1998. P. A. Selden (ed.). *Proceedings of the 17th European Colloquium of Arachnology, Edinburgh 1997.*

Implications of microhabitat selection on prey capture for the web spider *Neriene radiata* (Walckenaer) (Araneae: Linyphiidae)

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Summary

The linyphiid sheet web spider *Neriene radiata* (Walckenaer) was studied in a patch of regrowth forest in eastern Austria. The spiders constructed their webs either on one of the numerous young Douglas-fir trees (*Pseudotsuga menziesii*) or in the shrub understorey surrounding those trees. Web size, web height and prey capture were measured for webs on the fir trees and in the understorey. Microhabitat choice had a significant effect on web height and prey capture, but not on web or spider size. Whereas spiders constructed their webs at similar heights in spring, web height on the fir trees became greater than that of webs in the understorey as the seasons progressed. Furthermore, the types of prey captured also differed significantly between the two web sites. Webs in the understorey captured more Delphacidae than webs on the fir trees. These differences in prey capture are also reflected in prey size, as webs constructed in the understorey captured larger prey than those on the fir trees. However, prey capture rates were similar between the two sites. Whereas spiders are expected to use the understorey more frequently because they capture larger prey there, a movement into the grass vegetation may be disadvantageous because of the lack of sufficiently rigid support, such as is provided by the fir trees.

Introduction

Recent studies concerned with the ecology of web-building spiders found that specific differences in web structure (see Foelix, 1992 for a summary), spatial distribution (e.g. Enders, 1974; Pasquet, 1984; Ward & Lubin, 1992; Herberstein, 1997a), temporal activity period (e.g. Ward & Lubin, 1992; Herberstein & Elgar, 1994) and species-specific attack behaviour (e.g. Vasconcellos-Neto & Lewinsohn, 1984; Nentwig, 1987) result in the utilization of different prey resources (Enders, 1974; Uetz *et al.*, 1978; Brown, 1981; McReynolds & Polis, 1987; Eberhard, 1990; see Wise, 1993 for a summary). However, it is difficult to isolate which particular parameter (distribution, behaviour, web structure, etc.) is responsible for the observed differences. This could be overcome by observing single spider species that occupy distinct microhabitats. If only one species is examined, additional sources of variation, such as specific web structure, activity period, or attack behaviour, can be expected to be minimal.

The present study is concerned with the prey captured by the sheet web spider *Neriene radiata* (Walckenaer) that placed its webs on two very different vegetation types: young fir trees and the surrounding understorey vegetation (Herberstein, 1995, 1997a), allowing a rare insight into the effect of microhabitat choice on prey capture.

The results presented here should be considered a continuation of previously published results on the niche parameters of *N. radiata* in comparison with two other linyphiid species *Frontinellina frutetorum* (C. L. Koch) and *Linyphia triangularis* (Clerck), that also occur in the same habitat (Herberstein, 1997a).

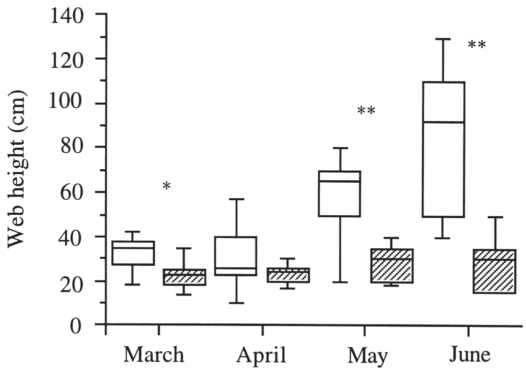


Fig. 1: Box plots describing the first quartile, the median (second quartile) the third quartile and range of web heights for webs constructed on the fir trees (white) and in the understorey vegetation (hatched) (*$P < 0.05$, **$P < 0.01$).

Materials and methods

As most of the methods used in this study have already been published (Herberstein, 1997a), I will only present a condensed version of the methodology here.

Study site and duration

The study was conducted from March to June 1993 in an area of forest regrowth in eastern Austria. The area was planted with young Douglas-fir trees (*Pseudotsuga menziesii*) which were surrounded by a dense layer of understorey vegetation, consisting of mostly grasses, ferns, and blackberry and raspberry bushes.

