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Spiders (*Araneae*) of open habitats in the Biebrza National Park, Poland[1]

Abstract: The main aim of the study was to characterise the communities of spiders from 26 open typical habitats of the Biebrza River valley. The habitats were located in different ecological zones of the valley and formed a humidity gradient. Here, I compare spider species composition, their diversity and dominance structure, studied in the years 1991–1996 and 2002. A total of 56898 spiders were collected, representing 285 species from 21 families. The majority of the spider species were hygrophilous and peat-bog species. Least abundant were forest and eurytopic species as well as those of unknown environmental preferences. Among the 285 species, 20% (49 species) were rare, i.e. known from fewer than 10 localities in Poland. The largest numbers of rare species were found in sedge marshes. Diversity (H') and evenness (J') indices were highest in sedge marshes, psammophilous grasslands, and natural wet meadows. The lowest indices were obtained for aquatic and anthropogenic habitats (mowed meadows, sweet marsh). In meadows and on sedge marshes the diversity of spider communities increased with humidity and vegetation diversity of the habitat. Similarity of species composition (So>50%) was highest among spider communities found in habitats of similar vegetation structure (sedge marshes, psammophilous grassland), similar humidity (marshes) and in mowed plant communities (meadows and *Glyceria* marshes).

Key words: freshwater marshes, meadows, psammophilous grassland, flooded valley

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INTRODUCTION

The fens of the Biebrza National Park form one of the largest natural wetlands in Central Europe. There are numerous faunistic, autecological and taxonomical publications on spiders of various areas of the Biebrza river valley (STARĘGA 1984, STARĘGA & NAKAZIUK 1987, KUPRYJANOWICZ 1994a, b, 1995a, b, c, 1996, 1997, STARĘGA & STANKIEWICZ 1996,

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KUPRYJANOWICZ *et al.* 1997, ŻABKA & KUPRYJANOWICZ 1997). However, few studies have dealt with the structure of spider communities of this region of Poland. These primarily synecological investigations focused on spider communities of sedge marshes transformed into meadows and changes of their dynamics incurred by on-going drainage works in those areas (KAJAK 1960, 1962, 1987, 1991, KAJAK *et al.* 2000). Only one publication was concerned with spider communities of peat bogs (KUPRYJANOWICZ et al. 1998).

In arachnological literature related to open habitats, the majority of publications have been devoted to spiders of meadows, pastures and extremely dry habitats (KAJAK 1960, 1962, PRÓSZYŃSKI 1961, ŁUCZAK 1976, JĘDRYCZKOWSKI & STARĘGA 1980, HUBLÉ & MAELFAIT 1981, THALER 1985, STARĘGA 1989, RUSHTON & EYRE 1992, WOŹNY & SZYMKOWIAK 2000). Relatively few studies have been concerned with spiders of wetlands such as fenlands, reed beds and old riverbeds (MIKULSKA 1955, STĘPCZAK 1962, PALMGREN 1977, DECLEER 1990, SZYMKOWIAK 1993, HÄNGGI et al. 1995, SZINETÁR 1995, 2000, HOLEC 2000). Only a few publications have dealt with spider communities of seasonally flooded river valleys (e.g. VAN HELSDINGEN 1997).

The aim of this work was to analyse communities of epigeic spiders and spiders living in the herb layer of open habitats which in various ecological zones of the Biebrza river valley, forming a gradient of ground humidity.

STUDY AREA

The Biebrza National Park (BPN) was established in 1993 to protect the wetlands of the valley. It is located in Northeast Poland and covers almost the entire Biebrza valley (Fig. 1). Its length is 120 km and its width varies from a few to 40 km. The valley is divided into three parts called basins, which differ with respect to thickness of the peat.

The total area of the park amounts to over 59 000 ha, with open habitats covering almost 45 000 ha. More than 40% of the park area is covered by waterlogged habitats. A well-developed ecological zonation of the Biebrza valley testifies to its primeval character and uniqueness (OŚWIT 1973, PAŁCZYŃSKI 1988).

There are rich stands of *Glycerietum maximae* and *Phragmitetum australis* along the river banks in the zone of spring flooding (immersion zone). Water plant associations (e.g. *Hydrocharis morsus-ranae, Stratiotes aloides* and *Nymphaea alba*) cover the old riverbeds. Further down the riverbed, where the flooding is shallower, there are sedge marshes with *Carex acuta* and *C. elata*. Associations with *Carex appropinquatae* dominate in the immersion-emersion zone (occasional flooding). In the emersion zone, beyond the reach of annual flooding, sedge-moss marshes are found. These associations are formed by low sedges: *Carex paradoxa, C. rostrata, C. diandra* and abundant moss turf. Water is present under the layer of moss all year round.

In the Biebrza valley, among vast areas of sedge marshes, one can find mineral elevations formed during the last glaciation and called „grądziki". They are covered by open (e.g. psammophilous grasslands) as well as forest habitats.

Spiders were collected in the years 1991–1996 and 2002. The research was conducted on 26 study sites located in the Biebrza National Park. The sites were located along and across the valley in accordance with its ecological zoning and humidity gradient (Fig. 1). The choice of the research sites was based on plant community maps (PAŁCZYŃSKI 1980). I use a terminology of plant associations found in MATUSZKIEWICZ (2001). A description of the research sites is given in Table I.

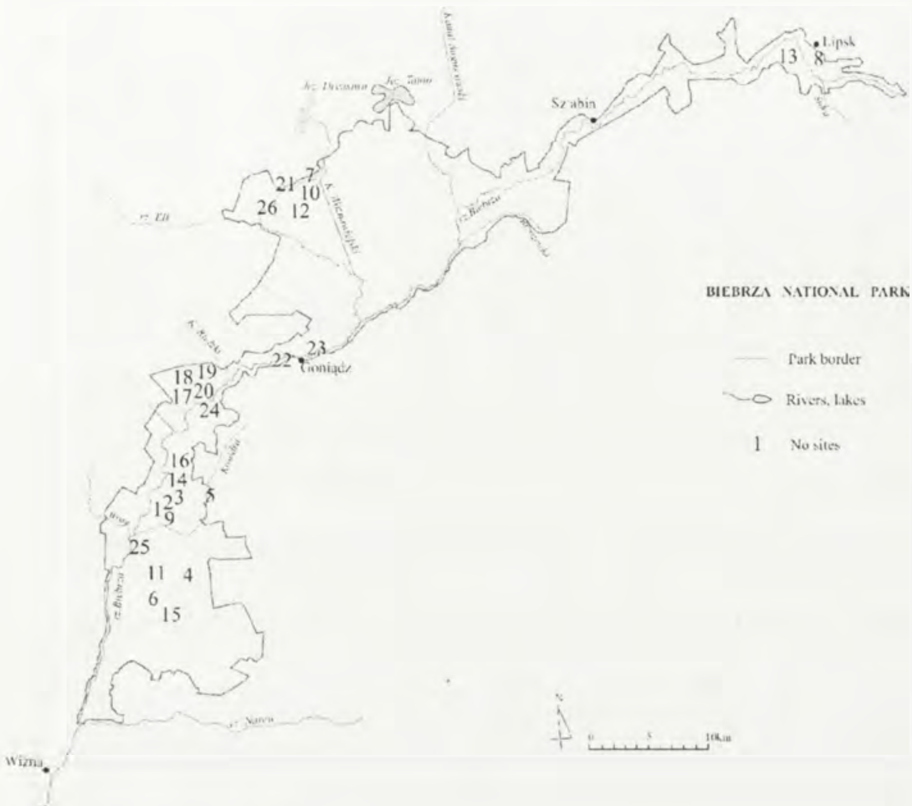

Fig. 1. Localisation of the study sites.

SAMPLING METHODS

Barber traps (plastic cups partly filled with 50% ethylene glycol solution, and placed 10 in a line, 1 metre apart) were used to collect epigeic fauna. In aquatic habitats (old riverbeds) floating traps were used. They were a modified version of Barber traps, with the cups placed in floating polystyrene rafts. Floating traps were in place from the beginning of June till the end of September. Samples, however, were collected irregularly, whenever water level allowed access to the old riverbeds. In July 2002, due to a complete drying out of old riverbeds, the floating traps were replaced by Barber traps and left until the end of September. In the remaining habitats the traps were installed permanently from the beginning of April till the end of October. Material was collected regularly every 2 weeks.

Table I. Characteristics of study sites in the open habitats of the Biebrza National Park. Sites were listed from least to most humid. Names of plant assemblages after MATUSZKIEWICZ (2001).

Type habitats	No sites	Location; habitat description; zone of river flooding; years of sampling; data publication
1	2	3
Psammophilous grasslands	1	Barwik, ur. Grądy; psammophilous grassland *Corynephoretalia canescentis*, large amounts of *Hieracium pilosella*, on the "grądzik", height of herb layer early in the summer up to 10 cm, close to site 3 (20 m), out of reach for river flooding, 1991;
	2	Barwik, ur. Grądy; psammophilous grassland *Corynephoretalia canescentis*, large amounts of *Cladonia ssp*; on the "grądzik", height of herb layer early in the summer up to 5 cm, close to site 1 (20 m), out of reach for river flooding, 1992;
	3	Barwik, ur. Grądy; psammophilous grassland *Corynephoretalia canescentis*, large amounts of *Cladonia ssp* and *Helichrysum arenarium*, on the "grądzik", height of herb layer early in the summer up to 10 cm, close to site 2 (20 m), near by grow singly *Pinus sylvestris*, out of reach for river flooding; 1993;
	4	Gugny, edge of Biebrza valley; psammophilous grassland *Corynephoretalia canescentis*, height of herb layer early in the summer up to 2 cm, near to pine greenwood, out of reach for river flooding; 1991;
Mowing meadows	5	Dobarz; dry mowing meadow from order Molinietalia, periodically grazing, height of herb layer early in the summer up to 30 cm, emersion zone; 1991–1993;
	6	Bagno Ławki, Pogorzały; dry mowing meadow from order *Molinietalia*, height of herb layer early in the summer up to 30 cm, out of reach for river flooding; 1992;
	7	Kuligi, by the Jegrznia river, mowing meadow from order *Molinietalia*, height of herb layer early in the summer up to 30 cm, emersion zone; 1996;
	8	Lipsk; moist mowing meadow from order Molinietalia, near plant association with *Betula humilis*, height of herb layer early in the summer up to 40 cm, emersion zone; 1994;
Natural meadows	9	Barwik, ur. Grądy; moist natural meadow from order *Filipendulion*, height of herb layer early in the summer up to 30 cm, close to sites 1 and 14 (respectively 50 m and 20 m); immersion-emersion zone; 1992;
	10	Kuligi, moist natural meadow from order *Molinion caeruleae* (with *Gentiana pneumonanthe*), height of herb layer early in the summer up to 50 cm, emersion zone, 1996;
Sedge-moss marshes	11	Gugny; sedge-moss marsh *Caricetum rostratae*, height of herb layer early in the summer up to 50 cm; near to alder carr (ca. 200 m); emersion zone; 1991;
	12	Piekielne Wrota; sedge-moss marsh *Caricetum appropinquatae*, with nettle near birch forest, close to ground fire in 1992, height of herb layer early in the summer up to 60 cm; emersion zone, 1995;
	13	Szuszalewo; sedge-moss marsh *Caricetum limosae*, height of herb layer early in the summer up to 50 cm, emersion zone; 1994; (KUPRYJANOWICZ 1997);
	14	Barwik; sedge-moss marsh *Caricetum appropinquatae*, height of herb layer early in the summer up to 60 cm; emersion zone; 1992–1994;
	15	Bagno Ławki, Batalionowa Łąka; sedge-moss marsh *Caricetum rostratae*, height of herb layer early in the summer up to 50 cm; emersion zone; 1991–1993, 2002;
Sedge marshes	16	Barwik, ur. Grądy; sedge marsh *Caricetum elatae*, height of herb layer early in the summer up to 100 cm; immersion zone; 1991–1993 (KUPRYJANOWICZ a, b; 1995a, b, 1997);
	17	Sośnia 2002, sedge marsh *Caricetum acutae*, height of herb layer early in the summer up to 100 cm; close to site 20, immersion zone; 2002
Glyceria marshes	18	Sośnia; *Glyceria* marsh (*Glycerietum maximae*), height herb layer early in the summer to 150 cm; immersion zone, 2002;
	19	Sośnia 2002, mowed *Glyceria* marsh (*Glycerietum maximae*), near old riverbed, height of herb layer early in the summer up to 150 cm, immersion zone, 200;

