Spider Assemblages in an Inland Dune Complex of Northwest Germany

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Abstract: Spider assemblages in an inland dune complex of Northwest Germany. – The study took place in the northern part of North Rhine-Westphalia in 2005. Nine sites in different habitat types of an inland dune complex were sampled by pitfall trapping and hand collecting for the presence of spiders. Sampling was done to determine a possible spider species community that is characteristic of open inland dunes. Possible indicator species for these habitats were sought. A total catch of 5,396 individuals included 136 species from 21 families. Among them were 16 species listed in the Red Data Book of North Rhine-Westphalia, six of the recorded species are listed as rare or had only seldom been recorded previously. A spider assemblage of dry habitats could be separated from communities inhabiting agricultural and forested sites by subjecting the spider data to a redundancy analysis (RDA). It was impossible to define indicator species for open inland dune habitats, but the occurrence of species typical of sand habitats indicates a certain importance of the fragmented sites of the study area for nature conservation. Extensive habitat management is essential for a long-term maintenance of those species.

Introduction

Nutrient-poor sandy grasslands and heaths are among the most endangered ecosystems in Germany (Rieken et al. 2006). During the past 50 years, the area of open sand habitats has considerably decreased due to the lack of disturbance (drifting sand, grazing, and fire) and the intensive cultivation and afforestation (Berger-Landefeldt & Sukopp 1965, Jeckel 1984, Jentsch et al. 2002, Kratochwil 2004). In north western Germany, sand habitats contain a large number of specialised and rare species (Bellmann 1997, Wiesbauer & Mazzucco 1997, Steven 2004). They are restricted to small areas (Verbücheln & Jöbges 2000, Pardey 2004) and many biotopes, as e.g., dry grasslands, heathlands, and inland dunes, are endangered in North Rhine-Westphalia (Verbücheln et al. 1999) and Lower Saxony (Drachenfels 1996). Hence, many stenotopic species of these habitats are endangered by habitat loss and fragmentation.

Spiders are useful indicators of overall species richness and ecological status of biotic communities – they are abundant, easy to record, inhabit a wide array of spatial and temporal niches and respond immediately to habitat change (Kiechle 1992, Duffey 1993, Wise 1993, Schultz & Finch 1996, Norris 1999). Information about spiders in the sand habitats of Northwest Germany has hitherto been restricted to single studies in Lower Saxony (Rabeler 1951, Lademann 1995, Finch 1997, Merkens 2002) and North Rhine-Westphalia (Buchholz & Hartmann 2008).

The inland dune complex of the nature reserve Elter Sand can be taken as an example for the landscape changes mentioned above: Huge parts of the study area have been afforested or cultivated, which caused a fragmentation and reduction of former open sand habitats (Flierdt & Köster 2002). The aim of this study is to investigate the impact of the described landscape changes on the spider fauna by asking the following questions:

Is there a community of spider species which is characteristic of open inland dunes and unique for these habitats? Is it possible to define indicator species for open inland dune habitats which can be used for conservation and habitat management?

Study area

This study was undertaken at the nature reserve Elter Sand in the northern part of North Rhine-Westphalia. The area is located southeast of the city of Rheine (TK [topographic map] 25 3711-3, coordinates: R 2603862, H 5790197) and lies along the river Ems at an elevation of 38 to 54 m a.s.l. covering 205 ha (Fig. 1). The study area has formed glacially and the top layers are aeolic sands which were deposited in two periods: The first started after the river depositions of the Weichsel ice age and ended in the Preboreal (about 10,500 years ago), the second one was caused by clearings resulting from human land use between the 9th and 19th centuries (Grabert 1951).

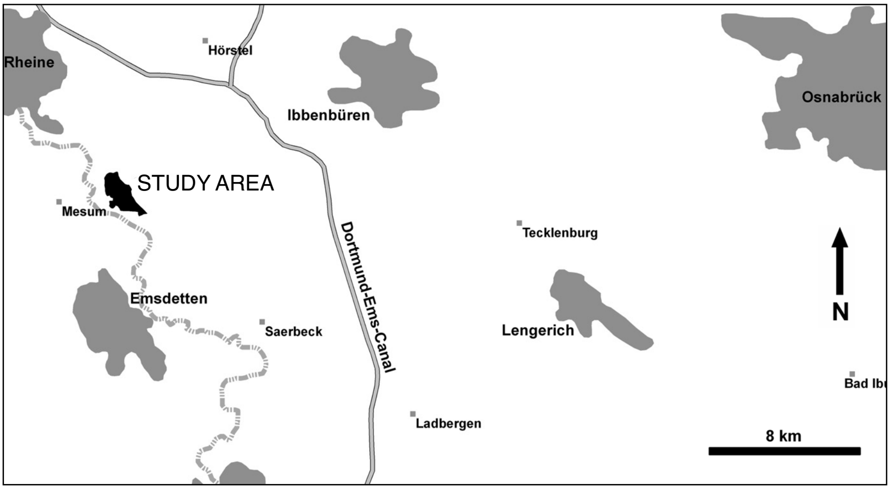

Fig. 1: Location of the study area (TK25 3711-3, coordinates: R 2603862, H 5790197).

The climate is sub-Atlantic with an average annual temperature of 9.5 to 10.0°C and mean annual precipitation of 700 to 750 mm. The mean temperature from May to September is 15 to 16°C. Precipitation values for the same period are 300 to 350 mm (MEYNEN & SCHMITHÜSEN 1959, MURL NRW 1989). According to BURRICHTER (1973) the potential natural vegetation is the Betulo-Quercetum roboris and the Betulo-Quercetum molinietosum. FLIERDT & KÖSTER (2002) describe the current vegetation of the study area: pine-forests (e.g., Dicrano-Pinetum sylvestris) and mixed-oak-forests (e.g., Betulo-Quercetum roboris, Betulo-Quercetum molinietosum) are predominant. Today parts of the area are agriculturally used (improved meadows, pastures). Furthermore, dry grassland (Spergulo vernalis-Corynephoretum canescentis, Airetum praecocis), heathland (Genisto-Callunetum nardetosum) and patches with bare sand can be found.

Methods

Sampling: The spiders were caught in pitfall traps (BARBER 1931). The investigation took place in the period from May to October 2005. In each site three pitfall traps (diameter 9 cm, filled with a 4% formalin-detergent solution) were installed. The position of each trap was determined haphazardly. Emptying was done every four weeks. In addition to pitfall trapping one hand sampling session was carried out in June 2005.

Sites: Altogether, nine sites in the area of the Elter Sand were investigated (Tab. 1). Environmental data were documented for each site. The vegetation structure was recorded by measuring the average cover of the vegetation, the mean height of vegetation and density of herb layer between 0 and 20 cm (see SUNDERMEIER 1998a, b). Following AG BODEN (1994), five classes of ground humidity were defined: 1 = dry, 2 = slightly humid, 3 = humid, 4 = very humid, 5 = wet. Influence of shading was described by using four classes: 1 = open, 2 = semi-open, 3 = partly shaded, 4 = shaded.

Analysis: Spiders were identified up to species level. For each species, dominance values [d] were calculated according to ENGELMANN (1978). Rare spiders (d < 0.2%) were not taken into account for statistical analysis. Hence, catch numbers of 49 spider species were subjected to a RDA using Canoco 4.5 (TER BRAAK & SMILAUER 2002). To compare the sites the data were standardized (individual sums x 100/number of sampling days/number of pitfall traps). For RDA the abundances of each species were square root transformed. Automatic forward selection was used to define the best explaining variables (K = 5). Additional representation values were calculated as follows: $R = (100/n_x) * n_{x(A, B ... F)}$ (n_x = total number of individuals from species x, $n_{x(A, B ... F)}$ = specimens from species in community A, B ... F). A species is considered exclusive for a community if R $\geq$ 90% (KRATOCHWIL & SCHWABE 2001).