Web height

N. radiata webs were surveyed along randomly allocated transects within the study area. The height of webs on the fir trees and in the understorey was recorded monthly from March to June and heights were compared using Mann-Whitney-U tests.

Prey spectra

Prey was collected in May and June from adult female *N. radiata* webs found on either vegetation substrate (trees or understorey). At least 5 webs on the trees and 5 in the understorey were surveyed for 4–12 h on more than 20 days, choosing new spiders every day. Prey spectra were compared using Hierarchical log linear tests (Nie, 1983), including prey types captured at frequencies greater than 5%. Individual z values were calculated to determine which of the insect groups showed differences in frequencies.

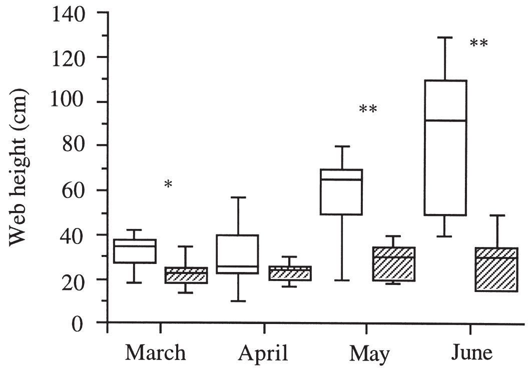
Insect traps

The prey potentially available to the spiders was sampled using sticky traps. The traps consisted of transparent plastic sheets (30 × 30 cm) that were evenly coated on one side with a clear, waterproof insect glue (Rotor Raupenleim). Four traps were erected adjacent to the fir trees (heights: 0–120 cm) and three within the understorey vegetation (heights: 0–90 cm). These heights were chosen with regard to the actual web heights. Insects were only collected when the webs of *N. radiata* were also being surveyed.

The insects captured by the traps in each vegetation substrate were analysed using Hierarchical log linear tests, considering prey types sampled at frequencies > 5%, as well as those prey types captured by the spiders at frequencies > 5%.

Prey type	**Fir trees**	**Understorey**
Aphidina	35.4 (0.84)	18.3 (–1.08)
Cicadellidae	22.0 (–1.15)	33.3 (1.46)
Delphacidae	0.0 (–1.76)	8.3 (2.25**)
Sciaridae	18.3 (1.37)	3.3 (–1.75)
Miridae	1.2	1.7
Cecidomyiidae	0.0	3.3
Eurytomidae	4.9	1.7
Formicinae	1.2	0.0
Anthomyiidae	3.7	5.0
Muscidae	2.4	0.0
Opomyzidae	0.0	5.0
Others	10.9	20.1
Total number of prey items	82	60

Table 1: Percentages of prey types captured by webs located in the fir trees and in the understorey vegetation. Individual z values are given in parentheses (**$P < 0.01$).



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Prey capture rates

There was no time effect on the prey capture rates sampled at different times of the day for webs on the fir trees (H = 2.65, d.f. = 3, P > 0.05) or for webs in the understorey (H = 3.35, d.f. = 3, P > 0.05). Therefore, the rates were pooled for the comparison between fir trees and understorey vegetation, but this also revealed no significant difference ($U_{51,55}$ = 1337, P > 0.05 (Fig. 3)).

Web size and spider size

The sizes of spiders and their webs found on the fir trees were similar to those found in the understorey vegetation (Table 3).

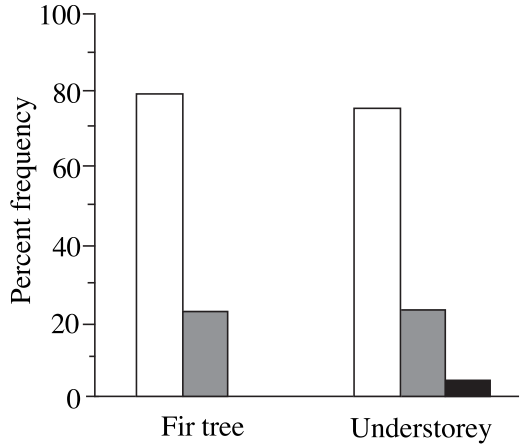

Fig. 3: Percentage frequency of the number of prey items captured per hour for *N. radiata* webs constructed on the fir trees and in the understorey vegetation. Zero items per hour (white), 0.5 prey items per hour (grey) and 1 prey item per hour (black).

