Turkish Journal of Zoology

http://journals.tubitak.gov.tr/zoology/

Research Article

Turk J Zool
(2015) 39: 877-887
© TÜBİTAK
doi:10.3906/zoo-1407-39

Spider assemblages and dynamics on a seasonal island in the Pripyat River, Belarus

Izabela HAJDAMOWICZ[1,*], **Lucyna PILACKA**[2,3], **Włodzimierz MEISSNER**[1]
[1]Department of Zoology, Institute of Biology, Faculty of Natural Science, Siedlce University, Siedlce, Poland
[2]Avian Ecophysiology Unit, Department of Ecology and Vertebrate Zoology, Gdansk University, Gdansk, Poland
[3]Ornithological Station, Museum and Institute of Zoology, Polish Academy of Sciences, Gdansk, Poland

Received: 18.07.2014 • **Accepted/Published Online:** 26.03.2015 • **Printed:** 30.09.2015

Abstract: Spider assemblages on a seasonal river meadow island were studied in spring 2006 and 2007. Samples were collected with a set of 20–30 pitfall traps once every 5 days. Altogether, 1179 spiders belonging to 30 species were collected. There were 5 constant dominant species: medium-sized wandering *Pardosa prativaga*, and small-sized air colonizers *Oedothorax retusus*, *Erigone dentipalpis*, *Oedothorax fuscus*, and *Pachygnatha degeeri*. The relatively low species diversity was higher in 2007 and grew throughout the season with the lowering of the water level. The total turnover of species involved the least abundant species (below 1% of the total), mainly Linyphiidae. Abundance of small-sized species was negatively correlated with abundance of medium-sized species. The activity density of small-sized species was higher at the beginning of the spring season with *O. retusus* being especially dependent on the high water level, while the number of medium-sized species and *P. prativaga* were correlated with the water lowering. The assemblages of ground-dwelling spiders were exposed to seasonal and annual changes, but due to the proximity of refugia and rapid colonization, not all assemblages were affected. Spider dynamics on the seasonal island reflected a general activity pattern where, over time, small-sized species avoided larger predators, which were additionally stopped by high water levels.

Key words: Araneae, Pripyat River, Belarus, floods, seasonal island, meadows, abundance, species diversity, species turnover, body size

1. Introduction

The activity of animals living on natural river banks depends on a general pattern of species activity (Lundgren et al., 2009) and on flood disturbances (Ward and Tockner, 2001; Robinson et al., 2002; Lambeets et al., 2008, 2009, 2010a, 2010b). In moderate climates of the northern hemisphere, diurnal spiders dominate in open habitats, contrary to tropical regions, where nocturnal spiders predominate (Alderweireldt, 1994; Uetz et al., 1999; Krumpálová and Tuf, 2013). This group of small and medium ground-dwelling predatory invertebrates was taken into consideration in our study. Furthermore, the seasonal activity of spiders is affected by 2 crucial processes: reproduction and dispersal. In the case of adult spiders, reproduction time is the main factor affecting the activity of spiders, when individuals, and in particular males, are most active in their movements (Foelix, 1996).

The species distribution patterns and the structure of species assemblages depend on the habitat preferences and dispersal ability of the species (Lambeets et al., 2008, 2009).

Natural river valleys are created by flood progressions and regressions. Hence, a complex mosaic of aquatic and terrestrial habitats is inhabited by species whose life cycles rely upon or are adapted to such unstable conditions and rapid succession changes (Robinson et al., 2002). Moreover, life-history traits such as dispersal capacity, hunting guild, reproduction strategy, and body size determine the species' occurrence in disturbed habitats, like river banks and seasonal river islands (Richter 1970a, 1970b; Richter et al., 1971; Lambeets et al., 2008; Pétillon et al., 2010; Puzin et al., 2011). One of the most important features of animals is body size, which is correlated with many life-history and ecological traits that may influence abundance of the species in assemblages (Gaston et al., 2001). Furthermore, processes of extinction and colonization observed on islands (Toft and Schoener, 1983; Keymer et al., 2000) can significantly affect species assemblages in dynamic riverine landscapes.

The mid-Pripyat River valley encompasses a natural unchanged or slightly modified swampy river floodplain in southern Belarus. Floodplain habitats include open sedge mires, oxbow and lake complexes, oak forests, and natural and extensively used meadows. Many of these habitats are unique and endangered throughout Europe, and they are suitable for many rare plant and animal species (Mongin and Pinchuk, 1999; Kozulin, 2000; Parsons, 2004).

* Correspondence: izabela.hajdamowicz@uph.edu.pl

The aim of our study was to describe the ground-dwelling spider assemblages on the seasonal river island and the influence of the water level and the passage of time on spiders on a local scale. The main question was what the levels of interseasonal and seasonal differences were in abundance, species composition, dominant structure, and species diversity. We expected that groups of small-sized and a medium-sized spider species, among them superdominant species, would differ in their responses after a spring water withdrawal, in spite of similar adaptations to regularly disturbed habitats, like a mainly active hunting strategy and dispersal capacity.

2. Materials and methods

2.1. Study area

The study area represents a fragment of natural, riparian meadows (the Turov Meadows) in the valley of the middle Pripyat River, located near the town of Turov (southern Belarus, 52°04′N, 27°44′E, in the province of Gomel, district of Żytkovichi) (Figure 1).

The area has an international conservation status (i.e. Important Bird Area, the Ramsar Convention). The Turov Meadows cover an area of approximately 500 ha and represent the best preserved, protected fragment of riparian meadows along the Pripyat River. The river valley is flooded each year during spring flooding (between March and June). The extensive flooded areas are characterized by a relatively low water level. The water on the floodplain near Turov remains for 62 days on average. At that time, the water level in the river bed rises by 3.5 to 4.5 m on average, and the highest parts of the inundated meadows remain exposed (not flooded) and form the so-called "islands"; one of these seasonal islands was chosen to conduct our case study. The size of the islands depends on the water level in flooded areas. Due to a low water level at the beginning of summer, most of the "island area" has a connection with the mainland. The highest water level is observed every year between late March and early April. The water level may also fluctuate during a season as a result of heavy rainfall. These fluctuations are irregular and may result in inundation to a much greater extent than spring flooding (Kozulin, 2000; Parsons, 2004).