Measurements of diversity were reported for each site. For alpha-diversity (diversity in individual sample units) the Brillouin index was calculated using $H_B = (\ln N! - \sum \ln n_x!)/N$ (N = total number of individuals; n_x = specimen of species x). For an approximation of the factorial Stirling's formula ($\ln n! \approx n * \ln n$) was used. Furthermore, the Brillouin-Evenness E_B was calculated as follows: $E_B = H_B / H_{Bmax}$ (H_B = Brillouin index; $H_{Bmax} = \ln S$, where S is the total number of species) (KRATOCHWIL & SCHWABE 2001, MAGURRAN 2004). All data concerning habitat bindings and endangerment of spider species were taken from KREUELS & BUCHHOLZ (2006). Nomenclature of spiders follows PLATNICK (2007).

Tab. 1: Site characteristics. Classes of ground humidity: 1 = dry, 2 = slightly humid, 3 = humid, 4 = very humid, 5 = wet. Classes for influence of shading: 1 = open, 2 = semi-open, 3 = partly shaded, 4 = shaded

site	N/E	humidity	shade	habitat description
E1	52°13.513' 007°31.850'	2	1	improved meadow, mowing (twice a year)
E2	52°13.620' 007°31.961'	2	2	Dicrano-Juniperetum communis, habitat mangement (once a year)
E3	52°13.337' 007°31.346'	1	1	bare sand
E4	52°13.509' 007°32.209'	3	4	mixed birch forest (*Betula pendula* with *Pinus sylvestris*)
E5	52°13.729' 007°31.869'	2	4	mixed pine forest (*Pinus sylvestris* with *Quercus robur*,
E6	52°13.807' 007°31.861'	2	2	Genisto-Callunetum nardetosum, facies with *Avenella flexuosa*
E7	52°14.132' 007°31.287'	2	4	mixed oak forest, (*Quercus robur* with *Pinus sylvestris*)
E8	52°13.989' 007°30.989'	1	1	Spergulo vernalis-Corynephoretum canescentis, facies with *Agrostis vinealis*
E9	52°13.990' 007°30.974'	2	1	*Calluna* heath

Results

Faunistics

A total of 5,396 individuals were identified from 136 species and 21 families (Appendix I). Dominant species were the lycosid spiders *Pirata hygrophilus* (n = 935), *Pardosa lugubris* (n = 680), *P. palustris* (n = 572), *Alopecosa pulverulenta* (n = 491), *Trochosa terricola* (n = 317), and *Pardosa prativaga* (n = 193). *Pachygnatha degeeri* and *Erigone dentipalpis* were also frequent. Six rare species were recorded (*Abacoproeces saltuum*, *Coriarachne depressa*, *Haplodrassus soerenseni*, *Neriene furtiva*, *Saaristoa firma*, *Zelotes clivicolus*) and for 16 species a status of endangerment is given. Apart from 12 species of category V (endangerment is to be assumed) and three endangered species (*Cheiracanthium virescens*, *Erigone arctica*, *Trachyzelotes pedestris*), the occurrence of the highly endangered spider *Trichopterna cito* is noteworthy.

Most of the species are classified as eurytopic and only 11 as stenotopic (= 8 %) occurring in low specimen numbers. Only six of them are typical for dry habitats, whereas only *Talavera petrensis* is stenotopic for dry grassland, while *Cheiracanthium virescens*, *Coriarachne depressa*, *Haplodrassus soerenseni*, and *Zilla diodia* are typical of dry forests.

The majority of specimens was caught on sites E1 and E4, while the number of specimens on all other sites is noticeably lower (Tab. 2). Five sites (E5–E9) had nearly the same number of species (50–56), followed by E2 and E4 with 42 species and E1 and E3 with the lowest amount of species (32 and 36, respectively). Sites E1 and E4 showed low di-

Tab. 2: Capture statistics and diversity measures for investigated sites (n ind. = total number of individuals, n spec = number of species, ind/day = ratio individuals per day, ind/day/trap = ratio individuals per day and trap, HB = Brillouin-Index, E = Brillouin-Evenness)

site	n ind.	n spec.	ind./day	ind./day/trap	HB	E
E1	1264	32	7.9	2.6	1.96	0.57
E2	301	42	1.9	0.6	2.66	0.71
E3	361	36	2.2	0.7	2.26	0.63
E4	1026	42	6.4	2.1	1.55	0.41
E5	688	56	4.3	1.4	2.43	0.60
E6	632	52	3.9	1.3	2.87	0.73
E7	325	50	2.0	0.7	2.43	0.62
E8	394	51	2.5	0.8	3.31	0.84
E9	405	52	2.5	0.8	2.96	0.75

versity values (1.96 and 1.55, respectively). The highest diversity was present at E8 (3.31), followed by E9 (2.96) and E6 (2.87). The same applies for the evenness, where the highest values were calculated for E8 (0.84), E9 (0.75), and E6 (0.73).

Community structures

RDA showed a clear separation of six species groups (Fig. 2). The first axis (eigenvalue = 0.362) represented a human impact or disturbance gradient where agricultural land use increased to the right. The second axis (eigenvalue = 0.286) reflected a humidity gradient with more humid (and presumably more heavily vegetated) sites on top. Dry and bare habitats were positioned in the lower part. Group A and B, comprising six and four

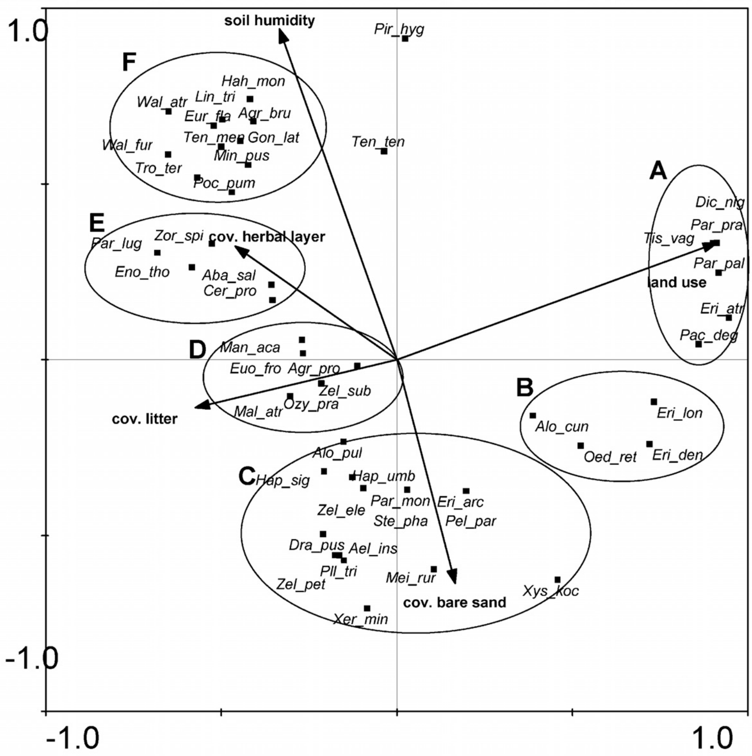

Fig. 2: Redundancy analysis of spider communities (A–F) and environmental data (cov. = coverage) from inland dune complex Elter Sand (eigenvalue first axis = 0.362, second axis = 0.286; cumulative percentage variance of species-environment relation first axis = 41.3, second axis = 73.9). Abbreviated species names per group: **(A)** Dic_nig = *Dicymbium nigrum*, Eri_atr = *Erigone atra*, Pac_deg = *Pachygnatha degeeri*, Par_pal = *Pardosa palustris*, Par_pra = *Pardosa prativaga*, Tis_vag = *Tiso vagans*; **(B)** Alo_cun = *Alopecosa cuneata*, Eri_den = *Erigone dentipalpis*, Eri_lon = *Erigone longipalpis*, Oed_ret = *Oedothorax retusus*; **(C)** Ael_ins = *Aelurillus v-insignitus*, Alo_pul = *Alopecosa pulverulenta*, Dra_pus = *Drassyllus pusillus*, Eri_arc = *Erigone arctica*, Hap_sig = *Haplodrassus signifer*, Hap_umb = *Haplodrassus umbratilis*, Mei_rur = *Meioneta rurestris*, Par_mon = *Pardosa monticola*, Pel_par = *Pelecopsis parallela*, Pll_tri = *Pellenes tripunctatus*, Ste_pha = *Steatoda phalerata*, Xer_min = *Xerolycosa miniata*, Xys_koc = *Xysticus kochi*, Zel_ele = *Zelotes electus*, Zel_pet = *Zelotes petrensis*; **(D)** Agr_pro = *Agroeca proxima*, Euo_fro = *Euophrys frontalis*, Mal_atr = *Malthonica atrica*, Man_aca = *Mangora acalypha*, Ozy_pra = *Ozyptila praticola*, Zel_sub = *Zelotes subterraneus*; **(E)** Aba_sal = *Abacoproeces saltuum*; Cer_pro = *Cercidia prominens*; Eno_tho = *Enoplognatha thoracica*, Par_lug = *Pardosa lugubris*, Zor_spi = *Zora spinimana*; **(F)** Agr_bru = *Agroeca brunnea*, Eur_fla = *Euryopis flavomaculata*, Gon_lat = *Gongylidiellum latebricola*, Hah_mon = *Hahnia montana*, Lin_tri = *Linyphia triangularis*, Min_pus = *Minyriolus pusillus*, Poc_pum = *Pocadicnemis pumila*, Ten_men = *Tenuiphantes mengei*, Tro_ter = *Trochosa terricola*, Wal_atr = *Walckenaeria atrotibialis*, Wal_fur = *Walckenaeria furcillata*. For species representation values see Tab. 3.