1	2	3
Riverside marshes	20	Sośnia 2002, reed marsh (*Phragmitetum australis*), height of herb layer early in the summer up to 200 cm, immersion zone; 2002;
	21	Kuligi, Jegrznia river; reed marsh (*Phragmitetum australis*), height of herb layer early in the summer up to 200 cm, immersion zone, 2002;
	22	Goniądz; sweet marsh (*Acoretum calami*), height of herb layer early in the summer up to 80 cm, immersion zone, 2002;
	23	Goniądz 2002; riverside of the Biebrza, plant association *Oenantho-Rorippetum* with *Mentha* and *Typha*, height of herb layer early in the summer up to 50 cm, immersion zone; 2002;
Aquatic habitats	24	Sośnia; old riverbed, plant association *Hydrocheritetum morsus-ranae* with *Hippuris vulgaris*, height of herb layer early in the summer up to 15 cm, immersion zone; 2002;
	25	Barwik, ur. Grądy; old riverbed, plant association *Hydrocheritetum morsus-ranae*; height of herb layer early in the summer up to 15 cm, immersion zone; 1993 (KUPRYJANOWICZ 1997);
	26	Kuligi, Jegrznia river; plant association *Potametum natantis* with *Nuphar luteum*, height of herb layer early in the summer up to 5 cm, close to site 18, immersion zone; 2002;

From the herb layer (epiphyton) spiders were collected with sweep nets 35 cm in diameter. Four samplings, 25 strokes in each, were taken once a month from May until October on 7 study sites. On other study sites with a prominent herb layer, material was collected irregularly.

Supplementary non-quantitative sampling methods consisted of Moericke traps, soil sampling and manual collection of specimens.

METHODS OF ANALYSIS

Species diversity was calculated using:

1. the Shannon-Wiener diversity index $H' = -\sum_{i=1}^{S} p_i \log p_i$
2. the Pielou evenness index $J: = H'/log_2 S$,

where p_i is the ratio of the number of individuals of the i–th species to the total number of individuals in the entire group made up of S species.

Sørensen's similarity index ($So = 2w/(a+b)100\%$) was used to compare the species composition of the habitats under study, where w is the number of species common to both habitats, a and b are the numbers of species in the two habitats being compared.

To describe the dominance structure of spider communities (D), defined as the percentage contribution of specimens of a given species to the total number of specimens of all species at the site, the spiders were divided into five classes according to their percentage representation (GÓRNY & GRŰM 1981): eudominants (D > 10.0%), dominants (D: 5.1% – 10.0%), subdominants (D: 2.1% – 5.0%), recedents (D: 1.1% – 2.0%), subrecedents (D ≤ 1.0%)

The definition of characteristic (exclusive and selective) species by GÓRNY & GRŰM (1981) was used. Exclusive species are those found at one particular site only. Selective species are species reaching the highest dominance values at a given site that, however, may occur at other sites, too.

RESULTS

In total, 56898 specimens were collected. I identified the species and genus affiliations of 55544 and 1354 of them, respectively. Those identified to genus level were juveniles belonging to 6 families, mainly *Lycosidae* and *Linyphiidae*.

Identified material comprised 285 species of spiders belonging to 21 families. Most numerous in species were *Linyphiidae* (117) and *Lycosidae* (30). Less numerous families included *Araneidae* (21), *Theridiidae* (19) (Appendix).

Representation of spider families

Most abundant in specimens were the families *Lycosidae* (25960), *Linyphiidae* (10117), *Tetragnathidae* (5036), *Araneidae* (2687), *Philodromidae* (1301), *Thomisidae* (1496), *Clubionidae* (1237) and *Hahnidae* (1174). Other families were represented by less than 1000 specimens.

The epigeic spider fauna of open habitats of the Biebrza valley was mainly classified at family level as *Lycosidae* (57%), *Linyphiidae* (19%) and *Tetragnathidae* (10%), while *Araneidae* (40%), *Linyphiidae* (21%) and *Philodromidae* (12%) dominated in the herb layer (epiphyton) (Table II & III). The high contribution of the families *Tetragnathidae* (in epigeon) and *Philodromidae* (in herb layer) was due to an abundance of specimens of just two spider species from the genera *Pachygnatha* and *Tibellus* respectively.

The contributions of individual spider families differed across sites. The percentage of *Gnaphosidae* increased in dry habitats (8–11%) and in the sedge marsh *Caricetum limosae* (site 13, 10%). In the dry habitats there was also a large share of *Salticidae* (5–15%) in epigeon and *Theridiidae* (26%) in epiphyton.

Number and percentage contribution of species

The number of spider species varied between habitats. The sedge marshes, particularly *Caricetum rostratae* and *Caricetum appropinquatae*, were the richest in spider species, while the aquatic communities (*Hydrocharitetum morsus-ranae, Potametum natans*) and *Acoretum talami* (Table IV) were the poorest.

Differences in the number of species were found in both habitat layers, with 81 species found in the epigeon of psammophilous grassland compared to only 28 in epiphyton. The greatest differences between layers were in a meadow (site 5) and on a sedge-moss marsh (site 14), and the smallest were on sedge marshes (sites 16 and 17) and on a sweet marsh (site 22) (Tables IV & V).

The vast majority of specimens represented hygrophilous species associated with peat bogs. They made up 80% of the total of species found on investigated sites. In the old riverbed, their contribution reached as much as 100%. Only in psammophilous grassland was it lower than 50%, with photophilous and xerophilous species forming 40% of the population there. These species made up about 19% of the population in the meadow habitat and 1% (in *Caricetum appropinquatae*) to 10% (in *Caricetum rostratae*) in sedge marshes. The remaining species were forest and eurytopic species as well as some of unknown environmental preferences.

Table II. Representation of spider families (in %) in epigeon of the open habitats of the Biebrza National Park.

Habitat	Psammophilous grasslands				Mowing meadows				Natural meadows		Sedge-moss marshes					Sedge marshes		*Glyceria* marshes		Riverside marshes				Aquatic habitats			All habitats
Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
Mimetidae	-									0.1		0.3			0.1												0.03
Nesticidae			0.1																								0.01
Theridiidae	0.2		0.1				0.1	0.2	0.1	1.0	0.4	1.5	2.3	0.4	0.1	0.1	0.1	1.2		0.1	0.1						0.20
Linyphiidae	5.6	18.1	10.6	39.1	24.6	16.5	58.0	38.6	17.3	36.8	16.4	17.2	9.9	10.8	11.2	37.1	25.1	14.2	15.9	33.5	16.9	8.5		1.0	11.9	7.2	19.00
Tetragnathidae	6.7	1.0	0.4	0.3	13.7	13.4	16.8	19.5	18	21.1	2.6	4.3	1.8	2.7	1.8	6.5	22.4	18.4	13.7	15.6	21.3	2.3		0.2	7.6	2.2	10.00
Araneidae	0.1		0.3	0.1	0.1		0.1		0.2	0.7	0.6	0.8	0.8	0.3	0.6	0.6	0.2	0.3	1.3		1.0				5.1		0.30
Lycosidae	69.5	47.0	61.1	32.1	59.9	61.0	18.3	39.9	58.7	32.7	57.0	63.1	54.9	69.0	67.5	49.3	38.7	58.0	46.1	13.8	31.8	89.1		97.1	55.9	86.3	57.00
Pisauridae						0.2	1.3	0.1	0.1	1.3		0.8		0.1	0.2		0.1	0.7	2.6	0.3	1.6			1.7	1.7	2.9	0.20
Cybaeidae															0.1			0.1							3.4	1.4	0.05
Hahnidae	0.2					0.2	2.9	0.2	0.5	2.2	18.7	0.2	14.7	9.0	8.9	1.6	0.1										2.60
Dictynidae	0.1		0.2	0.1			0.3	0.1	0.1	0.2	0.6		1.1	0.8	0.6	0.4	0.1			0.1							0.20
Miturgidae	0.4	1.3	1.8	0.3																							0.10
Liocranidae	0.1	0.9	0.1	1.7		0.1		0.1	0.2	0.2	0.6	0.2	0.4	0.4	2.2	0.8		0.1									0.30
Clubionidae	0.1	0.4	0.2			0.2			0.4	0.5	0.2	0.5	0.3	0.1	0.8	1.2	1.0	4.3	16.7	34.5	24.3				7.6		2.30
Corinnidae				0.9				0.1				0.2						0.1									0.01
Gnaphosidae	2.7	11.6	8.1	8.6	0.1	1.1		0.2	0.9	0.7	0.4	2.6	10.2	0.8	1.0	0.2	0.1	0.1									1.00
Zoridae	0.1			0.1		0.3	0.4		0.4	0.4	1.5	3.3		0.4	0.2	0.3	0.3	0.1									0.20
Philodromidae	8.2	3.0	7.5	0.1	0.1	0.3	0.4	0.1	0.1	0.5		0.5	0.1	0.2	0.2	0.4	0.1		0.1						6.8		1.00
Thomisidae	5.7	1.7	4.1	2.2	1.4	6.8	1.1	1.0	3.1	1.1	0.9	4.8	1.4	4.8	2.9	1.1	0.5	2.2	2.3	1.1	0.3						3.00
Salticidae	0.2	15.0	5.7	15.2			0.3			0.3			1.9	0.1	1.6	0.8	2.1	0.3	1.2	1.0	2.7						1.00

Table III. Representation of spider families (in %) in epiphyton of the open habitats of the Biebrza National Park.

Habitat	Psammophilous grassland	Mowing meadows	Sedge-moss marshes			Sedge marshes	*Glyceria* marshes	Riverside marshes			All habitats
Site	3	5	13	14	15	16	18	20	22	23	
Mimetidae						0.1				0	0.02
Theridiidae	28.2	2.0	1.5	2.2	2.4	0.7	2.0				2.4
Linyphiidae		26.0	4.9	30	9.8	51.7	35.6		11.6	10	21
Tetragnathidae	1.6	12.0	1.5	7.4	8.2	4.6	38.6	11.6	53	40	9
Araneidae	39.8	27.5	74.5	35.1	45.7	14.3	8.9	3.3	13.3	11.1	40
Lycosidae		0.2		2.0	2.1	3.0			0.8	17.8	2
Pisauridae	0.8	1.5		1.7	9.9	2.6			0.8		5
Hahniidae				0.1					0.8		0.1
Dictynidae	5.6	6.9	2.7	1.2	1.8	2.0					2
Miturgidae	4.0	0.2									0.1
Liocranidae						0.1					0.02
Clubionidae		0.9	0.2	0.8	1.9	4.0	2.0	66.7	15.0	16.7	
Gnaphosidae						0.1					0.03
Zoridae				0.8	0.5	1.2					0.5
Sparassidae	0.1				0.02						0.01
Philodromidae	9.5	19.8	9.4	13.8	11.7	8.6	4.0	1.7			12
Thomisidae	5.6	2.9	3.9	3.1	4.6	1.6	7.9	1.7	2.3		4
Salticidae	4.8	0.6	1.7	1.7	1.3	5.3	1.0	15	2.3	4.4	2

The most abundant epigeic spider species overall were *Pardosa palustris* (LINNAEUS, 1758) making up 13% of the total number of specimens, and *Pardosa prativaga* (L. KOCH, 1870) (11%). Overall dominant species (5–10%) were *Pardosa pullata* (CLERCK, 1757) (7%), *Pachygnatha clercki* SUNDEVALL, 1823 (5%) and *Pachygnatha degeeri* SUNDEVALL, 1830 (5%) (Table IV).

