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Effects of conspecific and heterospecific larval tracks on the oviposition behaviour of the predatory ladybird, *Harmonia axyridis* (Coleoptera: Coccinellidae)

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Abstract. The effect of the oviposition deterring pheromone (ODP) in the larval tracks of conspecific and heterospecific ladybirds on oviposition in *Harmonia axyridis* Pallas was studied in semi natural conditions. Gravid females of *H. axyridis* were deterred from ovipositing on plants contaminated with conspecific larval tracks, but not on those with heterospecific tracks. *H. axyridis* females spent significantly less time on plants contaminated with conspecific ODP than on those with heterospecific ODP. This behaviour may account for why fewer eggs were laid on plants contaminated with conspecific ODP.

INTRODUCTION

Recently, there has been an increase in our understanding of how females of predatory insects assess the quality of patches of prey as potential oviposition sites (Hemptinne et al., 1992, 1993; Růžička, 1994, 1996, 1997a; Dixon, 1997; Doumbia et al., 1998). The survival of their larvae mainly depends on the quality and quantity of prey in a patch (Kindlmann & Dixon, 1993; Hemptinne et al., 1993). The number of eggs laid by females in the field is influenced by prey abundance (Wratten, 1973; Mills, 1982). In addition the presence of an oviposition deterring pheromone (ODP) has been shown to be important in the assessment of patch quality in several insect species (Růžička, 1994, 1996, 1997a, b; Dixon, 1997; Doumbia et al., 1998; Růžička & Havelka, 1998).

Most of the studies on oviposition in predatory ladybirds were done in small vials or Petri dishes (Evans & Dixon, 1986; Hemptinne et al., 1992, 1993; Doumbia et al., 1998). There is now a need to confirm the results so obtained using more natural experimental conditions. For instance, in the presence to conspecific larvae of *Adalia bipunctata* (L.) females might leave a patch without ovipositing (e.g., Hemptinne et al., 1992). The presence of ODPs in other ladybird species also needs to be established.

Coccinella septempunctata L. and *Harmonia axyridis* Pallas are common species in Japan, and in spring often coexist in aphid colonies on trees (Hironori & Katsuhiro, 1997). *H. axyridis* larvae often eat *C. septempunctata* larvae and appear to be better adapted to survive interspecific predation (Yasuda et al., unpubl.). Of these two species, *C. septempunctata* arrives and oviposits in patches of aphids first (Hironori & Katsuhiro, 1997). The role of ODP in the assessment of oviposition sites by these species is unknown.

The aim of this study was to determine the effect of ODPs in the tracks of conspecific and heterospecific larvae on the selection of oviposition sites by *H. axyridis.* In addition, the experiments were designed to simulate more closely field condition.

MATERIALS AND METHODS

Eggs of *H. axyridis* were obtained from Aguro-Kanesho Corporation and stock cultures were raised in the laboratory at 25±1°C and a 15L : 9D photoperiod and fed the aphid, *Aphis craccivora* Koch. Mated females were kept individually in plastic containers on excess aphids (9 cm in diameter and 8 cm in height) and the females that laid eggs in the previous 24 hours were used in the experiment.

Broadbean plants, *Vicia faba* L., 20 cm in height, planted in standard plant pots, were used in the experiment. Prior to use, each of three leaves on each plant had larvae confined on them for 12 hours: either (1) two third instar larvae of *H. axyridis*; or (2) two third instar larvae of *C. septempunctata*. This was achieved by covering each leaf with a small nylon bag after placing the two larvae on the leaf. A plant with larval tracks was referred to as a plant with ODP. Then, each broadbean plant was infested with approximately 200 adult aphids of *A. craccivora.* A clear plastic cage (15 × 50 cm and 30 cm in height) was placed over two plants, which were kept 20 cm apart, one with ODP+200 aphids and the other without ODP+200 aphids. A gravid female of *H. axyridis* was released into the cage.

The experiment was started at 0600 after which observations were made at 0900, 1200, 1500, 1800, and 0600. The relative position of the female and any eggs and the number of eggs laid were recorded at each observation. Eggs were counted and then removed by means of a brush. This was repeated ten times using a different female each time.

All experiments were carried out at a constant temperature (25±1°C) and photoperiod (15L : 9D) in the laboratory.