Tab. 3: Representation values for all species which were included in the RDA. Abbreviated species names see fig. 2

group A species	R [%]	group B species	R [%]	group C species	R [%]	group D species	R [%]	group E species	R [%]	group F species	R [%]
Dic_nig	80	Alo_cun	26	Ael_ins	62	Agr_pro	88	Aba_sal	72	Agr_bru	25
Eri_atr	73	Eri_den	96	Alo_pul	27	Euo_fro	23	Cer_pro	28	Eur_fla	30
Pac_deg	70	Eri_lon	94	Dra_pus	43	Mal_atr	78	Eno_tho	26	Gon_lat	20
Par_pal	96	Oed_ret	99	Eri_arc	100	Man_aca	86	Par_lug	41	Hah_mon	38
Par_pra	94			Hap_sig	29	Ozy_pra	97	Zor_spi	14	Lin_tri	46
Tis_vag	92			Hap_umb	45	Zel_sub	66			Min_pus	18
				Mei_rur	43					Poc_pum	35
				Par_mon	100					Ten_men	23
				Pel_par	100					Tro_ter	17
				Pll_tri	73					Wal_atr	42
				Ste_pha	84					Wal_fur	32
				Xer_min	81						
				Xys_koc	80						
				Zel_ele	71						
				Zel_pet	58						

species, respectively, had similar positions along the first axis due to the influence of agricultural land use. *Pardosa palustris*, *P. prativaga*, and *Tiso vagans* were exclusively found in group A. *Erigone dentipalpis*, *E. longipalpis*, and *Oedothorax retusus* were unique in group B, which showed some intergrading with group C. The third community correlated with dry sites and the cover of bare sand. *Erigone arctica*, *Pardosa monticola*, and *Pelecopsis parallela* were exclusively found in these habitats, others preferred them (e.g., *Steatoda phalerata*, *Xerolycosa miniata*, *Xysticus kochi*). Some species belonging to group C also occurred on other habitat types (e.g., *Alopecosa pulverulenta*, *Drassyllus pusillus*, *Haplodrassus signifer*, *Meioneta rurestris*).
Group D, E and F were arranged along the humidity gradient. *Agroeca proxima*, *Malthonica atrica*, *Mangora acalypha*, and *Zelotes subterraneus* showed higher representation values for group D, but only *Ozyptila praticola* was exclusively found in this community. The species of group E (*Abacoproeces saltuum*, *Cercidia prominens*, *Enoplognatha thoracica*, *Pardosa lugubris*, *Zora spinimana*) and group F (*Agroeca brunnea*, *Euryopis flavomaculata*, *Gongylidiellum latebricola*, *Hahnia montana*, *Linyphia triangularis*, *Minyriolus pusillus*, *Pocadicnemis pumila*, *Tenuiphantes mengei*, *Trochosa terricola*, *Walckenaeria furcillata*, *W. atrotibialis*) correlated with a higher cover of the herb layer and higher soil humidity. Both groups had hardly any exclusive species.

Discussion

The dominant spider species recorded during this study, like *Pirata hygrophilus*, *Pardosa lugubris*, *P. palustris*, *Trochosa terricola*, and *Pardosa prativaga*, are eurytopic and occur in a wide array of habitats all over North Rhine-Westphalia (Kreuels & Buchholz 2006). Apart from the occurrence of several endangered spiders, six extremely rare species are faunistically remarkable findings. *Abacoproeces saltuum*, *Haplodrassus soerenseni*, and *Zelotes clivicolus* are mainly distributed in southern and eastern Germany and sporadically in northern Germany, while *Coriarachne depressa*, *Neriene furtive*, and *Saaristoa firma* are rare but occur all over Germany (Staudt 2008). Maybe this distribution can be explained by a lower recording level in the north-western parts of Germany. In North Rhine-Westphalia records of all species are limited to just a few studies: *Abacoproeces saltuum* (Bösenberg 1902, Wiehle 1960), *Coriarachne depressa* (Jäger 1996, Buchholz & Kreuels 2005), *Haplodrassus soerenseni* (Becker 1977, Hermann 1994), *Neriene furtiva* (Säcker 1993, Doer 2000), *Saaristoa firma* (Casemir 1963, 1976), and *Zelotes clivicolus* (Weiss 1985).

The highest diversity was calculated for site E8, which is a dry grassland fragment located in a mosaic of different habitat types like *Calluna* heathland, dry fringes and forests.

Diverse habitat structures always cause high species diversity (HEUBLEIN 1982, 1983, SCHEIDLER 1990, HART & HORWITZ 1994, SCHAEFER 2003). Low values for diversity and evenness in species groups indicate dynamic and disturbed habitats, for example due to agricultural land use as at site E1 (KRATOCHWIL & SCHWABE 2001). In contrast to this, the remarkably frequent occurrence of the lycosid spider *Pirata hygrophilus* (about 66% of all individuals) reduces the diversity and evenness on site E4.
Is there a community of spider species characteristic to open inland dunes and unique for these habitats? On the basis of this study it is possible to define a spider assemblage which seems to be typical of dry grasslands and heathlands in the investigation area. But due to the low number of exclusive species recorded during this study – only *Erigone arctica*, *Pardosa monticola*, and *Pelecopsis parallela* are unique – it seems better to define this species group as typical of dry habitats in general. Most species occur on dry grassland sites as well as in dry forests and forest edges, e.g., *Aelurillus v-insignitus*, *Haplodrassus umbratilis*, *Pellenes tripunctatus*, and *Zelotes electus* (HEUBLEIN 1982, BAUCHHENSS 1990, KREUELS & BUCHHOLZ 2006). This is caused by the fragmentation and the small size of the remaining former open inland dune habitats, as mentioned by JAKOBITZ & BROEN (2001) for spiders in dry grasslands of Brandenburg. FALKE & ASSMANN (1997, 2001) found similar results for carabid beetles in dry grasslands in Lower Saxony, where the number of stenotopic species increases significantly with increasing habitat size. Especially highly mobile spiders, like species from the families Gnaphosidae, Lycosidae, and Salticidae (see above), are able to move from site to site and within mosaic habitats and thus form mosaic communities (HEUBLEIN 1982, WEBB & HOPKINS 1984). Apart from this, a general problem of dry grasslands and inland dunes of north-western Germany could be the Atlantic climate, which seems to reduce the extreme character of the habitat by accelerating succession. So these dunes are probably less hot and dry, which makes them more suitable for habitat generalists (MERKENS 2002).

