BOLL. ACC. GIOENIA SCI. NAT.	Vol. 26	n. 345	pp. 323-334	Catania 1993

Spider and harvestmen fauna (Arachnida: *Araneae, Opiliones*) of pine trees (*Pinus silvestris* L.) and its stratification

SIMON U.
Institut für Biologie - Technische Universität Berlin
Franklinstraße 28/29 - 10587 Berlin

RIASSUNTO

L'aracnofauna degli alberi di pino vicino Berlino è studiata con due diversi metodi di trappolamento a 5 differenti altezze (m 1,5; m 6; m 10; m 15; corona). Nella corona è stato utilizzato un nuovo tipo di trappola che è posta attorno a un ramo dell'albero (branch eclector). Per raggiungere la chioma è stato utilizzato un sistema di arrampicata alpina che evita i danni alla corteccia.

I risultati evidenziano una caratteristica cenosi di ragni e opilioni degli alberi di pino, ma anche sensibili differenze nella composizione in specie e numero di individui di alcune specie alle differenti altezze (stratificazione).

I risultati sono discussi nella prospettiva di chiarire la funzione di questi animali nell'ecosistema forestale.

Parole chiave: Stratificazione dei ragni, Fauna della chioma, Alberi di pino, Ecosistema forestale.

SUMMARY

With two different trapping methods the spider fauna of pine trees in Berlin is investigated in 5 different hights (m 1,5; m 6; m 10; m 15; crown). In the crowns a new trap is used, which is put round a branch of a tree (branch eclector); second is an alpine climbing system to reach the canopy without damage of the bark.

The results show a characteristic pine tree coenosis of spiders and harvestmen, but also evident differences in the species composition and individual numbers of certain species in different heights (stratification).

The results are discussed on the background of the function of spiders in a forest ecosystem.

Key words: Spider stratification, Canopy fauna, Pine trees, Forest ecosystems.

Introduction

In a lot of terrestrial ecosystems there are not only existing horizontal structures like soil layers and litter, but also vertical structures. These are grass, herbs, bushes and, the most important in forests, trees. While the first can be investigated more or less easily by walking on the ground (trapping with pitfall-traps, photeclectors, by sweeping etc.) the higher strata of trees (more than three meters) are getting out of the main explorers reach. There is some research work of the arthropod fauna in canopies of trees done by cutting branches or sweeping after climbing into the crown region (e.g. HESSE, 1940; KLOMP & TEERINK, 1973; SOUTHWOOD *et al.*, 1982; BORKOWSKI, 1986), mostly with climbing irons, or some did cut the whole tree collecting the fleeing animals from white sheets. All these used methods are non-continously or are damaging the object of interest, respectively.

Methods

Investigating the strata distribution of spiders on pine trees in the Grunewald forest in Berlin and the crown fauna in a pine forest in Eberswalde 80 km northeast of Berlin I use stem-eclectors (BEHRE, 1989) in four different heights (1,5 meter, 6 meters, 10 meters and 15 meters) and a newly developped branch eclector (SIMON & BEHRE in prep.). In every of four explored tree-crowns per stand six of these branch eclectors are installed. As a trapping liquid 1% $CuSO_4$-solution is used.

To reach all the traps we use a climbing system developped for the investigation of the canopy area of tropical trees by D. PERRY (PERRY, 1978, 1988; PERRY & WILLIAMS, 1981): using a harness and a rock-climbing rope installed at a tree which is not investigated one can reach the canopy region in a height of 25 meters. To reach the trees where the branch eclectors are installed on one goes traverse by a pulley connected to the harness and hanging at a rope leading from the one tree to the other one. This method provides no damage of the bark of explored trees.

I have been starting this project in May 1991 and it will end in February 1994.

Results

70 species of spiders and 4 species of harvestmen were found during 1991 and 1992. Some of them occur in all strata or most of strata of the pine trees, some of them only in lower strata and some only in higher strata. This might change from year to year (Tab. 1a and 1b).

Tab. 1 - Distribution of the spider species found on trunks of pine trees during 1991 (a) and 1992 (b). Note the differences between the two years in the species-composition of every stratum!