2.2. Study plot

The research was conducted on the largest island. When the water level is high, the island assumes an arched shape and consists of 2 parts. As the water level in the river is lowering and the water is withdrawing from the floodplain, the 2 parts of the island become connected with each other and the island area gradually increases. At the end of April, the island is approximately 3 ha in area (Szurlej-Kielańska,

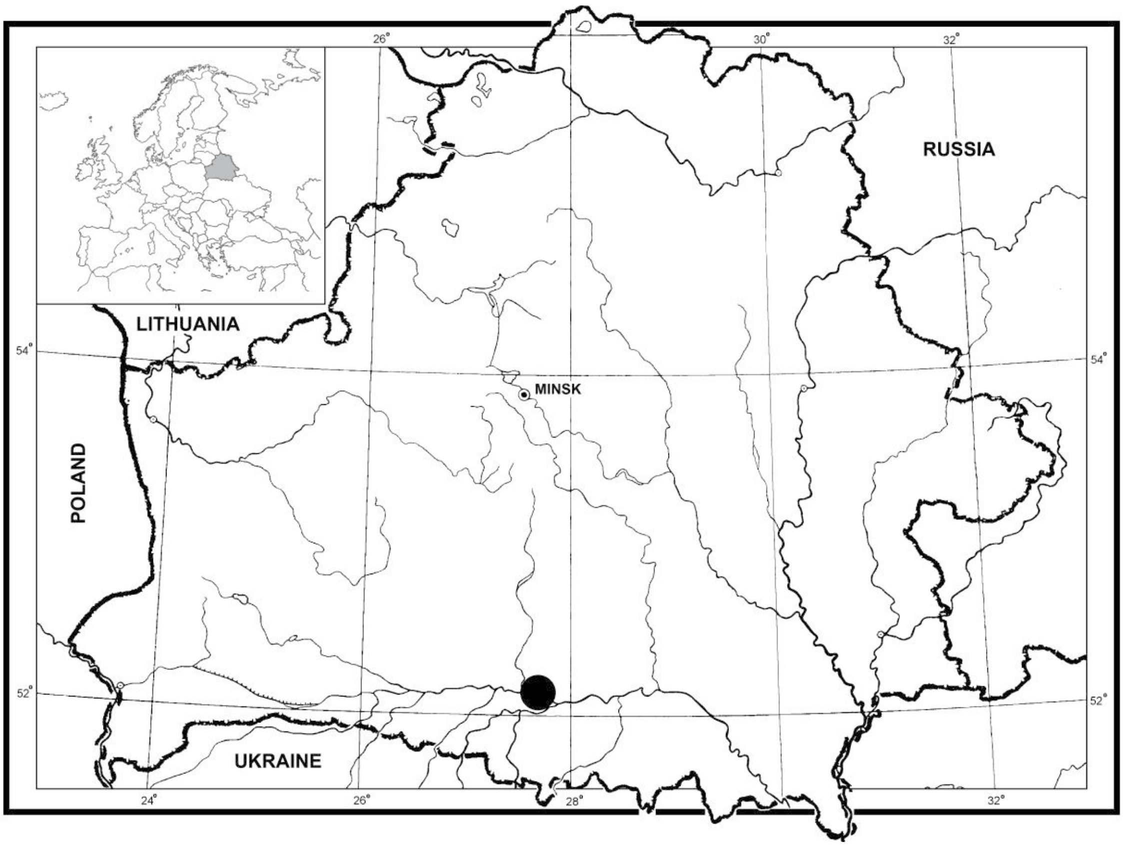

Figure 1. Location of the study area – Belarus, the Turov Meadows at the Pripyat River (●).

personal communication). Plants of mesic meadows quantitatively dominated on the studied island. Those were mainly grasses: *Poa pratensis*, *Festuca rubra*, and *Phleum pratense*. In addition, dicotyledonous plants were represented by *Achillea millefolium*, *Cardamine pratensis*, *Cerastium holosteoides*, and *Rumex acetosa* (Afranowicz-Cieślak et al., 2014). The area has been used as an extensive pasture for cattle and horses. Grazing was occasional and irregular throughout the sampling period. The research seasons differed from each other in hydrological conditions (Figure 2). The year of 2006 was typical in hydrological terms. In the spring of 2007, the water level rapidly dropped and the island merged with the mainland at the end of the first week of May (i.e. approximately 2 weeks earlier than in 2006).

2.3. Sampling methods

Our research on the seasonal island was conducted during 2 spring seasons, until the second week when the island connected with the mainland: in 2006 from 30 April to 11 June (10 samples) and in 2007 from 30 April to 30 May (7 samples). Samples were collected on average once every 5 days using pitfall traps, opened for 12 h (from 0800 to 2000 hours). The pitfall trap is a standard method for catching ground-dwelling spiders, in our case diurnal spiders. PVC containers were used; these were 7.4 cm in diameter and 13 cm deep, half-filled with water and with a surfactant added to reduce the surface tension (Uetz and Unzicker, 1976; Topping and Luff, 1995; Stańska et al., 2002).

A total of 20 pitfall traps were located in the area of one seasonal meadow island. Two transects were laid out: one in the center of the island and the other at a distance of 0.5–1 m from the shore, to identify all possible spider species with different microhabitat preferences. The arrangement of set traps at the edge of the island was always dependent on the water level in the floodplain. In each row, 10 traps were placed 2 m apart from each other. Initially, in the spring season of 2006, there were 15 traps in each row; they were used during 3 collections. The number of traps was reduced to 10 due to local damage caused by grazing animals. In order to protect the traps from rain, each of them was covered with a cap placed 1 cm above the container's inlet. Collected material was preserved in 80% ethanol. One sample collected on each sampling day consisted of the spiders caught in all traps (from both trap rows).

2.4. Spider identification

Determination of spider species and families was done on the basis of diagnostic features according to specialist identification keys (Heimer and Nentwig, 1991; Roberts, 1993; Almquist, 2005; Nentwig et al., 2014), and in the case of *Pardosa plumipes*, on the basis of the paper by Tongiorgi (1966). Specimens were divided into 2 age groups: adults with distinctive genital organs, and all immature stages of juveniles combined (Foelix, 1996). Nomenclature of spider species followed Platnick (2014). Spider specimens were identified by one of the authors (I Hajdamowicz). The material was deposited at the Department of Zoology, Siedlce University of Natural Sciences and Humanities, Poland.

