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HABITAT SELECTION OF ANT-TENDED APHIDS ON WILLOW TREES

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Abstract. We studied the spatial distribution of aphid populations as a function of host plant's properties and the ant species associated with them on dispersed willow trees (*Salix alba*) in the flood area of river Tisza. Our data based on the examination of 63 trees, 10 shoots on each. The presence of tending ants on willows promotes the maintenance of the aphid species diversity. The density of aphid populations were also positively influenced by the mutualists (mainly by *Lasius fuliginosus*). The relationships between the different aphid species and ants were various: *Chaitophorus vitellinae* showed stronger mutualistic interaction, than *Pterocomma* species. We have not experienced competitive interactions between aphid populations for services of ants. The different tree attributes had no significant influence on the habitat selection of aphids. Spatial distribution of aphids was affected by both the presence of ants and their number.

Keywords: aphids, ant-aphid mutualism, spatial distribution, ant-attendence, competition

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Introduction

In the mutualistic association of ants and aphids the main attractant is that aphids offer honeydew to ants, and ants provide them protection from natural enemies in return for this food source (Sudd 1987, Cushman and Beattie 1991). Host plant can influence this interaction, as the chemical composition and/or quantity of honeydew produced by herbivores varies with changes in host quality (Cushman 1991). The physiological state of host plants can play a role in determining the growth and size of aphid populations, too (Hales *et al.* 1997).

It is a well-known fact that an ant colony tends simultaneously several aphid species, thus there can be intra- or interspecific competition between aphid groups for the services of ants (Sudd 1987, Cushman and Addicott 1989, 1991, Dixon 1998).

According to Southwood and Kennedy (1983) trees are relatively large, structurally complex habitats, which have characteristic faunas within a species. The scattered willow trees could be regarded as microhabitats where the aphid and ant populations live more or less isolated from one another. The trees, however, provide different environmental conditions for aphids from several points of view. In this paper, we address the following questions: Which attributes of trees may play a significant role in the spatial distribution of aphids? Is there any role of ants in the survival of aphids having colonised randomly? Is there any difference between the aphid species in their mutualistic interactions with ants under these circumstances? Does the pattern of aphid populations indicate competition for the service of ants?

Methods

Aphid colonies were sampled from dispersed willow trees (*Salix alba*) in a flood plain of river Tisza in Kesznyéten Nature Reserve, NE-Hungary in May of 1998. May was convenient period because of great abundance of aphids and high activity of ants.

As distances between trees were relatively great (minimum distance between nearest trees was 3 m, maximum was 69 m), these trees could be regarded as microhabitats for aphids, characterised with size of trees and ant species living on them. We examined 63 willow trees, and 10 shoots on each.

Ant individuals staying on the tree trunk were counted for two minutes at each tree.

Trees were characterised with the distances to the nearest tree, the canopy area, trunk diameter and trunk height. We have computed correlation coefficients between the tree attributes and the occurrence of aphid species.

Results

We gathered approximately 15000 individuals of 5 aphid species and registered the presence of ants at the colonies. The most frequent aphid species were *Chaitophorus vitellinae* (Schrank), *Pterocomma rufipes* (Hartig) and *Pterocomma pilosum konoi* Hori (all three of the species are monoecious), while *Chaitophorus salijaponicus niger* Mordvilko and *Cavariella theobaldi* (Gillette and Bragg) were found in smaller quantity. Each aphid species were tended by ants but in variable degrees. Out of the 10 ant species found *Lasius fuliginosus* (Latreille) seemed to be the most important. Also *Lasius niger* (Linnaeus) and *Lasius brunneus* (Latreille) can play a role in attending aphids. The detailed analysis of ants basing on six years' field observation is given elsewhere (Gallé *et al.*, in prep.)

In the presence of attending ants there were more species of aphids per tree. The difference proved to be significant (by randomization test, $p<0.05$). We considered only those trees where aphids were found (59 trees).

Aphid species differed in their dependence on ants. Mutualism between *Chaitophorus vitellinae* and tending ants was stronger than that of *Pterocomma* species (Fig. 1). Mostly *Lasius fuliginosus* was responsible for these interactions (Fig. 2). The figures show that the individual number of *Ch. vitellinae* was strongly affected by the presence of ants. In the case of *P. rufipes* there is larger number of individuals in the absence of mutualists, however it indicates not a negative, but rather an indifferent interaction, as this species is also ant-attended.