(a)

Species name 1991	1,5 m	6 m	10 m	15 m	crown
Achaearanea lunata	+	+	+	+	+
Anyphaena accentuata	+	+	+	+	+
Clubiona brevipes	+	+	+	+	+
Moebelia penicillata	+	+	+	+	+
Philodromus aureolus	+	+	+	+	+
Philodromus fuscomarginatus	+	+	+	+	+
Philodromus margaritatus	+	+	+	+	+
Salticus zebraneus	+	+	+	+	+
Theridion mystaceum	+	+	+	+	+
Theridion tinctum	+	+	+	+	+
Dipoena torva	+	+	+	+	
Lepthyphantes minutus	+	+	+	+	
Diaea dorsata	+	+	+		
Enoplognatha ovata	+	+	+		
Steatoda bipunctata	+	+	+		
Clubiona compta	+	+			
Clubiona terrestris	+	+			
Drapetisca socialis	+	+			
Entelecara acuminata	+	+			
Ero furcata	+	+			
Textrix denticulata	+	+			
Theridion pallens	+	+			
Theridion varians	+	+			

Cont. Tab. 1a

Species name 1991	1,5 m	6 m	10 m	15 m	crown
Araeoncus humilis	+				
Ballus depressus	+				
Centromerus sylvaticus	+				
Clubiona stagnatilis	+				
Dictyna puella	+				
Leptlyphantes angulipalpis	+				
Mioxena blanda	+				
Tegenaria ferruginea	+				
Tetragnatha obtusa		+	+	+	+
Clubiona genevensis			+	+	+
Coriarachne depressa			+	+	+
Heliophanus dubius					+
Philodromus albidus					+
Philodromus emarginatus					+
Zilla diodia					+
Bianor aurocinctus		+			
Dictyna pusilla		+			
Porrhomma pallidus		+			
Trematocephalus cristatus		+			
Xysticus lanio		+			
Dendryphantes rudis			+		
Nigma flavescens			+		
Pisaura mirabilis			+		
Hyptiotes paradoxus				+	
Segestria senoculata		+	+		
Philodromus cespitum			+	+	
Agroeca brunnea	+		+	+	
Anelosimus vittatus	+	+			+
Araneus diadematus		+			+
Araniella cucurbitina					+
Atea sturmi		+	+		+
Clubiona pallidula		+		+	+
Clubiona subsultans	+		+		+
Dictyna arundinacea		+		+	+
Gibbaranea omodea					+
Harpactea hombergi	+	+			+
Meioneta innotabilis	+	+			+
Microneta viaria		+			+
Nuctenea umbratica	+		+	+	+
Philodromus collinus	+	+			+

Cont. Tab. 1a

Species name 1991	1,5 m	6 m	10 m	15 m	crown
Philodromus rufus			+		+
Syedra myrmicarum		+			+
Xysticus audax	+	+	+		+
Xysticus cristatus		+		+	
Total amount	40	43	30	23	35

(b)

Species name 1992	1,5 m	6 m	10 m	15 m	crown
Anyphaena accentuata	+	+	+	+	+
Clubiona brevipes	+	+	+	+	+
Clubiona genevensis	+	+	+	+	+
Coriarachne depressa	+	+	+	+	+
Diaea dorsata	+	+	+	+	+
Philodromus aureolus	+	+	+	+	+
Philodromus fuscomarginatus	+	+	+	+	+
Theridion tinctum	+	+	+	+	+
Achaearanea lunata	+	+	+	+	
Lepthyphantes minutus	+	+	+	+	
Steatoda bipunctata	+	+	+	+	
Enoplognatha ovata	+	+	+		
Philodromus emarginatus	+	+	+		
Textrix denticulata	+	+	+		
Theridion pallens	+	+	+		
Theridion varians	+	+	+		
Xysticus audax	+	+	+		
Ero furcata	+	+			
Trematocephalus cristatus	+	+			
Araniella displicata	+	+			
Xysticus ulmi	+	+			

Cont. Tab. 1b

Species name 1992	1,5 m	6 m	10 m	15 m	crown
Drapetisca socialis	+				
Entelecara acuminata	+				
Segestria senoculata	+				
Linyphia triangularis	+				
Tegenaria parietina	+				
Gibbaranea omodea	+				
Lepthyphantes angulipalpis	+				
Lepthyphantes tenuis	+				
Pachygnatha degeeri	+				
Tegenaria ferruginea	+				
Lepthyphantes mengei	+				
Walckenaeria acuminata	+				
Clubiona corticalis		+	+	+	+
Nuctenea umbratica		+	+	+	+
Theridion mystaceum			+	+	+
Anelosimus vittatus			+	+	+
Meioneta innotabilis					+
Dictyna maior					+
Ceratinella brevis		+			
Dictyna arundinacea		+			
Syedra myrmicarum		+			
Tegenaria agrestis		+			
Zora spinimana		+			
Clubiona subsultans			+		
Dendryphantes rudis			+		
Euophrys petrensis			+		
Pardosa agrestis			+		
Tetragnatha obtusa			+		
Agroeca brunnea					+
Araniella cucurbitina					+
Tetragnatha pinicola					+
Harpactea hombergi				+	+
Atea sturni	+		+	+	
Centromerus sylvaticus		+	+		+
Diponoea torva	+	+	+		+
Leptyphantes flavipes	+		+		
Leptyphantes pallidus	+		+	+	+
Moebelia penicillata			+		+
Philodromus collinus		+			+
Philodromus margaritatus	+	+		+	+

