FOLIA OECOLOGICA – vol. 43, no. 2 (2016). ISSN 1336-5266

Assemblages of ground living spiders (Araneae) in peatland habitats, surrounding dry pine forest and meadows

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Abstract

Gajdoš, P., Majzlan, O., Igondová, E., 2016. Assemblages of ground living spiders (Araneae) in peatland habitats, surrounding dry pine forest and meadows. *Folia Oecologica*, 43: 147–155.

This research was conducted to study assemblages of ground living spider of a peatland and their surrounding habitats (margin of dry pine forest and meadows) in the Šuja peat bog (in northern part of Slovakia) in 2013. The aim of study was to classify assemblages of ground living spider into different habitat types, compare their composition and analyse the relation of species occurrence at study sites. Spiders were sampled between April and October 2013 at 8 study sites using pitfall traps. 1,974 individuals belonging to 100 species and to 21 families were captured in total. Diversity, equitability, species composition, preference for humidity, inclusion in the group of their ecological valence and habitat association were used to characterize ground living spider communities at each study site. In order to evaluate the relationship among the communities of the spiders at the sampling sites we used principal component analysis. Based on their ecological characteristics, spiders formed five groups of species associated with semi dry to mesophilous open meadow habitats, semi dry woodland habitats, mesophilous unshaded habitats, mesophilous partly shaded habitats without herbal vegetation cover and hygrophilous habitats.

Key words

Araneae, diversity, ground living spiders, meadows, peatlands, pine forest margin

Introduction

Peatlands comprise over 50% of the world's wetlands. They have generally been regarded as wasteland rather than as any special, or even recognisable, part of the natural world. Recently, perceptions of peatlands have begun to change dramatically, and they are now increasingly acknowledged as a habitat type of global significance. Apart from their biological diversity, they provide goods and services to people, they play an important role in water regulation, they store carbon, and they are of value for education and research. Central European peatlands play an important role in the global and international conservation of species (Bragg et al., 2003). Peatlands are very rare, threatened and often relict ecosystems. In general, there is a lack of knowledge about ecosystem functioning and management planning and not all protected areas are protected effectively (Stanová, 2000). Therefore peatlands and other wetland fragments are mainly surrounded by drier habitats such as forests or meadows (Igondová and Majzlan, 2015).

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Spiders, an important component of peatland fauna, are used as bio-indicators of environmental quality (Buchar, 1983, 1991; Buchar and Růžička, 2002; Růžička and Boháč, 1994; Růžička, 1986, 1987; Scott et al., 2006) and for evaluation of biota changes in relation to land management and the succession (Maelfait et al., 1990; Maelfait, 1996; Maelfait et al., 2002; Buchholz, 2016).

Presented study deals with description of community of ground dwelling spiders in Šujské rašelinisko territory. The equitability and similarity in peatland habitats, surrounding dry pine forest and meadows near Šujské rašelinisko territory and classification the studied plots according to their importance from the point of view of nature conservation were assessed.

From the arachnological point of view no study was carried out on study area. Only a few studies dealt with insect fauna in this territory. Bitušík (1998) studied chironomid flies (*Chironomidae*), Badík (1994) and Šácha and Racko (2014) analysed community of dragonflies (Odonata). Majzlan et al. (2004), Majzlan and Igondová (2013) and Igondová and Majzlan (2015) provided the first data about beetles (Coleoptera) in Šujské rašelinisko locality.

Study area and sampling sites

The Nature Reserve Šujské rašelinisko is located near the village Šuja along Rajčanka River in the cadastre territory of the village Rajecká Lesná (10.8 ha). It belongs to the Malá Fatra National Park (north Slovakia) and its conservation is subject to 4th level of nature protection. This Reserve is also part of Special Area of Conservation (SAC) which belongs to the NATURA 2000 network (13.48 ha). The area is located in altitude 470 m asl. The objects of conservation for this SAC are following habitats listed in Annex I of the Habitats Directive, namely the natural dystrophic lakes and ponds, the *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*), the hydrophilous tall herb fringe communities of plains and of the montane to alpine levels and the alkaline fens. During the 1970s, the territory was destroyed by a peat exploitation mainly in the north-western part of territory (Igondová and Majzlan, 2015).