However, based on this study, spider assemblages of dry habitats can clearly be distinguished from those in other habitats of the investigation area. Lycosid species like *Alopecosa cuneata*, *Pardosa palustris*, and *P. prativaga* as well as the linyphid spider *Tiso vagans*, belonging to group A and B, are typical of meadows (see BUCHHOLZ & HARTMANN 2008). *Erigone dentipalpis*, *E. longipalpis*, and *Oedothorax retusus* are pioneer species which are able to tolerate disturbances like mowing and grazing (BELL et al. 2001). In the study area these species are mainly restricted to agriculturally used sites like improved meadows and pastures (e.g., E1). Three further groups (D-F) comprise species which prefer more humid and vegetated habitats and thus can be characterised as typical of forested sites in the study area (e.g., E4, E5). Most of the species of group D and E are common in semi-dry or semi-humid forests but also extend their occurrence into ecotones, for example *Agroeca proxima*, *Enoplognatha thoracica*, *Euophrys frontalis*, *Ozyptila praticola*, and *Pardosa lugubris* (BAUCHHENSS 1990, FINCH 1997, MERKENS 2002, KREUELS & BUCHHOLZ 2006). Within assemblage F, species of humid sites are grouped, whereas e.g., *Gongylidiellum latebricola*, *Hahnia montana*, *Linyphia triangularis*, and *Minyriolus pusillus* seem to be restricted to these sites (HEIMER & NENTWIG 1991), while *Agroeca brunnea* and *Trochosa terricola* are generalists that are able to cope with a wide ecological amplitude (BOLAÑOS 2003).

Is it possible to define indicator species for open inland dune habitats which can be used as target species for conservation and habitat management? It is arguable to define these indicator species, because most of the species seem to prefer dry habitat conditions in general. Only three species, *Erigone arctica*, *Pardosa monticola*, and *Pelecopsis parallela* are unique for dry grassland and heathland sites, whereas *Erigone arctica* is the only species which is really typical of sandy habitats of the lowlands of northern Germany (MERKENS 2002, KREUELS & BUCHHOLZ 2006) as well as in coastal habitats (FINCH et al. 2007). *Pardosa monticola* is normally very frequent on semi-dry grasslands (BONTE et al. 2003, BUCHHOLZ & HARTMANN 2008) and herbaceous heathlands (LISKEN-KLEINMANS 2000). According to BONTE & MAELFAIT (2001) this lycosid species can be used as an indicator for the quality of dune ecosystems. *Pelecopsis parallela* is eurytopic and spreads into all habitats (BAUCHHENSS 1990, HEIMER & NENTWIG 1991), showing preference for semi-dry meadows (BUCHHOLZ & HARTMANN 2008).

However, it is impossible to define indicator species for open inland dune habitats of the study area, although the occurrence of species typical of sand habitats indicates a certain importance of the fragmented sites of the study area for nature conservation, even if a low number of specimens were caught. Apart from *Talavera petrensis*, which is stenotopic in dry grasslands (Kreuels & Buchholz 2006), further typical species of dry and open inland dune habitats were recorded, for example *Alopecosa accentuata*, *Arctosa perita*, *Pardosa nigriceps*, and *Trichopterna cito* (Leist 1994, Merkens 2002, Schnitter et al. 2003, Ratschker 2006). As opposed to this, species like *Agroeca lusatica*, *Clubiona frutetorum*, *Sitticus distinguendus*, *S. saltator*, and *Steatoda albomaculata*, found by Lademann (1995) and Finch (1997) to be typical of inland dunes of north-western Germany, are missing or could not be recorded yet.

When monitoring or evaluating the habitat using spiders as indicators, the absence of typical or stenotopic species is often symptomatic of low habitat qualities, i.e. low quality in vegetation structure (cf. Bonte & Maelfait 2001). In the present study, the missing species show that the open inland dune habitats of the investigation area are already too fragmented and affected by habitat degradation. Thus, a major aim of habitat management must be to recreate more suitable conditions for a more frequent occurrence of the species mentioned above. Consequently, extensive management as well as increasing dynamics (for example through disturbances) are essential for a long-term conservation of xerophilous species. Sites of sparse vegetation in xerothermic grasslands and heathlands are best generated by grazing, trampling and other effects of browsing animals. By way of contrast, extreme forms of management like burning or topsoil removal may be useful but should be treated with caution (cf. Bell et al. 2001). Schmidt & Melber (2004) stated that the dominance of hygrophilous or shade-preferring species declines, because of the changed microclimatic conditions after burning activity, while xero-, thermo- or heliophilous species increase. Even if most of the invertebrate animals survive a winter fire by hibernating in the organic soil layer or because they are able to withdraw there as winter active individuals, further studies are necessary to assess the impacts of such intensive management (in particular that of summer fires) on spiders (cf. Gerland 2004).

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References

AG Boden/Arbeitsgruppe Boden der Geologischen Landesämter und der Bundesanstalt für Geowissenschaften und Rohstoffe der Bundesrepublik Deutschland (1994): Bodenkundliche Kartieranleitung. – Bundesanstalt für Geowissenschaften und Rohstoffe und Geologische Landesämter, Hannover. 392 pp.

Barber, H. S. (1931): Traps for cave-inhabiting insects. – Journal of the Elisha Mitchell Scientific Society **46**: 259–266.

Bauchhenss, E. (1990): Mitteleuropäische Xerotherm-Standorte und ihre epigäische Spinnenfauna – eine autökologische Betrachtung. – Abhandlungen des Naturwissenschaftlichen Vereins in Hamburg **31/32**: 153–162.

Becker, J. (1977): Die Trockenrasenfauna des Naturschutzgebietes Stolzenburg (Nordeifel). – Decheniana **130**: 101–113.

Bell, J. R., C. P. Wheater & W. R. Cullen (2001): The implications of grassland and heathland mangement for the conservation of spider communities: a review. – Journal of Zoology **255**: 377–387.

Bellmann, H. (1997): Zum Vorkommen dünenspezifischer Arthropoden in Mitteleuropa. – Mitteilungen der Deutschen Gesellschaft für Allgemeine und Angewandte Entomologie 11: 839–842.

Berger-Landefeldt, U. & H. Sukopp (1965): Zur Synökologie der Sandtrockenrasen, insbesondere der Silbergrasflur. – Verhandlungen des Botanischen Vereins der Provinz Brandenburg **102**: 41–98.

BOLAÑOS, A. (2003): Spider assemblages and habitat bindings in Central Europe. – Verlag Agrarökologie, Bern. 125 pp.

BONTE, D. & J.-P. MAELFAIT (2001): Life history, habitat use and dispersal of a dune wolf spider (*Pardosa monticola* [CLERCK, 1757] Lycosidae, Araneae) in the Flemish coastal dunes (Belgium). – Belgian Journal of Zoology **131**: 145–157.

BONTE, D., L. LENS, J.-P. MAELFAIT, M. HOFFMANN & E. KUIJKEN (2003): Patch quality and connectivity influence spatial dynamics in a dune wolfspider. – Oecologia **135**: 227–233.

BÖSENBERG, W. (1902): Die Spinnen Deutschlands. – Zoologica **14**: 97–192, 193–288, 289–384.

BRAAK, C. J. F. TER & P. SMILAUER (2002): Canoco 4.5 Reference Manual. – Wageningen University and Research Centre, Wageningen. 500 pp.

BUCHHOLZ, S. & V. HARTMANN (2008): Spider fauna of semi-dry grasslands of a military training area in Northwest Germany. – Arachnologische Mitteilungen **35**: 51–60.

BUCHHOLZ, S. & M. KREUELS (2005): Die Spinnen (Arachnida: Araneae) im Naturschutzgebiet „Heiliges Meer" – eine vorläufige Artenliste. – Natur und Heimat **65**: 97–112.

BURRICHTER, E. (1973): Die potentielle natürliche Vegetation in der Westfälischen Bucht. – Siedlung und Landschaft in Westfalen **8**: 1?58.

CASEMIR, H. (1963): Zwei für Deutschland neue Spinnenarten aus der Familie Linyphiidae: *Lepthyphantes angulatus* CAMBR. und *Oreonetides firmus* CAMBR. – Decheniana **115**: 129–132.

CASEMIR, H. (1976): Beitrag zur Hochmoor-Spinnenfauna des Hohen Venns (Hautes Fagnes) zwischen Nordeifel und Ardennen. – Decheniana **129**: 38–72.

DOER, D. (2000): Die epigäische Spinnenfauna (Arachnida: Araneae) verschiedener Sukzessionsstadien auf Industriebrachen im Landschaftspark Duisburg-Nord. – Unpubl. diploma thesis, University of Münster. 92 pp.