Cont. Tab. 1b Species name 1992	1,5 m	6 m	10 m	15 m	crown
Philodromus rufus			+		
Salticus zebraneus	+		+		+
Total amount	**39**	**33**	**35**	**22**	**21**

Not only the occuring of a species in a habitat can be a criterium for the main habitat of a species but also its individuals number.

If one looks at the individual numbers of *Steatoda bipunctata* (Linné), this species has a higher abundance in the lower parts of the tree trunk with a peak at a height of 6 meters (Fig. 1). It seems never to reach the canopy region.

Dipoena torva (Thorell) is found very rarely in Berlin (PLATEN, 1990) and elsewhere (HEIMER & NENTWIG, 1991, p. 284). The first record for Berlin was in a colour trap in the trunk region of pine trees. In my investigation this species is not very rare but relatively abundant (Fig. 2). It is never found in pitfall traps in the area and in Berlin (PLATEN, pers. comm.; KIELHORN, 1989). *D. torva* seems to have its main habitat in a height of 10 meters on the investigated pine trees. This species seems to feed on ants catched by a web which is still not found. But I did find a *D. torva* specimen feeding on an ant hanging at the end of a silk thread. During the year *D. torva* has a very distinct period (Fig. 3). Juveniles or subadult spiders occur first (which are difficult to separate from other Theridiid spiders), then males are active and a last the females. In 1992, which was a very warm year in Berlin, *D. torva* brought up a second generation of subadult specimen in early autumn. This generation did not reach maturity in the same year.

The opilionid species *Paroligolophus agrestis* (Meade) has its highest abundance in a height of six and ten meters, too. There are very high individual number of 400 and more harvestmen per tree and year (Fig. 4).

Conclusion

a) Comparing these results with results from an investigation some years ago (SIMON, 1989; 1991) pine trees of the same age do have a highly characteristic spider community. In single species there may be

differences between two stands. E. g. in the crowns of the other investigated stand in Eberswalde occurs beside *Paroligolophus agrestis* (which has a lower abundance there) *Lacinius dentiger* (C.L. KOCH) in a high number of individuals (Fig. 5).

b) This characteristic coenosis seems to be stratified with ground-dwelling spiders climbing in the lower parts of the stems, some bark-living species settle in all parts of the pine-trees and some species have a spatial niche at the stem or in the canopy.

c) At least one spider species is found which occurs only on the tree trunks, but never on the ground. What about the genetic relationships between these isolated meta-populations? This topic needs further investigation!

d) What about the population dynamics of species like *Anyphaena accentuata* and some Clubionid species which are often trapped on the ground and even that often on tree trunks? Do they put their cocoons at or under the bark, develop for the first stages and climb down to the ground for maturity or the other way round?

e) Investigations of the fauna of other tree species or of *Pinus silvestris* in other geographical regions (e. g. BRAUN, 1992) may give new results in the species number, species composition and population dynamics of spiders depending on the different surrounding of where the pine trees grow.

All these results and discussion show the necessarity of investigations concerning the higher strata of forest ecosystems. These compartiments seem to be very important for the ecosystem wood and for our understanding of the functions and the role of spiders in forests.

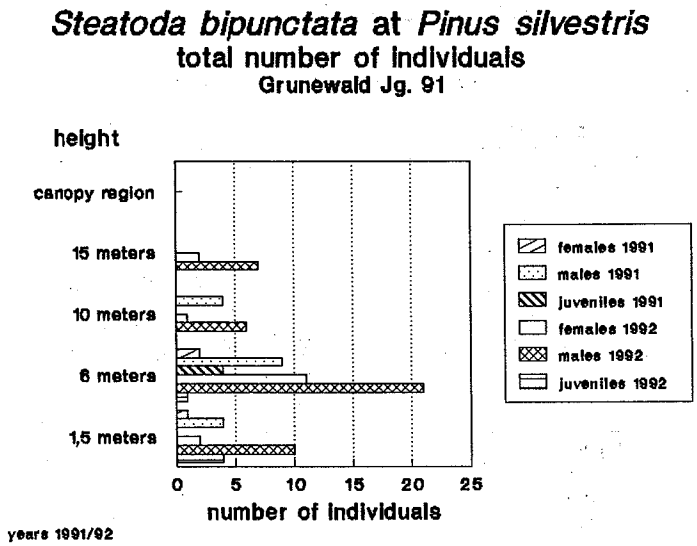

Fig. 1 - Distribution of *Steatoda bipunctata* at the stems of pine trees in different heights.