In 2010 the surrounding of the protected area was disturbed by building proposal of large parking place (ITV Rajec, 2010). Finally, the proposal was rejected and the area seems to be revitalised now. Nevertheless, studied area is still a valued wetland in Slovakia, but threatened by increasing succession. *Pinus nigra* is spreading on the north-western part from the surrounding dry pine forest and more willow shrubs spread to the centre of the peat bog from the east part of Rajčianka riverside. The exploited area is being gradually overgrown by autochthonous vegetation and partly also by ruderal vegetation. The small island situated in the centre of Šuja peat bog is shrubby with *Rubus* sp. and *Urtica* sp. in canopy and undergrowth. This island is influenced by the decline of groundwater level. The edges of neighbouring roads are surrounded by *Salix* sp. and *Alnus glutinosa* in canopy and a dense stand of reeds (*Phragmites* sp.) in the north-western and eastern parts of the territory (Igondová and Majzlan, 2015).

Eight sampling sites of peatland habitats, surrounding dry pine forest and meadows were established and they are the same as for carabid study (Igondová and Majzlan, 2015) (Fig 1):

1 (49°03’40.4”N, 18°36’57.2”E), dry pine forest (for) – forest edge at slope of Strážov hills on the limestone ground with *Pinus* sp.

2 (49°03’37.7”N, 18°36’58.6”E), osier (osi) – waterlogged area at mild depression with *Salix repens* and *Salix purpurea*

3 (49°03’37.6”N, 18°37’02.1”E), playground (plg) – meadow, mown area, flat surface, without trees, slightly dry, with frequent appearance of molehills

4 (49°03’40.3”N, 18°37’05.2”E), peat (pet) – peat bench, unexploited part of peatland, with *Rubus idaeus*

5 (49°03’42.6”N, 18°37’05.8”E), gravel bars (gra) – gravel bench in the middle of the reservation with *Betula* sp. and *Pinus* sp.

6 (49°03’44.6”N, 18°37’05.8”E), reed (ree) – damp areas around slightly flowing water with *Phragmites australis*

7 (49°03’46.3”N, 18°37’09.8”E), overgrow (ovg) – on the peat bench with *Salix* sp. and *Rubus* sp.

8 (49°03’36.9”N, 18°37’18.4”E), field-meadow (fim) – edge of the meadow and field by the Rajčianka riverside, ruderal, overgrown with vegetation.

Material and methods

Ground living spiders were pitfall-trapped at eight sampling sites bi-weekly during the season 2013 (on following dates: 3 May, 17 May, 2 June, 16 June, 1 July, 15 July, 29 July, 12 August, 27 August, 14 September, 27 September, 12 October and 1 November 2013). Pitfall traps were installed on 14 April 2013 and exposed for 201 days. Covered traps (500 ml in size, 10 cm in diameter, half-filled with 4% formalin solution) were used to collect samples. Five traps were placed in lines in each habitat. The humidity preference was classified using an eight degree semiquantitative scale (1 – very dry, 2 – dry to very dry, 3 – slightly dry to semi-humid, 4 – unspecific, 5 – semi-humid (mesohydrophilous), 6 – semi-humid to humid, 7 – humid to very humid, 8 – very humid (Buchar and Růžička, 2002).

The Shannon-Wiener index (H’) (Shannon and Weaver, 1949; Spellerberg and Fedor, 2003) was used to consider both abundance and evenness of species in the spider community. As an equitability index we used Pielou’s Evenness Index or Equitability (E)