The diversity (*H'*) and evenness (*J'*) indices reached their highest values in sedge marshes and psammophilous grassland, were relatively high in natural meadows, and lowest in water and antropogenic habitats (Table IV).

Rare species

Among the 285 species of spiders collected in open habitats of Biebrza valley 20% (49 species) were rare species, known in Poland from no more than 10 localities (Appendix). The largest numbers of rare species were found in sedge marshes, particularly at sites 14, 15 and 16 (24, 30 and 21 species, respectively). The smallest numbers of rare species were found in habitats with low structural diversification of the vegetation (aquatic environments and riverside marshes) as well as in cultivated and dried meadows.

Rare species of spiders in the Biebrza National Park are northern elements (boreal and atlantic) at the limit of their distribution in our country (see Appendix). Some of them are only known in Poland from the Biebrza valley (*Crustulina sticta, Baryphyma gowerense, B. trifrons, Carorita limnaea, Ceraticelus bulbosus, Entelecara omissa, Maso gallicus*) (KUPRYJANOWICZ 1997).

Table IV. Percentage contribution of epigeic spider communities of the open habitats of the Biebrza National Park. + – subrecedents (≤1%)

No.	Habitat	Psammophilous grasslands				Mowing meadows				Natural meadows		Sedge-moss marshes					Sedge marshes		*Glyceria* marshes		Riverside marshes			Aquatic habitats		
	Species / Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26
1	*Aelurillus v-insignitus*		13.4	5.2	11.8																					
2	*Agroeca dentigera*	+	+	+					+	+	+	+		+	+	2.2	+									
3	*Allomengea scopigera*									+							+	2.6		+	2.7	+				
4	*Allomengea vidua*								+	+	+	+	+		+	+	3.5	1.1		1.6	3.4	1.6				+
5	*Alopecosa accentuata*	+	14.8	5.8	6.9																					
6	*Alopecosa cuneata*	5.3	1.5	4.7		1.5		+	+						+											
7	*Alopecosa cursor*	+	12.4	1.7																						
8	*Alopecosa pulverulenta*	18.5	1.7	9.9	6.2	2.7	5.5	+	2.0	18.4	1.3		6.3	+	1.5		+	+								
9	*Antistea elegans*	+						2.9	+	+	2.2	18.7		14.7	9.0	8.9	1.6	+								
10	*Argyroneta aquatica*															+			+						3.4	1.4
11	*Bathyphantes approximatus*	+						4.2	+		1.2	+			+		+				+	+				
12	*Bathyphantes gracilis*	+	+	+	+	+		5.4	1.2	+	2.2	4.9		1.3	1.3	+	1.1	1.7	+	+	+	+				+
13	*Centromerita bicolor*	1.5	+	+	17.7	1.7	+		1.1	7.3		1.1			+	+										
14	*Clubiona phragmitis*																+	+	1.7	14.3	34.2	21.1			+	
15	*Clubiona stagnatilis*			+			+			+	+	+	+		+	+	+	9.3	2.6	2.2	+	3.2			6.8	
16	*Dicymbium nigrum*			+		1.6	1.5		1.3	1.6			2.1													
17	*Dolomedes plantarius*																	+	+	2.2	+	1.6		1.7	1.7	2.9
18	*Donacochara speciosa*																			1.6	12.3	3.7			+	3.6
19	*Erigone atra*		+			8.3	+	28.1	15.0	+	9.7	+		+	1.6	+		1.1	1.7	2.3	+	1.2	4.7	+	+	1.4
20	*Erigone dentipalpis*					2.9		5.5	2.6		2.4				+							+				
21	*Euryopis flavomaculata*								+				+	2.1	+											
22	*Gnathonarium dentatum*							1.7		+	+						+	3.6	1.3	4.7	2.5	1.4				
23	*Haplodrassus signifer*	+	3.2	1.6	+					+				+												
24	*Hypomma bituberculatum*	+	+			+		+		+	+				+	+	6.9	2.0	+		+	1.1			5.9	
25	*Kaestneria pullata*	+		+		+		+		+		+	+		+		5.1	1.3	+							
26	*Larinioides cornutus*									+	+						+			+		+			4.2	

No.	Habitat	Psammophilous grasslands				Mowing meadows				Natural mead-ows		Sedge-moss marshes					Sedge marshes		*Glyceria* marshes		Riverside marshes			Aquatic habitats		
	Species / Sample site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26
27	*Marpissa radiata*		+														+	2.1		+	+	2.4				
28	*Microlinyphia pusilla*	+		+	+	+					+			2.7	+	+	+									
29	*Oedothorax fuscus*			+		4.5	6.5	+	+		+	+			+			+	+	+	+	+				
30	*Oedothorax gibbosus*		+	+		+	+	+		+	1.1		+		+	+	5.6	+	+	+	+					
31	*Oedothorax retusus*					1.6	6.0	3.6	13.0		5.0					+					+					
32	*Ozyptila gertschi*									+				+	+	2.2										
33	*Ozyptila scabricula*	+	1.1	2.6	1.8																					
34	*Ozyptila trux*	+				+	+	+	+	1.7	+	+	4.4	+	4.2	+	+	+	1.4	+	+					
35	*Pachygnatha clercki*	+	+	+	+	1.3	3.9	9.5	16.0	1.4	19.7	2.3	1.1	+	2.4	1.6	6.1	22.4	18.1	13.3	15.6	18.2	2.3		5.9	
36	*Pachygnatha degeeri*	5.7		+		12.4	9.4	6.7	3.4	16.5	1.2	+	+	1.2	+	+	+					+				
37	*Pachygnatha listeri*					+	+		+				3.1													
38	*Pardosa lugubris*		+		5.0				+						+				+							
39	*Pardosa maisa*	+		+		+	+			1.6	+	1.5	27.6		10.8	+	2.0									+
40	*Pardosa paludicola*	2.4		+		+	+	+	1.8	5.5	+		+		+	+	+		+		2.4					
41	*Pardosa palustris*	27.8	3.3	31.7	2.1	37.7	15.8	10.3	6.5	+	1.2		+	+	+	+	+	+								
42	*Pardosa prativaga*	2.1	1.7	+		5.4	1.3	+	6.4	10.7	4.4	19.4	+	+	13.7	15.7	33.7	30.3	29.6	10.8	4.8	3.3	+			+
43	*Pardosa pullata*	6.4		+		10.5	29.4	+	15.1	9.7	+		1.1	13.4	11.3	+	3.9		+							
44	*Pardosa sphagnicola*					+	5.2	+	+	5.9	4.0	5.1	1.6		14.8	13.5	4.5	+	11.7	+	1.1	+				
45	*Pirata hygrophilus*						+					4.0	+		+	+	+									
46	*Pirata latitans*					+			1.2	+	+	6.6	+	4.6	4.0	4.6	+									
47	*Pirata piraticus*	+	+	+		+		1.8	1.1	+	12.4		+	+	+	1.5	1.2	7.3	15.0	33.3	3.9	27.9	88.4	96.6	48.3	82.0
48	*Pirata piscatorius*										1.1	1.9		+	+	11.1	+	+		+	+	+		+	5.9	1.8
49	*Pirata tenuitarsis*					+	+		+	+	2.7	15.3		+	1.9	10.3	1.7		+		+				+	
50	*Pirata uliginosus*					+			+	+	+	+	8.9		1.6	6.0										
51	*Pocadicnemis pumila*									+			2.9		+	+	+									
52	*Porrhomma pygmaeum*	1.6	3.1	3.0		+		1.5		1.1	3.0	+			+	+	2.1	+	+	2.2	3.4	4.5	2.3	+		+
53	*Savignya frontata*	+	+	+	+	+	+	+	+	+	1.4	+			+	+	4.3	+	1.2	+	+	+	1.6			+
54	*Silometopus elegans*			+					+	+	1.6	+		+	+	+	+	3.3	2.6	+	+					
55	*Tallusia experta*	+	+		+	+	+		+	1.1		+	1.1	2.3	+	+	+									

No.	Habitat	Psammophilous grasslands				Mowing meadows				Natural mead-ows		Sedge-moss marshes					Sedge marshes		*Glyceria* marshes		Riverside marshes			Aquatic habitats		
	Species / Sample site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26
56	*Tetragnatha extensa*	+				+		+		+	+			+	+	+	+		+	+		1.9		+		2.2
57	*Thanatus arenarius*	8.2	3.0	7.5		+	+																			
58	*Tibellus maritimus*							+	+		+		+	+	+	+	+			+					6.8	
59	*Trichopterna cito*	+	11.4	3.5	14.3	+																				
60	*Trochosa spinipalpis*					+	1.7	3.8	2.6	5.6	2.4	2.6	14.0	34.6	6.5	3.5			+							
61	*Trochosa terricola*	2.2	+	+	3.3	+			+						+	+										
62	*Xerolycosa miniata*	2.6	9.2	4.4	3.2	+																				
63	*Xerolycosa nemoralis*				3.3																					
64	*Xysticus cristatus*	4.5	+	+	+	1.2	5.5		+	1.1	+		+	+	+		+		+							
65	*Xysticus ulmi*	+			+	+	+	+	+	+	+			+	+	+	+	+	+	2.2	+	+				
66	*Zelotes electus*	1.1	1.7	4.7	1.7								+													
67	*Zelotes latreillei*	+	+	+		+	+		+	+			1.3	8.5	+											
68	*Zelotes longipes*	+	4.9	+	5.1							+														
69	*Zora spinimana*	+				+	+	+		+	+		2.9				+									
	Other species	10.1	13.6	13.7	17.6	6.7	8.3	15	9.7	10.8	19.8	16.6	21.6	14.6	15.4	18.9	16.7	11.9	13.1	9.3	13.7	6.9	0.7	1.7	11.1	4.7
	Number of species (S)	74	46	81	64	91	55	44	64	86	85	52	80	56	123	125	90	47	57	23	45	35	19	29	19	14
	Index of diversity (H')	3.76	4.12	3.98	4.28	3.36	3.58	3.97	3.98	4.05	4.16	3.98	4.30	3.50	4.33	4.33	4.15	3.47	3.44	3.58	3.42	3.25	2.81	2.30	2.94	1.67
	Index of evenness (J)	0.61	0.75	0.63	0.71	0.52	0.62	0.73	0.66	0.63	0.74	0.70	0.68	0.60	0.62	0.62	0.64	0.63	0.59	0.79	0.62	0.63	0.66	0.47	0.69	0.44

Table V. Dominance structure (%) of spiders in herb layer of the open habitats of the Biebrza National Park. + – subrecedents (<1%)