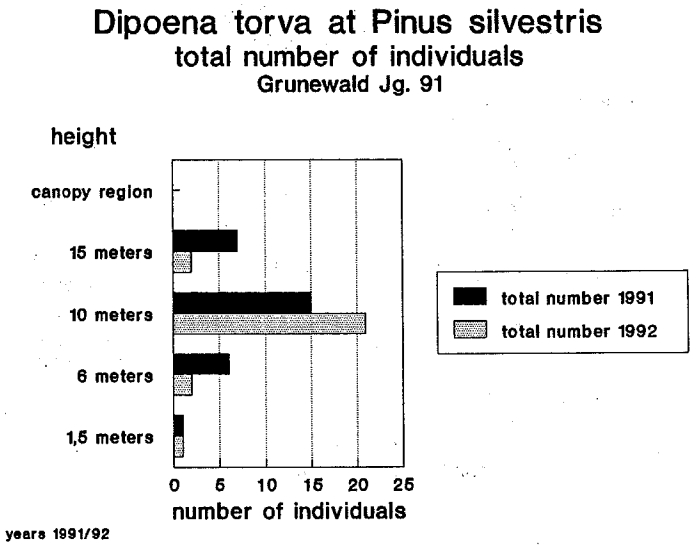

Fig. 2 - Number of individuals of *Dipoena torva* in different heights during the years of 1991 and 1992.

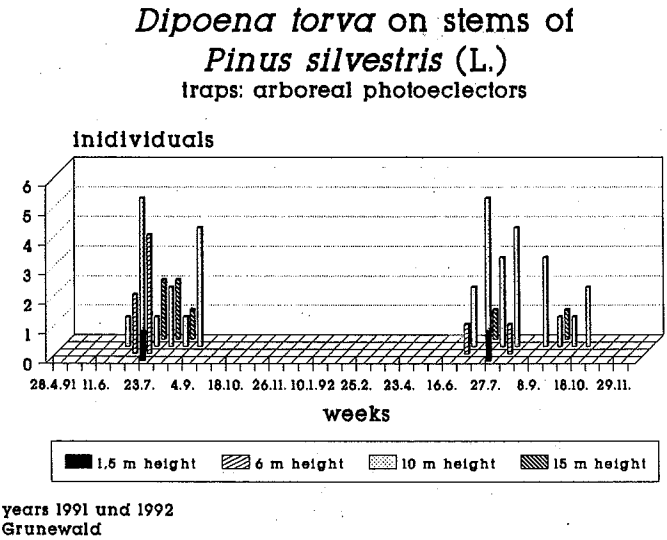

Fig. 3 - Number of individuals of *Dipoena torva* in different heights and two different years. Note the low number per two weeks!

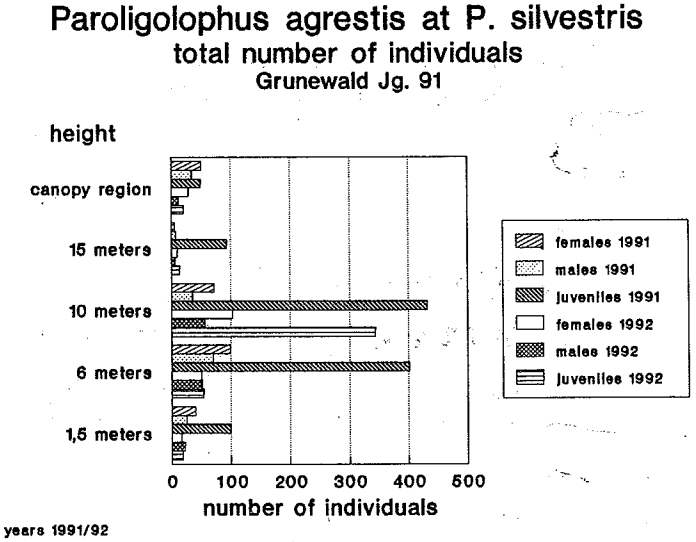

Fig. 4 - Individual numbers of the opilionid *Paroligolophus agrestis* at the stems of pine trees in different heights. This species occurs also in the crown of *Pinus*!

