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Epigeic spiders of alder swamp forests in Eastern Poland

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Abstract
Studies of epigeic spiders collected by pitfall traps in selected alder swamp forests in eastern Poland are presented. A list of 14 spider species shared by all analysed plots is given. The fauna of alder swamp forests is described as typical for wet European lowland forests, with no habitat indicator species being recognised. Despite similarities in species composition and dominance structure, species diversity of spiders in primeval alder swamp forests was higher than in managed forests.

Key words: spider assemblages, alder swamp forests, primeval forests, Białowieża Forest, Poleski National Park, Poland

INTRODUCTION

Due to drainage and forestry management only remnants of alder swamp forests (*Carici elongatae-Alnetum*) have been preserved in Europe, mostly in river valleys or/and in dips with limited water run-off (Kwiatkowski 1994; Matuszkiewicz 1984). Human impact has caused both the destruction of alder swamp forest communities and the decrease of biodiversity (Kwiatkowski 1994).

Because of their rarity, and for logistic reasons, the alder swamp forests are not popular areas for arachnological studies. In Poland the spider fauna of alder forests was investigated by Dąbrowska-Prot & Łuczak (1968), Dąbrowska-Prot et al. (1973), Staręga (1988), Sielicki & Staręga (1996) and Stankiewicz (1999). There is also some data from Germany (Baehr 1983; Löser et al. 1982), Belgium (Maelfait et al. 1995) and Austria (Komposch 2000).

The aims of our study were: 1) To investigate whether it is possible to distinguish a specific spider species assemblage characteristic for alder swamp forests. 2) To determine whether there are differences in species composition and dominance structure between spider assemblages of primeval and managed alder swamp forests.

STUDY AREA

The spiders of alder swamp forests were sampled from three collecting plots in Białowieża Forest and Poleski National Park (Fig. 1):
-Plot 1: primeval forest in Białowieża National Park (52°43'N, 23°50'E, 140 m above sea level), strictly protected since 1921. There is no management, and human access is restricted. Most trees are about 130 years old.
-Plot 2: managed forest in Białowieża Forest (52°40'N, 23°51'E, 145 m a.s.l.) with no dead trees; the average age of trees is 70 years. The plot is located near a village and 200 m from a camping site.
-Plot 3: forest in Poleski National Park (51°4' N, 23°06' E, 169 m a.s.l.) in the initial succession stage on a mire, most trees are about 30 years old.

Hummocks and dips are very distinctive structural features of alder swamp forests (*Carici elongatae-Alnetum*). The hummocks are covered with alder (*Alnus glutinosa*), birch

Fig. 1. Location of analysed alder swamp forests. 1: Białowieża - primeval forest, 2: Białowieża - managed forest, 3: Poleski National Park, 4: Wigierski National Park (Stankiewicz 1999), 5: Solnicki Forest (Sielicki & Staręga 1996).

(*Betula pubescens*) and in Białowieża Forest also with spruce (*Picea abies*). The scrub layer is mostly made up of *Frangula alnus* and *Alnus glutinosa*. The moss layer is poor and dominated by *Climacium dendroides*. The dips are filled with stagnant water for most of the year and covered by marshy vegetation of *Carex elongata*, *Dryopteris thelypteris*, *Solanum dulcamara*, *Iris pseudacorus*, *Menyanthes trifoliata* (Kwiatkowski 1994; Matuszkiewicz 1984; Sokołowski 1993).

MATERIAL AND METHODS

Epigeic and litter-dwelling spiders were sampled by pitfall traps in Poleski National Park from 1995 to 1998, and in Białowieża Forest in 1998-1999. In each plot ten traps were placed on the hummocks and they were operating throughout the year, being emptied fortnightly, from March to November.

Pitfall traps (plastic cups of 7 cm diameter and 10 cm depth) contained a solution of propylene glycol as preservative, with the addition of detergent to prevent the spiders from escaping (Topping & Luff 1995). The study period differed between particular plots. However, as stated by Merrett (1967) this does not significantly influence the dominance structure although increasing the length of the study period enriches the species list.

The comparison of spider assemblages in primeval and managed alder swamp forests was only made for Białowieża Forest plots.