DRACHENFELS, O. V. (1996): Rote Liste der gefährdeten Biotoptypen in Niedersachsen – Bestandsentwicklung und Gefährdungsursachen der Biotop- und Ökosystemtypen sowie ihrer Komplexe – Stand Januar 1996. – Naturschutz und Landschaftspflege in Niedersachsen **34**: 1–148.

DUFFEY, E. (1993): A review of factors influencing the distribution of spiders with reference to Britain. – Memoirs of the Queensland Museum **33**: 497–502.

ENGELMANN, H.-D. (1978): Zur Dominanzklassifizierung von Bodenarthropoden. – Pedobiologia 18: 378–380.

FALKE, B. & T. ASSMANN (1997): Die Laufkäferfauna unterschiedlich großer Sandtrockenrasen in Niedersachsen (Coleoptera: Carabidae). – Mitteilungen der Deutschen Gesellschaft für Allgemeine und Angewandte Entomologie **11**: 115–118.

FALKE, B. & T. ASSMANN (2001): Zur Käferfauna von Sandtrockenrasen und Heidegesellschaften in Hudelandschaften des Emslandes (Nordwest-Deutschland). – Drosera **2001**: 35–52.

FINCH, O.-D. (1997): Die Spinnen (Araneae) der Trockenrasen eines nordwestdeutschen Binnendünenkomplexes. – Drosera **97**: 21–40.

FINCH, O.-D., H. KRUMMEN, F. PLAISIER & W. SCHULTZ (2007): Zonation of spiders (Araneae) and carabid beetles (Coleoptera: Carabidae) in island salt marshes at the North Sea coast. – Wetlands Ecology and Management **15**: 207–228.

FLIERDT, M. VAN DE & M. KÖSTER (2002): Pflege- und Entwicklungskonzept für die Elter Dünen, Kreis Steinfurt. – Unpubl. diploma thesis, University of Applied Science Osnabrück. 370 pp.

GERLAND, K. (2004): Empfehlungen zur Heidepflege durch Feuer, abgeleitet aus Untersuchungen zur Besiedlung von Brandflächen durch Spinnen. – Unpubl. diploma thesis, University of Applied Science Lippe and Höxter. 94 pp.

GRABERT, H. (1951): Zur Dünenbildung im Münsterland. – Geologisches Jahrbuch **66**: 693–702.

HART, D. D. & R. J. HORWITZ (1991): Habitat diversity and the species-area relationship: alternative models and tests. – In: S. S. BELL, E. D. MCCOY & H. R. MUSHINSKY (eds.), Habitat structure: the physical arrangement of objects in space: 47–68. Chapman & Hall, London.

HEIMER, S. & W. NENTWIG (1991): Spinnen Mitteleuropas. – Parey, Berlin. 543 pp.

HERMANN, E. (1994): Die Spinnenfauna von Eichen-Birken-Niederwäldern am Beispiel eines Siegerländer Haubergs (Arachnida, Araneae). – Unpubl. diploma thesis, University of Gießen. 89 pp.

HEUBLEIN, D. (1982): Untersuchungen zum Einfluss eines Waldrandes auf die epigäische Spinnenfauna eines angrenzenden Halbtrockenrasens. – Laufener Seminar-Beiträge **5**: 79–94.

HEUBLEIN, D. (1983): Räumliche Verteilung, Biotoppräferenzen und kleinräumige Wanderungen der epigäischen Spinnenfauna eines Wald-Wiesen-Ökotons; ein Beitrag zum Thema „Randeffekt". – Zoologische Jahrbücher: Systematik, Ökologie und Geographie der Tiere **110**: 473–519.

JÄGER, P. (1996): Spinnen (Araneae) der Wahner Heide bei Köln. – Decheniana **35**: 531–572.

JAKOBITZ, J. & B. V. BROEN (2001): Die Spinnenfauna des NSG Pimpinellenberg. – Naturschutz und Landschaftspflege in Brandenburg **10**: 71–80.

JECKEL, G. (1984): Syntaxonomische Gliederung, Verbreitung und Lebensbedingungen nordwestdeutscher Sandtrockenrase (Sedo-Scleranthetea). – Phytocoenologia **12**: 9–153.

JENTSCH, A., W. BEYSCHLAG, W. NEZADAL, T. STEINLEIN & W. WELSS (2002): Bodenstörung – treibende Kraft für die Vegetationsdynamik in Sandlebensräumen – Konsequenzen für Pflegemaßnahmen im Naturschutz. – Naturschutz und Landschaftsplege **34**: 37–44.

KIECHLE, J. (1992): Die Bearbeitung landschaftökologischer Fragestellungen anhand von Spinnen. Arten- und Biotopschutz in der Planung: Methodische Standards zur Erfassung von Tierartengruppen. – Ökologie in Forschung und Anwendung **5**: 119–134.

KRATOCHWIL, A. & A. SCHWABE (2001): Ökologie der Lebensgemeinschaften. – Ulmer, Stuttgart. 756 pp.

KRATOCHWIL, A. (2004): Sand-Ökosysteme im Binnenland: Dynamik, Restitution und Beweidungsmanagement – das Beispiel: Emsland. – In: WESTFÄLISCHER NATURWISSENSCHAFTLICHER VEREIN (ed.), Dünen und trockene Sandlandschaften – Gefährdung und Schutz: 13–21. Wolf & Kreuels, Havixbeck-Hohenholte.

KREUELS, M. & S. BUCHHOLZ (2006): Ökologie, Verbreitung und Gefährdungsstatus der Webspinnen Nordrhein-Westfalens. – Wolf & Kreuels, Havixbeck-Hohenholte. 116 pp.

LADEMANN, J. (1995): Die Spinnenfauna (Araneae) unterschiedlicher Vegetationseinheiten eines norddeutschen Sandtrockenrasens. – Unpubl. diploma thesis, University of Bremen. 93 pp.

LEIST, N. (1994): Zur Spinnenfauna zweier Binnendünen um Sandhausen bei Heidelberg (Arachnida: Araneae). – Veröffentlichungen der Landesstelle für Naturschutz und Landschaftspflege Baden-Württemberg, Beiheft **80**: 283–324.

LISKEN-KLEINMANS, A. (2000): Ökologische Charakterisierung und Bewertung von Spinnenzönosen in Trockenheidebiotopen der Fischbeker Heide. – Dissertation, University of Hamburg. 164 pp.

MAGURRAN, A. E. (2004): Measuring biological diversity. – Blackwell, Oxford. 255 pp.

MERKENS, S. (2002): Epigeic spider communities in inland dunes in the lowlands of Northern Germany. – In: S. TOFT & N. SCHARFF (eds), Proceedings of the 19th European Colloquium of Arachnology, Aarhus 17–22. July 2000: 215–222.

MEYNEN, E. & J. SCHMITHÜSEN (eds.) (1959): Handbuch der naturräumlichen Gliederung Deutschlands, 6. Lieferung. – Veröffentlichungen der Bundesanstalt für Landeskunde und des Deutschen Instituts für Länderkunde, Remagen.

MURL NRW (MINISTERIUM FÜR UMWELT, RAUMORDNUNG UND LANDWIRTSCHAFT DES LANDES NRW) (ed.) (1989): Klima-Atlas von Nordrhein-Westfalen. – Eigenverlag, Düsseldorf. 65 pp.

NORRIS, K. C. (1999): Quantifying change through time in spider assemblages: Sampling methods, indices, and sources of error. – Journal of Insect Conservation **3**: 1–17.

PARDEY, A. (2004): Dünen und Sandlandschaften in Nordrhein-Westfalen unter besonderer Berücksichtigung der Situation in Westfalen. – In: WESTFÄLISCHER NATURWISSENSCHAFTLICHER VEREIN (ed.), Dünen und trockene Sandlandschaften – Gefährdung und Schutz: 3–11. Wolf & Kreuels, Havixbeck-Hohenholte.

PLATNICK, N. J. (2007): The world spider catalog, version 8.0. – American Museum of Natural History. http://research.amnh.org/entomology/spiders/catalog/index.html [31.03.2008].