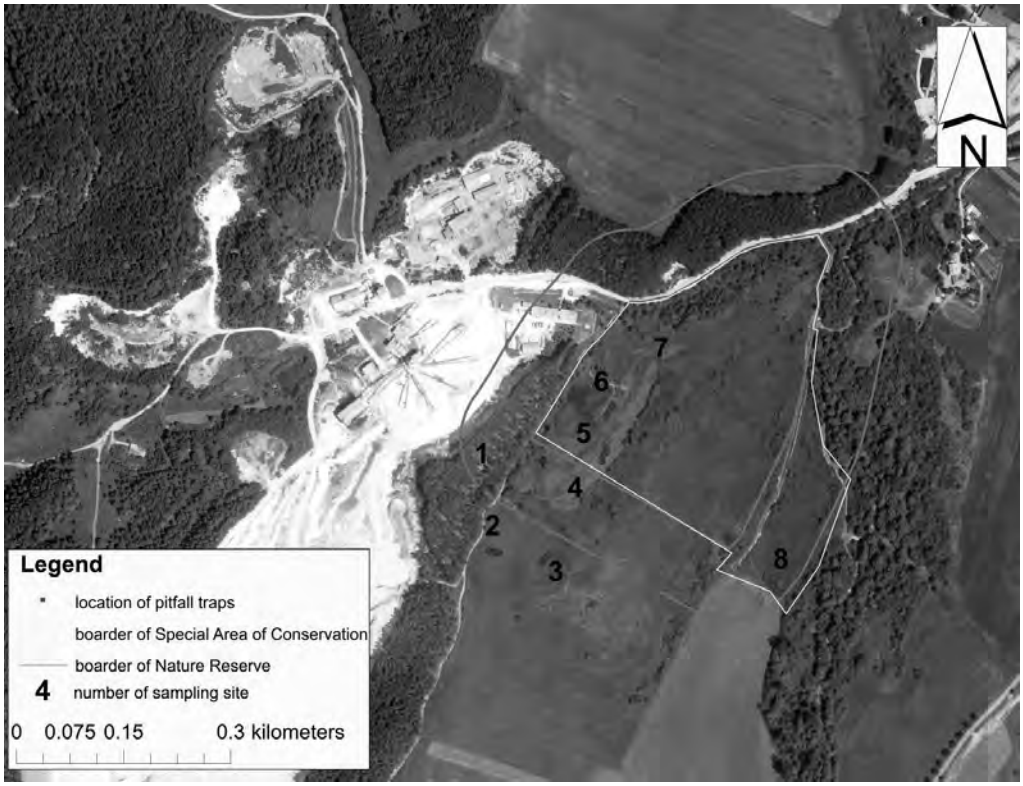

Fig. 1. Distribution of sampling sites of Šujské rašelinisko territory.

(Pielou, 1966). Analyses were carried out using the PAST program. The ground living spiders were divided into four groups: 1 (climax), 2 (climax and seminatural), 3 (climax, seminatural and disturbed or artificial), 4 (disturbed or artificial), according to the range of their ecological valence and their association with the originality of habitats (Buchar and Růžička, 2002). Principal component analysis (PCA) was conducted to evaluate the relationship among the communities of the ground living spiders at the sampling sites using the CANOCO software program (TerBraak and Šmilauer, 1998).

Though smaller distances between species points and sampling site points represent higher correlation between the values. The nomenclature and systematic order of spiders follow last version of the World Spider Catalog (World Spider Catalog, 2015).

Results and discussion

A total of 1,974 specimens belonging to 100 species were documented (Table 1). Species *Trochosa terricola, Piratula hygrophila and Pardosa riparia* representing 46% of captured species were with the highest dominancy at studied sites. *Trochosa terricola* occurred abundantly at all sampling sites. Species *Piratula hygrophila* preferred wet habitats and *Pardosa riparia* was associated with mesophilous open habitat (Fig. 2).

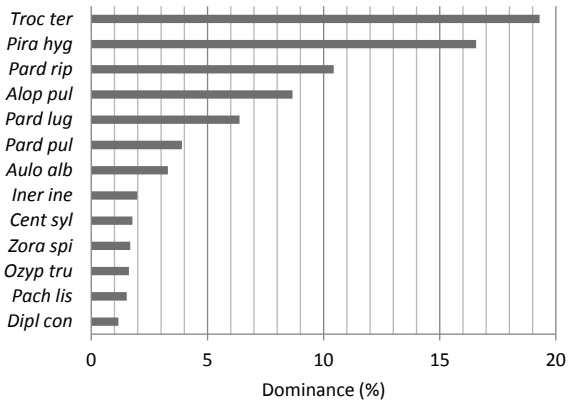

Fig. 2. Species with dominance higher than 1%.