To compare the dominance structure and species composition of the spider communities, Renkonen's similarity index (Re) and Sørensen's similarity index (So) were applied, respectively (Trojan 1978). Sørensen's similarity index (So) was calculated according to the following formula:

$So = 2c/a+b \times 100$,

where a, b are the numbers of species in the two compared communities, c the number of shared species. Renkonen's similarity index (Re) was calculated according to the formula:

$Re = \sum D_{min}$,

where D_{min} is the lower value of dominance coefficient (D) of species shared by the two communities.

The dominance groups were proposed after Woźny (1992): E = eudominants (>10%), D = dominants (5.1-10%), I = influents (2.1-5%), R = recedents (1.1-2%), + = subrecedents (≤1%). The nomenclature follows Platnick (1993, 1997) and Żabka (1997).

RESULTS

Altogether 115 species and 8587 specimens were collected; 7172 of them were identified to species level, 1982 from plot 1; 886 from plot 2 and 4304 from plot 3.

Most species (77) were found in the Poleski National Park (plot 3); 71 species were found in plot 1 and 50 in plot 2, both in the Białowieża Forest; 27 species were shared by all studied plots (Table 1).

In the primeval forest (plot 1) the number of exclusive species (34) was higher than in the managed forest in plot 2 (13), and the percentage of specimens of exclusive species was considerably higher there (7.9% and 1.7%, respectively). In the primeval forest (plot 1) eudominants, dominants, influents and recedents were

Tab. 1. List of spider species in particular study plots. 1: Białowieża - primeval forest, 2: Białowieża - managed forest, 3: Poleski National Park. E: eudominants (>10%), D: dominants (5.1-10%), I: influents (2.1-5%), R: recedents (1.1-2%), +: subrecedents (≤1%), *: subrecedents represented by one specimen in the plots 1 and 2.

