

## SPIDERS (ARANEAE) OF SUBOTICA SANDLAND (SERBIA): ADDITIONAL ARGUMENTS IN ENVIRONMENTAL PROTECTION

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Good environmental management needs evidence-based conservation measures, and those measures need both faunistical and ecological information. Following this path, for the first time in Serbia, a faunistical research of spiders at Subotica Sandland was organised in 2014 as a base for ecological arguments in landscape management of the area. The spiders were collected at ten different habitats on sandy soil, in the period from 27th April till 30th October by pitfall trapping and sweep netting. A total of 16304 adult and 7246 juvenile individuals were captured, and 225 species from 27 families were determined. Thirty species represent new records for Serbia. Diversity and species compositions provided an insight into the quality of the habitats and the influence of the conservation and development measures that were already applied. The main endangerment factors are outlined. Conclusions and suggestions according to the analysis of the spider fauna, are mostly in correlation with those made earlier based on other groups of organisms. Within the scope of nature protection, wet and sandy meadows are prioritised over the woods. For future monitoring, two flagship and umbrella species are suggested: *Argiope lobata* (Pallas, 1772) for the sandy area and *Dolomedes plantarius* (Clerck, 1757) for the wetlands.

Keywords: Araneae, spiders, environmental protection, bioindicators, clear-cutting, mowing, nature protection, new records.

### INTRODUCTION

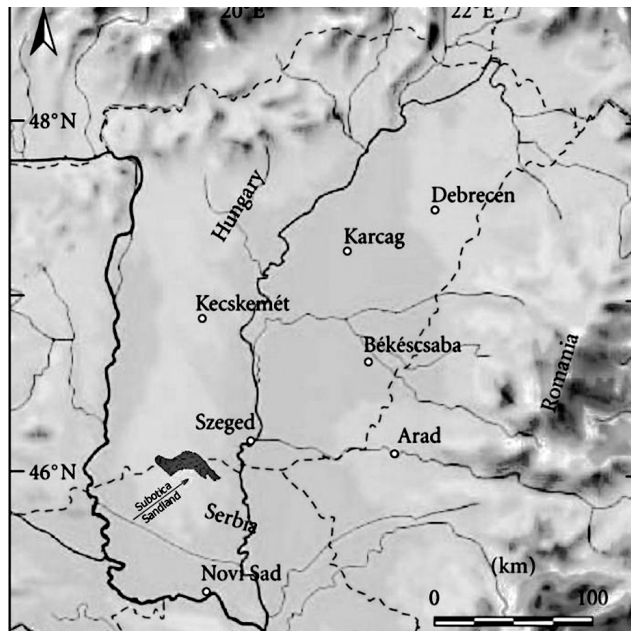
The oldest written document about spiders in Serbia is on the species *Geolycosa vultuosa* (C. L. Koch, 1838) found near Belgrade (SPASOJEVIĆ 1891). Subsequent records correspond to several countries and territories that Serbia as a state implied over the years (SPASOJEVIĆ 1891, CHYZER & KULCZYŃSKI 1894, 1897, BRESJANČEVA 1907, STOJICJEVIĆ 1929, NIKOLIĆ & POLENEC 1981, DELTSHEV *et al.* 2003) and they are sometimes difficult to track. Finally, available data were summarised by DELTSHEV *et al.* (2003), and the list contains 618 spider species from 36 families.

Between 2003 and 2019, additional papers appeared concerning the hypogeic (ĆURČIĆ *et al.* 2007, DELTSHEV & ĆURČIĆ 2011, DELTSHEV *et al.* 2014) and the epigeic fauna (ĆURČIĆ *et al.* 2007, KOMNENOV & PAVIĆEVIĆ 2008, STANKOVIĆ

2010, 2012, DUDIĆ *et al.* 2013). Some localities, like the Fruska Gora National Park (TOMIĆ & GRBIĆ 2008, GRBIĆ & SAVIĆ 2010, GRBIĆ *et al.* 2015), The Special Nature Reserve Zasavica (GRBIĆ *et al.* 2011, GAJIĆ & GRBIĆ 2016) and Deliblato Sand (GRBIĆ *et al.* 2019) were more systematically researched. The study of the Vršac Mountain also began (GAJIĆ, *in litt.*). However, many more protected and unprotected areas are still left unexplored. One of those areas was Subotica Sandland in the northern part of Serbia.

A landscape of outstanding features, the Subotica Sandland ("OFFICIAL GAZETTE OF RS" no. 66/91, 127/2003, 113/2004), occupies the southern part of the Danube–Tisza Interfluvium Area (Fig. 1) in Serbia. The northern part of this area, the Kiskunság National Park, is situated in Hungary and spreads northwards to Budapest.

Unlike the flora, the fauna of the Subotica Sandland has not been studied thoroughly (INPS 2003). Most of the information is about birds and plants, so arguments for nature protection management are based on that knowledge. No information on spiders and very little on other small, ground-living invertebrates is available (INPS 2003). So, the question arises: could the management be based on small ground-living invertebrates like spiders and be beneficial for them, too?



**Fig. 1.** Geographical position of the Subotica Sandland (Serbia) at the southern part of the Danube-Tisza Interfluvium (area marked in black with arrow pointer). The northern part belongs to the Kiskunság Sand which spreads northwards to Budapest. The Serbian – Hungarian border separates both protected areas

Spiders could be influenced by complexes of abiotic and biotic factors that govern the area they inhabit (FOELIX 1996). For these reasons, in some European countries spiders are used as ecological indicators in nature conservation (CLAUSEN 1986, NEET 1996, MAELFAIT & HENDRICHX 1998, POZZI *et al.* 1998, BLICK 1999, MAELFAIT *et al.* 2003). There is a link between changes in habitat quality and changes in the composition of the spider community and vice-versa – a visible change in the specific community structure of the spiders can indicate changes in the quality of habitat (MAELFAIT & HENDRICHX 1998, MAELFAIT *et al.* 2003). Also, in some cases, based on the presence or absence of highly specialised species in a particular habitat, conclusions can be drawn concerning the quality of the studied habitat e.g. the degree of disturbance or impacts of protection measures (MAELFAIT & HENDRICHX 1998, MAELFAIT *et al.* 2003, POZZI & BORCARD 2001, SZMATONA-TURI & VONA-TURI 2016).