2.5. Data analysis

Both seasons were different in length of sampling periods and therefore, in the comparative analyses, only data obtained between 30 April and late May were used. All data were calculated per 30 traps in order to standardize the results obtained based on different numbers of traps. The sampling efforts (the number of traps) allowed for smoothing out the impact of the short research period for species diversity evaluation (Ulrich et al., 2013).

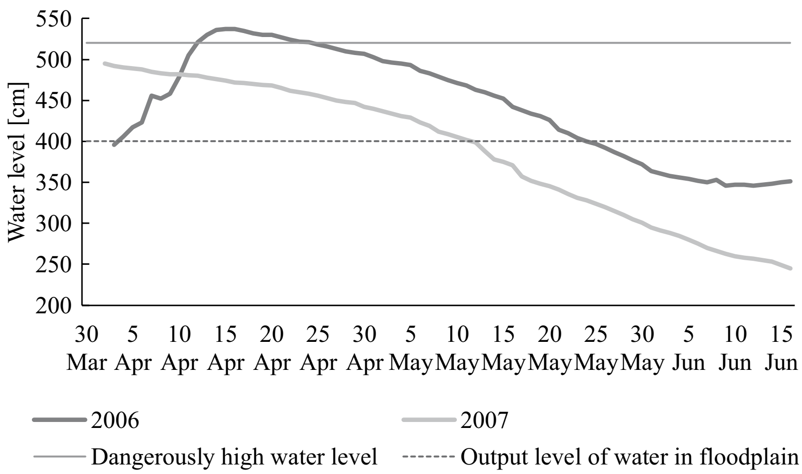

Figure 2. The water level in the Pripyat River in the study area during spring seasons of 2006 and 2007 (the gauge point at Chernichi). The dangerously high water level threatened buildings in settlements.

Only adult spiders were included in the analysis of species dominance. Species that represented more than 5% of the assemblage were defined as dominant, whereas species with a contribution of higher than 30% were defined as superdominant (Górny and Grüm, 1981).The epigeic activity pattern and species diversity were assessed based on the species abundance obtained from pitfall traps and were treated as activity densities (Drapela et al., 2011).

Moreover, the group of adult spiders was divided into 2 body-size categories of spider species, small-sized species (below 5 mm) and medium-sized species (more than 5 mm), to reveal the importance of the life-history traits for the spider assemblage of a seasonal river island. The spider species division reflects an occurrence of the most numerous spider families in the region—smaller Linyphiidae and larger Lycosidae. The 2 categories of spider species size were evaluated on the basis of average maximum length of males' and females' bodies provided by Nentwig et al. (2014).

To evaluate the differences between abundance of adult spiders in the two research seasons, the Mann–Whitney U test was used. The differences between frequencies of dominant species in the two research seasons were calculated using the G-test. All statistical methods followed Zar (1996). Statistical analyses were performed with Statistica 9.1 (www.statsoft.com). To evaluate the species diversity, the species richness (S, number of species), the Shannon–Wiener index (H′), and the evenness index (J) were used (Magurran, 1996). To compare values of the Shannon–Wiener indices, Hutcheson's test was applied (Hutcheson, 1970). To estimate the total species richness and alpha diversity for the studied island, PAST (Paleontological Statistics) was used (Hammer, 1999–2014). The estimator Chao-1 was calculated and the lower and upper limits for 95% confidence intervals were computed by the method of bootstrapping (Hammer, 1999–2014; Upamanyu Hore and Uniyal, 2008).

To compare the exchange of species between years, the turnover index (T_n) was applied (Norris, 1999; Relys et al., 2002). The turnover index (value 0–1) is the sum of species appearing and disappearing in the subsequent 2 years divided by the sum of species in each of the years. The species turnover index was originally designed in biogeographical island research for the assessment of local colonization and extinction processes (MacArthur and Wilson, 1967; Wilson, 2009). Moreover, it was applied by Norris (1999) and Relys et al. (2002) to study species turnover on terrestrial islands.

To analyze the effect of the river water level and the sampling day on the abundance and number of spider species, linear multiple regression analysis was applied. The daily water level in the Pripyat was obtained from a gauge at Chernichi, 3 km downstream of the study area. The first day of sampling in the season was defined as day 1 (i.e. 30 April 2006 and 30 April 2007). The effect of the water level and the sampling day on the number of specimens was analyzed for adult spider species of small size (<5 mm) and medium size (>5 mm). To measure the strength of an association between the two groups of spiders, the Pearson correlation coefficient was used. Moreover, the effect of the water level and the sampling day on the abundance of the two most abundant dominant species, *P. prativaga* and *O. retusus*, was analyzed.

3. Results

3.1. Abundance, species composition, and dominance structure

Altogether, 1179 specimens of spiders belonging to 30 species were collected. For comparative analysis of spider assemblages in the study years of 2006 and 2007, 865 adult spiders (collected between 30 April and 30 May) representing 30 species were used (Table 1). During the 2 years of the study, the collected species represented 8 families, including the most abundant and species-rich Linyphiidae (49% of adult specimens, with 11 species) and Lycosidae (39.9% of adult specimens, with 11 species). The next largest family was Tetragnathidae (7.2% of adult specimens), with only 2 spider species. Species of the other 5 families were represented by single specimens. The group of small-sized spider species consisted of 17 species (58.6% of all adult specimens) including all species from Linyphiidae, and the group of medium-sized spider species combined 14 species (41.3% of all adult specimens), with all species from Lycosidae (Table 2).

Table 1. The number of specimens of spiders in the period of 30 April to 30 May in 2006 and 2007.

Numbers	Years of study		
	2006	2007	2006–2007
No. of specimens	573	466	1039
No. of adults	447	418	865
No. of juveniles	126	48	174

Table 2. Frequency of adult specimens of the spider species in the period of 30 April to 30 May in 2006 and 2007. Body size category of spider species: s – small-sized (<5 mm length); m – medium-sized (>5 mm length).