Study plots	1	2	3	Study plots	1	2	3
Pirata hygrophilus Thorell	E	E	E	*Hilaira excisa* (O. P.-Cambridge)	*		
Pachygnatha listeri Sundevall	E	D	E	*Lepthyphantes alacris* (Blackwall)	+		
Centromerus sylvaticus (Blackwall)	R	E	D	*Lepthyphantes angulatus* (O. P.-C.)	+		
Pachygnatha clercki Sundevall	D	D	R	*Linyphia hortensis* Sundevall	*		
Trochosa spinipalpis (F.O.P.-Cambridge)	+	+	D	*Meioneta innotabilis* (O. P.-Cambridge)	*		
Bathyphantes nigrinus (Westring)	I	I	I	*Neriene emphana* (Walckenaer)	+		
Oedothorax retusus (Westring)	I	I	+	*Pirata piscatorius* (Clerck)	*		
Diplostyla concolor (Wider)	I	I	+	*Pityohyphantes phrygianus* (C.L. Koch)	*		
Diplocephalus picinus (Blackwall)	R	I	R	*Pseudeuophrys erratica* (Walckenaer)	*		
Dicymbium nigrum (Blackwall)	I	R	+	*Theridion tinctum* (Walckenaer)	*		
Allomengea vidua (L. Koch)	+	I	+	*Tiso vagans* (Blackwall)	*		
Walckenaeria nudipalpis (Westring)	R	R	+	*Walckenaeria kochi* (O. P.-Cambridge)	*		
Antistea elegans (Blackwall)	R	+	+	*Xysticus cristatus* (Clerck)	*		
Walckenaeria vigilax (Blackwall)	+	R	+	*Ceratinella brevis* (Wider)		+	+
Ozyptila trux (Blackwall)	+	+	R	*Erigone atra* Blackwall		*	+
Tallusia experta (O. P.-Cambridge)	+	+	R	*Pachygnatha degeeri* Sundevall		*	+
Walckenaeria alticeps (Denis)	+	+	R	*Pirata latitans* (Blackwall)		*	+
Walckenaeria atrotibialis O. P.-Cambridge	+	+	+	*Agroeca proxima* (O. P.-Cambridge)		*	
Clubiona lutescens Westring	+	+	+	*Lepthyphantes flavipes* (Blackwall)		*	
Robertus arundineti (O. P.-Cambridge)	+	+	+	*Lepthyphantes minutus* (Blackwall)		*	
Gongylidium rufipes (Linnaeus)	+	+	+	*Neriene furtiva* (O. P.-Cambridge)		*	
Lepthyphantes tenebricola (Wider)	+	+	+	*Pardosa amentata* (Clerck)		+	
Tapinocyba insecta (L. Koch)	*	+	+	*Pardosa pullata* (Clerck)		*	
Pirata piraticus (Clerck)	*	+	+	*Pirata tenuitarsis* Simon		*	
Ozyptila praticola (C. L. Koch)	+	+	+	*Porrhomma pygmaeum* (Blackwall)		+	
Drapetisca socialis (Sundevall)	+	+	+	*Walckenaeria antica* (Wider)		*	
Centromerus arcanus (O. P.-Cambridge)	+	*	+	*Hygolycosa rubrofasciata* (Ohlert)			I
Oedothorax gibbosus (Blackwall)	D	I		*Bathyphantes parvulus* (Westring)			+
Agraecina striata (Kulczyński)	I		D	*Centromerita bicolor* (Blackwall)			+
Robertus lividus (Blackwall)	R	I		*Centromerus semiater* (L. Koch)			+
Cicurina cicur (Fabricius)	R	+		*Clubiona pallidula* (Clerck)			+
Helophora insignis (Blackwall)	+	I		*Clubiona phragmitis* C.L. Koch			+
Lepthyphantes cristatus (Menge)	+	R		*Clubiona rosserae* Locket			+
Bathyphantes approximatus (O. P.-C.)	+	+		*Dicymbium tibiale* (Blackwall)			+
Coelotes atropos (Walckenaer)	+	*		*Drassyllus pusillus* (C.L. Koch)			+
Gonatium rubellum (Blackwall)	+	+		*Ero cambridgei* Kulczyński			+
Savignia frontata Blackwall	*	+		*Euophrys frontalis* (Walckenaer)			+
Walckenaeria obtusa Blackwall)	+	+		*Gongylidiellum murcidum* Simon			+
Pirata uliginosus (Thorell)	+		D	*Lepthyphantes alutacius* Simon			+
Agyneta subtilis (O. P.-Cambridge)	+		+	*Lepthyphantes angulipalpis* (Westring)			+
Araneus diadematus Clerck	*		+	*Maro minutus* O. P.-Cambridge			+
Centromerus levitarsis (Simon)	+		+	*Maso sundevalli* (Westring)			+
Clubiona germanica Thorell	*		+	*Meioneta affinis* (Kulczyński)			+
Clubiona terrestris Westring	*		+	*Metellina mengei* (Blackwall)			+
Linyphia triangularis (Clerck)	+		+	*Metellina segmentata* (Clerck)			+
Lophomma punctatum (Blackwall)	+		+	*Micrargus herbigradus* (Blackwall)			+
Macrargus rufus (Wider)	+		+	*Neon reticulatus* (Blackwall)			+
Microneta viaria (Blackwall)	+		+	*Neriene montana* (Clerck)			+
Neriene clathrata (Sundevall)	+		+	*Pardosa paludicola* (Clerck)			+
Pardosa lugubris (Walckenaer)	+		+	*Pelecopsis mengei* (Simon)			+
Walckenaeria cuspidata Blackwall	*		+	*Pocadicnemis juncea* Locket et Millidge			+
Zora spinimana (Sundevall)	*		+	*Pocadicnemis pumila* (Blackwall)			+
Agyneta conigera (O. P.-Cambridge)	+			*Porrhomma oblitum* (O. P.-Cambridge)			+
Amaurobius fenestralis (Stroem)	+			*Taranucnus setosus* (O. P.-Cambridge)			+
Ceratinella brevipes (Westring)	*			*Trochosa ruricola* (De Geer)			+
Erigonella hiemalis (Blackwall)	*			*Zelotes latreillei* (Simon)			+
Haplodrassus cognatus (Westring)	*			*Zelotes subterraneus* (C.L. Koch)			+
Haplodrassus silvestris (Blackwall)	*						

represented by 15 species (86.5% of all specimens). In managed forest (plot 2) their number reached 17 species (90.5%). The number of subrecedents was considerably higher in plot 1 than in plot 2 (56/33 species and 13.5%/9.5%, respectively). The number of species represented by one specimen was higher in plot 1 than in plot 2 (22 and 12, respectively).