No.	Habitat	Psammo-philous grasslands	Mowing meadows	Sedge-moss marshes			Sedge marshes	*Glyceria* marshes	Riverside marshes	
	Species / Sample site	3	5	13	14	15	16	18	22	23
1	*Araneus quadratus*	2.5	1.4	26.8	3.1	2.1	+			
2	*Araniella cucurbitina*	+	2.5		+	+	+			
3	*Baryphyma gowerense*				+	2.9	+			
4	*Cheiracanthium erraticum*	4.2				+				
5	*Clubiona phragmitis*								+	8.9
6	*Clubiona stagnatilis*		+		1.8	2.0	4.2	2.0	14.7	7.8
7	*Dictyna arundinacea*	5.8	6.9	2.7	1.2	1.8	2.0			
8	*Dolomedes fimbriatus*	+	1.1		1.7	9.8	2.6		+	
9	*Erigone atra*			+		+			3.9	
10	*Heliophanus flavipes*	4.2			+					
11	*Hypomma bituberculatum*		+	+	16.2	1.9	31.6	12.9	+	8.9
12	*Hypsosinga heri*				9.9	31.6	6.7	1.0		
13	*Hypsosinga pygmaea*	2.5	9.8	15.6	5.3					
14	*Larinia jeskovi*				+	5.5	1.6			
15	*Larinioides cornutus*	2.5	4.5	1.0	3.4	1.4	3.3	7.9	13.2	11.1
16	*Mangora acalypha*	2.5		+	2.1	+	+			
17	*Marpissa radiata*			1.0	+	+	4.7	1.0	1.6	4.4
18	*Microlinyphia pusilla*		23.5	2.9	4.0	+	+			
19	*Micrommata virescens*	2.5				+				
20	*Neoscona adianta*	26.7		18.2	+		+			
21	*Oedothorax gibbosus*					+	2.1			
22	*Pachygnatha clercki*		+		+	1.3	+	2.0	3.1	10
23	*Pachygnatha degeeri*				+		+			
24	*Pardosa amentata*									10
25	*Pardosa prativaga*		+		+	+	2.5			
26	*Pirata piraticus*					+	+		+	7.8
27	*Porrhomma pygmaeum*		+		4.0	1.1	8.4	21.8	2.3	1.1
28	*Savignya frontata*		+		+	+	2.0		+	
29	*Singa hamata*	+	8.8	11.9	8.6	1.9	1.3			
30	*Tetragnatha extensa*	1.7	11.1	1.5	6.3	6.9	4.1	36.6	49.6	22.2
31	*Tetragnatha reimoseri*									2.2
32	*Tetragnatha striata*									5.6
33	*Theridion impressum*	21.7	1.7	+	+	+				
34	*Tibellus maritimus*		19.8	9.4	13.8	11.5	8.2	3.0		
35	*Tibellus oblongus*	10								
36	*Xysticus cristatus*	+	2.0	2.4	+	+	+			
37	*Xysticus ulmi*	2.5	+		2.0	2.8	+	7.9	2.3	
	Other species	10.7	6.9	6.6	16.6	15.5	14.7	3.9	9.3	0
	Number of species (S)	27	29	26	50	80	56	14	18	12

Baryphyma gowerensis (3%) and *Larinia jeskovi* (5%) were dominant species in the herb layer at site 15, *Pardosa maisa* (11%) was dominant in epigeon at site 14 and they are regularly found in spider communities in the above habitats (Table IV & V). *Pardosa maisa,* however, is a eudominant in the epigeon at site 14 (Table IV). This species dominates in peat bogs in the BPN (KUPRYJANOWICZ *et al.* 1998).

More information about rare species, including redescriptions and data on phenology and environmental preferences can be found elsewhere (KUPRYJANOWICZ 1994 a, b, 1995a, b, c, 1996, 1997, KUPRYJANOWICZ et al. 1997, ŻABKA & KUPRYJANOWICZ 1997).

Spider communities in the habitats investigated

Psammophilous grasslands (sites 1, 2, 3, 4). The epigeon of psammophilous grasslands turned out to be a rich habitat, both in terms of quality and quantity, yielding 14548 spider specimens representing 145 species. The Shannon diversity index H′ had high values here (from 3.76 to 4.28) (Table IV). The eudominants were *Pardosa palustris* (25.2%) and *Alopecosa pulverulenta* (13.2%). The dominant species include species selective for psammophilous grasslands such as *Thanatus arenarius, Aelurillus v-insignitus* and *Trichopterna cito* (Table IV). The last two of them were very abundant on psammophilous grasslands adjacent to pine greenwood.

Of all species collected, 37 were exclusive to psammophilous grasslands. The share of hygrophilous species was lowest (38%) here, and a relatively big proportion of xerophilous (24%) and heliophilous (20%) species was found. Among the psammophilous grasslands the highest spider diversity (H′= 4.28) was at the edge of the Biebrza valley, near the pine greenwood (site 4). It was at this site that the largest number of exclusive species (13) was also found. The majority of them were species which had migrated from the pine greenwood (*Macrargus excavatus, Palliduphantes alutacius, Tapinocyboides pygmaeus, Thyreosthenius biovatus, Alopecosa schmidti, Xerolycosa nemoralis, Scotina palliardi, Drassodes pubescens, Zelotes apricorum, Zora silvestris, Heliophanus dubius*).

The large number of species is due to the presence of species characteristic of that habitat as well as species immigrating from sedge marshes. This is because the psammophilous grassland is relatively small compared to the surrounding sedge marshes.

A relatively high and constant percentage of *Cheiracanthium campestre* (1.4%) in this habitat is noteworthy. It is a rare species in Poland, occurring in dry and sun-lit biotopes (PRÓCHNIEWICZ 1991).

In the herb layer of psammophilous grasslands (site 3), the representation of the most abundant species was similar to that of dry mowing meadow (site 5), and a sedge marshes in the same Biebrza Valley basin (sites 14, 15, 16), and sedge-moss marsh located near psammophilous grasslands (site 13) (Table V).

Meadows (sites 5, 6, 7, 8, 9, 10). A total of 18691 specimens representing 154 species were collected from the epigeon of meadows. *Pardosa palustris* (23.2%), *Pardosa pullata* (12%) and *Pachygnatha degeeri* (11.3%) were eudominants, while dominant species included *Erigone atra* (7.5%) and *Pardosa prativaga* (5.8%). The diversity index of spider was higher on moist natural meadows (from 4.05 to 4.16) than in mowed meadows (from 3.36 to 3.98) (Table IV).

Table VI. Sørensen's similarity index of the epigeic spiders of the open habitats of the Biebrza National Park.

Habitat		Psammophilous grassland				Mowing meadowds				Natural mead-ows		Sedge-moss marshes					Sedge murshes		*Glyceria* murshes		Riverside murhes			Aquatic habi-tats		
	Site	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	24	25	26
Psammophilous grassland	1	X																								
	2	51	X																							
	3	59	56	X																						
	4	41	45	42	X																					
Mowing meadowds	5	49	36	44	31	X																				
	6	39	28	32	17	55	X																			
	7	42	29	29	15	53	44	X																		
	8	38	29	33	22	57	45	52	X																	
Nat. meadows	9	50	26	33	15	54	53	42	42	X																
	10	43	21	34	16	55	49	65	58	60	X															
Sedge-moss marshes	11	42	23	24	17	37	40	40	43	47	51	X														
	12	35	17	31	18	43	49	35	49	49	50	35	X													
	13	38	24	29	20	45	29	32	51	42	47	37	35	X												
	14	49	30	34	20	57	48	51	59	65	70	54	53	55	X											
	15	43	24	29	18	51	46	47	47	62	64	54	47	51	75	X										
Sedge murshes	16	44	23	31	14	51	47	48	41	63	68	50	46	51	66	64	X									
	17	32	26	28	13	41	40	58	33	44	53	41	30	25	48	40	52	X								
Glyc. Murshes	18	32	24	28	14	44	39	56	40	41	53	43	32	33	49	45	47	61	X							
	19	18	22	22	8	31	26	49	32	32	48	34	22	30	38	35	49	60	54	X						
Riverside murhes	20	25	22	24	9	34	32	50	43	33	53	42	27	28	42	38	50	67	60	67	X					
	21	22	23	19	10	30	20	47	31	28	44	31	16	27	36	31	42	58	47	71	68	X				
	22	13	23	11	6	15	13	24	14	12	13	18	7	13	11	13	12	23	21	28	24	31	X			
Aquatic habitats	24	8	12	5	0	10	3	16	6	8	11	11	2	13	9	11	10	19	17	28	20	31	51	X		
	25	13	15	8	2	17	11	22	14	16	23	25	10	18	18	28	23	30	39	42	34	42	23	31	X	
	26	18	20	13	5	19	12	24	18	17	22	28	11	17	19	21	20	30	27	43	38	47	51	60	35	X

So ≤ 33%   33% < So < 67%   So ≥ 67%

Table VII. Sørensen's similarity index of the spiders in herb layer of the open habitats of the Biebrza National Park.

Site	3	5	13	14	15	16	18	20	22	23
3	X									
5	46	X								
13	49	51	X							
14	44	66	50	X						
15	32	44	32	62	X					
16	31	54	39	68	66	X				
18	15	37	25	34	28	37	X			
20	14	14	20	22	17	20	14	X		
22	18	43	27	35	31	32	56	18	X	
23	10	29	21	23	17	24	46	22	60	X

So ≤ 33%   33% < So < 67%   So ≥ 67%

The shares of most species varied at different meadow sites. *Pardosa palustris* was most numerous in dry, cut and grazed meadows (site 5) and least numerous in moist, natural ones (sites 9, 10) (Tables IV). In the natural meadows, hygrophilous species (*Pirata piraticus*) and sphagnophilous species (*Pardosa prativaga* and *P. sphagnicola*) were more numerous. The natural meadow (site 9) was also suitable for *Alopecosa pulverulenta* and *Pardosa paludicola*, while mowing meadows also supported large numbers of *Oedothorax fuscus* (sites 5 and 6), *O. retusus* (sites 6 and 8) and *Xysticus cristatus* (site 6).

There was considerable similarity between epigeic spider communities of the meadow near village Dobarz (site 5) and other meadows (Table VI). High species similarity of epigeic spider communities was also found between natural meadows (sites 9 and 10) or sites neighbouring each other (sites 7 and 10) as well as between a natural meadow and a sedge marsh (sites 14 and 16).

Species selective for mowing meadows were *Arctosa leopardus* and *Tiso vagans*, and *Clubiona frutetorum* and *Walckenaeria atrotibialis* were selective for natural meadows they. Exclusive species for environments listed above were respectively *Agyneta cauta, Agyneta ramosa, Agyneta subtilis, Gongylidiellum latebricola, Troxochrus scabriculus* and *Tapinocyba insecta, Agyneta conigera, Tenuiphantes flavipes.*

In the herb layer of hay-growing meadows (site 5) the representation of the most abundant species was similar to that of sedge marshes. A significantly larger contribution of meadow species (*Microlinyphia pusilla*) and xerophilous species (*Dictyna arundinacea*) on the hay-growing meadow is noteworthy (Tables V).

Sedge-moss marshes and sedge marshes (sites 11, 12, 13, 14, 15, 16, 17). In total, 14566 specimens representing 173 species were collected from sedge marshes and sedge-moss marshes. The Shannon diversity index had its highest values here (H'= 3.5 – 4.3) (Table IV). *Pardosa prativaga* was a eudominant (16.2%). Dominant species were: *Pardosa sphagnicola* (10%), *Antistea elegans* (7.5%), *Trochosa spinipalpis* (6.8%), *Pardosa maisa* (6.7%) and *Pardosa pullata* (6.2%).

Among sedge-moss marshes the highest species diversity (H' = 4.3) of epigeic spiders was found for sedge-moss marshes *Caricetum appropinquatae* (site 14) and

Caricetum rostratae (site 15), with 123 and 125 species of spiders collected, respectively (Table IV). They were mainly hygrophilous (60%) and sphagnophilous (40%) spider species. At site 14, the group of eudominants was formed by four species of the genus *Pardosa*: *P. sphagnicola*, *P. prativaga*, *P. pullata* and *P. maisa*. At site 15 the eudominants were: *Pardosa sphagnicola*, *P. prativaga*, *Pirata piscatorius*, *P. tenuitarsis* and *P. uliginosus*. The contribution of *Antistea elegans* (dominating species) was the same at both sites (Tables IV & V). *Pirata tenuitarsis* and *Pardosa sphagnicola* inhabit mosses, hence their high numbers in sedge-moss marshes. *Pirata tenuitarsis* is also known from peat bogs (Dziabaszewski 1991, Kupryjanowicz *et al*. 1998).

