The role of Pheromones in the distribution of Spiders in the forest litter layer

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Abstract

Specimens of *Pardosa lugubris* (Walckenaer), (Lycosidae) and *Tapinopa longidens* (Wider), (Linyphiidae) were confronted with pine litter that previously was inhabited by other spiders.

Pine litter was collected in the field, thoroughly washed with hot water, to remove odorous substances and living animals, and air-dried for some days. In half the amount of litter spiders were then kept for 48 hours; the other half was used as control litter and was treated in the same way, except that no spiders were put in.

Individual specimens were then given a choice between "contaminated" and control litter. Each experiment was repeated several times.

It was concluded that females of *P. lugubris* and *T. longidens* were attracted by litter that was contaminated by females of the same species, but not by litter that was contaminated by males of the same species.

Males of both species were also attracted by litter that was contaminated by females of the same species, but not by litter that was contaminated by males of the same species.

Females of *T. longidens* avoid litter previously contaminated by *P. lugubris* females.

P. lugubris females were not attracted to litter previously contaminated by *T. longidens* females.

It is concluded tentatively that *T. longidens* females use aggregation pheromones of *P. lugubris* to avoid this much bigger species, that is a potential predator.

For *Micrargus herbigradus* (Blackwall), (Linyphiidae) a similar behaviour was demonstrated.

Introduction

When a spider meets a new web-site it has to decide if that particular site suits its demands, it has to make a decision whether to stay in that spot or to move on.

The factors underlying that decisions are abiotic factors as humidity, wind velocity and temperature and biotic factors. The latter can be divided in two groups:

1. Factors pertaining to the structure of the web-site, the structure of the vegetation or in the case of ground-living spiders, the structure of the litter layer.
2. Other animals, that is prey animals, competitors and predators.

This paper concerns the reaction of spiders to other spiders. It must be important for a spider to asses if the new web-site contains conspecifics and/or other species that act as competitors and potential predators .

Although there is enough evidence of the use of pheromones in sexual behaviour (Tietjen & Rovner, 1982), knowledge about other uses of pheromones in intra- and interspecific relationships in spiders is scarce .

We reasoned that probably a spider can distinguish litter, contaminated by waste products of other spiders, from "clean" litter. We investigated whether it is attracted to or deterred by contaminated litter. We used *Pardosa lugubris* (Walckenaer), (Lycosidae) and *Tapinopa longidens* (Wider), (Linyphiidae) as test animals because they are both abundant in the forest floor and it is known that *P. lugubris* predates on Linyphiidae (Edgar 1969). Furthermore we found (Kessler, Vermeulen & Wapenaar 1984) that small spiders avoid aggregations of bigger spiders in sedge tussocks.

Methods

Pine needle litter (Pinus nigra) was collected outside and washed thoroughly with hot tap water (80 ^{0} C) to remove other animals and odorous substances. In a number of circular PVC containers (diam. 13 cm, height 6 cm.) a layer of $\pm$ 2 cm of pine needle litter was put. In every container was a layer of Plaster of Paris of about 3 cm. that was kept moist. In these containers 4 spider specimens were kept. They were removed after 48 hours. The control litter was treated in exactly the same way except that there were no spiders added to the containers.

The same type of containers were used for the experiments. Half of the container bottom was covered with a 2 cm. layer of the litter that was contaminated by spiders, the other half was covered with clean litter from the control containers. Care was taken to put the same amount of litter in both halves. One specimen of spider was then introduced in the middle of the container and left in the container for 5 hours. After that its position, either in contaminated or clean litter was noted down. There were about 20 replicates in each experiment. Both the preparing of the litter and the experiments proper were done in a climatized room (temperature 15 ^{0} C, RH 60 %). First we established the reaction of *P. lugubris* specimens on conspecifics, then *T. longidens* specimens on conspecifics and *P.*

lugubris females against *T. longidens* females and vice versa. Due to a scarcity of experimental animals only females were tested in this experiment.

Finally another Linyphiid, *Micrargus herbigradus* was also tested against *P. lugubris* females, to check if the reaction of *T. longidens* is unique.

