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Value of the aphid *Hyalopterus pruni* as food for the spider *Clubiona phragmitis*

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Abstract
It has been suggested that the aphid *Hyalopterus pruni* from *Phragmites* plants might be an important prey for the sac spider *Clubiona phragmitis* during summer and early autumn. However, studies on other aphids and spiders have all indicated a low quality of aphids as spider food. We tested the food value of the aphid against hatchlings of *C. phragmitis* using the collembolan *Sinella curviseta* as a high-quality comparison prey. Both growth and development were very low in spiders fed aphids compared with spiders fed the Collembola. However, a mixed diet of aphids and Collembola led to a higher growth rate than a pure collembolan diet. These results show that the aphid in itself is a low-quality prey but it may contribute some nutrients that are in short supply in other prey. *H. pruni* is probably not a staple prey of *C. phagmitis* but it may be a valuable supplement.

Key words: Aphidoidea, Araneae, diet, food quality, nutrition

INTRODUCTION

Nentwig (1982) suggested that the aphid *Hyalopterus pruni* might be an important, if not the most important prey for the sac spider *Clubiona phragmitis* C.L. Koch (Clubionidae) in reed beds, at least during part of the year. *H. pruni* has the reed *Phragmites australis* as its secondary (summer) host and here develops huge populations over the summer and early autumn. The aphids swarm in masses during this period (Nentwig 1982) and thus make themselves available to both hunting and web-building spiders. The wingless aphids in dense colonies on the reed leaves must be easy prey for a predator like *C. phragmitis* that occurs abundantly in marshy habitats (Hänggi et al. 1995) and, like most other species of *Clubiona*, actively search for prey on the vegetation (Duffey 1969). From a predator/prey-size consideration the aphids might especially be appropriate prey for the younger instars of this biennial spider that hatch during the summer months and develop through the first 2–3 instars before their first hibernation (Toft 1979), whereas the larger juveniles and adults of the previous generation are expected to rely on larger prey than aphids but still may take them as supplementary prey.

Though the aphids are a highly available potential food source, their actual importance to the spider populations depends also on their food value to the spiders. Several aphids have turned out as low-quality or even toxic prey to many species of spiders and other generalist predators (review in Toft 2005) and no case of an aphid being of high food quality to a spider has yet been reported. Even so the aphids might add some positive contribution to the spiders' fitness. Toft (1995) and Bilde & Toft (2000) found enhanced performance of spiders when aphids were added to an otherwise monotonous diet of fruit flies (*Drosophila melanogaster*), even though the aphids were eaten in quite low amounts. With such an effect the aphid would be a positive dietary supplement.

Most of the predator-aphid studies were conducted with the purpose of investigating the potential of spiders as biocontrol agents of aphids in agricultural fields. This system is peculiar in that the predators and the aphids belong to different sections of the agricultural food web: the aphids feed on the plants (i.e. belong to the grazing food chain) while most of the generalist predators feed mainly on prey from the detrital food web, thriving on small arthropods of the soil surface and preying on aphids that come to the ground (Sopp et al. 1987). The possibility therefore exists that a predator that normally hunts on the vegetation where the aphids live would be better adapted to this potential prey. This would be revealed by a better food quality of the aphid to the sac spider than to another spider that hunts on the ground.

In this study we tested the food quality of *H. pruni* to hatchlings of *Clubiona phragmitis* in laboratory experiments, using the collembolan *Sinella curviseta* as a high-quality comparison prey (Vanacker et al. 2004). Since both the aphid and the spider were of different species than the ones tested in the earlier studies reviewed by Toft (2005), *H. pruni* was also tested against one of our previous test species, the ground-hunting *Pardosa prativaga* (Lycosidae), a species that occurs in the same wetland habitat. This control experiment also allowed us to evaluate whether the plant hunting spider might be better at coping with aphids as food.

MATERIALS AND METHODS

For the first experiment two eggsacs of *C. phragmitis* were collected from a *Typha* swamp at Bodil Mølle near Århus, Denmark, on 28 August 2007. Hatchlings of *P. prativaga* stemmed from two mothers collected with eggsacs at Tåstrup Lake. Aphids for food were collected regularly from reed plants along Århus River and *Sinella* came from a laboratory culture raised on a mixture of fruit fly medium and yeast (Vanacker et al. 2003). The *C. phragmitis* hatchlings from the two eggsacs were divided evenly into three groups of 20 spiderlings each, the groups being assigned randomly to the three diet treatments: aphid, collembolan, and mixed (aphid + collembolan). Hatchlings of *P. prativaga* were divided into two groups of 10 assigned to two treatments: aphids and collembolans. All spiders were weighed at the start of the experiments and again after 10 and 17 days (*C. phragmitis*) or only 7 days (*P. prativaga*). At the same time it was noted if the spiderlings had moulted in the intervening period.