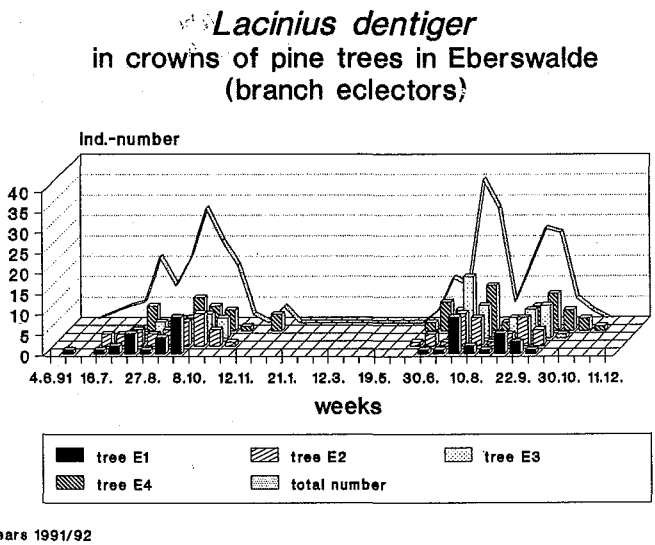

Fig. 5 - Temporal occurence of the opilionid *Lacinius dentiger* in the crowns of pine trees in Eberswalde.

Acknowledgement

A part of this work is supported by a grant of the Technical University of Berlin (FIP 14/5). Thanks to Nina Lehmkuhl for helping and Ralph Platen for discussion.

REFERENCES

BEHRE G.F., 1989 - *Freilandökologische Methoden zur Erfassung der Entomofauna (Weiter- und Neuentwicklung von Geräten)*. Jber. naturwiss. Ver. Wuppertal, **42**: Abb. 1-6.

BORKOWSKI K., 1986 - *Contribution to the knowledge of the insect fauna of Scotch pine tree crowns*. Pol. Pismo. Entomol., **56**: 667-676.

BRAUN D., 1992 - *Aspekte der Vertikalverteilung von Spinnen (Araneae) an Kiefernstämmen*. Arachnol. Mitt., **4**: 1-20.

HESSE E., 1940 - *Untersuchungen an einer Kollektion Wipfelspinnen*. Sitzungsber. naturf. Freunde Berlin: 350-363.

HEIMER S. & NENTWIG W., 1991 - *Spinnen Mitteleuropas*. Parey, Berlin & Hamburg.

KIELHORN U., 1989 - *Spinnen (Araneida und Weberknechte (Opilionida))*. in: WEIGMANN G., KRATZ W., HECK M., JAEGER-VOLLMER J., KIELHORN U., KRONSHAGE J., RINK U.: Bodenbiologische Dynamik immissionsbelasteter Forsten. Abschlußberecht FE-Vorhaben "Ballunsraumnahe Waldökosysteme". UBA & SenStadtUm Berlin.

KLOMP H. & TEERINK B.J., 1973 - *The density of the invertebrate summer fauna on the crowns of pine trees, Pinus silvestris, in the central part of the Netherlands*. Beitr. Ent. **23**: 325-340.

PERRY D., 1978 - *A method of access into the crowns of emergent and canopy trees*. Biotropica, **10**: 155-157.

PERRY D., 1988 - *Leben im Dach des Dschungels*. Frankfurt a. M.

PERRY D. & WILLIAMS J., 1981 - *The tropical rain forest canopy: A method providing total access*. Biotropica, **13**(4): 283-285.

PLATEN R., MORITZ M. & v. BROEN B., 1991 - *Liste der Webspinnen- und Weberknechtarten (Arach.: Araneida, Opilionida) des Berlin Raumes und ihre Auswertung für Naturschutzzwecke (Rote Liste)*. -in: AUHAGEN A., PLATEN R. & SUKOPP H.: Rote Listen der gefährdeten Pflanzen und Tiere in Berlin, Schwerpunkt Berlin (West). Landschaftsentwicklung und Umweltforschung S6, TU Berlin.

SIMON U., 1989 - *Die Spinnenzönose der Kiefernrinde*. Diplomarbeit, Berlin.

SIMON U., 1991 - *Die Spinnenzönosen (Arachn.: Araneae) der Kiefernrinde (Pinus silvestris L.)*. Beih. Verh. Ges. f. Ökol., **2**: 107-118.

SOUTHWOOD T.R.E., MORAN V.C. & KENNEDY C.E.J., 1982 - *The assesment of arboreal insect fauna: comparisons of knockdown sampling and faunal lists*. Ecol. Entomol., **7**: 331-340.