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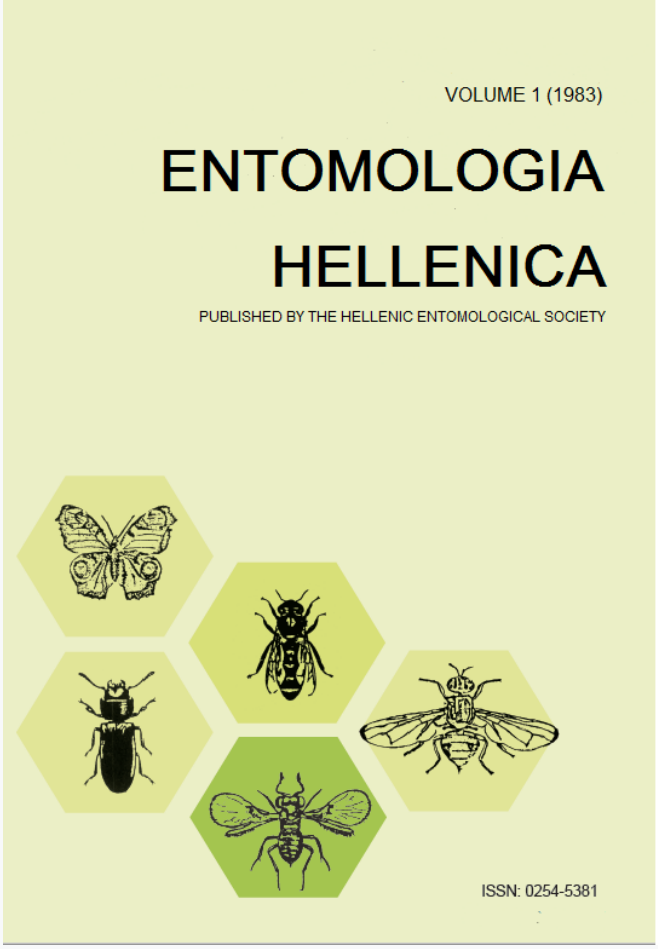

Movement away from feeding site of the aphid Sitobion avenae (F.) (Hemiptera: Aphididae) when parasitized by Aphelinus abdominalis (Dalman) (Hymenoptera: Aphelinidae)

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Movement away from Feeding Site of the Aphid *Sitobion avenae* (F.) (Hemiptera: Aphididae) when Parasitized by *Aphelinus abdominalis* (Dalman) (Hymenoptera: Aphelinidae)[1,2]

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ABSTRACT

The aphid *Sitobion avenae* (F.), parasitized by *Aphelinus abdominalis* (Dalman), tends to leave either the feeding sites gathering in particular parts of its host-plant or even the host-plant. This behavior partially explains the phenomenon of reduced parasitism contribution to the overall mortality in several aphid population studies as interpreted by Hughes' method.

Introduction

Behrendt (1968) found that the last instar larvae of the parasite *Aphelinus chaonia* Wilk. frequently caused *Aphis fabae* Scopoli to leave the aphid colony and usually the infested plant (*Euonymus europaeus*). Furthermore, Powell (1980) found that *Toxares deltiger* (Haliday) parasitizing *Metopolophium dirhodum* (Walk.), formed only 1% the parasitized individuals whem mummies were collected in the field, whilst it comprised 67% of the mummies formed when aphids were reared in the laboratory. Powell also reported that most mummies of *M. dirhodum* parasitized by *T. deltiger* on potted wheat plants in the laboratory were found on the floor of the cage or on the underface of the pot. The above mentioned studies indicate that some aphids parasitized by certain parasites tend to leave the plants. However from these studies it is not clear whether parasitized aphids have increased motility as compared to healthy aphids.

It was the purpose of the present study to investigate the rate of movement away from feeding site between healthy and parasitized aphids.

Materials and Methods

Aphids (*Sitobion avenae* (F.)) and parasites (*Aphelinus abdominalis* (Dalman)) used in this study originated from stock cultures maintained in a glasshouse at approximately 20° C. 60-80% relative humidity and 16 hours light daily. About one hundred apterous and alate adults of *S. avenae* taken from the stock cultures were placed on barley leaf-pieces to produce offspring in each of four plastic containers 10 cm in diameter. Barley leaf-pieces were placed on cotton wool moistened with distilled water which covered the bottom of each plastic container. These containers were placed in an environmental cabinet at 22.5° C, 70 ± 3% relative humidity and 16:8 hours light-dark cycle.