Furthermore, some spider species are used as charismatic flagship species, to raise public awareness for conservation measures (MILASOWSKY & ZULKA 1998, FUKUSHIMA *et al.* 2019). Even if a flagship species has been defined in various ways (CARO *et al.* 2004), the general idea is to make it a symbol and leading element of an entire ecosystem conservation campaign (CARO *et al.* 2004, SATTLER *et al.* 2013). Very often flagship species are also thought to be umbrella species that depend on key environmental elements in an ecosystem, and so stand in for the needs of other species. Flagship species mostly are big, beautiful and well-known species. In the case of spiders, flagship species include *Brachypelma* species in America (FUKUSHIMA *et al.* 2019), and the giant European wolf spider *Lycosa singoriensis* (Laxmann, 1770) in the National Park Neusiedler See-Seewinkel (MILASOWSKY & ZULKA 1998).

With the idea to test the assumptions above, a project was organised in the Nature Protection zone of Subotica Sandland. The main goal of it was to provide faunistic and ecological information about spiders and to suggest evidence-based conservation measures. It was designed to create a link between spiders as bioindicators, habitat quality and maintenance activities realised within the area

Several starting assumptions and hypotheses were established: 1) the inventory list of species will contribute not only to Subotica Sandland but to the general knowledge of Serbian arachnofauna; 2) as spiders are good bioindicators of the environment, they could be useful as an additional argument for nature conservation in Subotica Sandland; 3) as diversity and species compositions can give us an insight into the environmental quality of the studied habitats, conclusions about the influence of the active conservation and development measures at the different localities can be drawn; 4) these conclusions will be comparable with those based on other groups of organisms (plants or birds) and will help to evaluate the existing protection management. Last but not least, some highly specialised species could be found and suggested as indicator, flagship, and/or umbrella species for a future monitoring program.

## MATERIAL AND METHODS

### *Study area*

The protected area of Subotica Sandland covers some 2500 ha and is composed of widely distributed sandy dunes covered by steppe, meadows, sandy and marsh plant vegetation, with the highest peak at 134 m a.s.l. (INPS 2003). The dune area is dry, but interdune depressions are influenced by groundwater close to the surface, creating marsh and wet soils. In larger depressions there are bogs. The only river flowing through the Subotica Sandland is the Körös River, which is slowly drying out (INPS 2003). Nowadays, open sands are very rare. Autochthonous and planted forest fragments intersect the whole area. A large part is under orchards and vineyards on sand (INPS 2003).

According to regulations on the conservation of The Subotica Sandland ("OFFICIAL GAZETTE OF RS", no. 66/91, 127/2003, 113/2004), three levels of the protection regime are established in the area, to preserve the natural and semi-natural conditions – Level I: Total protection (8.32% of the area); Level II: Active protection (21.55% of the area); Level III: Proactive protection (69.72% of the area).

**Level I:** covers the most vulnerable areas like lowland peat meadows and other wet fields, plus some fragments of original sandy and steppe meadows. The only activities that are permitted here are scientific research or monitoring and some measures related to the conservation and enhancement of natural species within a particular plan and program (clear-cutting, mowing, grazing).

**Level II:** preserves meadows, pastures and neglected land with typical sandy vegetation. A significant part encompasses planted and autochthonous wood fragments. There are also microhabitats of some relict or endemic species that are isolated and enjoy level I protection. Special measures are undertaken to improve and preserve indigenous natural resources. Controlled educational excursions and eco-tourism are also permitted.

**Level III:** is a forest area with some agricultural land. Only 9% of the forest consists of fragments of autochthonous white and grey poplar or oak wood, whilst 91% is planted wood of black locust, common hackberry or black pine. Here also exist microhabitats of some relict or endemic species that are isolated and enjoy level I protection. In this area development and economic use are allowed within ecologically sustainable limits.

In our research, three localities with ten different habitats were investigated in 2014 (Fig. 2). All selected study sites are in level I or II protection regime with specific active conservation and development programs. The selection of the habitats in the terrain was made together with the rangers of the protected area. Description of the study sites was based on INPS (2003) and the reports of the ranger service of the Public company "Palic-Ludas" that manage the area. Geographical coordinates were given as WGS84 in degrees with decimal minutes.

### *Characteristics of study sites*

**Locality 1.** Local name: Krčevine; N46°09.545' E19°43.254', five habitats.

M1: sandy meadow, dominated by the xerophilic steppe vegetation on brown sand, plant community *Chrysopogonetum pannonicum* Stjepanović-Veseličić 1953, 127 m a.s.l., shadow at ground 0%, vegetation cover 20–30%, litter 10%, the floor is not fully covered, there are places with visible sand, the visible hawthorn shrubs, roses and black locust are cut as a regular revitalisation work of autochthonous sandy meadow. N46°09.545' E19°43.254'.

W1: fragment of autochthonous poplar wood (*Populus alba*), very young wood (around 30 years) with poorly developed shrub layer, natural not planted, 126 m a.s.l., shadow at ground 60%, vegetation cover 10%, litter 20%. N46°09.482' E19°43.279'.

W2: fragment of mixed poplar wood (*Populus alba* + *Populus nigra*), also autochthonous and very young wood (30 years old) with a well-developed shrub layer, 125 m a.s.l., shadow at ground 40%, vegetation cover 30%, litter 80%. N46°09.521' E19°43.339'.

W3: fragment of mixed poplar and oak wood (*Quercus robur* + *Populus alba*), autochthonous, slightly inclined, 120 m a.s.l., shadow at ground 90%, vegetation cover 10%, litter 80%. N46°09.596' E19°43.308'.

W4: self-grown grove of black locust (*Robinia pseudoacacia*), slightly inclined, 126 m a.s.l., shadow at ground 60%, vegetation cover 10%, litter 0%. N46°09.537' E19°43.232'.