In the presence of *L. fuliginosus* colony on the tree in question, more shoots were found colonised by aphids ($p<0.01$). Therefore, we can assume that the presence of *L. fuliginosus* is a crucial factor for aphids (Fig. 3)

No significant association was experienced between the different species of aphids occurring on the same tree according to $\chi 2$ test. Therefore, no competition can be assumed between the three most frequent aphid species for the services of ants.

The different attributes of willow trees (canopy area, trunk diameter and height) had no influence on the aphid species in selecting their habitats (Figs 4, 5, 6), since there is no detectable relationship between the habitat features and the percentage occurrence of the most frequent aphid populations. The most important habitat property was the density of ants (Fig. 7). These results are also demonstrated in Table 1.

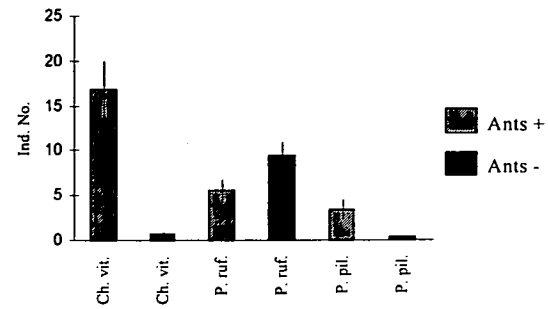

Fig. 1 Adult number of the most frequent aphid species in the presence and absence of attending ants.

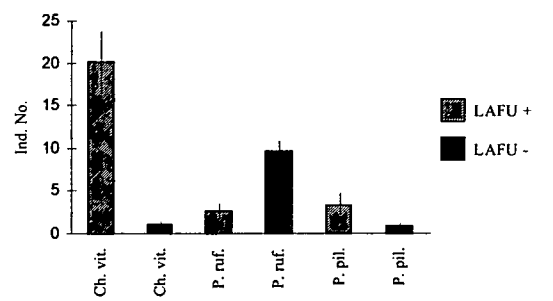

Fig. 2 Adult number of the most frequent aphid species in the presence and absence of *Lasius fuliginosus*.

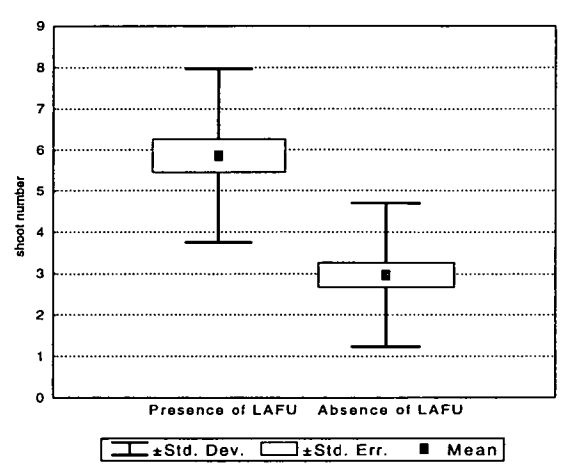

Fig. 3 Number of shoots per tree with aphids in the presence and absence of *Lasius fuliginosus*.

Significant correlation was found between the distances of the nearest trees and the trees' similarity based on aphid species composition ($r=-0.26$, $p<0.05$, $n=58$).

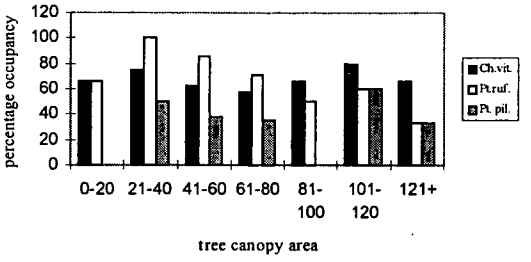

Fig. 4 Percentage occupancy of trees by the most frequent aphid species in tree canopy area (m^2) classes.