Dominance structure was analysed only for adult spiders. *Pirata hygrophilus* was the most numerous eudominant in all plots (>30% of specimens). *Pachygnatha listeri* was eudominant in plots 1 and 3 (10.1% and 20.7%, respectively) and dominant in plot 2 (6.0%). *Centromerus sylvaticus* and *Pachygnatha clercki* were shared by all sites, but they were numerous only in two plots, being eudominant in plot 2 and dominant in plot 3. *Oedothorax gibbosus* occurred abundantly and exclusively in plots 1 (dominant) and 2 (influent), whereas in plot 3 other dominants (*Agraecina striata*, *Trochosa spinipalpis* and *Pirata uliginosus*) were present. *Agraecina striata*, a rather rare species, was numerous (influent) in plot 1. *Bathyphantes nigrinus* was the only influent shared by all study plots.

The dominance structure and species composition of epigeic spiders communities showed considerable similarities (Table 2), the highest similarity was observed for plots 1 and 2, both in Białowieża Forest. There was less similarity between spider assemblages from plots 1 and 3 than from plots 2 and 3.

The similarity of dominance structure (Re) of epigeic spider assemblages was higher than similarity of species composition (So). The differences in species composition were probably the result of study site locations (Fig. 1). Plots 1 and 2 were placed in NE Poland in one large forest complex, whereas plot 3 was situated in SE Poland and surrounded by mires, fields and meadows.

In all investigated plots, several rare European spider species were found (sensu Hänggi et al. 1995). *Centromerus levitarsis* and *Meioneta innotabilis* were recorded in plot 1 and *Pirata tenuitarsis* in plot 2, both plots in Białowieża Forest. *C. levitarsis* was also found in Poleski National Park (plot 3). Other rare species in plot 3 include *P. tenuitarsis*, *Centromerus semiater*, *Clubiona rosserae*, *Ero cambridgei* and *Taranucnus setosus*. All of them prefer peat bogs and fens.

Tab. 2. Similarity of species composition according to Sørensen's index (%) and dominance structure according to Renkonen's index (%). 1: Białowieża - primeval forest, 2: Białowieża - managed forest, 3: Poleski National Park.

	Sørensen's index		Renkonen's index	
Study sites	2	3	2	3
1	61.2	56.8	70.9	59.1
2	-	48.8	-	55.6

DISCUSSION

The analysis of species composition of epigeic spiders in Białowieża Forest and in Poleski National Park allows us to construct a list of 27 species common to the three studied plots (Table 1). The comparison of our data with the results for other alder swamp forests in NE Poland (Stankiewicz 1999; Sielicki & Staręga 1996; Fig. 1) reduced the list of species shared by all five sites to 14 (Table 3).

Although the species composition of the five areas differs (Table 4), eudominant and dominant species are similar, though not identical (Table 3). For instance, *Oedothorax gibbosus* was dominant or influent in Białowieża Forest, while in Wigierski National Park (Stankiewicz 1999) it belonged to dominants and was missing in Poleski National Park. *Trochosa terricola* and *Ozyptila praticola* were two additional eudominants found by Sielicki & Staręga (1996) in Solnicki Forest. *Trochosa terricola* was missing in our study and belonged to the subrecedents in Stankiewicz (1999). *Ozyptila praticola* belonged to the subrecedents in our plots and was missing in the study by Stankiewicz (1999). Both species are known to occur in drier habitats, e.g. woodlands and open areas (Hänggi et al. 1995; Prószyński & Staręga 1971).

Table 3. Spider species from Polish alder swamp forests shared by all studied plots. 1: Białowieża - primeval forest, 2: Białowieża - managed forest, 3: Poleski National Park, 4: Wigierski National Park (Stankiewicz 1999), 5: Solnicki Forest (Sielicki & Staręga 1996). E: eudominants (>10%), D: dominants (5.1-10%), I: influents (2.1-5%), R: recedents (1.1-2%), +: subrecedents (=1%).