Adult aphids were left in the containers for 24 hours for larviposition and then removed. Subsequently 15 adults *A. abdominalis* were introduced into each plastic container, by means of an aspirator, to oviposit on the newly born first instar aphids

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[2] This paper is part of the senior author's Ph.D. thesis: "Studies under controlled conditions on the effects of parasites on the population dynamics of *Sitobion avenae* (F.)", submitted to the University of Reading.
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(Lykouressis 1982). Prior to their use the parasites had been kept for one day without aphids in small plastic containers, 3.5 cm in diameter, to have a higher supply of eggs available for deposition. Subsequently, they were left for 24 hours in the containers with the first instar aphids and then discarded. Groups of 20 of these first instar aphids taken randomly were removed and put in each clip-on cage, 3 cm in diameter, on the middle part of the second leaf on each individually potted barley plant maintained in the glasshouse mentioned above. Each pot was covered by a cylindrical plastic cage keeping the plants free from aphids and parasites. The soil surface in each pot was covered by white filter paper bearing a centrally positioned hole allowing the stem of the plant to pass through it. A total of 30 caged pots were used.

The infestation by *S. avenae* took place at the stage of seedling growth (3 leaves unfolded) (Tottman et al. 1979). Clip-on cages were retained for 24 hours and then they were removed carefully. The number of the aphids with their stylets inserted in the leaf tissues was recorded for each replicate at that time. Eight days after the removal of clip-on cages, the number of mummies and live aphids as well as their position on the plants was recorded. The period of eight days is the mean duration from oviposition by *A. abdominalis* to aphid mummification (black mummy) (Lykouressis and van Emden 1983). First instar aphids were excluded from these records to avoid errors because they would have been born after the parasites had been removed.

Results

In preliminary experiments it was observed that mummification of *S. avenae* parasitized by *A. abdominalis* usually took place on certain parts of cereal plants, i.e. more mummies were found on the top and the basal part of the first leaf, stem and coleoptile as well as on the inner walls of different kind of cages than on the upper leaves. The number of mummies found was considerably reduced on the upper leaves of cereal plants, although aphid densities were high on these leaves before ear emergence. Particularly in an experiment conducted in individually caged pots with cylindrical plastic cages (Lykouressis 1982), the percentage of mummies found 10 days after the parasites had been removed from the cages, was considerably higher on the first leaf, stem and coleoptile (44.76%) and on the inner walls of the cages (26.19%) than on the upper 2nd, 3rd and 4th leaves (29.05%). Also, only 4.28% of the mummies formed were found at the feeding sites at which the aphids had been placed initially. These results indicated that parasitized aphids show a tendency to move from their feeding sites to lower parts of the plants or even to leave the plants entirely at a late stage of their parasitization.

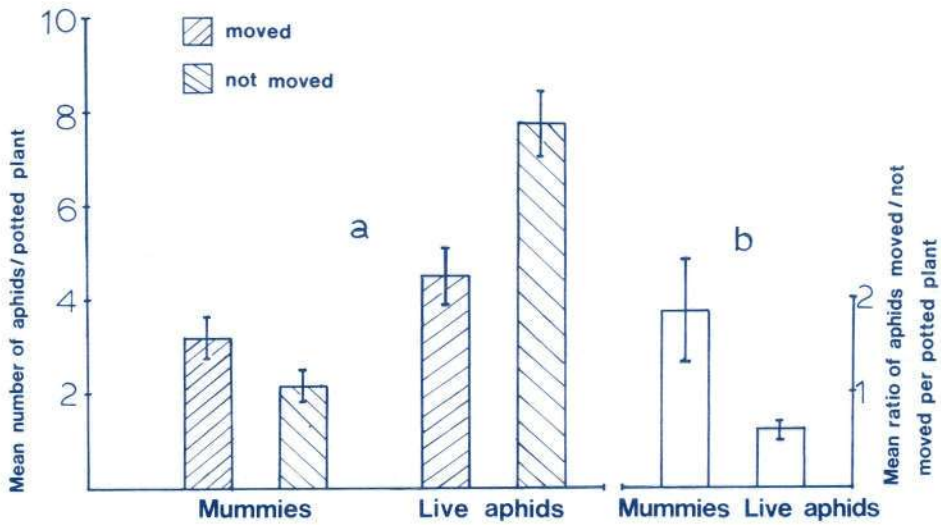

FIG. 1.a. Mean number of mummies and live aphids found away or not from their initial feeding sites. b. Mean ratio of mummies and live aphids found away to those found in the initial feeding sites. Vertical bars represent 95% confidence limits.