Families and species	Body size	Years of study		
		2006	2007	2006–2007
		Frequency of specimens (%)		
Dictynidae				
Argenna subnigra	s	0.2	0.5	0.4
Gnaphosidae				
Drassyllus lutetianus	m	-	0.2	0.1
Micaria pulicaria	s	-	0.2	0.1
Hahniidae				
Hahnia nava	s	0.7	2.6	1.6
Linyphiidae				
Oedothorax retusus	s	39.4	14.8	27.1
Erigone dentipalpis	s	13.2	6.9	10.1
Oedothorax fuscus	s	11.4	7.2	9.3
Erigone atra	s	1.8	1.5	1.6
Araeoncus humilis	s	0.2	-	0.1
Porrhomma pygmaeum	s	0.2	-	0.1
Savignya frontata	s	0.2	-	0.1
Oedothorax apicatus	s	-	0.5	0.3
Bathyphantes gracilis	s	-	0.2	0.1
Agyneta rurestris	s	-	0.2	0.1
Walckenaeria vigilax	s	-	0.2	0.1
Lycosidae				
Pardosa prativaga	m	18.8	42.8	30.8
Pardosa palustris	m	2.5	3.0	2.7
Xerolycosa miniata	m	1.8	2.4	2.1
Pardosa agrestis	m	1.1	3.6	2.1
Pardosa plumipes	m	0.4	3.0	1.6
Arctosa leopardus	m	0.2	0.5	0.4
Pardosa sphagnicola	m	0.2	0.5	0.4
Pardosa paludicola	m	0.2	-	0.1
Trochosa ruricola	m	-	0.5	0.3
Pardosa pullata	m	-	0.2	0.1
Pirata piraticus	m	-	0.2	0.1
Salticidae				
Talavera aequipes	s	-	0.2	0.1
Tetragnathidae				
Pachygnatha degeeri	s	7.4	6.2	6.8
Pachygnatha clercki	m	-	0.7	0.4
Thomisidae				
Ozyptila trux	s	-	1.2	0.6
Total		100	100	100

In both years of the study, 5 constant dominant species (above 5% of all individuals) accounted for 84% of adult spiders: *P. prativaga* (31%), *O. retusus* (27%), *E. dentipalpis* (10%), *O. fuscus* (9%), and *P. degeeri* (7%) (Figure 3). The next 2 dominant groups differed in the number of species recorded each year. Species with frequency between 1% and 5% of all individuals represented 4 species in 2006 and 7 species in 2007, for 8% and 16% of all adult individuals in assemblages, respectively. The last group of spider species (less than 1% of all adult individuals) represented 9 species in 2006 and 15 species in 2007, and 2.3% and 5.3% of all adult individuals, respectively (Table 3). *P. plumipes*, a rare riparian species, was detected in the group with a frequency between 1% and 5%. The beginning of the species' activity was observed in the second half of May in both years of the study.

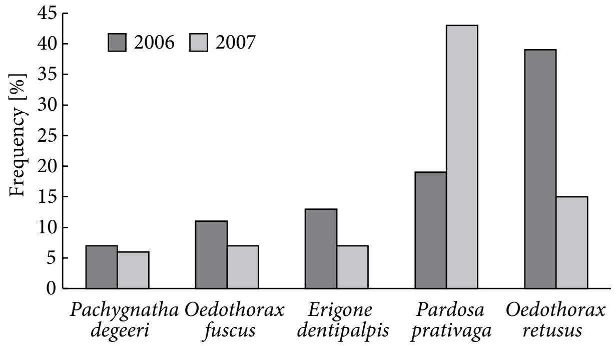

Figure 3. Spider species with frequency above 5% in spider assemblages for the period of 30 April to 30 May in 2006 and 2007.

The species turnover index had the highest value for the species whose individuals accounted for less than 1% of the assemblage and for the family Linyphiidae. In the case of small-sized species, the species turnover index was slightly higher than for medium-sized spider species (Table 3).

There were no differences in total abundance of specimens in the seasons of 2006 and 2007. However, significant differences were found in the contribution of dominant species (above 5% representation in a given assemblage) between the seasons of 2006 and 2007 (G-test; $G = 100.64$; $df = 4$; $P < 0.0001$). These differences involved 2 species, *O. retusus* and *P. prativaga* (Figure 3). The former was a superdominant species in 2006, and the latter in 2007. No significant differences were found between the seasons for the 3 other species from this group: *E. dentipalpis*, *O. fuscus*, and *P. degeeri*.

3.2. Spider species diversity

The number of species was different each year of the study, and the taxa were more diverse in 2007 (Table 3). The value of the Shannon–Wiener index for the spider assemblages was significantly higher in 2007 compared to 2006 (Hutcheson test; $t = 3.317$; $P < 0.0001$). Since the evenness index (J) was almost identical in both years, there were no differences in the values. The significant difference

Table 3. Frequency of number of species and exclusive species in the species group and the turnover index: in 3 groups of species according to their specimen frequency in the assemblage (above 5%, between 5% and 1%, below 1%), in the 3 most numerous spider families, and in 2 categories of spider species on the basis of the body size (small-sized below 5 mm length, medium-sized above 5 mm) for the period of 30 April to 30 May in 2006 and 2007.

Species group	Frequency of species group			Frequency of exclusive species		Turnover index
	2006	2007	2006–2007	2006	2007	2006–2007
Frequency of specimens						
>5%	27.8	18.5	16.1	0.0	0.0	0.00
<5% and >1%	22.2	25.9	19.4	0.0	7.7	0.09
<1%	50.0	55.6	64.5	100.0	92.3	0.67
Family						
Lycosidae	44.4	40.7	38.7	25.0	30.8	0.26
Linyphiidae	38.9	29.6	35.5	75.0	30.8	0.47
Tetragnathidae	5.6	7.4	6.5	0.0	7.7	0.33
Other families	11.1	22.3	19.3	0	30.7	0.5
Body size						
Small-sized	55.6	51.9	54.8	75.0	53.8	0.42
Medium-sized	44.4	48.1	45.2	25.0	46.2	0.33
All species	100.0	100.0	100.0	100.0	100.0	0.38

in the species diversity between the seasons resulted from the fact that more species were found in 2007 (Table 4). The estimated species richness on the seasonal island was 49.33 for Chao-1, with the lower limit of 31.75 and the upper limit of 53 for 95% confidence intervals calculated by the bootstrapping method.