All these habitats are in Level II of the protection regime. This is an area of active protection with a precise conservation and development program, all to preserve the indigenous sandy steppe vegetation at habitat M1. Such activities began in 2008. The clear-cutting was done two or three times a year, which depends on the season. Usually, the first cutting of older *Robinia* and hawthorn trees is organised in December of the current year, while the following year, tree sprouts are cut twice (the second half of July and November). In 2014, cutting shoots were organised in late July and late November.

**Locality 2.** Local name: Livada kod Djavolovog kanala, N46°09.703' E19°44.008'; three habitats.

M2: meadow, plant community *Festucetum vaginate danubiale* Soó 1929, mown twice a year, high influence of groundwater, 122 m a.s.l., shadow at ground 0%, vegetation cover 90%, litter 10%. N46°09.703' E19°44.008'.

W5: flooded wood of white and grey poplar (*Populus alba* + *Populus canescens*) where a high groundwater level reaches up to a height of 1 m. The bark is covered with moss, 120



**Fig. 2.** Position of the localities at Subotica Sandland (Serbia) in 2014; Locality 1: Krčevine, Locality 2: Livada kod Djavolovog Kanala, Locality 3: Livada kod Stare škole. Habitats: M1 (*Chrysopogonetum pannonicum*), W1 (*Populus alba*), W2 (*P. alba* + *P. nigra*), W3 (*Quercus robur* + *P. alba*), W4 (*Robinia pseudoacacia*), M2 (*Festucetum vaginate danubiale*), W5 (*P. alba* + *P. canescens*), F (*Carex* spp.), M3 (*Molinietum caeruleae*), W6 (*Celtis occidentalis*)

m a.s.l. shadow at ground 70%, vegetation cover 10% (+20% moss), litter 10%. N46°09.696' E19°43.978'.

F: a wet field of sedges, *Carex* spp., high influence of groundwater, in some years level of water on the field can be 20 cm for several days, and the activity of wild boars is common, 119 m a.s.l. shadow at ground 0%, vegetation cover 0–80%, litter 0%. N46°09.742' E19°43.969'.

**Locality 3.** Local name: Livada kod stare škole, N46°09.789' E19°44.489'; two habitats.

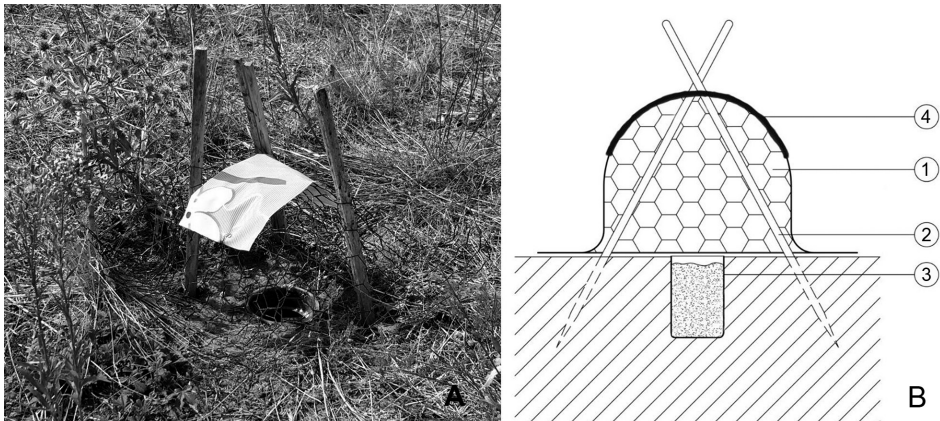
M3: lowland peat meadows along the border to Hungary and the Körös River, the dominant plant association is *Molinietum caeruleae* (All 1922) W. Koch 1926 s.l., usually mown twice a year, flooded by groundwater. Level of water can reach 20 cm and can stay for several weeks, 117 m a.s.l., shadow at ground 0%, vegetation cover 100%, litter 0%. N46°09.789' E19°44.489'.

W6: fragment of common hackberry (*Celtis occidentalis*) and willow (*Salix caprea*), a small shrubby place around the lowland peat bog, that has water all year, but levels vary, situated beside the Körös River and Hungarian border, 115 m a.s.l., shadow at ground 80%, vegetation cover 20%, litter 10%, general appearance shrubby rather than woody. N46°09.776' E19° 44.520'.

All habitats in Locality 2 and 3 are in Level I of the protection regime. There is a strict management plan for the meadows M2 and M3. At the meadows M2 and M3, mowing was organised twice a year, and the corridors left behind as re-colonisation sites are about 50 cm wide. In 2014, the first mowing in the M3 meadow was at the end of June, whilst in the M2 meadow it was in early July. The second mowing in both meadows was organised in the second half of September. Apart from these management measures, only scientific research is allowed.

### Collecting protocol

Spiders were collected with pitfall traps and sweep netting. Pitfall traps were made of plastic cups with a volume of 50 cl and an opening diameter of 70 mm, with a roof of



**Fig. 3.** Pitfall traps used at Subotica Sandland in 2014. A) in situ at habitat M1, Locality 1. B) Construction of the traps 1) wire mesh, 2) wooden sticks, 3) sampling cup, 4) plastic folium as roof

wire mesh and a plastic folium (Fig. 3). Wooden sticks were used to fix the wire mesh to the ground. Trapping liquid was 40 cl of formalin (4%) with a few drops of detergent. In total, 60 traps were placed, 6 traps per habitat were positioned in a line, with 10 m distance between each trap. The sampling period lasted from 27th April till 30th October 2014 and the traps were emptied on a frequency of 15 days. Sweep netting was applied with no standardised procedure, only at habitats M1, M2, and M3, in order to complete the species list.

### *Spider determination*

Determination of species was primarily based on the website Araneae – spiders of Europe (NENTWIG *et al.* 2020). Further literature for individual groups or species was also used but will be mentioned only, where details are discussed. Reference collections are deposited in the Natural History Museum of Basel, Switzerland, in the Natural History Museum, Belgrade, Serbia, and in the Grbić private collection. Nomenclature follows The World Spider Catalogue (Wsc 2020).