Sedge-moss marshes were characterised by the highest number of exclusive species (*Robertus ungulatus*, *Robertus scoticus*, *Anguliphantes angulipalpis*, *Diplocephalus dentatus*, *Floronia bucculenta*, *Meioneta affinis*, *Metopobactrus prominulus*, *Pelecopsis mengei*, *Tapinocyba pallens*, *Hypselistes jacksoni*, *Heliophanus auratus*, *Glyphesis cottonae*, *Peponocranium orbiculatum*, *Neon valentulus*, *Maso gallicus*) and selective species (*Hygrolycosa rubrofasciata*, *Gonatium rubens*, *Erigonella hiemalis*, *Pelecopsis parallela*, *Trichopterna thorelli*, *Liocranoeca striata*, *Araeoncus crassiceps*, *Satilatlas britteni*, *Pirata piscatorius*, *Ozyptila gertschi*, *Hypsosinga heri*) adding up to 15 and 11, respectively. Whereas for sedge marshes there was only one exclusive species (*Maro minutus*) and only two selective ones (*Baryphyma trifrons*, *Microlinyphia impigra*).

Among spiders collected from between mosses (soil samples) at site 14, three species dominated: *Erigonella ignobilis* (8%), *Porrhomma pygmaeum* (6.7%) and *Sitticus caricis* (9%). At site 15 eudominants were: *Pirata tenuitarsis* (13.1%) and *P. uliginosus* (10.5%). Compared with pitfall traps material, *Pardosa prativaga* (5.9%) and *P. sphagnicola* (2.1%) were relatively less abundant. This could be due to large numbers of indeterminate juvenile specimens of that genus. Among the dominants, species typical of mosses were: *Oxyptila gertschi*, *Neon valentulus* and *Sitticus caricis*. They belonged to the subdominant group in the pitfall trap catches.

The dominance structure of epigeic spider communities living in sedge-moss marshes with similar vegetation structures (sites 11, 14 and 15) and collected at the same time was similar (see Tables I & IV). However, the similarity in spider dominance structures in *Caricetum acutae* (site 17) and marshes with *Glyceria maximae* (site 18) may have been the result of proximity (50 m) of these sites (Table VI).

Despite a relatively high number of species common to sedge marshes (So: 35% – 75%), each of these habitats had its own characteristic species. The largest number of characteristic spider species was identified at site 12, where eight exclusive species were found. Among them, however, only *Floronia bucculenta*, *Meioneta affinis* and *Metopobactrus prominulus* are open habitat species (Martin 1991, Hänggi *et al*. 1995). Others are connected with moist forests (Hänggi *et al*. 1995). They had probably arrived from nearby areas with mire birches.

Among ten spider species characteristic of *Caricetum rostratae* (site 15) five were typical of peat bogs. Only *Peponocranium orbiculatum* (1 specimen) had probably come there by chance, as it is a species of dry habitats (Hänggi *et al*. 1995). On the remaining sedge marshes the characteristic species were hygrophilous and typical of fens (Martin 1991, Hänggi *et al*. 1995).

High spider species similarity was seen between spider communities from sedge-moss marshes (all sites) and sedge marshes (sites 16 and 17) (Table VI). Sedge-moss marshes with *Carex appropinquatae* (sites 12 and 14) differed from others in a relatively high contribution of *Pardosa maisa* (28% and 11% respectively). It is a boreal species found mainly in peat bogs (HIPPA & MANNILA 1982, ITÄMIES & JARVA 1983). It is also dominant in the peat bogs of Biebrza valley (KUPRYJANOWICZ *et al.* 1998). It prefers poorly forested peat bogs that are exposed to sunlight, or fens with clumps of sedge and bushes of willows and birches (ITÄMIES & JARVA 1983, KUPRYJANOWICZ *et al.* 1998).

In the herb layer of sedge marshes in the lower Biebrza basin, the same spider species were eudominants but their contribution varied between communities. *Hypsosinga heri* was most abundant at site 15 (31%) and in the other sedge marshes it was a dominant (Tables IV & V). In the sedge marshes in the northern Biebrza basin (site 13), which is a relatively narrow valley (Fig. 1) neighbouring on psammophilous grasslands, *Hypsosinga heri* was rare (<1%), and the share of photophilous and xerophilous spiders increased (*Neoscona adianta, Hypsosinga pygmaea*). *Tibellus maritimus* representation in the herb layer of sedge marshes was constant (11.3%).

A large contribution of *Larinia jeskovi* in the spider community of the herb layer of *Caricetum rostratae* (site 15) is noteworthy, the species being very rare in Europe (KUPRYJANOWICZ 1995a). It has been concluded from breeding work on this species that the female overwinters in the adult stage without hiding in a retreat (J. KUPRYJANOWICZ, unpublished data). Its high abundance may be related to the presence of a thick and loose layer of mosses, which is necessary for overwintering of these spiders. In other sedge marshes, without a layer of mosses and with a compressed turf, the numbers of this species are low.

***Glyceria* marshes and riverside marshes (sites 18, 19, 20, 21, 22, 23).** In total, 4036 individuals representing 77 spider species were captured in the epigeon of riverside marshes and the vegetation along old riverbeds. The spider communities of these habitats were characterised by a large number of eudominants (except site 22) and a lack of dominants (one dominant only at site 21). In *Glyceria* marshes (sites 18, 19) eudominants were: *Pardosa prativaga, Pirata piraticus, Pachygnatha clercki, Clubiona phragmitis* and *Pardosa sphagnicola*. However, in these marshes the contribution of the last two species differed. *C. phragmitis* was more numerous at the site located close to the old riverbed (site 19) than at the mowed site 18 (14% and 2% respectively). Conversely, the contribution of *P. sphagnicola* at the two sites was 0.5% and 12%, respectively (Table IV). Species exclusive for *Glyceria* marshes were *Enoplognatha caricis* and *Abacoproeces saltuum*.

In reed marshes, at both sites 21 and 20, eudominats were *Clubiona phragmitis* (21% and 34%) and *Pachygnatha clercki* (18% and 16%). Similar percentage contribution of these species have been obtained at marshes in Belgium (HENDRICKX *et. al.* 1997). Other eudominant species varied between sites. In the marsh on the bank of the River Jegrznia (site 21) *Pirata piraticus* was eudominant (28%). However in the marsh in the Biebrza's old riverbed (site 20), *Donacochara speciosa* was a third eudominant (12%). An exclusive species for this habitat was *Hypomma fulvum* – also frequently found in riverside marshes of the River Scheldt in Belgium (HENDRICKX *et. al.* 1997). The sweet marsh (site 22) was the poorest in spider species, with only one eudominant – *Pirata piraticus* (88%).

The dominance structure of the spider communities in the vegetation layer of reed and sweet marshes differed, though their species composition was similar. This could be due to a low overall number of specimens collected (only 218) (Tables IV & V).

The *Oenantho-Rorippetum* (site 23), resembling marshes in floral structure, had a similar composition of spider species in its herb layer (Table VII).

Worth noting is the relatively large percentage of *Tetragnatha striata* (6%) – a species extending its hunting web just above the water table. An exclusive species for that habitat was *Tetragnatha reimoseri* (2.2%) – a rare species previously found only in western Poland (DZIABASZEWSKI 1974, 1978). Species selective for that habitat were *Tetragnatha striata* and *Larinioides cornutus*.

Aquatic communities (sites 24, 25, 26). 808 spider specimens collected from aquatic communities were represented by 28 species. *Pirata piraticus* (84%) is the only eudominant in this environment. The contribution of eudominant and subdominant species varies on the three sites. At Jegrznia river (site 26) there were no dominants and 3 spider species were subdominants, with 4 recedents and 6 subrecedents. Among the subdominants, *Donocochara speciosa* obviously had a higher representation (3, 6%) here than at other sites. The Shannon diversity index had its lowest values here (H'= 1.67–2.94) (Table IV).

At site 24 only 6 species were collected. *Pirata piraticus* was the most abundant (96,6%). There were no dominants or subdominants, and *Dolomedes plantarius* was a recedent species here (Table IV). Species selective for aquatic habitats were *Dolomedes plantarius* and *Donacochara speciosa*.

Site 25 is the aquatic habitat richest in spider species (20 species). *Pirata piraticus* was less dominant here (48%), giving way to 5 dominants (*Pirata piscatorius, Hypomma bituberculatum, Pachygnatha clercki, Clubiona stagnatilis, Tibellus maritimus*). The subdominants were *Argyroneta aquatica* and *Larinioides cornutus*. Although *Dolomedes plantarius* is not a numerical dominant in aquatic environments, it is quite typical of these habitats DUFFEY (1995) reports its preference for environments with a large water table.

DISCUSSION

Open plant communities of the Biebrza valley turned out to be habitats with a rich spider fauna. The number of species found here was larger than in other similar habitats in Poland (KAJAK 1960, 1962, PRÓSZYŃSKI 1961, JĘDRYCZKOWSKI & STARĘGA 1980, SZYMKOWIAK 1993). The spider communities of open habitats of Biebrza valley differed both in species composition and dominance structure (Tables IV–VII). The largest differences were found between extremely moist habitats and the smallest between sedge marshes.

It appears, therefore, that the vegetation structure and humidity of the investigated habitats has a decisive influence on similarities in their spider communities.

Similarities in species composition of epigeic spider communities (So>50%) were found between spider communities of habitats with similar vegetation structure (sedge marshes, psammophilous grasslands) and a similar degree of humidity as well as periodically mowed communities (hay-growing meadows and *Glyceria* marshes) (Table VI). Habitats with similar vegetation structures and neighbouring each other show the highest similarity (So: 60 – 70%).

Although there are numerous data related to spider fauna of psammophilous grasslands, their comparison to spider congregations of Biebrza psammophilous grasslands is difficult because of different methods used and lack of quantitative data (e.g. PRÓSZYŃSKI 1961, STARĘGA 1976,1988, JĘDRYCZKOWSKI & STARĘGA 1980, WOŻNY 1985). However, it is important to point out that, like Biebrza psammophilous grasslands, mountain psammophilous grasslands *Festuco-Brometea* and *Origano-Brachypodietum* are the habitats richest in spider species (STARĘGA 1976, 1988). Although many species are common, the spider dominance structure of mountain and Biebrza psammophilous grasslands is different.

Similar spider species composition has been noted for spider communities from psammophilous grasslands in Włocławek and dunes in Kampinos Primeval Forest (PRÓSZYŃSKI 1961, JĘDRYCZKOWSKI & STARĘGA 1980).

Although many spider species are common to both types of meadows (So > 50%), the dominance structure is different in mowed and natural meadows. Differences in spider dominance are also found between meadows of the same type (Tables IV). The example of *Pardosa prativaga* and *P. sphagnicola*, whose numbers are smaller in mowed meadows and on the mowed *Glyceria* marsh (Table IV), can be used as an indication of a negative influence of mowing on numbers of spiders. ZULKA *et al.* (1997) also reported a negative influence of grazing on the numbers of *Pardosa prativaga* on meadows in Austria. Meadow mowing has been reported as the cause of a decrease in the number of predatory fauna by some authors (e.g. KAJAK 1962, JACEK & JACEK 1981). SOUTHWOOD & EMDEN (1967) found that abundance of such predators as Coleoptera, Acarina and Chilopoda is bigger in uncut grassland, but spiders are not significantly more numerous in such grassland areas.