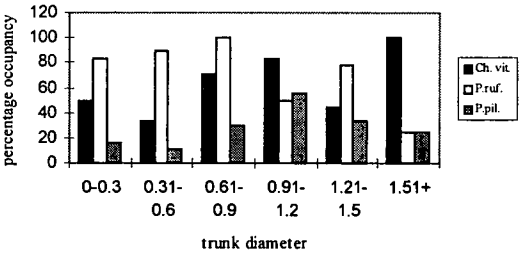

Fig. 5 Percentage occupancy of trees by the most frequent aphid species in tree trunk diameter (m) classes.

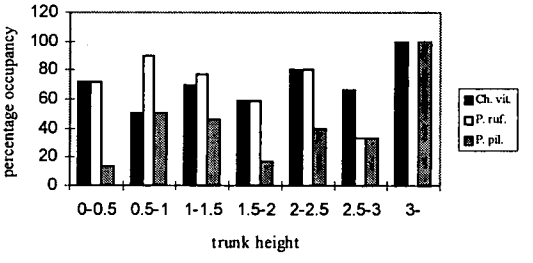

Fig. 6 Percentage occupancy of trees by the most frequent aphid species in tree trunk height (m) classes.

Discussion

Our study demonstrated that the presence of tending ants on willows promotes the maintenance of the aphid species diversity and population density. This is in accordance with the results of Fowler and MacGarvin (1985).

The number, distribution and activity of visiting ants are mainly regulated by the abundance and status of aphid populations and the peculiarities of aphid attendence vary with the ant species (Novgorodova and Reznikova 1996). According to an earlier investigation by Gallé *et al.* (1995) at the same site the habitat selection of ants depends on tree properties, such as inundation, trunk diameter and the density of aphids. Moreover, the distribution of ants is affected also by their interspecific competition, therefore they have mosaic-like distribution pattern.

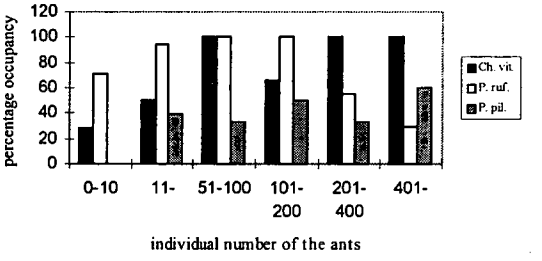

Fig. 7 Percentage occupancy of trees by the most frequent aphid species. Classes are established on the basis of individual number of the ants living on the willow trees.

Table 1 Correlation coefficients (Spearman Rank Correlation) with significancy levels between different tree attributes and the adult number of the most frequent aphid species.

	Ch. vitellinae	*P. rufipes*	*P. pilosum*
canopy area (n=59)	0.168 n.s.	-0.147 n.s.	-0.024 n.s.
trunk diameter (n=56)	0.209 n.s.	-0.192 n.s.	0.055 n.s.
trunk height (n=56)	0.200 n.s.	-0.101 n.s.	0.031 n.s.
ant individuals (n=63)	0.714 <0.001	-0.465 <0.01	0.368 <0.01

Mutualistic interactions are different in their strength and symmetry (Cushman and Addicott 1991). Aphids seem to be more dependent on ants than vice versa, because their distributional pattern on willows is determined only by ants, while ants' occurrence depends on other factors (e. g. competition), too. However, the aphid species differ in their dependence on the ants.

The role of host plants in aphid-ant mutualistic interactions was studied in different ways. According to Bristow (1991) the feeding site (floral or leaf tip) of aphids affects the ant attraction. The differential attractiveness probably reflects chemical differences in the honeydew. Skinner and Whittaker (1981) showed that the number of aphids increased with bud length, but this effect was far less important than that of ants. Cushman and Addicott (1989) revealed in their paper significant host impact on the *Aphis-Formica* mutualism if the analysis had involved the

presence or absence of ants, but their measure of host quality was rather crude: two levels of plant height (*Epilobium=Chamaenerion angustifolium*). The habitat selection of insect herbivores is affected by the host plant quality (Kareiva 1986). In the case of aphids the species and quantity of ants foraging on the herbivore's host plant also have a considerable importance.

The presence of aphids and the aphids' density on certain trees seem to depend on ant colonies living on the willows.

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