Specimens of *P. lugubris* were collected in the field and after only a few days in storage in the climatized room, were used in the experiments. The same holds for *M. herbigradus.*

T. longidens was raised to adults from egg sacs that were collected in the field. This was necessary to obtain enough experimental animals of about the same age. Every single specimen was only used once, be it for contamination or for choice experiments. All results were analysed with the binomial test.

Results

The results of the experiments are summarized in tables 1, 2, 3 and 4. (In the tables the probability of obtaining the lowest number , determined by the binomial test, is given).

Table 1. Preference for contaminated litter in *Pardosa lugubris*

contaminated by	experimental group	number in contam. litter	number in clean litter	P
females	females	14	6	p = 0.058
females	males	15	5	p = 0.021
males	females	11	9	p = 0.999
males	males	9	11	p = 0.999

Females are attracted to other females, the results are not significant however. Males are attracted significantly by females. Females do not react on males, neither do males react on other males.

Table 2. Preference for contaminated litter in *Tapinopa longidens*

contaminated by	experimental group	number in contam. litter	number in clean litter	P
females	females	15	5	p =0.021
females	males	17	6	p =0.017
males	females	13	7	p =0.132
males	males	10	10	

In *T. longidens* the same results as in *P. lugubris* are obtained. The only difference is that the attraction between females in this case is statistically significant.

Table 3. Preference for contaminated litter in females of *Tapinopa longidens* and *Pardosa lugubris*

contaminated by	experimental group	number in contam. litter	P	number in clean litter
P. lugubris	*T. longidens*	5	p = 0.021	15
T. longidens	*P. lugubris*	7	p = 0.240	11

In this experiment *T. longidens* avoids litter that is contaminated by *P. lugubris*. There is no reaction of *P. lugubris* on litter contaminated by *T. longidens*.

Table 4. Preference for contaminated litter in females of *Micrargus herbigradus* and *Pardosa lugubris*

contaminated by	experimental group	number in contam. litter	P	number in clean litter
P. lugubris	*M. herbigradus*	8	p = 0.115	17

M. herbigradus shows the same avoidance behaviour as *T. longidens* towards *P. lugubris*.

Discussion

The use of pheromones in sexual behaviour in spiders is well documented (Tietjen & Rovner, 1982; Pollard et al. 1987). Spider silk plays an important role in this. It is likely that pheromones are deposited on draglines, so male specimens can follow the trail of females to make contact (Ibidem). The positive reaction of male *P. lugubris* and *T. longidens* on females, demonstrated in our study, undoubtedly enhances the mating success of the species.

Pheromones that elicit aggregation behaviour are demonstrated for Collembola by Verhoef (1984). For these animals it is advantageous to live in aggregations because reproductive efficiency is enhanced in this way (Ibidem).

We suggest that the aggregation behaviour of *T. longidens* females serves the same purpose. Once one female is detected by a male the finding of another female is relatively easy.

Little is known of the role of pheromones in interspecific communication. Tretzel (1959) demonstrated the recognition of the web of *Coelotes terrestris* by other spiders and their avoidance reaction. It seems unlikely that the use of pheromones and other chemical cues in assessing the suitability of a web-site is not widespread among spiders.

Since *Pardosa spp.* are known predators of Linyphiidae (Edgar, 1969, 1970), avoidance of the microhabitat of *Pardosa lugubris* seems a good enough tactic for Linyphiids.

P. lugubris, in pine woods in the Netherlands, lives only on the edges where there are sufficient beech or oak leaves on top of the pine needles. So avoidance of *P. lugubris* is feasible.

It is likely that *T. longidens* uses chemical cues , probably a sex pheromone on the draglines of *P. lugubris* in avoiding the latter. It is not excluded however that draglines alone or other waste products of *P. lugubris* serve as cues.

Since *T. longidens* deposits the egg sacs in the web, avoidance behaviour of the adult females towards *P. lugubris* is also advantageous for the young. The more so while in May /June when the young *T.longidens* emerge, either young specimens of *P. lugubris* or females that are developing eggs , or both, are around and can exert a heavy predation pressure.

The similar reaction of *M. herbigradus* towards *P. lugubris* suggests that this avoidance behaviour is probably common among Linyphiidae.

Further studies on the use of chemical cues in microhabitat selection are needed and, in our opinion, are worthwhile.

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