactions in biological pest control. As it is essential to encourage the predator into the field they are needed, the important role of plant in *E. balteatus* host location may offer opportunities for exploitation. Using crops emitting large amounts of attractive chemicals could allow the predator to locate its prey at early stage and increase aphid biological control by natural enemies.

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