The species that were identified as “new to Serbia” were singled out as a separate chapter in results. Their global distribution is simplified according to Wsc (2020) (for Europe see NENTWIG *et al.* 2020) and the literature cited for determination. Information about the ecological niches of the species is given as “habitats” and preferences are mostly based on NENTWIG *et al.* (2020) and HÄNGGI *et al.* (1995); otherwise, literature is cited. The listing is in alphabetical order by family and species names. Most of these species were not caught in high numbers; we, therefore, list all material with dates. If useful, taxonomical notes, often with photos of the habitus and genital structures, are given. Photos were made with a KEXENCE 6000 with autostaking.

The analysis of the Red lists of several countries in Europe (GAJDOŠ & SVANTON 1993, ŘEZÁČ *et al.* 2015, BLICK *et al.* 2016, HARVEY *et al.* 2017, HYVÄRINEN *et al.* 2019), is presented as additional information only for the “new species for Serbia”, since there is no Red Book or Red List of spiders in Serbia.

### *Data analysis*

The analysis of the spider fauna was done based on qualitative and quantitative methods. Qualitative methods involved the total number of spider species, as well as the presence or absence of specialists. Quantitative methods involved the relative or absolute presence of particular species or groups of species. To gain more information about species community, rareness and commonness of the species, we applied several indices of diversity and similarity: Simpson’s Diversity Index (D), Shannon–Weaver’s Diversity Index (H’) and Shannon’s Equality Index of Species (E). According to MAGURRAN (2004), the most abundant species influence the value of Simpson’s index, while the Shannon–Weaver index is more sensitive to the frequency of rare species. For a better presentation of the results, we calculated the complement value of Simpson’s Diversity Index (1-D). Renkonen similarity indexes (RS) were used to test the specificity of the spider communities in the habitats. This index is based on the relative abundance of the species and is calculated according to the following formula:  $RS_{ij} = \sum \min p_{ni}/p_{nj}$ , where  $ij$  = sample of habitat  $i$  and  $j$ ,  $p_{ni}/p_{nj}$  relative abundance of species  $n$  in sample  $i$  and  $j$  respectively. For calculating the dendrogram UPGMA cluster analysis was used.

## RESULTS

*Faunistic overview*

In total, 16304 adult specimens (11239 males, 5065 females) and 7246 juveniles were caught, and 225 species from 27 families were identified. Only *Eresus* sp. was identified to the genus level, due to mismatches between diagnostic characters and material present. Altogether 196 species were caught using pitfall traps. Sweeping yielded 63 species, 29 of these were never caught by pitfalls. Only 34 species were caught by both methods. In Table 1, a short overview and some important faunistic data are given. A detailed species list with individuals per habitat is given in the Supplement.

The largest family in the study material was Linyphiidae with 47 species (20.8%), followed by Gnaphosidae (27 sp., 12%), Lycosidae (27 sp., 12%), Thomisidae (22 sp., 9.7%), Araneidae (18 sp., 8%), Salticidae (17 sp., 7.5%) and Theridiidae (13 sp., 5.7%). All other families had less than 10 species. Five of them (18.5%) were represented by only two species and eight families (29.6%) by one. *Pardosa alacris* with 3182 individuals or 19.5% (1770 ♂♂ and 1412 ♀♀) was by far the most abundant species, followed by *Ozyptila praticola* (1612 individuals, 9.8%, 1527 ♂♂, 85 ♀♀) and *Pardosa prativaga* (1523 individuals, 9.3%, 950 ♂♂, 573 ♀♀). However, if we look at every locality separately (Table 1), there is a clear difference between the most numerous families and species. This indicates differences in environmental conditions that are present at the sites.

Of the 225 spider species recorded in this area, 30 are new records for the Serbian arachnofauna (marked with an asterisk) in the Supplement. These species will be discussed below.

**Table 1.** An overview of the most important faunistic data on spiders collected in 2014 at three localities in the Subotica Sandland, Serbia.

|                            | Subotica Sandland          | Locality 1                | Locality 2                     | Locality 3                 |
|----------------------------|----------------------------|---------------------------|--------------------------------|----------------------------|
| Individuals                | 16304                      | 6515 (40%)                | 4801 (29.4%)                   | 4988 (30.6%)               |
| Species                    | 225                        | 115 (51.1%)               | 146 (64.8%)                    | 138 (61.3%)                |
| Most species rich families | Linyphiidae (47 species)   | Gnaphosidae (20 species)  | Linyphiidae (35 species)       | Linyphiidae (31 species)   |
|                            | <i>Pardosa alacris</i>     | <i>Pardosa alacris</i>    | <i>Pardosa prativaga</i>       | <i>Pachygnatha degeeri</i> |
| Most abundant species      | <i>Ozyptila praticola</i>  | <i>Ozyptila praticola</i> | <i>Piratula latitans</i>       | <i>Pardosa prativaga</i>   |
|                            | <i>Pardosa prativaga</i>   | <i>Drassylus villicus</i> | <i>Piratula hygrophila</i>     | <i>Trochosa hispanica</i>  |
|                            | <i>Arctosa lutetiana</i>   | <i>Arctosa lutetiana</i>  | <i>Ozyptila praticola</i>      | <i>Pardosa alacris</i>     |
|                            | <i>Pachygnatha degeeri</i> | <i>Zelotes apricorum</i>  | <i>Trachyzelotes pedestris</i> | <i>Arctosa lutetiana</i>   |



Family Araneidae  
*Singa lucina* (Audouin, 1826)

Material: 30.05.2014 M3 1♀.

Determination: LOKSA 1972, LEVY 1984.

Global distribution: Mediterranean to Central Asia.

Habitat: Dense vegetation on the bank of fish ponds (LEVY 1991).

Note: The species mainly lives on low plants and is commonly collected by sweeping the vegetation, whilst their orb webs are hardly noticed (LEVY 1984). It closely resembles specimens of *Singa hamata* and *S. nitidula*, and mixed collections of all three species are very common (LEVY 1984). In accordance with literature data (LEVY 1984), our finding is also connected with water. According to NENTWIG *et al.* (2020) *Singa lucina* is already known from most of the Balkan countries. Its female was figured by LOKSA (1972) from Hungary and by DRENSKY (1943) from Bulgaria. *Singa lucina* is not treated in any of the consulted Red List of species.