RABELER, W. (1951): Zur Kenntnis der Spinnenfauna osthannoverscher Heideflächen. – Abhandlungen des Naturwissenschaftlichen Vereins zu Bremen **28**: 165–182.

RATSCHKER, U. M. (2006): The spider assemblages of nutrient-poor and sandy dry grasslands. – In: M. FLADE, H. PLACHTER, R. SCHMIDT & A. WERNER (eds.), Nature conservation in agricultural ecosystems. Quelle & Meyer, Wiebelsheim: 417–423.

RIECKEN, U., P. FINCK, U. RATHS, E. SCHRÖDER & A. SSYMANK (2006): Rote Liste der gefährdeten Biotoptypen Deutschlands. Zweite fortgeschriebene Fassung 2006. – Naturschutz und Biologische Vielfalt **34**: 1–318.

SÄCKER, K. (1993): Ökologische Untersuchungen an Hecken im Münsterland am Beispiel der Spinnen (Araneae). – Unpubl. diploma thesis, University of Münster. 92 pp.

SCHAEFER, M. (2003): Wörterbuch der Ökologie. – Spektrum Akademischer Verlag, Heidelberg. 433 pp.

SCHEIDLER, M. (1990): Influence of habitat structure and vegetation architecture on spiders. – Zoologischer Anzeiger **225**: 333–340.

SCHMIDT, L. & A. MELBER (2004): Einfluss des Heidemangements auf die Wirbellosenfauna in Sand- und Moorheiden Nordwestdeutschlands. – NNA-Berichte **17**: 145–164.

SCHNITTER, P. H., M. TROST & M. WALLASCHEK (eds.) (2003): Tierökologische Untersuchungen in gefährdeten Biotoptypen des Landes Sachsen-Anhalt. I. Zwergstrauchheiden, Trocken- und Halbtrockenrasen. – Entomologische Mitteilungen Sachsen-Anhalt, Sonderheft **2003**: 1–216.

SCHULTZ, W. & O.-D. FINCH (1996): Biotoptypenbezogene Verteilung der Spinnenfauna der nordwestdeutschen Küstenregion. – Cuvillier, Göttingen. 141 pp.

STAUDT, A. (2008): Nachweiskarten der Spinnentiere Deutschlands. – http://www.spiderling.de/arages. [31.03.2008]

STEVEN, M. (2004): Anforderungen an den Naturschutz in Flugsandgebieten Westfalens aus Sicht des Naturschutzbundes (NABU). – In: WESTFÄLISCHER NATURWISSENSCHAFTLICHER VEREIN (ed.), Dünen und trockene Sandlandschaften – Gefährdung und Schutz: 83–91. Wolf & Kreuels, Havixbeck-Hohenholte.

SUNDERMEIER, A. (1998a): Methoden zur Ermittlung der Vegetationsdeckung. – In: A. TRAXLER (ed.), Handbuch des vegetationsökologischen Monitorings. Teil A: Methoden: 102–122. Umweltbundesamt, Wien.

SUNDERMEIER, A. (1998b): Methoden zur Analyse der Vegetationsstruktur. – In: A. TRAXLER (ed.), Handbuch des vegetationsökologischen Monitorings. Teil A: Methoden: 123–158. Umweltbundesamt, Wien.

VERBÜCHELN, G. & M. JÖBGES (2000): Verbreitung und aktueller Zustand der Heiden, Sandtrockenrasen und Borstgrasrasen in Nordrhein-Westfalens. – NUA-Hefte **6**: 6–23.

VERBÜCHELN, G., G. SCHULTE & R. WOLFF-STRAUB (1999): Rote Liste der gefährdeten Biotoptypen in Nordrhein-Westfalen – 1. Fassung. – LÖBF-Schriftenreihe **17**: 37–56.

WEBB, N. R. & P. J. HOPKINS (1984): Invertebrate diversity on fragmented *Calluna* heathland. – Journal of Applied Ecology **21**: 921–933.

WEISS, I. (1985): Artenlisten zweier Projekte der LÖBF in NRW. – Unpublished.

WIEHLE, H. (1960): Die Tierwelt Deutschlands und der angrenzenden Meeresteile nach ihren Merkmalen und nach ihrer Lebensweise: Spinnentiere oder Arachnoidea (Araneae), XI: Microphantidae – Zwergspinnen. – Fischer, Jena. 620 pp.

WIESBAUER, H. & K. MAZZUCCO (1997): Dünen in Niederösterreich. Ökologie und Kulturgeschichte eines bemerkenswerten Landschaftselements. – Fachberichte des Niederösterreichischen Landschaftsfonds **6** (97): 1–90.

WISE, D. H. (1993): Spiders in ecological webs. – Cambridge University Press, Cambridge. 328 pp.

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Appendix 1: Species list (nomenclature follows PLATNICK 2007). Abbreviations: RL = status of endangerment (according to KREUELS & BUCHHOLZ 2006): * = not endangered, V = endangerment is to be assumed, R = extremely rare, not declining species, 3 = endangered, 2 = highly endangered; HB = habitat bindings: e = eurytopic, s = stenotopic (1 = dry non-forested habitats, 2 = wet non-forested habitats, 3 = forests, 4 = fringes); A = abundance; D = Dominance [%]; M = method: hs = hand-sampling, pt = pitfall-trapping; frequency: I = 1–5 individuals, II = 6–25, III = 26–75, IV = 76–150, V > 150