Community of ground dwelling spiders at forest margin sampling site included eudominant species (>10%) *Trochosa terricola* (19.7%) and *Inermocoelotes inermis* (15.8%), further domimant species (5–10%), *Pardosa lugubris* (6.4%), *Zodarion germanicum* (6.4%), *Ceratinella brevis* (5.6%) and *Tapinocyba insecta* (5.1%). These species prefer shaded or semi shaded habitats (silvicol species) and semi or slightly dry habitats.

The osier sampling site is characterized by balanced equitability values with *Piratula hygrophila* (54.2%) as a eudominant species. This species prefers

Table 1. Abundance of ground living spiders (Araneae) sampled

Species	Abbr	for	osi	plg	pet	gra	ree	ovg	fim	RL	Hum	O-h
Mimetidae												
Ero furcata (Villers, 1789)	*Ero fur*			1	2			1	3		5	2
Theridiidae												
Robertus neglectus (O.P.-Cambridge, 1871)	*Robe neg*		2						1	NT	5	2
Linyphiidae												
Agyneta affinis (Kulczyński, 1898)	*Agyn aff*			2	1						4	2(1)
Agyneta rurestris (C.L.Koch, 1836)	*Agyn rur*			1							6	3
Araeoncus crassiceps (Westring, 1861)	*Arae cra*				1					EN	7	2(1)
Bathyphantes gracilis (Blackwall, 1841)	*Bath gra*								2		5	3
Bathyphantes nigrinus (Westring, 1851)	*Bath nig*							1			6	2
Bathyphantes parvulus (Westring, 1851)	*Bath par*	1									5	2
Centromerus brevipalpus (Menge, 1866)	*Cent bre*	2								NT	5	2
Centromerus sylvaticus (Blackwall, 1841)	*Cent syl*	2	7	2	3	1	14	5	1		6	3
Ceratinella brevis (Wider, 1834)	*Cera bre*	13	1				1				6	2
Cnephalocotes obscurus (Blackwall, 1834)	*Cnep obs*							1			6	2
Dicymbium brevisetosum Locket, 1962	*Dicy bre*			5				1	4		6	3
Diplostyla concolor (Wider, 1834)	*Dipl con*	3	1		10		1	7	1		7	2
Dismodicus bifrons (Blackwall, 1841)	*Dism bif*		1		1						5	2
Entelecara erythropus (Westring, 1851)	*Ente ery*								1	LC	5	2
Gonatium paradoxum (L.Koch, 1869)	*Gona par*		3	1							7	2
Gongylidiellum latebricola (O.P.-Cambridge, 1871)	*Gong lat*		1	1	1						8	2
Gongylidium rufipes (Linnaeus, 1758)	*Gong ruf*				1			1			7	2
Mansuphantes mansuetus (Thorell, 1875)	*Mans man*	9		1	1						6	3
Micrargus herbigradus (Blackwall, 1854)	*Micr her*		1								6	2
Micrargus subaequalis (Westring, 1851)	*Micr sub*			2		2					3	2
Neriene clathrata (Sundevall, 1830)	*Neri cla*	2		1	1				1		6	2
Palliduphantes alutacius (Simon, 1884)	*Pall alu*								1		5	2
Pocadicnemis juncea Locket & Millidge, 1953	*Poca jun*		2	2	1	1	7	4			7	2
Tapinocyba insecta (L.Koch, 1869)	*Tapi ins*	12	2	1							5	2
*Tapinopa longidens (*Wider, 1834)	*Tapi lon*							1			5	2
Tenuiphantes cristatus (Menge, 1866)	*Tenu cri*	1			1						6	2
*Tenuiphantes flavipes (*Blackwall, 1854)	*Tenu fla*	3									3	2
Tenuiphantes mengei (Kulczyński, 1887)	*Tenu men*		1	2	5	1	1				4	2
Walckenaeria acuminata Blackwall, 1833	*Walc acu*				1		1			LC	6	2
Walckenaeria atrotibialis (O.P.-Cambridge, 1878)	*Walc atr*	2	1								4	2
Walckenaeria dysderoides (Wider, 1834)	*Walc dys*	1		3							3	2
Walckenaeria furcillata (Menge, 1869)	*Walc fur*	2			1	1					3	2
Walckenaeria mitrata (Menge, 1868)	*Walc mit*	1									5	2
Walckenaeria obtusa Blackwall, 1836	*Walc obt*								1		6	2
Tetragnathidae												
Pachygnatha degeeri Sundevall, 1830	*Pach deg*			8	1						4	3
Pachygnatha listeri Sundevall, 1830	*Pach lis*		7	3	2		1	10	7		7	2
Araneidae												