3.3. The effect of the time and the water level on the number of species and the abundance of spiders

The number of species changed during the research seasons (Figure 4). Based on the data collected in both seasons, a relationship between the number of species and the water level and no relationship between the number of species and the day number in the season were found. It can be concluded that the number of captured species was increasing with the water level lowering, according to the following regression equation (S: the number of spider species; both seasons combined):

S = –0.049 × (water level) + 31.311 (R^2 = 0.73; F (2,12) = 16.075, P = 0.0004).

No relationships were found for the total number of individuals of all species.

3.4. The effect of time and water level on the small-sized and medium-sized adult spider species

Water level had a negative impact on the number of medium-sized spider species, but not on the number of small-sized species. The number of small-sized species significantly decreased in the following days, which was not found in the case of medium-sized species. The final regression models included only variables with significant impact on spider number are (both seasons combined):

N small-sized spider species = –1.113 × (no. of day in a given season) (R^2 = 0.71; F (2,12) = 14.493, P = 0.0006),

N medium-sized spider species = –0.408 × (water level) + 200.894 (R^2 = 0.70, F (2,12) = 14.075, P = 0.0007).

A negative correlation was found between the number of small- and medium-sized species for the research seasons (r = –0.56; P = 0.02; N = 17).

3.5. The effect of time and water level on the dominant species

At the beginning of the research seasons, the activity density of the dominant species *O. retusus* was increasing, and then it was decreasing towards mid-May. Increased activity density was observed for the dominant species *P. prativaga* mid-season. Its activity density was decreasing towards the end of May (Figure 5).

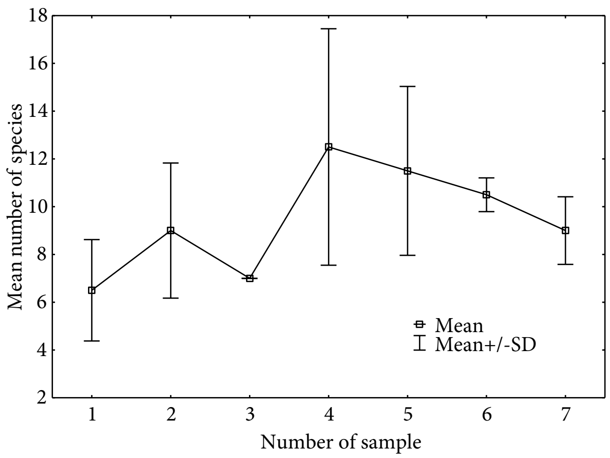

Figure 4. Number of spider species in the period of 30 April to 30 May, 2006 and 2007 data combined with number of samples of the 2 study years averaged. The mean number of species (☐) with arms of standard deviation values.

In the case of *O. retusus*, the number of individuals was significantly affected only by the water level, and no relationship was found between the number of individuals and the day number in the season. The number of individuals of this species was higher when the water levels were high. The high coefficient of determination (R^2 = 0.76) indicates that the water level has a major effect on the number of individuals of this species. (N: the number of individuals of *O. retusus*; both seasons combined):

N of *O. retusus* = 0.1822 × (water level) (R^2 = 0.76; F (2,12) = 19.050, P = 0.0002).

The number of individuals of *P. prativaga* was dependent only on the water level. Contrary to what was observed in *O. retusus*, more spiders were captured when the water levels were low; no relationship was found between the number of *P. prativaga* individuals and the day number in a given season. Changes in the water level accounted for 51% of the observed variation in the number of *P. prativaga* individuals in the studied seasons. (N: the number of individuals of *P. prativaga*; both seasons combined):

Table 4. Species diversity of spider assemblages for the period of 30 April to 30 May in 2006 and 2007.

	Years of study		
Species diversity measurements	2006	2007	2006–2007
Shannon–Wiener index (H’)	0.794	0.913	0.891
Species richness: number of species (S)	18	26	30
Evenness value (J)	0.632	0.645	0.604

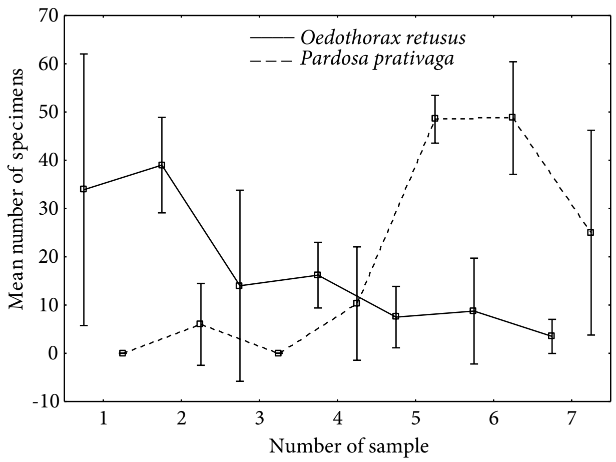

Figure 5. Activity density dynamics of dominants *Oedothorax retusus* and *Pardosa prativaga* in the period of 30 April to 30 May, 2006 and 2007 data combined with number of samples of the 2 study years averaged. The mean number of specimens (☐) with arms of standard deviation values.

N of *P. prativaga* = –0.257 × (the water level) + 125.366 (R^2 = 0.51; F (2,12) = 6.248, P = 0.01).

4. Discussion

The annual and seasonal changes of the water level in a river can influence abundance, species composition, and dominance structure of spider assemblages on a seasonal river island in different ways. The annual and seasonal changes of the water level in the Pripyat River did not influence the total abundance of spiders on the seasonal river island, but changes in the species composition and the dominance structure were observed during our study.

The species composition of the spider assemblages on the seasonal island in the Pripyat River was characteristic for flooded meadows in the region. River islands often represent fragments of meadows and riparian grasslands (Kozulin, 2000); therefore, they are colonized by species characteristic of these types of habitats in Central and East Europe (Szymkowiak and Woźny, 1998; Kajak et al., 2000; Kupryjanowicz, 2003; Lukashevich, 2004). At the time when the water level is lowering, the enlarging islands are colonized by individuals coming from exposed (not flooded) areas and from riverside habitats, i.e. they serve as refuges for the invertebrate fauna. The life-history traits of the spider species such as active hunting and air, ground, and water surface dispersal capacity enable spiders to settle in a newly emerged territory (Richter, 1970a; Richter et al., 1971; Lambeets et al., 2008, 2009; Pétillon et al., 2010).

