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Effects of feeding experience on the odour-conditioned anemotaxes of Colorado potato beetles

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Introduction

Recent studies have shown that adult insects will shift their host plant preference as a result of experience. Learning in oviposition site selection occurs in *Drosophila melanogaster* (Jaenicke, 1983) and *Rhagoletis pomonella* (Prokopy *et al.,* 1982). In *Pieris rapae* landing responses, which precede oviposition, are also influenced by previous exposure of females to different oviposition substrates (Traynier, 1984). This example illustrates that learning is not solely restricted to the ultimate decision of host acceptance since orientation responses are affected as well.

Experiments have been reported on the olfactory orientation of the Colorado potato beetle, *Leptinotarsa decemlineata* Say, towards the odour of its host plant potato, *Solanum tuberosum* L. (Visser & Nielsen, 1977; Thiery & Visser, 1986). Although experienced beetles which had fed on pota-

toes for some time, and non-experienced beetles were tested in these studies, a direct comparison between these two groups has not been carried out. Such a comparison was carried out in the present study to determine whether previous experience of host material might accelerate the release of an odour-conditioned positive anemotactic response. The results obtained showed that previous feeding on host plants did, in fact, increase the beetle's responsiveness to host plant odour.

Materials and methods

Newly-emerged female Colorado potato beetles were obtained from the laboratory stock culture, and isolated in petri dishes lined with wet filter paper. Prior to the experiments, one group of females was starved for at least 12 h (non-experienced beetles), while the other females were fed for 2 h on small disks of potato leaves (cultivar Eigenheimer) before being starved for at least 12 h (experienced beetles). At the time of the experiments all females were about one day old.

The experiments were conducted as described previously (Thiery & Visser, 1986). Behavioural responses of the beetles were studied by recording their walking tracks on the locomotion-compensator under three successive treatments of ten minutes each. Individual females were exposed to: (1) a control treatment, that is without stimulation by wind or plant odour, (2) a clean air flow of 80 cm/s as wind stimultion, and (3) the same air flow carrying *S. tuberosum* odour; six pots containing fully-grown potato plants were positioned upwind. At least one hour elapsed between the successive exposures of individual females.

Three parameters are used to describe the walking tracks: (a) vector length, the resultant displacement from the origin after 10 min; (b) upwind length, the upwind displacement after 10 min, and (c) upwind time, the proportion of angle observations with deviations of less than 60° from the wind direction. The angles were recorded every second during 10 min. Variables were compared using non-parametric statistics (Siegel, 1956): Wilcoxon's test (between treatments of a group), and Mann-Whitney *U* test (identical treatments between groups).

Results and discussion

Non-experienced as well as experienced beetles move upwind in response to host plant odour, as indicated by the increment in upwind length and upwind time compared to the measures under control and pure wind conditions (Table 1). The motor patterns underlying this odour-conditioned positive anemotaxis have been described previously (Visser & Thiery, 1985). Prior feeding experience enhances the upwind responses of beetles towards host plant odour: all three variables differ significantly between non-experienced and experienced beetles (Table 1).

Under pure wind conditions beetles move about twofold further from their starting points than in control treatments (Table 1). The enlargement of vector length results from changes in the beetle's orientation in response to wind. Wind stimulates beetles to walk straighter and faster (Visser & Thiery, 1985; Visser, in litt.). This kind of anemotaxis that is referred as anemomenotaxis (Linsenmair, 1969), is not affected by prior feeding

Table 1. Effects of feeding experience on the upwind responses of female Colorado potato beetles to host plant odour.

	Non-experienced beetles (n = 17)			Experienced beetles (n = 20)		
	Vector length (mm)	Upwind length (mm)	Upwind time (%)	Vector length (mm)	Upwind length (mm)	Upwind time (%)
Control	1444 a*	768 a	48 a	1706 a	292 a	47 a
Wind	3566 b	2430 ab	55 ab	3478 b	1592 a	55 ab
S. tuberosum	6581 c	5316 b	72 b	9251 d	8770 c	90 c

* Different letters indicate statistical differences at $P \leq 0.02$ (two-tailed); data are means.

experience. Experienced beetles do not differ from non-experienced beetles in their responses to pure wind.

The results show that prior feeding experience enhances the beetle's responses to host plant odour. Since the anemomenotaxis under pure wind conditions is not affected, the enhancement of upwind responses is interpreted in terms of an increase of the beetle's responsiveness to host plant odour. The experimental design of the present study does not allow to explain the results solely in terms of associative learning. Prior feeding on host plants may also cause sensitization, that is a form of nonassociative learning (Tully, 1984). On the increase of responsiveness to host plant odour, the olfactory channel which triggers the release of positive anemotaxis, receives more attention in the process of central integration.

It has been suggested that learning enhances the foraging efficiency of insects in search of host plant patches (Prokopy *et al.,* 1982). Post-diapause as well as newly-emerged Colorado potato beetles exhibit a period of maturation feeding which precedes reproduction or dispersal. Jermy (1958) reported that young Colorado potato beetles needed prior feeding on potatoes in order to respond to host plant odour. In the present study non-experienced beetles also respond to host plant odour, although, experienced beetles are more responsive. These observations indicate that the beetle's responsiveness to host plant odour will be increased during the period of maturation feeding. Beetles will take advantage of such improvement in situations of food shortage which force beetles to disperse and to search for other patches of host plants.

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