Table 1. Abundance of ground living spiders (Araneae) sampled – continued

Species	Abbr	for	osi	plg	pet	gra	ree	ovg	fim	RL	Hum	O-h
Araneus quadratus Clerck, 1757	*Aran qua*								1		6	2
Argiope bruennichi (Scopoli, 1772)	*Argi bru*		1								4	3
Cercidia prominens (Westring, 1851)	*Cerc pro*		1								4	2(1)
Lycosidae												
Alopecosa cuneata (Clerck, 1757)	*Alop cun*			3							4(1)	3
Alopecosa pulverulenta (Clerck, 1757)	*Alop pul*		16	93	14	6	3	31	8		4	3
Arctosa maculata (Hahn, 1822)	*Arct mac*		1			2					8	1
Aulonia albimana (Walckenaer, 1805)	*Aulo alb*	7	16	4	2	28	3	2	3		3	2
*Pardosa amentata (*Clerck, 1757)	*Pard ame*				3			2	12		7	3
Pardosa lugubris (Walckenaer, 1802)	*Pard lug*	15	1	8	13	2		78	9		3	3
Pardosa paludicola (Clerck, 1757)	*Pard pal*							6			7	3
Pardosa palustris (Linnaeus, 1758)	*Pard pal*			4	1				7		4	3
Pardosa pullata (Clerck, 1757)	*Pard pul*		6	35	5	4		2	25		3	3
Pardosa riparia (C.L.Koch, 1833)	*Pard rip*		9	140	15	3	1	12	26		4	2
Piratula hygrophila (Thorell, 1872)	*Pira hyg*		182	1	47		18	13	66		8	2
Piratula latitans (Blackwall, 1841)	*Pira lat*			1		5	2	5	1		8	2
Trochosa ruricola (De Geer, 1778)	*Troc rur*			1			1	1	2		6	3
Trochosa terricola Thorell, 1856	*Troc ter*	46	27	117	76	27	18	52	18		4	3
Pisauridae												
Pisaura mirabilis (Clerck, 1757)	*Pisa mir*		2								3	3
Miturgidae												
Zora nemoralis (Blackwall, 1861)	*Zora nem*	3									3	2
Zora spinimana (Sundevall, 1833)	*Zora spi*	15	8		1	3	1	2	3		4	3
Agelenidae												
Agelena labyrinthica (Clerck, 1757)	*Agel lab*	1									3	2
Coelotes atropos (Walckenaer, 1830)	*Coel atr*					1					5	1
Coelotes terrestris (Wider, 1834)	*Coel ter*	7					1				4	2
Inermocoelotes inermis (L.Koch, 1855)	*Iner ine*	37	1	1							5	2
Tegenaria campestris (C.L.Koch, 1834)	*Tege cam*	1									4	2
Cybaeidae												
Cybaeus angustiarum L.Koch, 1868	*Cyba ang*								4		6	2(1)
Hahniidae												
Antistea elegans (Blackwall, 1841)	*Anti ele*		14				4				7	2(1)
Dictynidae												
Cicurina cicur (Fabricius, 1793)	*Cicu cic*			2	1	1		1			5	3
Titanoecidae												
Titanoeca quadriguttata (Hahn, 1833)	*Tita qua*	1									2(1)	2(1)
Liocranidae												
Agroeca brunnea (Blackwall, 1833)	*Agro bru*					1	5				4	2
Phrurolithidae												
Phrurolithus festivus (C.L.Koch, 1835)	*Phru fes*	3		1	2	3		6			3	2
Clubionidae												
Clubiona reclusa O.P.-Cambridge, 1863	*Club rec*						1				6	2
Clubiona subtilis L.Koch, 1867	*Club sub*							1			7	2
Zodariidae												