	RL	HB	1	2	3	4	5	6	7	8	9	A	D	meth
Segestriidae														
Segestria senoculata (LINNAEUS, 1758)	*	eu	.	.	.	I	I	.	I	.	.	6	0,11	pt
Mimetidae														
Ero furcata (VILLERS, 1789)	*	eu	.	.	.	.	.	.	I	.	I	2	0,04	pt, hs
Theridiidae														
Enoplognatha thoracica (HAHN, 1833)	*	eu	.	I	I	I	II	I	II	I	I	39	0,72	pt
Episinus truncatus LATREILLE, 1809	*	eu	.	.	.	I	.	.	.	.	I	2	0,04	pt
Euryopis flavomaculata (C. L. KOCH, 1836)	*	eu	.	.	.	III	III	II	I	I	.	112	2,07	pt
Lasaeola tristis (HAHN, 1833)	*	2,3,4	.	.	.	.	I	.	.	.	.	1	0,02	pt
Robertus lividus (BLACKWALL, 1836)	*	eu	.	I	.	.	I	I	.	.	I	10	0,19	pt
Steatoda phalerata (PANZER, 1801)	*	eu	.	I	.	.	I	.	I	II	I	31	0,57	pt
Linyphiidae														
Abacoproeces saltuum (L. KOCH, 1872)	R	18	.	.	.	.	II	I	.	.	.	11	0,20	pt
Agyneta ramosa JACKSON, 1912	*	eu	.	.	.	I	.	.	.	.	.	2	0,04	pt
Araeoncus humilis (BLACKWALL, 1841)	*	eu	.	I	.	.	.	.	.	.	.	1	0,02	pt
Bathyphantes approximatus (O. P.-CAMBRIDGE, 1871)	*	eu	.	.	.	.	I	.	I	.	.	3	0,06	pt
Bathyphantes gracilis (BLACKWALL, 1841)	*	eu	I	.	I	.	.	.	.	.	.	5	0,09	pt
Centromerus incilium (L. KOCH, 1881)	*	eu	.	.	.	.	.	.	.	.	I	1	0,02	pt
Ceratinella brevis (WIDER, 1834)	*	eu	.	.	.	.	.	.	I	.	.	1	0,02	pt
Dicymbium nigrum (BLACKWALL, 1834)	V	eu	II	.	I	I	.	.	I	.	.	15	0,28	pt
Diplocephalus picinus (BLACKWALL, 1841)	*	eu	.	.	.	.	.	.	.	.	I	1	0,02	pt
Diplostyla concolor (WIDER, 1834)	*	eu	.	.	.	.	I	.	.	I	I	5	0,09	pt
Erigone arctica (WHITE, 1852)	3	12, 13	.	.	II	.	.	.	.	.	.	23	0,43	pt, hs
Erigone atra (BLACKWALL, 1841)	*	eu	III	I	II	.	.	.	I	.	.	64	1,18	pt
Erigone dentipalpis (WIDER, 1834)	*	eu	III	.	IV	.	.	.	.	II	.	162	3,00	pt, hs
Erigone longipalpis (SUNDEVALL, 1830)	*	eu	II	.	II	.	I	I	.	.	.	31	0,57	pt
Gongylidiellum latebricola (O. P.-CAMBRIDGE, 1871)	*	eu	.	I	I	I	II	I	I	I	I	25	0,46	pt
Linyphia triangularis (CLERCK, 1757)	*	eu	.	I	.	II	I	II	I	.	.	24	0,44	pt, hs
Macrargus rufus (WIDER, 1834)	*	eu	.	.	.	.	.	.	I	I	.	2	0,04	pt
Meioneta rurestris (C. L. KOCH, 1836)	*	eu	I	I	I	.	.	.	.	I	I	12	0,22	pt, hs
Metopobactrus prominulus (O. P.-CAMBRIDGE, 1872)	*	eu	.	I	.	.	I	.	.	.	.	2	0,04	pt
Micrargus herbigradus (BLACKWALL, 1854)	*	eu	.	.	.	I	I	.	.	I	I	4	0,07	pt
Micrargus subaequalis (WESTRING, 1851)	*	eu	.	.	.	.	.	.	.	I	.	1	0,02	pt
Microlinyphia pusilla (SUNDEVALL, 1830)	*	eu	.	.	I	.	.	.	.	.	.	1	0,02	pt
Minyriolus pusillus (WIDER, 1834)	*	eu	.	.	.	I	II	.	.	.	II	22	0,41	pt
Mioxena blanda (SIMON, 1884)	V	eu	.	.	I	.	.	.	.	.	I	2	0,04	pt
Neriene furtiva (O. P.-CAMBRIDGE, 1870)	R	6, 7	.	.	.	I	I	.	I	.	.	5	0,09	pt
Oedothorax apicatus (BLACKWALL, 1850)	*	eu	.	.	I	.	I	.	.	.	.	3	0,06	pt
Oedothorax retusus (WESTRING, 1851)	*	eu	II	.	IV	.	.	.	.	I	.	114	2,11	pt
Pelecopsis parallela (WIDER, 1834)	*	eu	.	.	III	.	.	.	.	.	.	29	0,54	pt
Pocadicnemis pumila (BLACKWALL, 1841)	*	eu	I	.	.	II	III	I	I	I	III	74	1,37	pt
Saaristoa abnormis (BLACKWALL, 1841)	*	eu	.	.	.	.	.	I	.	.	I	4	0,07	pt
Saaristoa firma (O. P.-CAMBRIDGE, 1905)	R	2	.	.	.	.	.	.	.	.	I	1	0,02	pt
Tapinopa longidens (WIDER, 1834)	*	eu	.	.	.	.	I	.	.	.	.	1	0,02	pt
Tenuiphantes cristatus (MENGE, 1866)	*	eu	.	.	.	.	.	.	I	.	.	2	0,04	pt
Tenuiphantes flavipes (BLACKWALL, 1854)	*	eu	.	.	.	.	I	I	I	.	.	5	0,09	pt
Tenuiphantes mengei KULCZYNSKI, 1887	*	eu	I	.	.	I	I	I	.	.	I	13	0,24	pt
Tenuiphantes tenuis (BLACKWALL, 1852)	*	eu	I	.	I	II	I	I	II	I	I	34	0,63	pt, hs
Tiso vagans (BLACKWALL, 1834)	*	eu	II	.	.	.	.	.	I	.	.	26	0,48	pt
Trichopterna cito (O. P.-CAMBRIDGE, 1872)	2	eu	.	.	.	.	.	.	.	II	.	10	0,19	pt
Walckenaeria acuminata BLACKWALL, 1833	*	eu	.	.	.	I	.	.	.	.	.	1	0,02	pt
Walckenaeria atrotibialis O. P.-CAMBRIDGE, 1878	*	eu	.	.	.	III	III	III	II	.	II	142	2,63	pt

	RL	HB	1	2	3	4	5	6	7	8	9	A	D	meth
Walckenaeria cucullata (C. L. Koch, 1836)	*	eu	.	.	.	.	I	.	.	.	.	3	0,06	pt
Walckenaeria dysderoides (Wider, 1834)	*	eu	.	.	.	I	I	.	.	.	.	4	0,07	pt
Walckenaeria furcillata (Menge, 1869)	*	eu	I	I	.	II	I	II	II	I	I	52	0,96	pt
Walckenaeria obtusa Blackwall, 1836	*	eu	.	.	.	I	I	I	.	.	I	5	0,09	pt
Tetragnathidae														
Metellina mengei (Blackwall, 1869)	*	eu	I	.	.	I	.	II	.	.	.	9	0,17	pt, hs
Metellina segmentata (Clerck, 1757)	*	eu	.	.	.	I	.	.	.	.	.	1	0,02	hs
Pachygnatha degeeri Sundevall, 1830	*	eu	IV	.	I	.	.	II	I	III	I	169	3,13	pt
Pachygnatha listeri Sundevall, 1830	*	eu	.	.	.	I	.	.	.	.	.	3	0,06	pt
Araneidae														
Araneus diadematus Clerck, 1757	*	eu	.	I	.	I	.	.	.	.	.	6	0,11	pt, hs
Cercidia prominens (Westring, 1851)	*	eu	.	.	.	I	I	I	I	.	.	11	0,20	pt
Cyclosa conica (Pallas, 1772)	*	eu	.	I	.	.	.	I	.	.	.	2	0,04	hs
Mangora acalypha (Walckenaer, 1802)	*	eu	.	.	I	I	I	II	I	.	I	37	0,68	hs
Neoscona adianta (Walckenaer, 1802)	*	eu	.	.	.	.	.	.	.	I	.	1	0,02	pt
Zilla diodia (Walckenaer, 1802)	*	3, 4	.	.	.	I	.	.	.	.	.	1	0,02	pt
Lycosidae														
Alopecosa accentuata (Latreille, 1817)	V	eu	.	.	.	.	.	.	.	I	.	4	0,07	pt
Alopecosa cuneata (Clerck, 1757)	*	eu	II	I	.	.	.	II	.	II	II	74	1,37	pt
Alopecosa pulverulenta (Clerck, 1757)	*	eu	III	III	I	II	II	V	II	III	IV	491	9,08	pt
Arctosa leopardus (Sundevall, 1833)	*	eu	.	.	.	.	.	.	.	I	.	4	0,02	pt
Arctosa perita (Latreille, 1799)	*	eu	.	.	I	.	.	.	.	I	.	5	0,09	pt, hs
Pardosa agrestis (Westring, 1861)	*	eu	.	I	.	.	.	.	.	I	.	4	0,07	pt
Pardosa amentata (Clerck, 1757)	*	eu	I	.	.	.	.	I	.	.	.	2	0,04	pt
Pardosa lugubris (Walckenaer, 1802)	*	eu	II	III	I	III	V	IV	IV	III	II	680	12,58	pt
Pardosa monticola (Clerck, 1757)	*	eu	.	I	.	.	.	.	.	II	.	18	0,33	pt
Pardosa nigriceps (Thorell, 1856)	V	eu	.	I	.	.	.	.	.	I	I	9	0,17	pt
Pardosa palustris (Linnaeus, 1758)	*	eu	V	I	I	.	I	I	.	II	.	572	10,58	pt
Pardosa prativaga (L. Koch, 1870)	*	eu	V	.	I	I	.	I	.	I	I	193	3,57	pt
Pardosa pullata (Clerck, 1757)	*	eu	.	.	I	.	.	.	.	I	.	2	0,04	pt
Pirata hygrophilus Thorell, 1872	*	eu	V	I	I	V	III	II	II	I	II	935	17,30	pt
Pirata piraticus (Clerck, 1757)	*	eu	I	.	.	.	.	.	.	.	.	1	0,02	pt
Pirata uliginosus (Thorell, 1856)	*	eu	.	.	.	.	.	.	.	.	II	9	0,17	pt
Trochosa terricola Thorell, 1856	*	eu	II	III	I	III	III	III	II	II	III	317	5,86	pt, hs
Xerolycosa miniata (C. L. Koch, 1834)	V	eu	.	III	I	.	I	II	I	II	.	108	2,00	pt
Pisauridae														
Pisaura mirabilis (Clerck, 1757)	*	eu	I	I	.	.	.	.	.	.	I	5	0,09	pt
Agelenidae														
Malthonia silvestris L. Koch, 1872	*	eu	.	.	.	.	I	.	.	.	.	3	0,06	pt
Tegenaria agrestis (Walckenaer, 1802)	*	eu	.	.	.	.	.	.	I	.	I	2	0,04	pt
Tegenaria atrica C. L. Koch, 1843	*	eu	I	.	I	.	I	II	I	.	.	14	0,26	pt
Hahniidae														
Hahnia helveola Simon, 1875	*	eu	.	.	.	.	I	.	.	.	.	1	0,02	hs
Hahnia montana (Blackwall, 1841)	*	eu	I	.	.	I	I	I	I	.	.	13	0,24	pt
Hahnia nava (Blackwall, 1841)	*	eu	.	.	.	.	.	.	I	.	.	1	0,02	pt
Hahnia ononidum Simon, 1875	*	eu	.	.	.	.	I	.	.	.	.	5	0,09	pt
Hahnia pusilla C. L. Koch, 1841	*	eu	.	I	.	.	.	.	.	.	.	2	0,04	pt
Dictynidae														
Cicurina cicur (Fabricius, 1793)	*	eu	.	.	.	.	I	I	.	.	.	3	0,06	pt
Lathys humilis (Blackwall, 1855)	*	eu	.	.	I	.	.	.	.	.	.	1	0,02	pt
Miturgidae														
Cheiracanthium virescens (Sundevall, 1833)	3	8	.	I	.	.	.	.	.	I	.	3	0,06	pt
Anyphaenidae														
Anyphaena accentuata (Walckenaer, 1802)	*	eu	.	.	.	.	.	.	I	.	.	1	0,02	hs
Liocranidae														
Agroeca brunnea (Blackwall, 1833)	*	eu	.	I	.	II	II	I	I	I	I	24	0,44	pt
Agroeca proxima (O. P.-Cambridge, 1871)	*	eu	.	I	.	.	.	.	.	I	II	18	0,33	pt
Clubionidae														
Clubiona comta C. L. Koch, 1839	*	eu	.	.	I	I	I	I	I	.	.	10	0,19	pt
Clubiona diversa O. P.-Cambridge, 1862	*	eu	.	I	.	.	.	.	.	I	I	7	0,13	pt