The natural meadow (site 9) was also suitable for *Alopecosa pulverulenta* and *Pardosa paludicola* (Table IV), whereas mowed meadows were occupied by large numbers of *Oedothorax fuscus* (sites 5 and 6), *O. retusus* (sites 6 and 8) and *Xysticus cristatus* (site 6).

Significant similarities in dominance structure can be seen between spider communities from mowed meadows along the Biebrza and those from meadows of Bohemia and Mazowsze (KLIMEŠ & SECHTEROVÁ 1989, STARĘGA 1989). *Pardosa palustris* was an obvious eudominant in the two latter meadows and species like *Erigone atra*, *Pardosa pullata*, *P. prativaga* and *Pachygnatha degeeri* dominated there.

The dominance structure of the epiphyton spider communities in the majority of habitats investigated is different from that given by KAJAK (1960) for a natural meadow at Kuwasy. The fauna of the sedge marshes investigated here is significantly richer than that of the Kuwasy meadows, being only similar to the spider dominance structure of cultivated meadows. The differences concern two species, *Araneus quadratus* and *Xysticus ulmi*, which were eudominants or dominants in the sedge marshes but were classified as less numerous species in the meadow. This may be caused by the meadow mowing method as suggested by KAJAK (1962).

Spider species diversity was higher in natural than in mowed meadows. Spider diversity in soil assessed by quadrat method was also higher in natural meadows than in mowed ones (KAJAK *et al.* 2000).

Spider species diversity was also higher in natural meadows than in habitats in the immersion zone (*Glyceria* marshes, riverside marshes, aquatic habitats) and in *Caricetum acutae.* Among four wet habitats (reed marsh, Filipendulion with patches of Calthion, *Caricetum acutae* sedge marsh and young alder) at Oostkamp (Belgium), the highest diversity of *Araneae, Opiliones, Carabidae* and *Staphylinidae* was observed in the Calthion/Filipendulion meadow, too (DECLEER & SEGERS 1989). There were changes in spider species diversity in meadows and on marshes consistent with an increase in relative humidity (level of river flooding) and vegetation structure (Table IV). This is confirmed by DŐBEL et al. (1990), who showed that flooding intensity and vegetation structure influence spider communities in an intertidal salt marsh. In places where heterogeneity of the vegetation structure was lower, diversity of the fauna was also proportionally lower (DECLEER & SEGERS 1989). GRAVESEN (2000) also proves that factors such as river water levels and grazing or mowing time are important for spider species composition in wet grasslands, especially marshes.

MERKENS (1997) reported a dominance structure for grazed *Caricetum gracilis* near lake Dümer (Germany) which was different from that of the sedge marshes described here. It showed the closest similarity to spider communities in hay-growing meadows of the Biebrza valley (sites 5 and 8). Also the abundance of spider species of *Caricetum gracilis* in Germany is lower than in the Biebrza sedge marshes. This confirms that the intensity of grazing and cutting has a negative effect on the abundance of spiders (MERKENS 1997).

The dominance structure is also different for the spider communities from *Caricetum acutae* sedge marshes associated with the Biebrza and the Oostkamp in Belgium (DECLEER & SEGERS 1989). Sedge-moss marshes with *Carex appropinquatae* (sites 12 and 14) differed from the others in a relatively high contribution of *Pardosa maisa* (28% and 11% respectively). It is a boreal species found mainly in peat bogs (HIPPA & MANNILA 1982, ITÄMIES & JARVA 1983). In the peat bogs of the Biebrza valley it is also dominant (KUPRYJANOWICZ et al. 1998). It prefers poorly forested peat bogs exposed to sunlight, or fens with clumps of sedge and bushes of willows and birches (ITÄMIES & JARVA 1983, KUPRYJANOWICZ *et al.* 1998).

Spider dominance structure in sedge-moss marshes with a rich layer of mosses (sites 13, 14, 15) is similar to that seen in peat bogs of the Biebrza valley, Polesie and the Kaliningrad region in Russia (SCHIKORA 1997, KUPRYJANOWICZ et al. 1998). Similarities include a large share of sphagnophilous species in these communities (*Pardosa sphagnicola, Antistea elegans, Pirata uliginosus* and *P. tenuitarsis*) as well as the presence of other peat-bog related species (e.g. *Aphileta misera, Drassyllus lutetianus, Graphosa nigerrima, Neon valentulus*.

The study by SZYMKOWIAK (1993) of spider dominance structure in sedge marshes of the Mielno reserve provides comparative data. The most numerous species described there were *Theridion pictum* (10%), *Hypomma bituberculatum* (9%) and *Microlinyphia impigra* (7%). Of these, only *Hypomma bituberculatum* was a eudominant in the Biebrza's sedge marshes. Other species were either not found here (*Theridion pictum*) or were represented by a small number of specimens (*Microlinyphia impigra*). Differences in araneofauna of sedge marshes may result from size differences between the two sedge marshes. The sedge marsh in the Mielno reserve forms a narrow strip around the lake and its spider species composition may be heavily influenced by the neighbouring habitats.

There is also a difference in spider species make-up between herbs and sedges and the soil surface. The spider communities associated with vegetation consist mainly of web weavers (*Araneidae, Linyphiidae, Theridiidae*) and spiders moving along sedge leaves (e.g. *Dolomedes fimbriatus, Tibellus maritimus, Marpissa radiata*), while spiders living on the ground mainly include running species (*Lycosidae, Gnaphosidae*). Differences between spider species composition of the two layers are not as big as those seen in forest habitats (ŁUCZAK 1976a, WOŻNY 1992) and the boundaries between layers are not as distinct as in a forest. Many species are often found in both epigeon and epiphyton (e.g. *Hypomma bituberculatum, Kaestneria dorsalis, Microlinyphia pusilla, Pardosa prativaga, Clubiona stagnatilis, Zora armillata, Tibellus maritimus*). The differences between layers are clearer when the dominance structure of spiders living in them is compared.

In most of the moist natural habitats, eudominants of epigeon are *Pirata piraticus* and *Pardosa prativaga* and of epiphyton *Hypomma bituberculatum, Tetragnatha extensa, Tibellus maritimus* and *Hypsosinga heri*. These species also dominate in the most humid habitats (riverside marshes and reeds) of other regions (STĘPCZAK 1962, PALMGREN 1977, SZYMKOWIAK 1993). In the epigeon of sedge marshes, the large representation of *Pardosa sphagnicola* is noteworthy as it is a species characteristic of peat bogs (CASEMIR 1976, PALMGREN 1977, SCHIKORA 1994, KUPRYJANOWICZ *et al.* 1998). There are many sphagnophilous and hygrophilous spider species found in sedge marshes though not so numerous as *P. sphagnicola*. This fact places these habitats in a line between peat bogs and moist meadows.

The dominance structure of the epiphyton spider communities in investigated habitats does not differ as much as that of the epigeon communities. Many species, such as *Hypomma bituberculatum, Tetragnatha extensa, Hypsosinga heri* and *Tibellus maritimus*, form the epiphyton of several habitats. They are species found in various open and moist environments (CASEMIR 1958, KAJAK 1960, 1962, SZYMKOWIAK 1993, HÄNGGI *et al.* 1995, STARĘGA & STANKIEWICZ 1996). Among epiphyton species found in abundance, there are also rare species (*Larinia jeskovi*) or species typical of sedge marshes only, such as *Hypsosinga heri* (SZYMKOWIAK 1993).

Riverside marshes are characterised by small species diversity and a relatively stable species composition of spider communities. A number of authors report some species such as *Clubiona phragmitis, Donacochara speciosa, Hypomma fulvum, Larinioides cornutus* and *Pirata piraticus* to be associated with reed marshes (*e.g.* MIKULSKA 1955, DECLEER & SEGERS 1989, HÄNGGI *et al.* 1995, SZINETAR 1995, HENDRICKX *et. al.* 1997, HOLEC 2000).

Floating pitfall traps used in the investigation proved very effective in wet habitats, where most running spiders were caught. Hydrophobic hairy legs allow running spiders to remain on the water surface (ROVNER 1986). This type of adaptation is characteristic of running spiders of the genera *Dolomedes*, *Pirata* and *Pardosa* (FOELIX 1982). Aeronautic spiders were also caught in floating traps, although less frequently. In the arachnological literature on aerial dispersal, there is a lack of information about some of these species (CRAWFORD & EDWARDS 1986, BLANDENIER & FÜRST 1998). They are: *Araeoncus crassiceps*, *Entelecara omissa*, *Hypomma bituberculatum*, *H. fulvum*, *Porrhomma pygmaeum*.

CONCLUSIONS

The habitats richest in spider species were psammophilous grasslands and sedge marshes, whereas the poorest ones were wet and antropogenic (mowed meadows, sweet marsh) habitats. The biggest numbers of rare species were also found in sedge marshes.

Similarities in species composition (So > 50%) were found between communities with similar vegetation structures (sedge marshes, psammophilous grasslands) and similar degrees of humidity (riverside marshes), as well as between seasonally mowed locations (mowed meadows, *Glyceria* marshes).

The diversity and evenness of spider communities were highest in sedge marshes and psammophilous grasslands, and relatively high on moist natural meadows, but lowest in aquatic and antropogenic habitats. On meadows and sedge marshes, spider species diversity rose with increasing relative ground humidity and diversity of the vegetation of the habitat.

In conclusion, humidity and vegetation structure, as well as cultivation (cutting and grazing) have a big influence on diversity and species composition of spiders in open habitats of the Biebrza valley.

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STRESZCZENIE

[Tytuł: Pająki (*Araneae*) środowisk otwartych Biebrzańskiego Parku Narodowego.]

Celem pracy było scharakteryzowanie zgrupowań pająków 26 środowisk środowisk otwartych, charakterystycznych dla doliny Biebrzy, rozmieszczonych zgodnie ze strefowością ekologiczną Doliny i w gradiencie wilgotnościowym. Badania prowadzono w latach 1991–1996 i 2002 na terenie Biebrzańskiego Parku Narodowego.

Ogółem zebrano 56898 osobników. Oznaczony materiał obejmował 285 gatunków pająków należące do 21 rodzin. Najbogatszymi w gatunki środowiskami były turzycowiska, a najuboższymi środowiska wodne i antropogenne (łąki kośne, szuwar tatarakowy). Zdecydowana większość złowionych gatunków to gatunki wilgociolubne i związane z torfowiskami. Pozostałe to gatunki leśne, eurytopowe lub o niejasnych wymaganiach środowiskowych. Wśród 285 gatunków pająków 20% (49 gatunków) to ga-

tunki rzadkie, znane w Polsce z nie więcej niż 10 stanowisk. Największa liczba gatunków rzadkich wystąpiła w turzycowiskach. Zgrupowania pająków badanych środowisk różniły się zarówno składem gatunkowym jak i strukturą dominacji. Największe podobieństwo składu gatunkowego (So > 50%) wykazują zgrupowania pająków występujących w środowiskach o podobnej strukturze roślinności (turzycowiska, murawy psammofilne) i podobnym stopniu wilgotności (szuwary nadbrzeżne), oraz zbiorowiska okresowo wykaszane (łąki kośne i szuwary mannowe). Wskaźniki różnorodności (*H'*) i równomierności (*J'*) osiągały największą wartość na turzycowiskach i na murawach piaskowych, oraz odpowiednio duże na wilgotnych łąkach naturalnych, a najmniejsze wartości miały w środowiskach wodnych i antropogennych. Na łąkach i turzycowiskach różnorodność gatunkowa pająków wzrastała wraz ze wzrostem względnej wilgotności podłoża i różnorodności roślinności badanych środowisk.

Appendix. List of spider species recorded in open habitats of the Biebrza National Park. Systematics after Platnick (2003).