Table 1. Abundance of ground living spiders (Araneae) sampled – continued

Species	Abbr	for	osi	plg	pet	gra	ree	ovg	fim	RL	Hum	O-h
Zodarion germanicum (C.L.Koch, 1837)	*Zoda ger*	15		2							2	2(1)
Gnaphosidae												
Drassodes cupreus (Blackwall, 1834)	*Dras cup*					4		1			2	2(1)
Drassodes lapidosus (Walckenaer, 1802)	*Dras lap*	1									2	2
Drassodes pubescens (Thorell, 1856)	*Dras pub*	1	1		1	3					2	2
Drassyllus lutetianus (L.Koch, 1866)	*Dras lut*				1						7	3
Drassyllus pusillus (C.L.Koch, 1833)	*Dras pus*			3					1		3	3
Micaria formicaria (Sundevall, 1831)	*Mica for*			1							2	2
Micaria pulicaria (Sundevall, 1831)	*Mica pul*			3	1						5	2
Scotophaeus scutulatus (L.Koch, 1866)	*Scot scu*			1							4	3
Zelotes apricorum (L.Koch, 1876)	*Zelo apr*	12						1			4	2
Zelotes erebeus (Thorell, 1871)	*Zelo ere*	1									3	1
Zelotes exiguus (Müller & Schenkel, 1895)	*Zelo exi*					3				CR	2	1
Zelotes latreillei (Simon, 1878)	*Zelo lat*			2	2	2	3	1	1		4	3
Zelotes petrensis (C.L.Koch, 1839)	*Zelo pet*	1		1		4					3	2
Philodromidae												
Philodromus collinus C.L.Koch, 1835	*Phil col*			1							5	2
Thomisidae												
Coriarachne depressa (C.L.Koch, 1837)	*Cori dep*	3									3	2
*Ozyptila atomaria (*Panzer, 1801)	*Ozyp ato*	1	1	6		1					3	2
Ozyptila trux (Blackwall, 1846)	*Ozyp tru*		16	4	2			2	8		7	3
Xysticus bifasciatus C.L.Koch, 1837	*Xyst bif*			3							4	3
Xysticus cristatus (Clerck, 1757)	*Xyst cri*			5					6		4	3
Xysticus ulmi (Hahn, 1832)	*Xyst ulm*			1	1						6	2
Salticidae												
Euophrys frontalis (Walckenaer, 1802)	*Euop fro*	3	1	1		6	1	3			3	2
Evarcha arcuata (Clerck, 1757)	*Evar arc*		1	1	1			2			5	2
Evarcha falcata (Clerck, 1757)	*Evar fal*	5	1		1						3	2
Heliophanus flavipes (Hahn, 1832)	*Heli fla*							1			2	1
Myrmarachne formicaria (De Geer, 1778)	*Myrm for*						2				4	1
*Neon reticulatus (*Blackwall, 1853)	*Neon ret*	1			2	1	1	5	1		5	2
Synageles venator (Lucas, 1836)	*Syna ven*						1				4	3
Talavera aperta Miller, 1971	*Tala ape*			1						DD	2	2(1)

forest (for); osier (osi); playground (plg); peat (pet); gravel bars (gra); reed (ree); overgrow (ovg); field-meadow (fim); Red list (RL); demand on humidity (Hum); association with the originality of habitats (O–h).

wet places from lowlands to mountains and are also present at other study sites.

The higher quantity refers to the playground sampling site and the community contained three eudominant species *Pardosa riparia* (28.99%), *Trochosa terricola* (24.22%) and *Alopecosa pulverulenta* (19.3%). These species are mesophilous, inhabiting unshaded non-forest habitats, mainly meadows.

The peat sampling site with high value of equitability had two eudominant species *Trochosa terricola* (33.63%), *Piratula hygrophila* (20.8%). *Trochosa terricola* is eurytopic species concerning humidity and light demands, inhabiting edge of all forests and also open habitats from lowlands to uplands.

The gravel bars sampling site with low number of species included two eudominant species *Aulonia albimana* (24.1%), *Trochosa terricola* (23.3%). These species prefer open or partly shaded habitats, often on rock steppes.

The reed sampling site was characterized by eudominant species *Piratula hygrophila* (19.57%), *Trochosa terricola* (19.57%) and *Centromerus sylvaticus*

(15.22%). *Piratula hygrophila* is very abundant in shaded wetlands. Other two species occur in a wide range of open and forest habitats.

