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MICROHABITAT SELECTION IN SOME LINYPHIID SPIDERS INHABITING THE FOREST FLOOR

by

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RESUME. - En plein air *Lepthyphantes zimmermanni* préfère les strates supérieures de la litière dans les bois de pins. *Micragus herbigradus* et *Centromerus dilutus* habitent les strates inférieures de la litière. Sous des conditions expérimentales *C. dilutus* préfère les aiguilles de pin fragmentées caractéristiques pour cette strate inférieure, *M. herbigradus* ne montre pas de préférence, et *L. Zimmermanni* préfère la strate supérieure de la litière de n'importe quel type d'aiguilles de pin *C. dilutus* et *M. herbigradus* possèdent un flux de transpiration haute et meurent rapidement de déshydration. *L. zimmermanni* est très résistant à la perte de l'eau.

SUMMARY. - In the field Lepthyphantes zimmermanni prefers the upper litter layer; both Micrargus herbigradus and Centromerus dilutus inhabit the deeper litter layers in pine woods.
In laboratory experiments C. dilutus prefers the fragmented pine needles that are typical for this deeper litter layer, M. herbigradus shows no preference, and L. zimmermanni prefers the upper litter layer, irrespective of the type of pine needles.
Both C. dilutus and M. herbigradus have a high evaporation rate and die quickly of dehydration; L. zimmermanni is very resistent to water loss.

Mots-clés: Linyphiidae, sélection de microhabitat, transpiration, litière.

Index entries: Linyphiidae, microhabitat selection, transpiration, litter layer.

INTRODUCTION

Even in the, relatively thin, litter layer of woods a vertical stratification of Linyphiid spider species can be found (HUHTA 1971). Similar to the vertical distribution of the bigger web spiders in the herbaceous layer (BLANDIN 1986), the type and the dimensions of the web play an important role in determining web-site selection of a spider species within the litter layer. It is evident that the second important feature for selection is the specific microclimate of the different horizons in the litter layer. The question arises if the type and structure of the different layers in the litter in itself are important in microhabitat selection.

We studied the vertical distribution in the pine wood litter layer of spider species in the field. Of 3 numerically dominant Linyphiid species we estimated the amount of water loss and the resistance to dehydration under dry experimental conditions. In the same species we attempted to establish experimentally a preference for certain types of litter per se.

MATERIAL AND METHODS

First the density and the distribution within the litter layer were established for the spider fauna in a pine wood litter layer (Roggebotzand, position: 52° 34' N, 5° 49' E).

We took 20 samples of 25 x 25 cm. Every sample was divided in an upper and a bottom litter layer. The upper layer is characterized by recently fallen, intact pine needles, the bottom layer consists of fragmented, partly decomposed needles.

On the basis of the results of this survey three numerically dominant Linyphiid species were selected for laboratory experiments: *Lepthyphantes zimmermanni* Bertkau, *Centromerus dilutus* (O.P.-Cambridge) and *Micrargus herbigradus* (Blackwall). Nomenclature follows LOCKET & MILLIDGE (1951, 1953, 1974).

In the laboratory the spiders were offered litter, consisting of either intact pine needles (intact) from the upper layer or fragmented pine needles (fragm.) from the deeper litter layers. In some experiments cut pine needles (cut) from the upper layer were used. They were cut to about the same size as the fragmented needles.

Two experimental set-ups were used:

1) Two PVC rings (diam. 31.5 cm.) were put on top of each other. In the bottom ring a layer of moist plaster of Paris was put and on top of that a litter layer of ± 4 cm. The upper ring was provided with a bottom of chicken wire on top of which the litter was deposited. No space was left then between the upper and lower litter layers. In this way both litter layers can be easily separated without disturbance of the spiders. In one experiment food in the form of springtails, *Orchesella cincta* (L.), was added; 10 springtails per replicate.

2) One PVC ring with a layer of plaster of Paris was separated in equal parts, both parts were then provided with a 4 cm. thick litter layer.

Only one spider was put in each experimental set-up. The experiments were finished after 4 days. Ten replicates were taken in every experiment.

Temperature was kept at 16°C, Relative Humidity at 60%. Light conditions were: 12 hours dark and 12 hours light.

Water loss of specimens of *M. herbigradus*, *C. dilutus* and *L. zimmermanni* was measured by continuous weight recordings in a special glass chamber with silicagel (RH ± 20%), attached to a Cahn RG Electrobalance, collected to a potentiometric recorder (for more details see VERHOEF 1980).

For the results of the field samples we used a G-test for independence, for the laboratory experiments the binomial test (SOKAL & ROHLF 1981).