Family Clubionidae  
*Clubiona rosserae* Locket, 1953

Material: 27.06.2014 F 1♂.

Determination: WIEHLE 1965, ROBERTS 1985, DAWSON 2011.

Global distribution: Europe.

Habitat: Wet habitats (DAWSON 2011).

Note: *Clubiona rosserae* seems to be a very rare species. Records are known from only seven European countries. According to DAWSON (2011) the species was recorded at only two sites in England where it was occasionally found. Even intensive research at the locus typicus from 2002 to 2005 was not successful (DAWSON 2011). On the Subotica Sandland, we found it in habitat F, a moist field of *Carex spp.* The single male was captured in June, which is in contrast to the literature data (males in October, according to NENTWIG *et al.* 2020). This very rarely collected species is listed as vulnerable in England and endangered in Slovakia.

Family Dictynidae  
*Argenna patula* (Simon, 1874)

Material: 13.06.2014 F 3♂♂; 13.06.2014 W5 2♂♂; 27.06.2014 F 3♂♂.

Determination: LOCKET & MILLIDGE 1951, WIEHLE 1953, ROBERTS 1985.

Global distribution: Palaearctic.

Habitat: Under detritus (NENTWIG *et al.* 2020). Under stones, often in dry habitats with scarce vegetation (ROBERTS 1985). Saline wetlands (halotolerant) (FINCH 2008).

Note: There are some problems for distinguishing the species from *Argenna subnigra* (*O. pickard* Cambridge, 1861) and, controlling museum collections, one will regularly find miss-matched determinations in the older times. In the males the form of the palpal tibia is a quite good character: short, rather square in *subnigra* and longer in *patula* (WIEHLE 1953). The conductor has no large bulb on the ventral side (KUZMIN & ESYUNIN 2016) and in *A. subnigra* there is a tuft of thick hair in the dorsal side of the tibia that is missing in *A. patula* (Fig. 4). The published information about the ecology of the species is somewhat confusing since it can be found from wet to dry habitats, mostly seashores (WIEHLE 1953, ROBERTS 1985, FINCH

2008). In our study, we found it in the very wet (groundwater) field of *Carex spp.* (habitat F). An important environmental factor for the species could be the sandy soil rather than the saline impact (WIEHLE 1953). The species is critically endangered in the Czech Republic, vulnerable in Slovakia, near threatened in Finland and least concern in Sweden.

### *Lathys stigmatisata* (Menge, 1869)

Material: 13.06.2014 M1 2♀♀.

Determination: MARUSIK *et al.* 2015, WIEHLE 1953, ROBERTS 1998, (sub *Lathys puta*).

Global distribution: Europe, Turkey.

Habitat: In sunny localities, on the ground and on lichens.

Note: This xerothermophilic species was to be expected for Serbia even if not yet known from the neighbouring countries to the west and east (NENTWIG *et al.* 2020). The habitat of our finding (sandy meadow M1) fits well to the ecological requirements of the species as known from the literature. It is listed as vulnerable (England, Czech Republic) in the Red List of species.

### Family Gnaphosidae

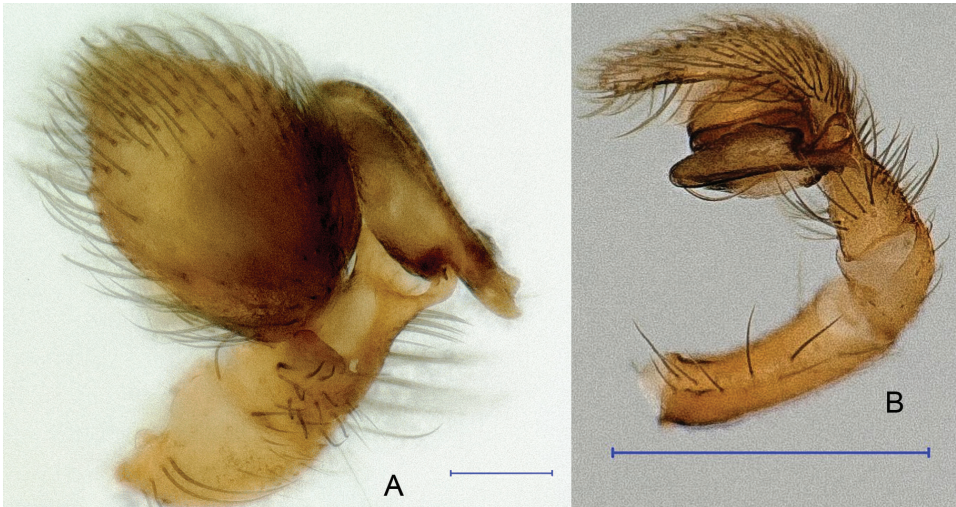
#### *Berlandina cinerea* (Menge, 1872)

Material: 27.04.2014 M1 1♂; 18.05.2014 M1 8♂♂ 2♀♀; 30.05.2014 M1 9♂♂ 5♀♀; 13.06.2014 M1 5♂♂; 30.09.2014 M1 1♀; 18.05.2014 M2 1♂; 30.05.2014 M2 2♂♂; 13.06.2014 M2 1♂ 1♀; 16.07.2014 M2 1♂; 18.05.2014 M3 1♂ 1♀; 30.05.2014 W4 1♀.

Determination: GRIMM 1985, TUNEVA & ESYUNIN 2002, MILLER 1971.

Global distribution: Palearctic.

Habitat: In dry, sandy locations under lichens or heath.