	RL	HB	1	2	3	4	5	6	7	8	9	A	D	meth
Clubiona neglecta O. P.-CAMBRIDGE, 1862	*	eu	.	.	.	.	.	.	.	.	I	1	0,02	pt
Corinnidae														
Phrurolithus festivus (C. L. KOCH, 1835)	*	eu	.	.	.	.	.	.	I	.	I	4	0,07	pt
Phrurolithus minimus C. L. KOCH, 1839	*	eu	.	.	.	.	.	I	.	I	I	4	0,07	pt
Gnaphosidae														
Drassodes cupreus (BLACKWALL, 1834)	*	eu	I	I	.	.	.	.	.	.	.	2	0,04	pt
Drassodes lapidosus (WALCKENAER, 1802)	*	eu	.	I	.	.	I	.	.	.	.	2	0,04	pt
Drassodes pubescens (THORELL, 1856)	*	eu	.	I	.	.	.	I	.	I	.	8	0,15	pt
Drassyllus pusillus (C. L. KOCH, 1833)	*	eu	I	I	.	.	I	II	I	II	I	40	0,74	pt
Haplodrassus signifer (C. L. KOCH, 1839)	*	eu	.	II	I	.	I	II	I	I	.	31	0,57	pt
Haplodrassus silvestris (BLACKWALL, 1833)	*	eu	.	.	.	.	.	.	I	.	.	3	0,06	pt
Haplodrassus soerenseni (STRAND, 1900)	R	3, 4	.	.	.	.	.	I	.	.	I	7	0,13	pt
Haplodrassus umbratilis (L. KOCH, 1866)	*	eu	.	I	.	.	.	II	.	I	.	11	0,20	pt
Micaria fulgens (WALCKENAER, 1802)	V	eu	.	II	.	.	.	I	.	.	.	9	0,17	pt
Micaria pulicaria (SUNDEVALL, 1832)	V	eu	.	.	.	.	I	I	.	.	.	2	0,04	pt
Trachyzelotes pedestris (C. L. KOCH, 1837)	3	eu	.	.	I	.	.	.	.	.	.	1	0,02	pt
Zelotes clivicolus (L. KOCH, 1870)	R	eu	I	.	.	.	.	.	.	.	.	1	0,02	pt
Zelotes electus (C. L. KOCH, 1839)	V	eu	.	.	.	.	.	I	.	II	.	14	0,26	pt
Zelotes petrensis (C. L. KOCH, 1839)	*	eu	.	II	.	.	I	II	.	II	II	53	0,98	pt
Zelotes subterraneus (C. L. KOCH, 1833)	*	eu	.	I	I	I	.	.	II	.	.	12	0,37	pt
Zoridae														
Zora silvestris KULCZYNSKI, 1897	*	18	.	.	.	.	I	I	.	.	I	5	0,09	pt
Zora spinimana (SUNDEVALL, 1833)	*	eu	.	.	.	I	I	I	I	I	II	22	0,41	pt
Philodromidae														
Philodromus albidus KULCZYNSKI, 1911	*	1,2,3,4	.	.	.	.	.	.	I	.	.	1	0,02	pt
Philodromus aureolus (CLERCK, 1757)	*	eu	.	.	.	I	.	.	I	.	.	2	0,04	pt
Philodromus dispar WALCKENAER, 1826	*	eu	.	.	.	.	.	.	I	.	.	1	0,02	pt
Philodromus rufus WALCKENAER, 1826	*	eu	.	.	.	.	.	.	I	.	.	1	0,02	pt
Thomisidae														
Coriarachne depressa (C. L. KOCH, 1837)	R	3, 4	.	.	.	.	I	.	.	.	.	1	0,02	pt
Ozyptila praticola (C. L. KOCH, 1837)	*	eu	.	.	.	.	I	.	III	.	.	34	0,63	pt, hs
Xysticus audax (SCHRANK, 1803)	*	eu	.	.	.	.	I	.	.	.	.	1	0,02	pt
Xysticus cristatus (CLERCK, 1857)	*	eu	I	II	I	.	.	II	I	II	II	43	0,08	pt
Xysticus kochi THORELL, 1872	*	eu	I	I	II	.	.	.	I	II	I	49	0,91	pt
Xysticus lanio C. L. KOCH, 1835	*	eu	.	.	.	I	I	.	.	.	.	2	0,04	pt
Salticidae														
Aelurillus v-insignitus (CLERCK, 1757)	V	eu	.	II	.	.	.	II	.	II	I	39	0,72	pt
Euophrys frontalis (WALCKENAER, 1802)	*	eu	.	I	I	I	II	I	.	I	I	26	0,48	pt
Evarcha falcata (CLERCK, 1757)	*	eu	.	.	.	I	I	.	.	I	.	3	0,06	pt
Heliophanus cupreus (WALCKENAER, 1802)	*	eu	.	.	.	.	.	I	.	.	.	1	0,02	pt
Marpissa muscosa (CLERCK, 1757)	*	eu	.	.	.	.	.	.	I	.	.	1	0,02	pt
Neon reticulatus (BLACKWALL, 1853)	*	eu	.	.	.	I	I	I	I	.	I	6	0,11	pt
Pellenes tripunctatus (WALCKENAER, 1802)	V	eu	.	I	.	.	.	I	.	II	I	15	0,28	pt, hs
Phlegra fasciata (HAHN, 1826)	V	eu	.	.	.	.	.	.	.	I	I	2	0,04	pt
Sibianor aurocinctus (OHLERT, 1865)	*	eu	I	.	.	.	.	.	.	.	I	2	0,04	pt
Talavera petrensis (C. L. KOCH, 1837)	V	8	.	.	I	I	.	.	.	.	.	2	0,04	pt

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