The spider species in the assemblages on the seasonal island represented the most numerous spider families in the region: small-sized Linyphiidae, medium-sized Lycosidae, and small- and medium-sized Tetragnathidae. The dominant ground-dwelling spider species on the island were *P. prativaga* from Lycosidae; *O. retusus*, *O. fuscus*, and *E. dentipalpis* from Linyphiidae; and small-sized *P. degeeri* from Tetragnathidae. *P. prativaga* and *O. retusus* were superdominant species on the river island. A very high dominance of a single species in a given assemblage is characteristic of assemblages with a higher level of permanent disturbances, like natural floods (Kupryjanowicz, 2003; Lukashevich, 2004) or agricultural farming (Szymkowiak and Woźny, 1998; Samu and Szinetár, 2002). *P. prativaga* is an active predator, like most Lycosidae. *O. retusus* and *O. fuscus*, as well as males of *E. dentipalpis* and adult individuals from the genus of *Pachygnatha*, are also active hunters, unlike most of the representatives of their families (Roberts, 1993; Eichenberger et al., 2009). Active foraging affects the animal's locomotion to facilitate colonization of new areas and escape in case of danger, which includes changes in the water level. The spider assemblage of this river island consisted mainly of common species (Platen et al., 1999), although the process of its development, determined by the water level in the river, is natural and unique in Europe. However, there were specimens of *P. plumipes* from the family of Lycosidae, a rare species distributed mainly in East Europe (Almquist, 2005). This stenotopic species, the biology of which has not been thoroughly explored, is associated with natural river valleys with damp meadows and sandy shores (Almquist, 2005). The species' specific habitat requirements and the lack of natural rivers and suitable habitats most likely reduce the species' occurrence. The set of species was replenished with active hunters associated with sandy grasslands, grazing lands, and arable fields: representatives of Lycosidae (*Xerolycosa miniata* and *Pardosa agrestis*), as well as Thomisidae (*Ozyptila trux*) (Roberts, 1993; Szymkowiak and Woźny, 1998; Samu and Szinetár, 2002). These xerophilous species appeared later in the season, only after the water level lowered.

Most of the Linyphiidae on the island, all dominant species, were characterized by well-developed ballooning dispersal capacity and were the first to colonize the disturbed habitats (Platen et al., 1999; Downie et al., 2000; Bonte et al., 2002; Kupryjanowicz, 2003). Common spiders like *O. retusus*, O. *fuscus*, *E. dentipalpis*, and *Erigone atra* usually populate areas extensively used as meadows and grazing lands in East Europe (Kupryjanowicz, 2003), but also ruderal areas and agricultural lands (Downie et al., 2000; Bonte et al., 2002). It is also thought that species living in an unstable, but at the same time rare, habitat have greater airborne dispersal capacity, e.g., *P. prativaga* occurring in the zone of low-growing plants on exposed beaches (Richter, 1970a, 1970b). Lycosidae, as a cursorial spider family, also demonstrates overland dispersal (Richter et al., 1971). *P. degeeri* is yet another dominant species inhabiting grasslands and characterized by both airborne and overland dispersal (Szymkowiak and Woźny, 1998; Kupryjanowicz, 2003; Gallé et al., 2011). Dispersal capacity of the dominant and characteristic spiders of the emerged habitat on Turov Meadows facilitates faster migration and island colonization, mainly due to the proximity of their habitats in the river valley.

The species exchange (species turnover) between the study years on the seasonal island applied to species occurring in small numbers and representing less than 1% of a given assemblage, mainly from the family of Linyphiidae. Moreover, annual changes in the assemblages were reflected in a variable high frequency of the 2 most abundant and dominant species: *P. prativaga* and *O. retusus*. In general, spiders are characterized by seasonal fluctuations in their activity, and their assemblages differ from each other more in the subsequent research months than in subsequent years (Norris, 1999). However, highly disturbed habitats, including those disturbed by nature, e.g., by river floods, and isolated habitats, like islands, are characterized by exchange of individuals and species, both during a season and between subsequent years (McArthur and Wilson, 1967; Relys et al., 2002; Ulrich et al., 2013).

The species diversity of spiders on the studied island was relatively low and related to changes of water level in the river. Hence, it changed significantly from year to year and was higher in 2007. Lowering of the water level had a major influence on the increasing spider species diversity on the seasonal island. Lambeets et al. (2008, 2009) revealed that diverse groups of arthropods (carabids and spiders) can respond differently to a flood disturbance. Intermediate flooding increased the number of carabid species, while in the case of riparian spiders, rising water levels decreased their species richness. In addition, too high or too low degrees of flooding had a detrimental effect mainly on stenotopic riparian species, but an increasing flood had a positive effect on eurytopic ones. However, anthropogenic influences in river channels, which suppresses natural overflows, hinder the distribution of common hygrophilous species and change specialization of arthropod assemblages (Lambeets et al., 2008, 2009). Although, in general, flood disturbances decrease the number of terrestrial species, riparian zones enlarge regional and global species diversity as a source of unusual habitats and species (Sabo et al., 2005).

The revealed dynamic patterns for adult spiders were typical for spider assemblages in the region. In general, adult ground-dwelling spiders have a higher activity density in spring, using suitable weather conditions for reproduction and development (Niemelä et al., 1994). For example, in central Belarus, the reproductive activity of ground-dwelling Lycosidae occurred between the end of April and the beginning of June (Lukashevich, 2004). Both dominant species *P. prativaga* and *O. retusus* are most active in spring, which was also shown by our research (Bell, 2014).

The influence of time and water level on spider dynamic patterns depended on the category of species body size. The activity density of small-sized species was higher at the beginning of the spring season and negatively correlated with the flow of time, while the activity density of medium-size species was higher in the second part of the studied seasons and depended on the water level lowering. However, the small-sized dominant *O. retusus* was especially dependent on the high water level, and medium-sized dominant *P. prativaga* was correlated with the water lowering. Furthermore, Lambeets et al. (2008), in a detailed study, revealed that the body size of Lycosidae decreased with increased flooding, but it increased in Linyphiidae.