**Fig. 4.** *Argenna patula*, male palp: A = conductor of the right, expanded palp, B = left palp, retrolateral. Scale bars: 0.1 mm for A, 0.5 mm for B

*Gnaphosa mongolica* Simon, 1895

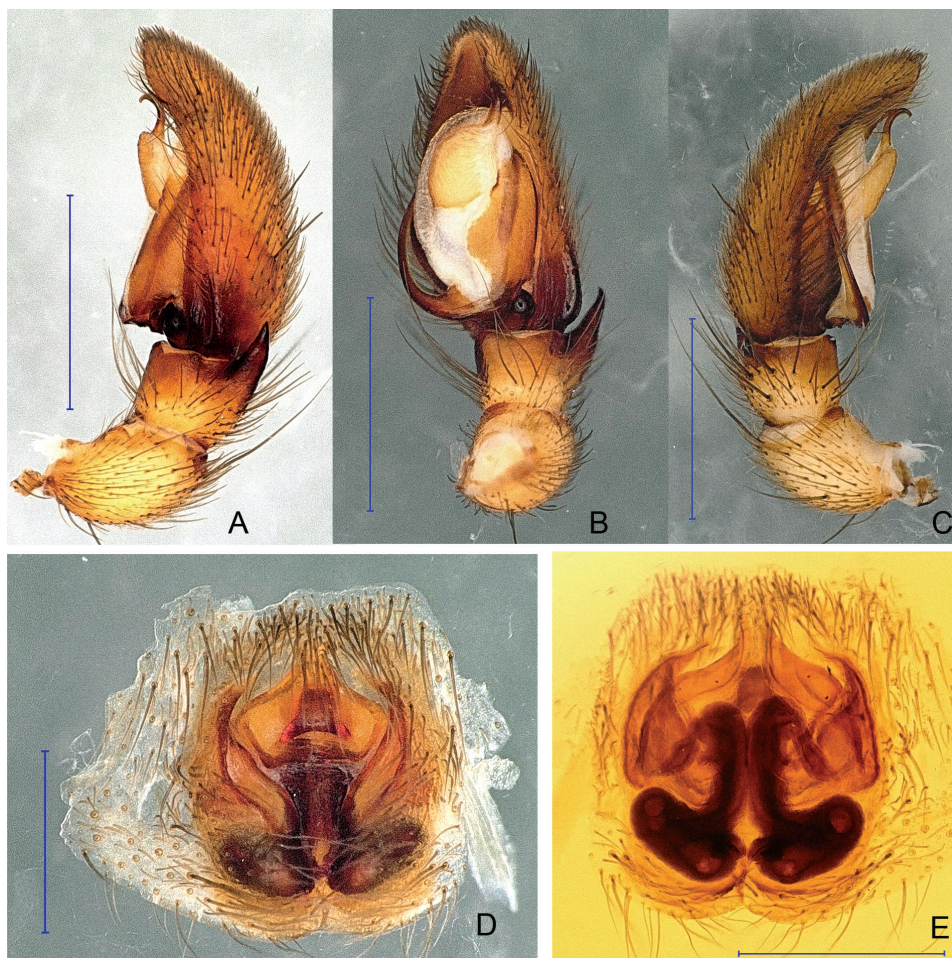
Material: 30.05.2014 M1 2♂♂1♀; 27.06.2014 M1 1♂.

Determination: WEISS & MARCU 1988, OVTSHARENKO *et al.* 1992, SZITA *et al.* 2005.

Global distribution: Palearctic (not in Western Europe).

Habitat: Under stones in the steppe

Note: The determination of this species is not entirely clear. Our material fits quite well to the figures of WEISS & MARCU (1988, sub *Gnaphosa spinosa* Kulczyński, 1897), but less to the figures in the other cited literature. The base of the median apophysis looks somewhat like the one of *Gnaphosa muscorum* (L. Koch, 1866), but the median apophysis seems to be a little bit expanded (Fig. 5). The tibial apophysis is smoothly bent without an inclined tip as in WEISS and MARCU (1988) and not with a median thickening as in SZITA *et al.*



**Fig. 5.** *Gnaphosa mongolica*, A–C = male left palp, A = retrolateral, B = ventral, C = prolateral, D = epigyne, ventral, E = vulva, dorsal. Scale bars: 1 mm for A–C, 0.5 mm for D–E

*al.* (2005) or OVTSHARENKO *et al.* (1992). Concerning the female, we think that the figures in WEISS and MARCU (1988) also correspond better to our material than those in OVTSHARENKO *et al.* (1992) and SZITA *et al.* (2005). *Gnaphosa spinosa* was synonymised with *G. mongolica* by OVTSHARENKO *et al.* (1992). At the moment, and without more material, we are not able to decide whether the small differences represent different species or even a new species.

In Hungary, the species is known since the late 19th century (sub *Gnaphosa spinosa*) and inhabits sandy meadows (SZITA *et al.* 2005). In the Subotica Sandland it was also found in the similar sandy habitat (habitat M1) with dominant xerophilous steppe vegetation on brown sand. To our knowledge, no photos of the genital structures are available, so we added some (Fig. 5) to facilitate determination in future. In the countries where the species is present no Red List of species exists. The species may be very abundant in suitable habitats (SZITA *et al.* 2005). However, with the limited geographical distribution in Europe and the narrow ecological niche (sandy steppe, a habitat type under economic pressure) we think that it should be classified as an endangered species.

### *Haplodrassus bohemicus* Miller et Buchar, 1977

Material: 30.05.2014 M1 3♂♂1♀; 16.08.2014 M2 1♀.

Determination: MILLER & BUCHAR 1977, KOVBLYUK *et al.* 2012, BOSMANS *et al.* 2018.

Global distribution: Southern and Eastern Europe (BOSMANS *et al.* 2018).

Habitat: Meadows, steppes and sand dunes (KOVBLUYK *et al.* 2012).

Note: This species was described based on specimens from steppes of Bohemia in the Czech Republic (MILLER & BUCHAR 1977). In the review on the Mediterranean *Haplodrassus* BOSMANS *et al.* (2018) questioned the identity of the specimens from Ukraine (KOVBLUYK *et al.* 2012) because of minor differences in the figures of the different authors. Our material (Fig. 6) corresponds well to the figures of the original description (MILLER & BUCHAR 1977) and the photos of BOSMANS *et al.* (2018). Current records are mainly from a sandy meadow (habitat M1) which is dominated by the xerophilic steppe vegetation on brown sand. However, one ♀ was caught in the meadow (M2). Moreover, it was caught quite late in the year (August) compared to reports in the literature (June). The species is classified as critically endangered in the Czech Republic.