In all experiments only female spiders were used.

RESULTS

Densities.

TABLE 1 shows the densities of all spiders found in the field samples. The total spider density is rather high, about 500 specimens m^{-2}. The vast majority of these spiders are juvenile Linyphiidae (382.4). Adult Linyphiidae amount to ± 100 specimens. There are three species that are comparatively important in numbers: *Centromerus dilutus*, *Micrargus herbigradus* and *Lepthyphantes zimmermanni*.

TABLE 1. Densities of spiders estimated with quadrat samples (25x25 cm.) *Lepthyphantes* sp. means all specimens of this genus that could not be identified to species level; SE = standard error.

Species	N m^{-2}	SE
Fam. Linyphiidae		
Agyneta conifera (O.P.-Cambridge)	1.6	4.92
Agyneta subtilis (O.P.-Cambridge)	3.2	6.57
Centromerus dilutus (O.P.-Cambridge)	12.0	20.02
diplostyla concolor (Wider)	0.8	3.58
Lepthyphantes sp. A Menge	23.2	20.42
Lepthyphantes zimmermanni Bertkau	11.2	14.77
Lepthyphantes tenebricola (Wider)	4.8	11.72
Lepthyphantes cristatus (Menge)	0.8	3.58
Linyphia clathrata Sundevall	1.6	7.15
Linyphia montana (Clerck)	0.8	3.58
Macrargus rufus (Wider)	0.8	3.58
Micrargus herbigradus (Blackwall)	36.8	36.37
Oreonetides abnormis (Blackwall)	2.4	5.86
Tapinocyba insecta (L. Koch)	1.6	4.92
Tapinocyba praecox (O.P.-Cambridge)	0.8	3.58
Linyphiidae juv.	382.4	202.9
Other families		
Agroeca proxima (O.P.-Cambridge)	3.2	6.57
Ero sp. C.L. Koch	3.2	8.37
Hahnia montana (Blackwall)	0.8	3.58
Meta sp. C.L. Koch	1.6	4.92
Neon reticulatus (Blackwall)	0.8	3.58
Robertus lividus (Blackwall)	3.2	6.57
TOTAL	496.8	

Microhabitat selection in the field

Both *M. herbigradus* and *C. dilutus* prefer the lower litter layer, whereas *L. zimmermanni* prefers the upper litter layer. (TABLE 2)

TABLE 2. Microhabitat selection in the field; total numbers of 20 samples (25x25 cm) found either in the upper litter layer (intact) or in the lower litter layer (fragm.)

	intact	fragm.		
Micrargus herbigradus	1	45	G=29.10	$P < 0.001$
Centromerus dilutus	1	14	G= 4.72	$P < 0.05$
Lepthphantes zimmermanni	13	1	G= 7.17	$P < 0.01$

Microhabitat selection in experiments

In experiments with the intact litter layer on top of the fragmented layer *M. herbigradus* shows a preference for the bottom litter layer. When the fragmented litter layer is on top of the intact layer, the reverse from the field situation, *M. herbigradus* still chooses the bottom layer.

(TABLE 3). This preference for the bottom layer persists when springtails (the normal prey animals for these spiders) are added, which aggregate in the top litter layer. *M. herbigradus* shows no preference when both experimental litter layers are of the fragmented type.

The same holds for *C. dilutus* except that there is an indication that the preference for the bottom layer is not as strong as in *M. herbigradus*

TABLE 3. Preference for intact or fragmented pine needles. In experiments where the two types of litter were arranged as in the field, 0.96 as expected proportion (H_0) was used, based on the field samples; in all other cases H_0 = 0.5. The numbers between brackets represent the number of springtails in that experiment. S = statistically significant; NS = not significant.

	M. herbigradus		*C. dilutus*	
intact	1		0	
fragm.	9	H_0 = 0.96, NS	9	H_0 = 0.96, NS
fragm.	5		7	
fragm.	5	H_0 = 0.50, NS	3	H_0 = 0.50, NS
fragm.	0		3	
intact	10	H_0 = 0.50, S	7	H_0 = 0.50, NS
intact	1 (55)		0 (47)	
fragm.	9 (6)	H_0 = 0.96 NS	10 (4)	H_0 = 0.96, NS

When the two types of litter are offered adjacent to each other *M. herbigradus* shows no preference whereas *C. dilutus*, in most cases, prefers the litter layer with the smallest pine needle fragments. (TABLE 4)

TABLE 4. Preference for intact, cut, or fragmented pine needles. In all cases H_0 = 0.50. S = statistically significant; NS = not significant.