Lambeets et al. (2008, 2010b) proved that stenotopic species connected with river banks are susceptible to changes in the water level. In contrast to habitat generalists, stenotopic species avoid unnecessary movements and look for a safe habitat in the event of flooding. Riparian stenotopic *P. plumipes* was not active when the water level was high. Time separation between the activity of small-sized and medium-sized species like the superdominants on the studied island reduces the possibility of cannibalism towards smaller Linyphiidae (Lundgren et al., 2009).

The assemblages of ground-dwelling spiders on the seasonal island were exposed to seasonal and annual changes dependent on water level. However, due to the proximity of refugia and rapid colonization, only species with the lowest frequency and abundance of species with the highest frequency were affected. The influence of time and water level on spider dynamic patterns depended on the category of species body size. The small-sized species, mainly Linyphiidae, dominated at the beginning of season, at the high level of water. Medium-sized species, like Lycosidae, predominated in the second part of the season and depended on the water level lowering. The spider dynamics on the seasonal island reflected general activity patterns of small-sized species avoiding larger predators, which were additionally hindered by the water.

Acknowledgments
We are grateful to the anonymous reviewers for their useful comments, which improved the quality of the manuscript. The first author was supported by Siedlce University (grant 222/05/S).

References

Afranowicz-Cieślak R, Żółkoś K, Pilacka L (2014). Plant species richness of riverbed elevations—the Pripyat river valley case study. Russian J Ecol 45: 473–479.

Alderweireldt M (1994). Day/night activity rhythms of spiders occurring in crop-rotated fields. Eur J Soil Biol 30: 55–61.

Almquist S (2005). Swedish Araneae. Part 1: Families Atypidae to Hahniidae (Linyphiidae excluded). Insect Syst Evol Supplements 62: 1–284.

Bell JR (2014). Summary for *Oedothorax retusus* (Araneae). Spider and Harvestman Recording Scheme Website: The National Recording Schemes for Spiders and Harvestmen in Britain. British Arachnological Society. Available online at http://srs.britishspiders.org.uk.

Bonte D, Baert L, Maelfait JP (2002). Spider assemblage structure and stability in a heterogeneous coastal dune system (Belgium). J Arachnol 30: 331–343.

Downie IS, Ribera I, McCracken DI, Wilson WL, Foster GN, Waterhouse A, Abernethy VJ, Murphy KJ (2000). Modelling populations of *Erigone atra* and *E. dentipalpis* (Araneae: Linyphiidae) across an agricultural gradient in Scotland. Agr Ecosyst Environ 80: 15–28.

Drapela T, Frank T, Heer X, Moser D, Zaller JG (2011). Landscape structure affects activity density, body size and fecundity of *Pardos*a wolf spiders (Araneae: Lycosidae) in winter oilseed rape. Eur J Entomol 108: 609–614.

Eichenberger B, Siegenthaler E, Schmidt-Entling M (2009). Body size determines the outcome of competition for webs among alien and native sheetweb spiders (Araneae: Linyphiidae). Ecol Entomol 34: 363–368.

Foelix RF (1996). Biology of Spiders. 2nd ed. New York, USA: Oxford University Press.

Gallé R, Vesztergom N, Somogyi T (2011). Environmental conditions affecting spiders in grasslands at the lower reach of the River Tisza in Hungary. Entomol Fennica 22: 29–38.

Gaston KJ, Chown SL, Mercer RD (2001). The animal species–body size distribution of Marion Island. P Natl Acad Sci USA 98: 14493–14496.

Górny M, Grüm L (1981). Metody stosowane w zoologii gleby. Warsaw, Poland: PWN (in Polish).

Hammer Ø (1999–2014). PAST: Paleontological Statistics, version 3.04. Reference Manual. Oslo, Norway: Natural History Museum, University of Oslo.

Heimer S, Nentwig W (1991). Spinnen Mitteleuropas. Berlin: Ein Bestimmungsbuch, Parey (in German).

Hutcheson K (1970). A test for comparing diversities based on the Shannon formula. J Theor Biol 29: 151–154.

Kajak A, Kupryjanowicz J, Petrov P (2000). Long term changes in spider (Araneae) communities in natural and drained fens in the Biebrza River valley. Ekol Bratislava 19: 55–64.

Keymer JE, Marquet PA, Velasco-Hernández JX, Levin SA (2000). Extinction thresholds and metapopulation persistence in dynamic landscapes. Am Nat 156: 478–494.

Kozulin V (2000). Mid-Pripyat State Landscape Zakaznik. Information Sheet on Ramsar Wetlands (RIS). Available online at http://sites.wetlands.org/reports/ris/3BY002en.pdf.

Krumpálová Z, Tuf IH (2013). Circadian rhythms of ground living spiders: mechanisms of coexistence strategy based on the body size. Pol J Ecol 61: 575–586.

Kupryjanowicz J (2003). Spiders (Araneae) of open habitats in the Biebrza National Park, Poland. Fragm Faun 46: 209–237.

Lambeets K, Breyne P, Bonte D (2010a). Spatial genetic variation of a riparian wolf spider *Pardosa agricola* (Thorell 1856) on lowland river banks: the importance of functional connectivity in linear spatial systems. Biol Conserv 143: 660–668.

Lambeets K, Van Ranst J, Bonte D (2010b). Is movement behaviour of riparian wolf spiders guided by external or internal information? J Arachnol 38: 313–318.

Lambeets K, Vandegehuchte ML, Maelfait JP, Bonte D (2008). Understanding the impact of flooding on trait-displacements and shifts in assemblage structure of predatory arthropods on river banks. J Anim Ecol 77: 1162–1174.

Lambeets K, Vandegehuchte ML, Maelfait JP, Bonte D (2009). Integrating environmental conditions and functional life-history traits for riparian arthropod conservation planning. Biol Conserv 142: 625–637.

Lukashevich IG (2004). Ecological studies on wolf spiders (Lycosidae, Araneae) in Central Belarus, seasonal activities and habitat preferences by pitfall trapping. In: Samu F, Szinetár C, editors. European Arachnology 2002. Proceedings of 20th European Colloquium of Arachnology; 22–26 July 2002; Szombathely, Hungary. Budapest, Hungary: Plant Protection Institute, pp. 171–177.

Lundgren JG, Nichols S, Prischmann DA, Elsbury MM (2009). Seasonal and diel activity patterns of generalist predators associated with *Diabrotica virgifera* (Coleoptera: Chrysomelide). Biocontrol Sci Techn 19: 327–333.