### *Haplodrassus moderatus* (Kulczyński, 1897)

Material: 27.04.2014 F 3♂♂; 18.05.2014 F 2♂♂; 30.05.2014 F 1♂; 27.04.2014 F 3♂♂; 13.06.2014 F 1♂1♀; 27.06.2014 F 2♂♂4♀♀; 16.07.2014 F 4♂♂1♀; 30.07.2014 F 3♂♂2♀♀.

Determination: MILLER (1971), GRIMM (1985), MARUSIK & LOGUNOV (1995).

Global distribution: Palaearctic.

Habitat: In humid meadows, moors and bog forests.

Note: Rarely found species (NENTWIG *et al.* 2020); however, this could be the result of a low number of investigations in swampy areas. The species is missing in the Mediterranean region and Serbia together with Romania seem to be the southernmost countries with records of the species. We add some photos of the male palp and the epigyne (Fig. 7). All our captures (27 individuals) come from the very wet *Carex spp.* field (habitat F). *Haplodrassus moderatus* is classified as endangered in Slovakia and the Czech Republic, but not endangered in Sweden and Germany.

## Family Lycosidae

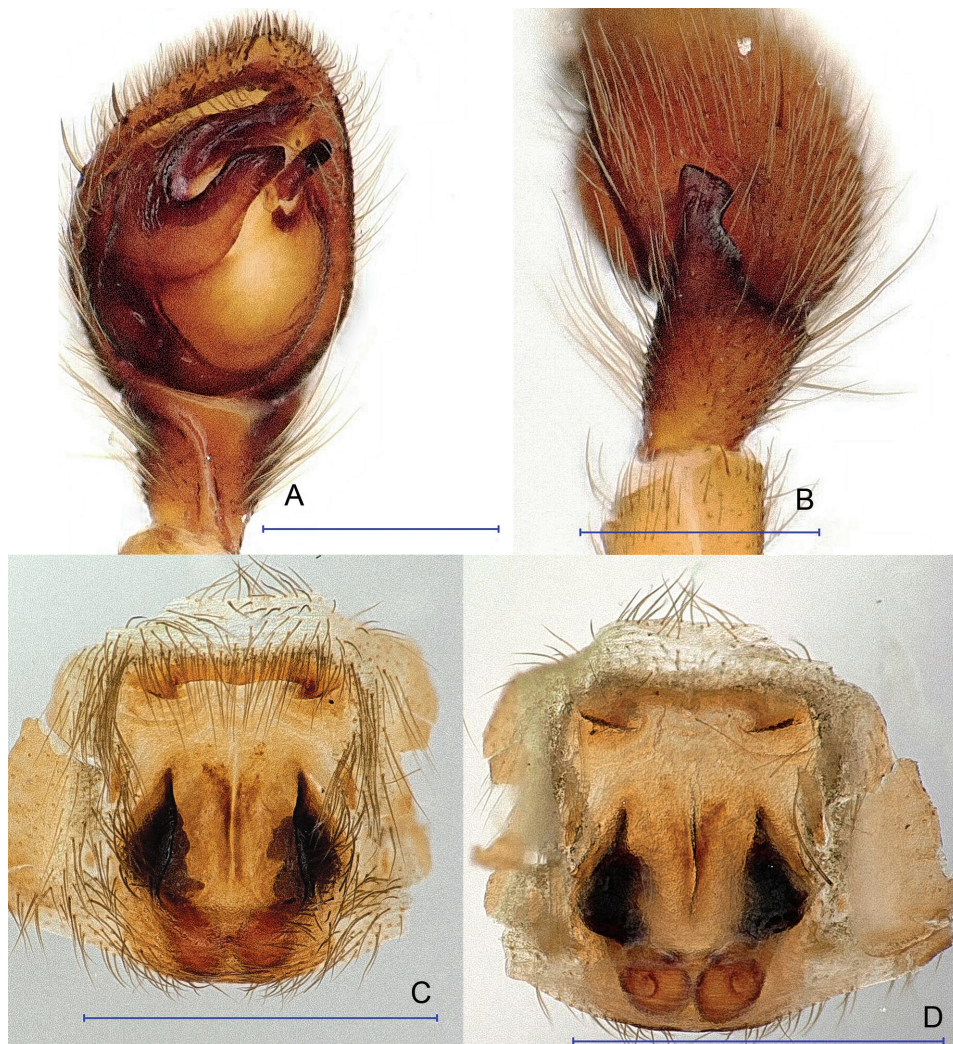
*Pardosa maisa* Hippa et Mannila, 1982

Material: 27.04.2014 F 4♂♂1♀; 18.05.2014 F 3♂♂; 30.05.2014 F 2♀♀; 16.07.2014 F 1♂; 27.04.2014 M2 1♂.

Determination: HIPPA & MANNILA (1982), SZINETÁR & GUITPRECHT (2001), GAJDOŠ *et al.* (2019).