No	Species	Rare species (R)	Samplin tool			
			soil sift	pitfall traps	sweep net	Moericke traps
1	2	3	4	5	6	7
	Mimetidae					
1	*Ero cambridgei* Kulczyński, 1911	R	+	+	+	
	Nesticidae					
2	*Nesticus cellulanus* (Clerck, 1757)			+		
	Theridiidae					
3	*Achaearanea simulans* (Thorell, 1875)				+	
4	*Crustulina sticta* (O. P.-Cambridge, 1861)	R		+		
5	*Enoplognatha caricis* (Fickert, 1876)	R		+	+	
6	*Enoplognatha latimana* Hippa & Oksala, 1982			+	+	
7	*Enoplognatha mordax* (Thorell, 1875)	R			+	+
8	*Enoplognatha ovata* (Clerck, 1757)		+	+	+	
9	*Euryopis flavomaculata* (C.L. Koch, 1836)			+		
10	*Neottiura bimaculata* (Linnaeus, 1767)		+	+	+	+
11	*Paidiscura pallens* (Blackwall, 1834)				+	
12	*Robertus arundineti* (O. P.-Cambridge, 1871)		+	+	+	+
13	*Robertus insignis* O. P.-Cambridge, 1907	R	+			
14	*Robertus lividus* (Blackwall, 1836)			+		
15	*Robertus scoticus* Jackson, 1914			+		
16	*Robertus ungulatus* Vogelsanger, 1944	R	+	+		
17	*Steatoda albomaculata* (De Geer, 1778)			+		
18	*Steatoda grossa* (C.L. Koch, 1838)			+		
19	*Steatoda phalerata* (Panzer, 1801)			+		
20	*Theridion impressum* L. Koch, 1881		+	+	+	
21	*Theridion varians* Hahn, 1833			+	+	
	Linyphiidae					
22	*Abacoproeces saltuum* (L. Koch, 1872)			+		+
23	*Agyneta cauta* (O. P.-Cambridge, 1902)			+		
24	*Agyneta conigera* (O. P.-Cambridge, 1863)			+		
25	*Agyneta decora* (O. P.-Cambridge, 1871)	R		+		
26	*Agyneta ramosa* Jackson, 1914			+		
27	*Agyneta subtilis* (O. P.-Cambridge, 1863)			+		
28	*Allomengea scopigera* (Grube, 1859)			+	+	+
29	*Allomengea vidua* (L. Koch, 1879)		+	+	+	+
30	*Anguliphantes angulipalpis* (Westring, 1851)			+		
31	*Aphileta misera* (O. P.-Cambridge, 1882)		+	+		+
32	*Araeoncus crassiceps* (Westring, 1861)	R	+	+		
33	*Araeoncus humilis* (Blackwall, 1841)			+	+	+
34	*Baryphyma gowerense* (Locket, 1965)	R	+	+	+	
35	*Baryphyma pratense* (Blackwall, 1861)			+	+	+
36	*Baryphyma trifrons* (O. P.-Cambridge, 1863)	R	+		+	
37	*Bathyphantes approximatus* (O. P.-Cambridge, 1871)		+	+	+	+
38	*Bathyphantes gracilis* (Blackwall, 1841)		+	+	+	+
39	*Bathyphantes nigrinus* (Westring, 1851)			+		
40	*Bathyphantes parvulus* (Westring, 1851)		+	+		
41	*Bathyphantes setiger* F. O. P.-Cambridge, 1894		+			
42	*Bolyphantes luteolus* (Blackwall, 1833)			+		
43	*Carorita limnaea* (Crosby & Bishop, 1927)	R		+		
44	*Centromerita bicolor* (Blackwall, 1833)		+	+		

1	2	3	4	5	6	7
45	*Centromerita concinna* (THORELL, 1875)			+		
46	*Centromerus incilium* (L. KOCH, 1881)		+	+		
47	*Centromerus levitarsis* (SIMON, 1884)	R		+		
48	*Centromerus semiater* (L. KOCH, 1879)	R	+	+		
49	*Centromerus sylvaticus* (BLACKWALL, 1841)		+	+		
50	*Ceraticelus bulbosus* (EMERTON, 1882)	R	+	+	+	
51	*Ceratinella brevipes* (WESTRING, 1851)		+	+	+	+
52	*Ceratinella brevis* (WIDER, 1834)		+	+	+	
53	*Dicymbium nigrum* (BLACKWALL, 1834)		+	+	+	
54	*Diplocephalus cristatus* (BLACKWALL, 1833)		+			
55	*Diplocephalus dentatus* TULLGREN, 1955	R		+		
56	*Diplocephalus picinus* (BLACKWALL, 1841)		+	+		
57	*Diplostyla concolor* (WIDER, 1834)			+	+	
58	*Donacochara speciosa* (THORELL, 1875)			+		+
59	*Entelecara omissa* O. P.-CAMBRIDGE, 1902	R	+	+	+	+
60	*Erigone atra* BLACKWALL, 1833		+	+	+	+
61	*Erigone dentipalpis* (WIDER, 1834)		+	+	+	
62	*Erigone longipalpis* (SUNDEVALL, 1829)	R		+		
63	*Erigonella hiemalis* (BLACKWALL, 1833)			+	+	
64	*Erigonella ignobilis* (O. P.-CAMBRIDGE, 1871)		+	+	+	
65	*Floronia bucculenta* (CLERCK, 1757)			+		
66	*Glyphesis cottonae* (LA TOUCHE, 1945)	R	+	+		
67	*Gnathonarium dentatum* (WIDER, 1834)		+	+	+	+
68	*Gonatium rubens* (BLACKWALL, 1833)			+		
69	*Gongylidiellum latebricola* (O. P.-CAMBRIDGE, 1871)			+		
70	*Gongylidiellum murcidum* SIMON, 1884		+	+	+	+
71	*Hypomma bituberculatum* (WIDER, 1834)		+	+	+	+
72	*Hypomma fulvum* (BÖSENBERG, 1902)			+		+
73	*Hypselistes jacksoni* (O. P.-CAMBRIDGE, 1902)	R			+	
74	*Kaestneria dorsalis* (WIDER, 1834)			+		+
75	*Kaestneria pullata* (O. P.-CAMBRIDGE, 1863)		+	+	+	+
76	*Leptothrix hardyi* (BLACKWALL, 1850)	R		+		
77	*Lophomma punctatum* (BLACKWALL, 1841)		+	+	+	
78	*Macrargus carpenteri* (O. P.-CAMBRIDGE, 1894)			+		
79	*Macrargus rufus* (WIDER, 1834)			+		
80	*Maro minutus* O. P.-CAMBRIDGE, 1906			+		
81	*Maso gallicus* SIMON, 1884	R			+	
82	*Maso sundevalli* (WESTRING, 1851)			+		
83	*Mecynargus foveatus* (DAHL, 1912)	R		+		
84	*Meioneta affinis* (KULCZYŃSKI, 1898)			+		
85	*Meioneta mollis* (O. P.-CAMBRIDGE, 1871)		+	+		
86	*Meioneta rurestris* (C.L. KOCH, 1836)		+	+	+	+
87	*Meioneta saxatilis* (BLACKWALL, 1844)		+	+		
88	*Metopobactrus prominulus* (O. P.-CAMBRIDGE, 1872)			+		
89	*Micrargus herbigradus* (BLACKWALL, 1854)		+	+		
90	*Micrargus subaequalis* (WESTRING, 1851)		+			
91	*Microlinyphia impigra* (O. P.-CAMBRIDGE, 1871)			+	+	+
92	*Microlinyphia pusilla* (SUNDEVALL, 1830)		+	+	+	
93	*Microneta viaria* (BLACKWALL, 1841)		+	+		
94	*Minyriolus pusillus* (WIDER, 1834)			+		
95	*Neriene clathrata* (SUNDEVALL, 1830)			+	+	
96	*Notioscopus sarcinatus* (O. P.-CAMBRIDGE, 1872)		+	+		
97	*Oedothorax apicatus* (BLACKWALL, 1850)		+	+		
98	*Oedothorax fuscus* (BLACKWALL, 1834)		+	+	+	+

1	2	3	4	5	6	7
99	*Oedothorax gibbosus* (BLACKWALL, 1841)		+	+	+	
100	*Oedothorax retusus* (WESTRING, 1851)		+	+		+
101	*Pallidiphantes alutacius* (SIMON, 1884)			+		
102	*Pelecopsis mengei* (SIMON, 1884)			+		
103	*Pelecopsis parallela* (WIDER, 1834)			+		
104	*Peponocranium orbiculatum* (O. P.-CAMBRIDGE, 1882)	R		+		
105	*Pocadicnemis juncea* LOCKET & MILLIDGE, 1953		+	+		+
106	*Pocadicnemis pumila* (BLACKWALL, 1841)		+	+	+	
107	*Porrhomma campbelli* F. P.-CAMBRIDGE, 1894	R		+		+
108	*Porrhomma microphthalmum* (O. P.-CAMBRIDGE, 1871)	R			+	+
109	*Porrhomma pygmaeum* (BLACKWALL, 1834)		+	+	+	+
110	*Satilatlas britteni* (JACKSON, 1913)	R		+		
111	*Savignya frontata* BLACKWALL, 1833		+	+	+	+
112	*Silometopus elegans* (O. P.-CAMBRIDGE, 1872)	R	+	+	+	+
113	*Stemonyphantes lineatus* (LINNAEUS, 1758)			+		
114	*Styloctetor stativus* (SIMON, 1881)		+	+		
115	*Syedra gracilis* (MENGE, 1869)		+			
116	*Tallusia experta* (O. P.-CAMBRIDGE, 1871)		+	+	+	
117	*Tapinocyba insecta* (L. KOCH, 1869)			+		
118	*Tapinocyba pallens* (O. P.-CAMBRIDGE, 1872)			+		
119	*Tapinocyboides pygmaeus* (MENGE, 1869)			+		
120	*Taranucnus setosus* (O. P.-CAMBRIDGE, 1863)	R	+	+	+	
121	*Tenuiphantes cristatus* (MENGE, 1866)			+		
122	*Tenuiphantes flavipes* (BLACKWALL, 1854)			+		
123	*Tenuiphantes mengei* (KULCZYŃSKI, 1887)			+		
124	*Thyreosthenius biovatus* (O. P.-CAMBRIDGE, 1875)	R		+		
125	*Tiso vagans* (BLACKWALL, 1834)		+	+	+	+
126	*Trichopterna cito* (O. P.-CAMBRIDGE, 1872)			+		
127	*Trichopterna thorelli* (WESTRING, 1861)			+		
128	*Troxochrus scabriculus* (WESTRING, 1851)			+		
129	*Walckenaeria alticeps* (DENIS, 1952)		+	+	+	
130	*Walckenaeria antica* (WIDER, 1834)			+		
131	*Walckenaeria atrotibialis* (O. P.-CAMBRIDGE, 1878)			+		
132	*Walckenaeria cucullata* (C.L. KOCH, 1836)			+		
133	*Walckenaeria cuspidata* BLACKWALL, 1833			+		
134	*Walckenaeria kochi* (O. P.-CAMBRIDGE, 1872)		+	+	+	
135	*Walckenaeria nodosa* O. P.-CAMBRIDGE, 1873		+	+		
136	*Walckenaeria nudipalpis* (WESTRING, 1851)		+	+	+	
137	*Walckenaeria unicornis* O. P.-CAMBRIDGE, 1861		+	+	+	
138	*Walckenaeria vigilax* (BLACKWALL, 1853)		+	+		+
	Tetragnathidae					
139	*Pachygnatha clercki* SUNDEVALL, 1823		+	+	+	+
140	*Pachygnatha degeeri* SUNDEVALL, 1830		+	+	+	
141	*Pachygnatha listeri* SUNDEVALL, 1830			+		
142	*Tetragnatha dearmata* THORELL, 1873			+	+	
143	*Tetragnatha extensa* (LINNAEUS, 1758)		+	+	+	
144	*Tetragnatha montana* SIMON, 1874				+	
145	*Tetragnatha reimoseri* (ROSCA, 1939)	R			+	
146	*Tetragnatha striata* L. KOCH, 1862			+	+	
	Araneidae					
147	*Aculepeira ceropegia* (WALCKENAER, 1802)				+	
148	*Agalenatea redii* (SCOPOLI, 1763)			+	+	
149	*Araneus alsine* (WALCKENAER, 1802)			+	+	
150	*Araneus diadematus* CLERCK, 1757			+	+	