Study plots	1	2	3	4	5
Pirata hygrophilus Thorell, 1872	E	E	E	E	E
Pachygnatha listeri Sundevall, 1830	E	D	E	I	E
Pachygnatha clercki Sundevall, 1823	D	D	R	E	+
Centromerus sylvaticus (Blackwall, 1841)	R	E	D	I	+
Trochosa spinipalpis (F.P.-Cambridge, 1895)	+	+	D	R	D
Bathyphantes nigrinus (Westring, 1851)	I	I	I	R	R
Diplocephalus picinus (Blackwall, 1841)	R	I	R	+	I
Diplostyla concolor (Wider, 1834)	I	I	+	+	I
Gongylidium rufipes (Linnaeus, 1758)	+	+	+	+	I
Lepthyphantes tenebricola (Wider, 1834)	+	+	+	+	R
Ozyptila trux (Blackwall, 1846)	+	+	R	+	+
Walckenaeria alticeps (Denis, 1952)	+	+	R	+	+
Clubiona lutescens Westring, 1851	+	+	+	+	+
Walckenaeria atrotibialis (O. P.-Cambridge, 1878)	+	+	+	+	+

Table 4. Numbers of shared spider species and similarity according to Sørensen's index (%) for Polish alder swamp forests.

Study sites	Wigierski National Park		Solnicki Forest	
	No. of shared spp.	Sørensen index	No. of shared spp.	Sørensen index
Białowieża primeval forest	46	52.0	32	45.7
Białowieża managed forest	34	43.6	25	39.4
Poleski National Park	44	48.1	31	42.5

In comparison to the list of 14 species shared by all Polish sites, the list for similar forests in Belgium (Maelfait et al. 1995) did not include *Trochosa spinipalpis* and *Walckenaeria alticeps*, and the dominance structure was different. *Pirata hygrophilus* and *Diplocephalus picinus* were eudominants, *Diplostyla concolor* was dominant, *Centromerus sylvaticus*, *Pachygnatha listeri*, *Bathyphantes nigrinus* were influents, *Pachygnatha clercki* was recedent, and the remaining 14 species found in Polish forests were subrecedents in Belgium.

The list of 14 common species was compared with lists from similar alder forests in Upper Bavaria (Löser et al. 1982) and Central Alps (Komposch 2000). *Centromerus sylvaticus*, *Diplostyla concolor*, *Clubiona lutescens*, *Pirata hygrophilus* and *Bathyphantes nigrinus* were also found in the forest of Central Alps but only the latter two were numerous. Only *Diplostyla concolor* and *Walckenaeria atrotibialis* were shared with the species list from Bavarian *Alnus incana*-forest and only *Pirata hygrophilus* with the species list of Bavarian *Alnus glutinosa*-forests. The distinctiveness of the spider communities in Austrian and German alder forests is probably due to their location in the mountain zone.

It would be tempting to consider the 14 species shared by Polish sites as a characteristic spider assemblage of lowland alder swamp

forests. However, the same species occur in other types of forests, e.g. ash-alder flood plain forest (Stankiewicz 1999), humid oak-lime-hornbeam forest (Stańska unpubl. data) and inundation forests (Gajdoš 1995). In humid oak-lime-hornbeam forests in Białowieża Forest all 14 shared species were found and the dominance structure of epigeic spider communities in one of these forests and in plot 1 showed considerable similarity (Re = 58%). In the ash-alder flood plain forest in Wigierski National Park 13 of the 14 (without *Bathyphantes nigrinus*) species were found and the dominants were almost the same as in our plots: *Pirata hygrophilus, Pachygnatha listeri, Centromerus sylvaticus* and *Lepthyphantes tenebricola* (Stankiewicz 1999). Also in the inundation forests (*Saliceto–Populetum*) the majority of the 14 species were found and the dominance structure was similar (Gajdoš 1995).

The proposed list of shared species seems characteristic for lowland wet/humid deciduous forests, including lowland alder forests. However all of those species are eurytopic, i.e. widespread in other habitats across Europe (Hänggi et al. 1995), and taken separately they should not be considered as indicator species for particular plant associations (sensu Neet 1995).

In spite of considerable similarity of spider dominance structure in Białowieża Forest plots (Re = 70.9), the 'tail' of subrecedent species and the list of species represented by one specimen were considerably longer in the primeval forest. The percentage of specimens of exclusive species was also distinctly higher in plot 1. The above data suggest that the spider assemblage in managed forest is less diverse than in primeval forest, probably because of the human impact, as other conditions (e.g. humidity) are very similar.

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