During the experiments the spiders were held in plastic tubes (height 6 cm, diameter 2 cm) with a 1 cm bottom of plaster with charcoal wetted regularly to maintain high humidity. Food was provided ad libitum. The experiment with *P. prativaga* was completed very late in the season and had to be stopped after one week because the aphids became heavily infested with fungi when brought to the laboratory.

We used JMP 6.0 for the statistical analyses. Data were tested for unequal variances before ANOVA (Bartlett's test) and no transformations were necessary. Growth curves were analysed by repeated measures MANOVA, using the time*diet interaction as an indicator of diet effects.

RESULTS

Clubiona phragmitis experiment

Tests of the initial weights of the spiders showed that though the spiderlings from the two eggsacs were significanly different in mass (t_{58} = 4.06, P = 0.002) there were no mass differences between the three treatments groups (one-way ANOVA $F_{2,57}$ = 1.29, P = 0.28). Diet effects on spider growth were

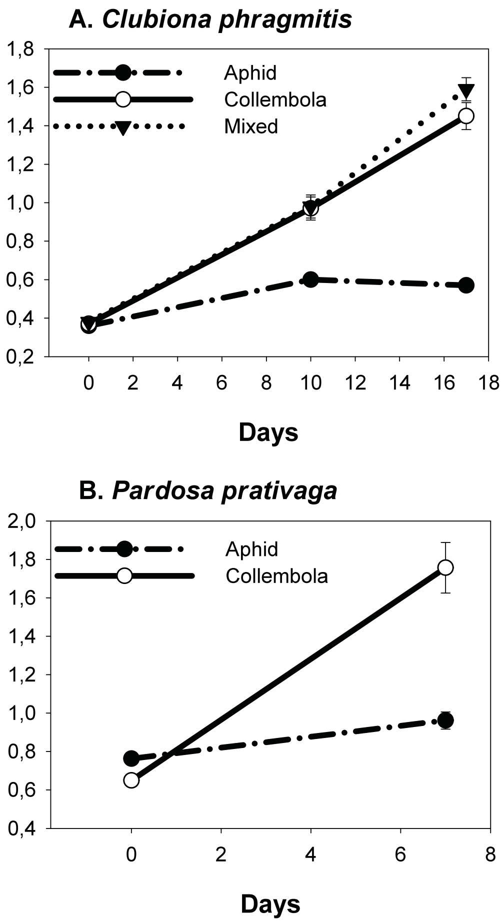

Fig. 1. Growth of *Clubiona phragmitis* hatchlings (A) and *Pardosa prativaga* hatchlings (B) fed different diets: the aphid *Hyalopterus pruni*, the collembolan *Sinella curviseta*, or a mixed diet of the two (only A).

clearcut already at 10 days and further exaggerated at 17 days (Fig. 1A, Table 1). The spiderlings fed aphids grew only a little during the first 10 days and then lost weight, whereas spiderlings fed collembolans or the mixed diet grew very well. On the last date the spiderlings fed the mixed diet were actually slightly heavier than those on the pure collembolan diet. A contrast analysis showed that the difference was significant (Table 1), indicating a positive contribution of aphids in the mixed diet.

The diets influenced not only the growth of the spiderlings but also their development (Table 2). Thus, all spiderlings on the collembolan and mixed diets and none on the aphid diet had moulted after 10 days. After 17 days, a few spiderlings of the aphid diet group had moulted and one from each of the better diets had even moulted a second time.

Pardosa prativaga experiment

We did not succeed with equalising the initial spiderling masses over the two treatments ($F_{2,8}$ = 17.54, P = 0.0012). We therefore analysed mass at day 7 using initial mass as covariate, which turned out to be of no influence ($F_{1,8}$ = 0.24, P = 0.64). The *P. prativaga* spiderlings fed aphids grew only little compared to the growth of those fed Collembola (effect of diet: $F_{1,8}$ = 34.2, P = 0.0004, Fig. 1B). As it is the group that was initially the smaller that ended up with the largest mass after one week, we conclude that *P. prativaga* responds to the aphid diet qualitatively in the same way as did *C. phragmitis*. A quantitative assessment revealed that *P. prativaga* hatchlings were more strongly affected by the aphid diet than were *C. phragmitis* hatchlings; thus, the relative growth rate per day during the first period of measurement of *P. prativaga* on aphids was only 15.0% of the relative growth rate on the Collembola; the corresponding value for *C. phragmitis* hatchlings was 39.4 %.