Figure 1a shows the results obtained from the present study, i.e. the mean number of mummies per potted plant at the initial aphids' feeding sites and those which moved away before mummification, as well as the number of unparasitized aphids which remained and those which left their initial feeding sites. It is obvious that the mean number of parasitized aphids which became mummies at their initial feeding sites (2.15 ± 1.37) was lower than the number of aphids mummified in other parts either on the plants or on the cage surface (3.17 ± 0.43). In contrast, the mean number of healthy aphids which did not move away from their initial feeding sites was higher (7.73 ± 0.65) than the number of those that moved (4.47 ± 0.60).

Figure 1b shows the ratios of mummies found away to those found in the feeding sites and live aphids moved to those that did not move away from feeding sites. A highly significant difference was found in the mean ratio between these two treatments ($t = 4.5$, $P < 0.001$ with 27.78 d.f.). The results demonstrate that the rate of movement away from feeding site in a colony of *S. avenae* is much greater in parasitized than in unparasitized individuals. This response of parasitized aphids might be associated with physiological changes in the aphid, mainly due to disturbances in its nervous system.

Discussion

The tendency of parasitized aphids to mummify on some particular parts of the plant, such as the lower leaves and more specifically on the basal and top part of the first leaf, coleoptile and stem, lead to inaccuracies in the estimate of parasitism. This inaccuracy is further increased by the fact that a considerable percentage of parasitized aphids leave the plants before mummy formation. In fact, by Hughes' method, parasitism is estimated by a sample (1b) equivalent to the first sample (1a), counting the number of mummies formed during one instar period (Lykouressis 1982). This procedure underestimates parasitism, since some parasitized aphids might have left the plants sampled before the sample (1b) was taken. A proportion of parasitized aphids are therefore excluded in the assessment of the true rate of parasitism within an instar-period. Therefore the distribution and density of mummies formed on a plant should be considered during sampling.

In fact parasitism and fungal diseases in aphid population studies interpreted by Hughes' method have been found to contribute very low percentages to the overall difference between the theoretical and observed population in each twin-sample, whilst predation (residual mortality is rather a large unexplained mortality ascribed to predation) contributed the greatest part of the overall gap (Foster 1972, Barbagallo et al. 1972, Dransfield 1975, Foster and van Emden 1976, Dickson 1979). In addition, in other aphid population studies, parasites have been found to play an unimportant role as compared with predators when based on counts of mummies in the field (Smith 1966). However in other studies on the effects of parasites and fungal diseases by methods other than counting mummies in the field or Hughes' method, such as estimating parasitism and disease rates by dissecting live aphids from field samples or keeping them in the laboratory and counting the mummified and killed aphids, much higher values due to parasitism and diseases have been found (Sluss 1967, van den Bosch et al. 1966, Dean and Wilding 1971, 1973, Latteur 1973, Jones 1976, Jones and Dean 1976).

These discrepancies have two main causes. Firstly, some already parasitized or diseased aphids are eaten by predators or sucked by adult aphelinid parasites at an early stage of their parasitization (Lykouressis and van Emden 1983) or fungal infection, before mummy formation or their death from infection. Secondly, a large proportion of parasitized aphids might leave the plants well before their mummification and some diseased aphids may fall from the plant before they die as it was assumed by Foster and van Emden (1976). The low rate of parasitism found in aphid population studies using Hughes' method may well be due to the second cause, as it is demonstrated in the present study, if similar behaviour occurs with parasitized individuals of other aphid species.

In order to estimate parasitism rates more precisely another procedure has been suggested, as far as the time of taking the twin-sample, which is part of an intergrated theoreti-

cal model (Lykouressis 1982).

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KEY WORDS: *Sitobion avenae, Aphelinus abdominalis,* Instar-period, Twin-sample

Απομάκρυνση από τό Σημείο Διατροφής της Αφίδας *Sitobion avenae* (F.) (Hemiptera: Aphididae) όταν Παρασιτίζεται από τό *Aphelinus abdominalis* (Dalman) (Hymenoptera: Aphelinidae)

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ΠΕΡΙΛΗΨΗ

Η τάση αφίδων *Sitobion avenae* (F.), παρασιτισμένων από το παράσιτο *Aphelinus ab-*

dominalis (Dalman) να φεύγουν είτε από τις αρχικές θέσεις διατροφής ή και ακόμα από το φυτό-ξενιστή τους αποδείχθηκε σ' αυτή τη μελέτη.

Η συμπεριφορά αυτή των παρασιτισμένων αφίδων εξήγησε μερικώς γιατί η θνησιμότητα λόγω παρασιτισμού ήταν μικρή ως προς τη συνολική απώλεια του πληθυσμού, όταν οι διάφοροι παράγοντες θνησιμότητας υπολογίσθηκαν με τη δημογραφική μέθοδο του Hughes, σε πληθυσμιακές μελέτες αφίδων στον αγρό.