M. herbigradus			*C. dilutus*		
intact	fragm.		cut	fragm.	
6	4	NS	1	9	S
cut	fragm.		cut	fragm.	
6	4	NS	3	7	NS
intact	cut		intact	cut	
4	6	NS	1	9	S

L. zimmermanni clearly prefers the uppermost litter layer, regardless of the composition of this layer (TABLE 5A); when offered two types of litter adjacent to each other, it shows no significant preference for one of them (TABLE 5B).

TABLE 5. Preference of *Lepthyphantes zimmermanni* for intact, cut, or fragmented pine needles. A: two litter layers on top of each other; B: two litter layers adjacent to each other. In one case only H_o = 0.90, based on the field sample, in all other cases H_o = 0.50.

A		
intact	10	
fragm.	0	H_o = 0.90, NS
fragm.	10	
intact	0	H_o = 0.50, S

B		
intact	fragm.	
7	3	H_o = 0.50, NS
cut	fragm.	
6	4	H_o = 0.50, NS
intact	cut	
8	2	H_o = 0.50, NS

Evaporation rates

TABLE 6 shows that the evaporation rates of *M. herbigradus* and *C. dilutus* do not differ much under the experimental conditions, whereas the rate of *L. zimmermanni* is much lower.

M. herbigradus and *C. dilutus* die very soon under the dry experimental conditions, in about 3 hours; under the same conditions.

L. zimmermanni dies after 30 hours.

TABLE 6. Evaporation rate under experimental conditions (20% relative humidity).

	Evaporation rate, µg.min.$^{-1}$	Time of dying, hrs.	mean initial weight, mg.	N
L. zimmermanni	0.16 µg	30	1.858	3
M. herbigradus	0.40 µg	3	0.865	6
C. dilutus	0.53 µg	3	0.371	6

DISCUSSION

The results of the experiments on littertype preference remain somewhat dubious, because certain properties of the litter are interconnected and difficult to separate. The capacity to take up water will be less for fresh litter than for allready partly decomposed litter, so there will be differences in water content and, probably in relative humidity. Further, if preference for the dark plays a role, the amount of light falling through will be different, depending on the more or less dense packing of the needles or needle fragments. Still, the differences between the species are quite clear. *M. herbigradus* does not show any preference for litter type, as long as the litter is humid enough, whereas *C. dilutus* prefers the litter type with the smallest needle fragments under the same conditions. In the field both species will find their preferent environment in the deeper litter layer, the F-horizon (BUCHE 1966; HUHTA 1971).

L. zimmermanni is different, probably because of its bigger web and, by consequence, the need for more space, which is only available on top of the litter layer. Therefore it has to be resistant to desiccation, as is clearly the case, especially when compared to *M. herbigradus* and *C. dilutus*. It also avoids windy places (JOCQUÉ 1973).

More rigorous experiments, preferably with artificial litter that is not influenced by different humidity conditions, are needed to determine whether the preferences of Linyphiid species for litter type are the result of the structure of the litter alone or are directed by their preferences for abiotic factors like humidity and light conditions.

Far more research is needed to determine if the differences in preference for different types of litter will result in a real niche-segregation of the species.

REFERENCES

BLANDIN, P. - 1986 - L'étude de la structure spatio-temporelle des communautés d'Araignées: une contribution à l'écologie évolutive. - *Actas X Congreso Internacional de Aracnologia, JACA. Espana*, 1: 143-168.

BUCHE, W. - 1966 - Beiträge zur Oekologie und Biologie winterreifer Kleinspinnen mit besonderer berücksichtigung der Linyphiiden *Macrargus rufus rufus* (Wider), *Macrargus rufus carpenteri* (Cambridge) und *Centromerus sylvaticus* (Blackwall). - *Zeitschrift für Morphologie und Oekologie der Tiere*, 57: 329-448.

HUHTA, V. - 1971 - Succession in the spider communities of the forest floor after clear-cutting and prescribed burning. - *Annales Zoologici Fennici*, 8: 483-542.

JOCQUÉ, R. - 1973 - The spider fauna of adjacent woodland areas with different humus types. - *Biologisch Jaarboek Dodonaea*, 41: 153-179.

LOCKET, G.H. & MILLIDGE, A.F. - 1951, 1952, 1953 - *British spiders* - 3 volumes. London, Ray Society.

SOKAL, R.R. & ROHLF, F.J. - 1981 - *Biometry* - 2nd ed., Freeman, San Francisco.

VERHOEF, H.A. & WITTEVEEN, J. - 1980 - Water balance in Collembola and its relation to habitat selection: cuticular water loss and water uptake. - *Journal of Insect Physiology*, 26: 201-208.