DISCUSSION

The results confirmed the expectation based on previous studies that the aphid *H. pruni* is a poor quality prey for both *C. phragmitis* and *P. prativaga* and thus forms no exception to the rule that aphids are low-quality prey for generalist predators and spiders in particular (Toft 2005). *C. phragmitis* spiderlings given a pure aphid diet grew very little compared to those on a collembolan diet and only a minority showed any development in the form of moults. This indicates that *H. pruni* is probably not an important prey for *C. phragmitis* quantitatively. However, our

Time*diet interaction:	F	NumDF	DenDF	Prob>F
Wilks' Lambda	36,3	4	94	<.0001
Contrast: aphid vs. collembolan+mixed	124.3	2	47	<.0001
Contrast: collembolan vs. mixed	3.4	2	47	0.0404

Table 1. Repeated measures MANOVA on growth of *Clubiona phragmitis* hatchlings fed three diets: the aphid *Hyalopterus pruni*, the collembolan *Sinella curviseta*, and a mixed diet of the two. Data presented in Fig. 1.

results revealed a significant positive effect of the aphids in the mixed diet through a slightly increased growth rate. This means that *H. pruni* may potentially be a valuable supplementary prey. If this is the case in the field cannot be concluded from the present data. Bilde & Toft (2000) found that aphids contributed positively to a mixed diet if the remaining diet (fruit flies) were of low nutritional value, but not if the fruit flies had been nutritionally enriched. Thus, it is possible that the aphids may be of some value if other prey available is restricted to one or just a few species, but valueless if a high diversity of prey types is available. This is likely to vary depending on season, locality and year.

The preliminary calculations indicate that *C. phragmitis* hatchlings were less inhibited in their growth by the aphid diet compared to high-quality collembolan. This difference was predicted from the fact that the natural foraging habitat of *C. phragmitis* includes the *Phragmites* leaves on which *Hyalopterus* colonies develop, and because *C. phragmitis* is an actively searching predator. In contrast, *P. prativaga* inhabits mostly the surface of the ground (though with some excursions into the low vegetation) and is more of a sit-and-wait predator (Samu et al. 2003). As such it depends more on prey insects that move (walk or fly) near the ground surface. To the extent that they feed on *Hyalopterus* aphids, it is probably only swarming winged individuals that happen to land on the ground. However, the question of better tolerance of vegetation hunting spiders to consumption of aphids must be addressed more directly before a final conclusion can be drawn.

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	Aphid		Collembola		Mixed	
	m1	m2	m1	m2	m1	m2
Day 10	0	0	20	0	20	0
Day 17	8	0	20	1	20	1

Table 2. Number of *Clubiona phragmitis* hatchlings that had completed their first (m1) and second (m2) moult on day 10 and 17 after start of the experiment. The hatchlings had been fed three diets: the aphid *Hyalopterus pruni*, the collembolan *Sinella curviseta*, and a mixed diet of the two.

REFERENCES

Bilde, T. & Toft, S. 2000. Evaluation of prey for the spider *Dicymbium brevisetosum* Locket (Araneae: Linyphiidae) in single-species and mixed-species diets. *Ekológia (Bratislava)* 19 Suppl. 3: 9–18.

Duffey, E. 1969. The seasonal movements of *Clubiona brevipes* Blackwall and *Clubiona compta* C.L. Koch on oak trees in Monks Wood, Huntingdonshire. *Bulletin of the British Arachnological Society* 1: 29–32.

Hänggi, A., Stöckli, E. & Nentwig, W. 1995. Habitats of Central European Spiders. *Miscellanea Faunistica Helvetiae* 4, CFCS, Neuchâtel, 459 pp.

Nentwig, W. 1982. Zur Biologie der Schilfsackspinne *Clubiona phragmitis* (Arachnida, Araneae, Clubionidae). *Entomologische Abhandlungen Staatliches Museum für Tierkunde in Dresden* 45: 183–193.

Samu, F., Sziranyi, A. & Kiss, B. 2003. Foraging in agricultural fields: local 'sit-and-move' strategy scales up to risk-averse habitat use in a wolf spider. *Animal Behaviour* 66: 939–947.

Sopp, P.I., Sunderland, K.D. & Coombes, D.S. 1987. Observations on the number of cereal aphids on the soil in relation to aphid density in winter wheat. *Annals of Applied Biology* 111: 53-57.

Toft, S. 1979. Life history of eight Danish wetland spiders. *Entomologiske Meddelelser* 47: 22–32.

Toft, S. 1995. Value of the aphid *Rhopalosiphum padi* as food for cereal spiders. J*ournal of Applied Ecology* 32: 552–560.

Toft, S. 2005. The quality of aphids as food for a generalist predator: implications for natural control of aphids. *European Journal of Entomology* 102: 371–383.

Vanacker, D., Deroose, K., Van Nieuwenhuyse, L., Vandomme, V., Vanden Borre, J. & Maelfait, J.P. 2004. The springtail Sinella curviseta: the most suitable prey for rearing dwarf spiders. In: *European Arachnology 2003* (D.V. Logunov & D. Penney eds.), pp. 333–342. KMK Scientific Press, Moscow.