Discussion

The results show that a spatial shift in web site, such as from a fir tree to the surrounding understorey, can have a significant effect on prey capture. *N. radiata* webs in the understorey, whilst being similar in size to those on the fir trees, captured different and larger prey. The rate of prey encounter was, however, similar for spiders on either vegetation substrate.

Physical habitat structure is an important parameter governing the attractiveness of a web site (Greenstone, 1984; Uetz, 1991). Dense and rigid branches can provide suitable sites for web-building spiders (Vermeulen & Kessler, 1980; Ward & Lubin, 1993) as well as provide important hiding places from bird predators (Gunnarsson, 1990, 1996; Sundberg & Gunnarson, 1994). Whereas the fir trees consisted of rigid horizontal layers of dense branches, the understorey vegetation appears less dense and more flexible, particularly the grasses. Furthermore, webs constructed in the understorey remained at a similar height, while the web height on the trees increased as the seasons progressed. It has been shown that the height increase on the fir trees is in direct response to the growth of the understorey vegetation around the trees which reduces the attractiveness of web sites closer to the ground (Herberstein, 1997b). Webs in the understorey are also likely to be limited by the overall height of shrub vegetation (reaching a maximum of 100–120 cm in summer) as well as the lack of stable support at greater heights.

Parameter	Fir trees	Understorey	Significance
Leg I length	1.40 ± 0.10	1.40 ± 0.04	t = –1.10 NS
Carapace length	0.21 ± 0.02	0.20 ± 0.00	t = 0.95 NS
Body length	0.52 ± 0.06	0.51 ± 0.04	t = 0.34 NS
Sheet length	13.3 ± 2.3	12.3 ± 2.1	t = 0.87 NS
Sheet breadth	11.6 ± 2.3	10.3 ± 2.7	t = 1.05 NS
Height of the entangling threads	10.5 ± 4.9	11.8 ± 4.8	t = 0.34 NS

Table 3: The average (mean ± SD) leg I length, carapace length and total body length of spiders and the average (mean ± SD) sheet length, sheet breadth and height of the entangling threads of webs found on the fir trees (n = 14) and in the understorey vegetation (n = 6). All parameters are measured in cm. NS = not significant.

The differences in prey types and prey size may reflect differences in prey availability between the fir trees and understorey vegetation, which is indicated by the differences in trap captures. However, the statistical methods used do not allow for any possible variation caused by individual webs or traps; therefore these results could have been affected by a single web or trap. Additionally, it is difficult to estimate total prey availability, as any type of trap may introduce some bias (Kajak, 1965; Castillo & Eberhard, 1983; Nentwig, 1989; Malt *et al.*, 1990). Unfortunately, hardly any Delphacidae were captured in the traps and therefore, it cannot be determined if they are more numerous in the understorey, as suggested by the web captures.

The results suggest that using the understorey may be advantageous in providing larger prey items for the spiders. However, the lack of rigid support structures or adequate hiding places may counteract an extensive use of the understorey vegetation. In 1994, 76% of *N. radiata* webs were found on the fir trees (Herberstein 1997a), compared to 47% in 1993 indicating that the fir trees are in fact favoured. Similarly, 95% of webs constructed by the sympatric *F. frutetorum* and *L. triangularis* were also placed on the fir trees (Herberstein, 1997a).

Acknowledgments

I thank Claudia Bischof, Mark Elgar, Norbert Milasowszky, Martin Predavec, Karl Sänger, and Gerhard Spitzer for helpful comments made on my research and about the typescript. Konrad Thaler, Maximilian Fischer, Wolfgang Waitzbauer and Harald Schillhammer helped with identifying the spiders, Hymenoptera, Diptera and Coleoptera, respectively. I am particularly grateful to my uncle, Johann Anton Herberstein, and to my aunt, Lisi Herberstein, who provided the forest and with whom I stayed throughout the field work. Financial support was provided by the University of Vienna.

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