1	2	3	4	5	6	7
151	*Araneus marmoreus* CLERCK, 1757		+	+	+	
152	*Araneus quadratus* CLERCK, 1757		+	+	+	+
153	*Araneus sturmi* (HAHN, 1831)				+	
154	*Araniella cucurbitina* (CLERCK, 1757)			+	+	+
155	*Araniella opisthographa* (KULCZYŃSKI, 1905)				+	
156	*Araniella proxima* (KULCZYŃSKI, 1885)	R			+	
157	*Argiope bruennichi* (SCOPOLI, 1772)				+	
158	*Cercidia prominens* (WESTRING, 1851)		+	+	+	
159	*Hypsosinga heri* (HAHN, 1831)		+	+	+	+
160	*Hypsosinga pygmaea* (SUNDEVALL, 1832)			+	+	
161	*Larinia jeskovi* MARUSIK, 1986	R	+	+	+	+
162	*Larinioides cornutus* (CLERCK, 1757)		+	+	+	+
163	*Larinioides patagiatus* (CLERCK, 1757)			+	+	
164	*Mangora acalypha* (WALCKENAER, 1802)		+	+	+	+
165	*Neoscona adianta* (WALCKENAER, 1802)			+	+	
166	*Singa hamata* (CLERCK, 1757)		+	+	+	+
167	*Singa nitidula* C.L. KOCH, 1844				+	
	Lycosidae					
168	*Alopecosa accentuata* (LATREILLE, 1817)			+		
169	*Alopecosa aculeata* (CLERCK, 1757)			+		
170	*Alopecosa cuneata* (CLERCK, 1757)			+		
171	*Alopecosa cursor* (HAHN, 1831)			+		
172	*Alopecosa pulverulenta* (CLERCK, 1757)			+		+
173	*Alopecosa schmidti* (HAHN, 1835)			+		
174	*Arctosa leopardus* (SUNDEVALL, 1833)			+		+
175	*Arctosa perita* (LATREILLE, 1799)			+		
176	*Hygrolycosa rubrofasciata* (OHLERT, 1865)			+		
177	*Pardosa agricola* (THORELL, 1856)			+		
178	*Pardosa amentata* (CLERCK, 1757)		+	+	+	
179	*Pardosa lugubris* (WALCKENAER, 1802)			+		+
180	*Pardosa maisa* HIPPA & MANNILA, 1982	R	+	+	+	
181	*Pardosa paludicola* (CLERCK, 1757)			+		+
182	*Pardosa palustris* (LINNAEUS, 1758)		+	+		
183	*Pardosa prativaga* (L. KOCH, 1870)		+	+	+	+
184	*Pardosa pullata* (CLERCK, 1757)			+	+	
185	*Pardosa sphagnicola* DAHL, 1908		+	+		+
186	*Pirata hygrophilus* THORELL, 1872		+	+		
187	*Pirata insularis* EMERTON, 1885	R	+			
188	*Pirata latitans* (BLACKWALL, 1841)		+	+		
189	*Pirata piraticus* (CLERCK, 1757)		+	+	+	+
190	*Pirata piscatorius* (CLERCK, 1757)		+	+	+	+
191	*Pirata tenuitarsis* SIMON, 1876	R	+	+	+	+
192	*Pirata uliginosus* (THORELL, 1856)		+	+	+	
193	*Trochosa ruricola* (DE GEER, 1778)		+	+		+
194	*Trochosa spinipalpis* (F. P.-CAMBRIDGE, 1895)		+	+		
195	*Trochosa terricola* THORELL, 1856		+	+		
196	*Xerolycosa miniata* (C.L. KOCH, 1834)		+	+		
197	*Xerolycosa nemoralis* (WESTRING, 1861)		+	+		
	Pisauridae					
198	*Dolomedes fimbriatus* (CLERCK, 1757)			+	+	+
199	*Dolomedes plantarius* (CLERCK, 1757)			+		+
200	*Pisaura mirabilis* (CLERCK, 1757)			+	+	
	Cybaeidae					
201	*Argyroneta aquatica* (CLERCK, 1757)			+		+

1	2	3	4	5	6	7
	Hahniidae					
202	*Antistea elegans* (BLACKWALL, 1841)		+	+	+	+
203	*Hahnia pusilla* C.L. KOCH, 1841		+	+		
	Dictynidae					
204	*Argenna patula* (SIMON, 1874)	R	+	+	+	+
205	*Argenna subnigra* (O. P.-CAMBRIDGE, 1861)			+		
206	*Cicurina cicur* (FABRICIUS, 1793)		+	+		
207	*Dictyna arundinacea* (LINNAEUS, 1758)		+	+	+	+
208	*Lathys humilis* (BLACKWALL, 1855)		+			
	Miturgidae					
209	*Cheiracanthium campestre* LOHMANDER, 1944	R		+		
210	*Cheiracanthium erraticum* (WALCKENAER, 1802)			+	+	
211	*Cheiracanthium virescens* (SUNDEVALL, 1833)			+	+	
	Liocranidae					
212	*Liocranoeca striata* (KULCZYŃSKI, 1882)			+		
213	*Agroeca brunnea* (BLACKWALL, 1833)			+		
214	*Agroeca dentigera* KULCZYŃSKI, 1913	R	+	+	+	
215	*Agroeca lusatica* (L. KOCH, 1875)		+	+		
216	*Agroeca proxima* (O. P.-CAMBRIDGE, 1871)			+		
217	*Scotina palliardi* (L. KOCH, 1881)	R		+		
	Clubionidae					
218	*Clubiona diversa* O. P.-CAMBRIDGE, 1862			+		
219	*Clubiona frutetorum* L. KOCH, 1866			+		
220	*Clubiona germanica* THORELL, 1871			+		+
221	*Clubiona phragmitis* C.L. KOCH, 1843			+	+	+
222	*Clubiona reclusa* O. P.-CAMBRIDGE, 1863			+		+
223	*Clubiona rosserae* LOCKET, 1953	R		+	+	
224	*Clubiona stagnatilis* KULCZYŃSKI, 1897		+	+	+	+
225	*Clubiona subtilis* L. KOCH, 1867		+	+	+	
	Corinnidae					
226	*Phrurolithus festivus* (C.L. KOCH, 1835)			+		+
	Gnaphosidae					
227	*Drassodes pubescens* (THORELL, 1856)			+		
228	*Drassyllus lutetianus* (L. KOCH, 1866)	R	+	+	+	+
229	*Drassyllus praeficus* (L. KOCH, 1866)			+		
230	*Drassyllus pusillus* (C.L. KOCH, 1833)			+		
231	*Gnaphosa nigerrima* L. KOCH, 1878	R	+	+		
232	*Haplodrassus dalmatensis* (L. KOCH, 1866)	R		+		
233	*Haplodrassus moderatus* (KULCZYŃSKI, 1897)	R	+	+	+	
234	*Haplodrassus signifer* (C.L. KOCH, 1839)			+		
235	*Haplodrassus silvestris* (BLACKWALL, 1833)			+		
236	*Micaria fulgens* (WALCKENAER, 1802)			+		
237	*Micaria pulicaria* (SUNDEVALL, 1832)			+		+
238	*Zelotes aeneus* (SIMON, 1878)	R		+		
239	*Zelotes apricorum* (L. KOCH, 1876)			+		
240	*Zelotes electus* (C.L. KOCH, 1839)			+		
241	*Zelotes latreillei* (SIMON, 1878)			+		
242	*Zelotes longipes* (L. KOCH, 1866)		+	+		
243	*Zelotes petrensis* (C.L. KOCH, 1839)			+		
244	*Zelotes subterraneus* (C.L. KOCH, 1833)			+		
	Zoridae					
245	*Zora armillata* SIMON, 1878	R	+	+	+	+
246	*Zora nemoralis* (BLACKWALL, 1861)			+		
247	*Zora silvestris* KULCZYŃSKI, 1897			+		

1	2	3	4	5	6	7
248	*Zora spinimana* (SUNDEVALL, 1833)		+	+		
	Sparassidae					
249	*Micrommata virescens* (CLERCK, 1757)				+	
	Philodromidae					
250	*Philodromus cespitum* (WALCKENAER, 1802)			+	+	
251	*Thanatus arenarius* L. KOCH, 1872			+		
252	*Thanatus striatus* C.L. KOCH, 1845	R	+	+	+	+
253	*Tibellus maritimus* (MENGE, 1874)		+	+	+	
254	*Tibellus oblongus* (WALCKENAER, 1802)			+	+	
	Thomisidae					
255	*Heriaeus graminicola* (DOLESCHAL, 1852)		+	+	+	
256	*Misumena vatia* (CLERCK, 1757)				+	
257	*Misumenops tricuspidatus* (FABRICIUS, 1775)				+	
258	*Ozyptila atomaria* (PANZER, 1801)			+		
259	*Ozyptila brevipes* (HAHN, 1826)			+	+	
260	*Ozyptila gertschi* KURATA, 1944	R	+	+	+	
261	*Ozyptila scabricula* (WESTRING, 1851)			+		
262	*Ozyptila trux* (BLACKWALL, 1846)		+	+	+	+
263	*Tmarus piger* (WALCKENAER, 1802)				+	
264	*Xysticus audax* (SCHRANK, 1803)			+		
265	*Xysticus cristatus* (CLERCK, 1757)		+	+	+	+
266	*Xysticus erraticus* (BLACKWALL, 1834)			+		
267	*Xysticus kochi* THORELL, 1872			+		
268	*Xysticus ulmi* (HAHN, 1831)		+	+	+	+
	Salticidae					
269	*Aelurillus v-insignitus* (CLERCK, 1757)			+	+	
270	*Euophrys frontalis* (WALCKENAER, 1802)			+		+
271	*Evarcha arcuata* (CLERCK, 1757)			+	+	
272	*Heliophanus auratus* C.L. KOCH, 1835				+	
273	*Heliophanus dubius* C.L. KOCH, 1835			+		
274	*Heliophanus flavipes* (HAHN, 1831)			+	+	
275	*Marpissa radiata* (GRUBE, 1859)			+	+	+
276	*Neon reticulatus* (BLACKWALL, 1853)				+	
277	*Neon valentulus* FALCONER, 1912	R	+	+	+	
278	*Pellenes tripunctatus* (WALCKENAER, 1802)			+		
279	*Phlegra fasciata* (HAHN, 1826)			+		
280	*Sibianor aurocinctus* (OHLERT, 1865)			+		
281	*Sitticus caricis* (WESTRING, 1861)		+	+	+	
282	*Sitticus floricola* (C.L. KOCH, 1837)		+	+	+	+
283	*Sitticus saltator* (O. P.-CAMBRIDGE, 1868)			+		
284	*Sitticus zimmermanni* (SIMON, 1877)			+		
285	*Talavera aequipes* (O. P.-CAMBRIDGE, 1871)			+		

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Janusz KUPRYJANOWICZ

Spiders (*Araneae*) of open habitats in the Biebrza National Park, Poland

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