At the overgrow sampling site were dominant *Pardosa lugubris* (29.77%) and *Trochosa terricola* (19.85%). *Pardosa lugubris* appears along woodland edges and sunny places within woods.

Finally at the field-meadow sampling site dominant species in spider community includes *Piratula hygrophila* (29.33%), *Pardosa riparia* (11.56%), and *Pardosa pullata* (11.11%). *Pardosa pullata* and *P. riparia* prefer open or partly shaded habitats, wet and dry meadows, heathland, edges of forests, forest clearings, orchards.

The results showed that the number of species registered in the studied sites was the lowest on the gravel bars (26) and reed (24) which is similar to carabid communities (Igondová and Majzlan, 2015). The highest number of individuals (483) refers to the playground sampling site, however the equitability reaches very law value (0.59) which is similar for carabid communities evaluation (Igondová and Majzlan, 2015). Similarly as for carabids, the lowest numbers of individuals were registered on gravel bars (116) and reed (92) sampling sites. The forest, gravel bars and reed sampling sites show a highest value of equitability in ground living spider communities (0.80) suggesting higher level of ecological stability than in other sites. The highest diversity index for spiders was on forest sampling area (2.87) where carabid communities had one of the lowest values (2.06). The lowest values of diversity and equitability were at osier sampling site (Table 2).

Table 2. Diversity and equitability

	for	osi	plg	pet	gra	ree	ovg	fim
Number of species	36	33	46	38	26	24	33	30
Number of individuals	234	336	483	226	116	92	262	225
Number of threatened species / potentionally threatened species	1/1	0/2	0/2	1/2	1/1	0/2	0/1	0/2
Diversity (Dsw) spiders	2.86	1.98	2.24	2.43	2.59	2.56	2.46	2.58
Max value of Diversity spiders (Hmax)	3.58	3.50	3.83	3.63	3.26	3.18	3.50	3.40
Diversity (Dsw) carabids	2.062	2.399	2.628	2.694	2.201	1.903	2.737	2.705
Equitability (Esw) spiders	0.80	0.57	0.59	0.67	0.80	0.80	0.70	0.76
Equitability (Esw) carabids	0.7613	0.7879	0.7279	0.8	0.9557	0.8265	0.8304	0.8118

forest (for); osier (osi); playground (plg); peat (pet); gravel bars (gra); reed (ree); overgrow (ovg); field-meadow (fim).

Principal component analysis (PCA)

The PCA ordination diagram of the ground living spider communities at 8 sampling sites is shown in Figure 3. Eigenvalues of the two first axes are $\lambda 1 = 0.35$ and $\lambda 2 = 0.20$. The first canonical axes account for 35% of the total variance of the species data. The axis x correlates with light conditions and the axis y is correlated with humidity. The species on PCA plot form five groups (Fig. 3).

The first group contains species *Alopecosa cuneata, Alopecosa pulvurenta, Ozyptila atomaria, Pardosa pullata*, *Pardosa riparia, Drassyllus pusillus* associated with semi dry or meso-termophilous and xerofil open habitats (the upper right quadrat and upper left quadrat of the ordination diagram). Species associated with dry to mesophilous open habitat had relation with playground sampling site.

The second group contains species *Ceratinella brevis*, *Inermocoelotes inermis, Mansuphantes mansuetus, Tapinocyba insecta*, *Tenuiphantes cristatus, Tenuiphantes flavipes, Zodarion germanicum* associated with semi dry woodland habitats, often under the stones, in moss (and upper left quadrat of the ordination diagram). Species associated with semidry forest habitats had relation with forest sampling site.

The third group contains species *Bathyphantes gracilis, Bathyphantes nigrinus, Cybaeus angustiarum, Diplostyla concolor*, *Ero furcata, Ozyptila trux*, *Pachygnatha listeri, Pardosa amentata* associated with mesophilous unshaded habitats (the lower left quadrat of the ordination diagram near axis x). Species associated with above mentioned habitats had relation with, overgrow, field-meadow and peat sampling sites.

The fourth group contains species *Aulonia albimana, Coelotes atropos, Drassodes cupreus, Drassodes pubescens, Euophrys frontalis, Zelotes exiguus* associated with mesophilous or drier partly shaded habitats without herbal vegetation cover (the upper right quadrat of the ordination diagram near axis x). The mentioned species had a relation with gravel bars sampling site.