RESULTS AND DISCUSSION

Gravid females of *H. axyridis* were deterred from ovipositing on plants contaminated with conspecific larval tracks (Fisher's LSD: $P < 0.05$), but not with heterospecific tracks ($F = 0.93$, $P > 0.05$; Fig. 1A). Doumbia et al. (1998) speculated that a similar response shown by the ladybird, *A. bipunctata,* might serve to reduce egg cannibalism, and the weak response to heterospecific ODP was attributed to a lower frequency of encounters with heterospecifics as each species of ladybirds occupies a different but overlapping habitat. The hypothesis suggested by Doumbia et al. (1998) might apply to the response of *H. axyridis* to conspecific ODP observed in this study because egg cannibalism has been recorded for the species in the field (Hironori & Katsuhiro, 1997; Sato, 1997). However, the weak response to heterospecific ODP is difficult to explain because *H. axyridis* usually coexists with *C. septempunctata* in many habitats in Japan (Takahashi, 1987; Hironori & Katsuhiro, 1997). Field studies suggest that *C. septempunctata* avoids eating *H. axyridis* eggs

(Hironori & Katsuhiro, 1997; Sato, 1997) and when the larvae of these two species coexist, *H. axyridis* survives significantly better than *C. septempunctata* (Hironori & Katsuhiro, 1997). Agarwala & Dixon (1992) showed that the eating of *A. bipunctata* eggs had a negative effect on the larval development of *C. septempunctata.* It is, therefore, reasonable to assume that the weak response of *H. axyridis* females to the ODP of *C. septempunctata* reflected the low risk of predation from this species.

H. axyridis females laid more eggs on plants infested with aphids than on the walls of the cages, but the difference was not significant (t = 1.65, df = 35, P > 0.05; Fig. 1B). Predatory ladybirds do not always oviposit where prey is abundant. Many species of ladybird prefer to lay eggs in aphid colonies (e.g., Wratten, 1973; Mills, 1982), but females of *C. septempunctata* are known to lay eggs in places without aphids (Sakuratani & Nakamura, 1997). The present study suggested that females of *H. axyridis* preferred to lay eggs close to aphids.

Time spent by ladybirds on plants contaminated by ODP is shown in Fig. 2. *H. axyridis* females spent significantly less time on plants contaminated with conspecific ODP than with heterospecific ODP (χ^2 = 4.16, P < 0.05) and spent less than 50% of the time on the walls of the cages. This behaviour would result in them laying fewer eggs on plants contaminated with conspecific ODP. This is consistent with our findings and those of the earlier experiments of Doumbia et al. (1998) using *A. bipunctata.*

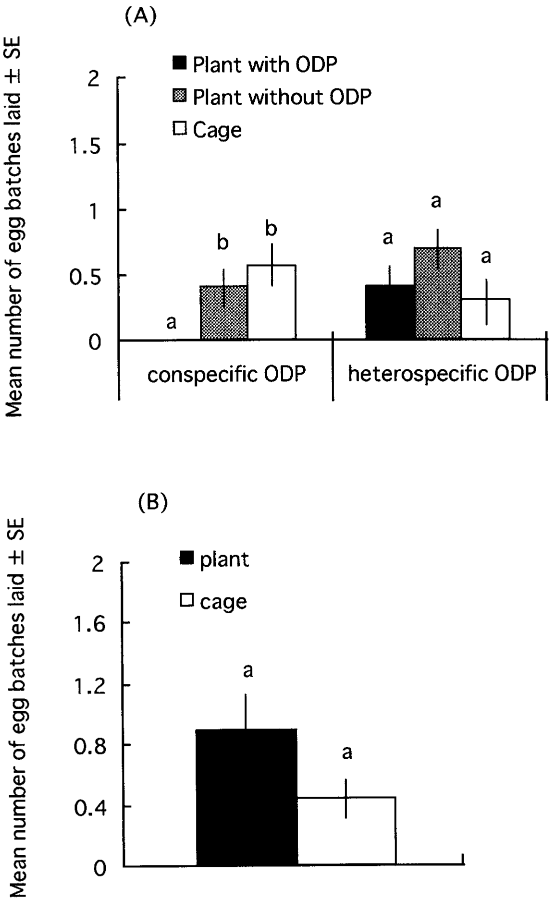

Fig. 1. Mean number of egg batches laid by females: (A) Response to ODP; means with different letters are significantly different (Fisher's LSD: P<0.05), and (B) Oviposition site; means with same letter are not significantly different (t-test: P>0.05).

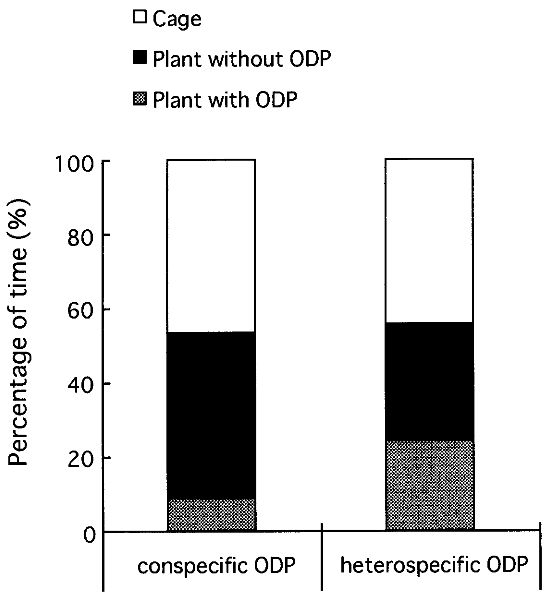

Fig. 2. Percentage of time female of *H. axyridis* spent in each place based on five observations replicated ten times.

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