MacArthur RH, Wilson EO (1967). The Theory of Island Biogeography. Princeton, NJ, USA: Princeton University Press.

Magurran AE (1996). Ecological Diversity and Its Measurement. London, UK: Chapman and Hall.

Mongin E, Pinchuk P (1999). A survey of spring wader migration on the floodplain meadows of the Pripyat River in south part of Belarus during 1994–1998. In: Abstracts of the 2nd Meeting of the European Ornithologists Union and 3rd International Shrike Symposium. Ring 21: 149.

Nentwig W, Blick T, Gloor D, Hänggi A, Kropf C (2014). Spiders of Europe. Version 29. Available online at www.araneae.unibe.ch.

Niemelä J, Pajunen T, Haila Y, Punttila P, Halme E (1994). Seasonal activity of boreal forest-floor spiders (Araneae). J Arachnol 22: 23–31.

Norris KC (1999). Quantifying change through time in spider assemblages: sampling methods, indices and sources of error. J Insect Conserv 3: 309–325.

Parsons SB (2004). How can hydrological science help meet the challenges of river basin management for the Pripyat River in Eastern Europe? In: Webb B, Acreman M, Maksimovic C, Smithers H, Kirby C, editors. Hydrology: Science and Practice for the 21st Century. Volume II. London, UK: British Hydrological Society, pp. 459–465.

Pétillon J, Lasne E, Lambeets K, Canard A, Vernon P, Ysnel F (2010). How do alterations in habitat structure by an invasive grass affect salt-marsh resident spiders? Ann Zool Fennici 47: 79–89.

Platen R, von Broen B, Herrman A, Ratschker UM, Sacher P (1999). Gesamtartenliste und Rote Liste der Webspinnen Weberknechte und Pseudoskorpione des Landes Brandenburg (Arachnida: Araneae Opiliones Pseudoscorpiones) mit Angaben zur Häufigkeit und Ökologie. Naturschutz und Landschaftspflege in Brandenburg. Beilage zum Heft 2: 1–80 (in German).

Platnick NI (2014). The World Spider Catalog, Version 14.5. New York, NY, USA: American Museum of Natural History. Available online at http://research.amnh.org/iz/spiders/catalog/INTRO3.html.

Puzin C, Acou A, Bonte D, Pétillon J (2011). Comparison of reproductive traits between two salt-marsh wolf spiders (Araneae, Lycosidae) under different habitat suitability conditions. Anim Biol 61: 127–138.

Relys V, Koponen S, Dapkus D (2002). Annual differences and species turnover in peat bog spider communities. J Arachnol 30: 416–424.

Richter CJJ (1970a). Aerial dispersal in relation to habitat in eight wolf spider species (Pardosa, Araneae, Lycosidae). Oecologia 5: 200–214.

Richter CJJ (1970b). Relation between habitat structure and development of glandulae ampullaceae in eight wolf spider species (*Pardosa*, Araneae, Lycosidae). Oecologia 5: 185–199.

Richter CJJ, den Hollander J, Vlijm L (1971). Differences in breeding and motility between *Pardosa pullata* (Clerck) and *Pardosa prativaga* (L. Koch), (Lycosidae, Araneae) in relation to habitat. Oecologia 6: 318–327.

Roberts MJ (1993). The Spiders of Great Britain and Ireland. Compact Edition, Vols. 1–3. Colchester, UK: Harley Books.

Robinson K, Tockner CT, Ward JV (2002). The fauna of dynamic riverine landscapes. Freshwater Biol 47: 661–677.

Sabo JL, Sponseller R, Dixon M, Gade K, Harms T, Heffernan J, Jani A, Katz G, Soykan C, Watts J et al. (2005). Riparian zones increase regional species richness by harbouring different, not more, species. Ecology 86: 56–62.

Samu F, Szinetár C (2002). On the nature of agrobiont spiders. J Arachnol 30: 389–402.

Stańska M, Hajdamowicz I, Żabka M (2002). Epigeic spiders of alder swamp forests in Eastern Poland. In: Toft S, Scharff N, editors. European Arachnology 2000. Proceedings of the 19th European Colloquium of Arachnology, Aarhus, Denmark, pp. 191–197.

Szymkowiak P, Woźny M (1998). Dominance structure and seasonal changes in the abundance of dominant epigeic spiders in pastures of northern Greater Poland. In: Selden PA, Proceedings of the 17th Colloquium of Arachnology; 14–18 July 1997; Edinburgh, UK. Burnham Beeches, UK: British Arachnological Society, pp. 245–252.

Toft CA, Schoener TW (1983). Abundance and diversity of orb spiders on 106 Bahamian islands: biogeography at an intermediate trophic level. Oikos 41: 411–426.

Tongiorgi P (1966). Wolf spiders of the *Pardosa monticola* group (Araneae: Lycosidae). Bulletin of the Museum of Comparative Zoology at Harvard College 134: 335–359.

Topping CJ, Luff ML (1995). Three factors affecting the pitfall trap catch of linyphiid spiders (Aranaea: Linyphiidea). Bull Br Arachnol Soc 10: 35–38.

Uetz GW, Halaj J, Cady AB (1999). Guild structure of spiders in major crops. J Arachnol 27: 270–280.

Uetz GW, Unzicker JD (1976). Pitfall trapping in ecological studies of wandering spiders. J Arachnol 3: 101–111.

Ulrich W, Zalewski M, Hajdamowicz I, Stańska M, Ciurzycki W, Tykarski P (2013). Towards a general species – time – area – sampling effort relationship. Pol J Ecol 61: 345–354.

Upamanyu Hore, Uniyal VP (2008). Diversity and composition of spider assemblages in five vegetation types of the Terai Conservation Area, India. J Arachnol 36: 251–258.

Ward JV, Tockner K (2001). Biodiversity: towards a unifying theme for river ecology. Freshwater Biol 46: 807–819.

Wilson OE (2009). Theory and experiment. In: Losos JB, Ricklefs RE, editors. The Theory of Island Biogeography Revisited. Princeton, NJ, USA: Princeton University Press, pp. 1–12.

Zar JH (1996). Biostatistical Analysis. London, UK: Prentice Hall.