The fifth group contains species *Antistea elegans, Centromerus sylvaticus, Pocadicnemis juncea, Piratula hygrophila* associated with more wet types of habitats,

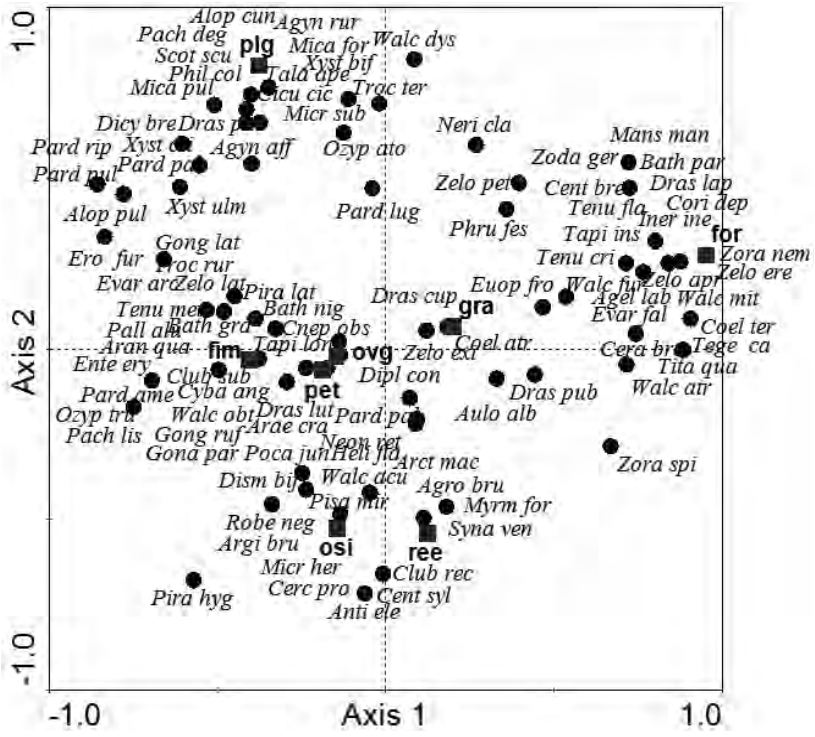

Fig. 3. Ordination diagram based on Principal Component Analysis (PCA) of ground living spiders and sampling sites, produced using CANOCO. The species are represented by blue circles with codes and study site by red squares also with codes. For codes of species see the Table 1. Codes of study sites: playground (plg); forest (for); field-meadow (fim); osier (osi); peat (pet); overgrow (ovg); gravel bars (gra); reed (ree); field-meadow (fim).

open or slightly shaded landscape (the lower left and right quadrats of the ordination diagram near axis y). Species associated with hygrophilous habitats had a relation with osier and reed sampling sites.

Ecosozological assessment

Eight documented species have IUCN threat status in the Slovak Red list (Gajdoš and Svatoň, 2001). Gnaphosid spider *Zelotes exiguus*, collected in forest habitat, belongs to critically endangered species (CR). This spider lives under stones on sun-exposed rocky slopes. Hygrophilous linyphiid spider *Araeoncus crassiceps*, collected in peatland, has status endangered (EN (Table 1).

According to originality of habitats the majority of collected spiders belongs to species which are characteristic for original (climax) and/or semi-natural habitats. Only five documented species are strictly associated with original undisturbed habitats. Species associated with high disturbed habitats were presented by less number of species (27 species) but they were abundant in several studied habitats (e.g. ovg – 70.2%, plg – 61.7%, pet – 54.9%, fim – 47.6%, ree – 44.6%). Our results correlate with anthropogenic degradation classification provided by Igondová and Majzlan (2015) on carabid beetles at the same sampling sites. They also found strong effect of level of anthropogenic degradation on community of ground dwelling beetles.

Acknowledgement

We would like to thank to doc. S. David for his help with statistic evaluation. This study was funded with grant VEGA No. 2/0117/13: “Evaluation of state and dynamics of biotopes using modelling and remote sensing”.

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Received January 18, 2016
Accepted February 5, 2016