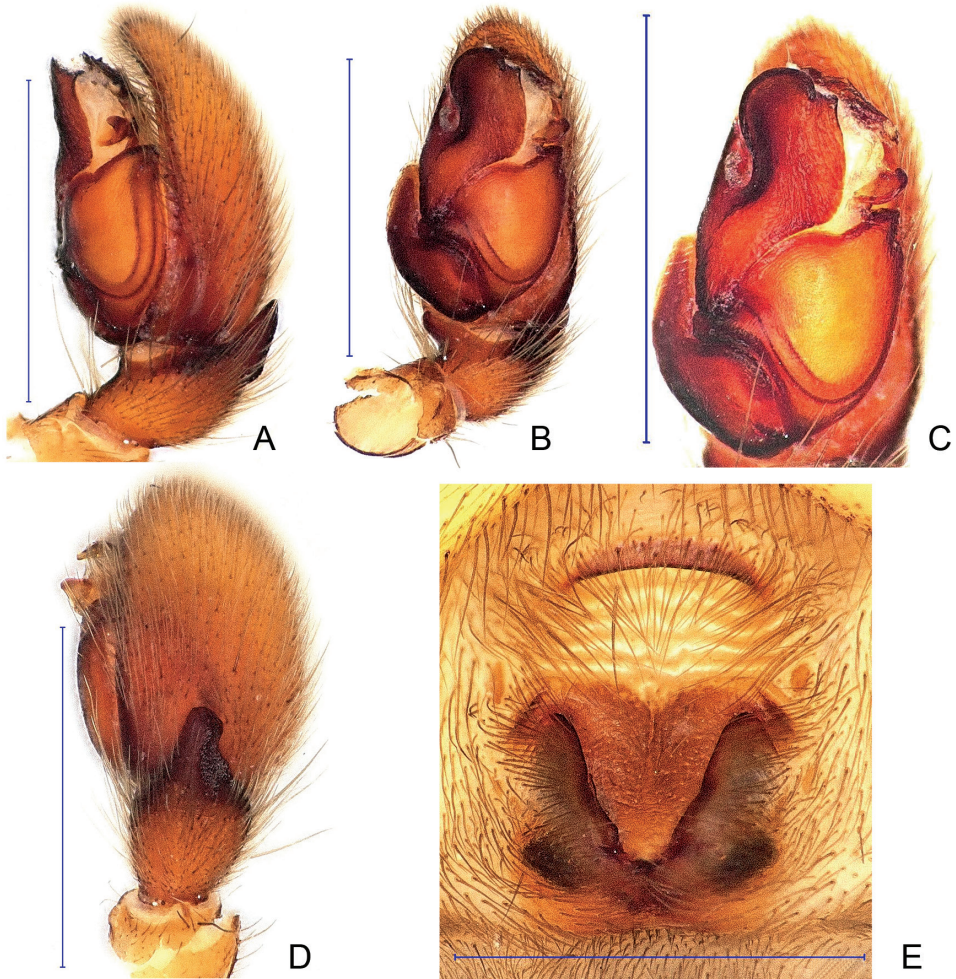
Global distribution: Palearctic (without western Europe).

Habitat: In very wet habitats such as the sphagnum layer of moors and fens.

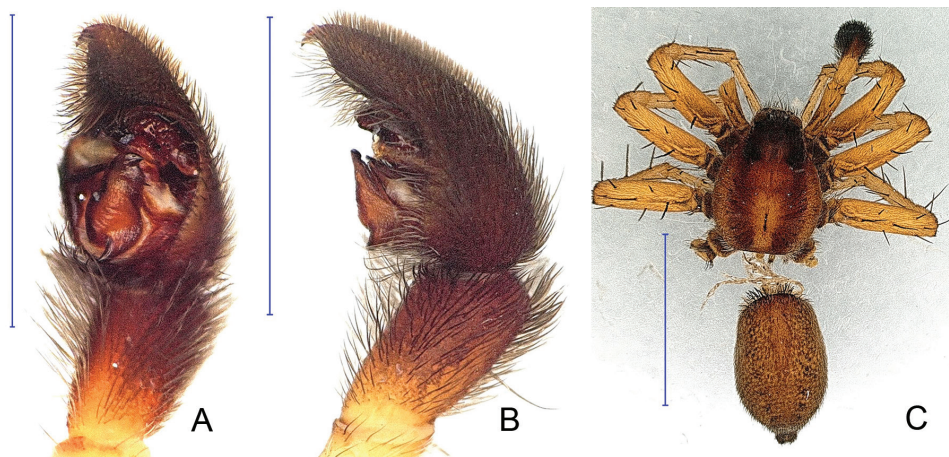


**Fig. 6.** *Haplodrassus bohemicus*: A–B = male left palp, A = ventral, B = tibial apophysis, C–D = epigyne in clove oil, C = ventral, D = dorsal. Scale bars: 0.5 mm for A–B, 1 mm for C–D

Note: This species was originally described from the transition zone between a pine peat bog and a swamp with acidophilous *Sphagnum* mosses (HIPPA & MANNILA 1982). In Hungary, it was found in fen meadows with good water supply (SZINETÁR & GUITPRECHT 2001). In our material, *Pardosa maisa* was recorded in a wet field of sedges (habitat F) and with a single ♂ in the nearby meadow (habitat M2). The known worldwide distribution, as mentioned above is not continuous. The reason for this is unknown. It could be a result of the natural distribution of the spider or because of low research intensity in wet habitats. The locality in Serbia is the southwestern border of its distribution. In our specimens, in contrast to NENTWIG *et al.* (2020) the lateral bands on the prosoma are clearly visible (Fig. 8) as also shown in GAJDOŠ *et al.* (2019). In the Czech Republic, the species is classified as critically endangered and in Finland as nearly threatened.



**Fig. 7.** *Halpodrassus moderatus*: A–D = male left palp, A = retrolateral, B = ventral, C = bulbus, ventral, D = dorsal; E = epigyne, ventral. Scale bars: 1 mm



**Fig. 8.** *Pardosa maisa*, male, A, B = mal left palp, A = ventral, B = lateral, C = male, habitus. Scale bars: 1 mm for A–B, 3 mm for C

### Family Linyphiidae

#### *Canariphantes nanus* (Kulczyński, 1898)

Material: 30.5.2014 F 1♂; 30.5.2014 M3 1♂; 13.6.2014 M3 2♂♂; 30.5.2014 W1 7♂♂; 27.6.2014 W1 2♂♂2♀♀; 18.5.2014 W2 2♂♂; 30.5.2014 W2 15♂♂1♀; 27.6.2014 W2 6♀♀; 30.9.2014 W2 1♀; 27.4.2014 W3 1♂; 30.5.2014 W3 6♂♂2♀♀; 27.6.2014 W3 4♀♀; 30.9.2014 W3 1♂; 30.5.2014 W4 2♀♀; 30.9.2014 W4 1♂; 30.10.2014 W4 2♂♂; 27.6.2014 W5 3♂♂; 30.5.2014 W6 4♂♂1♀; 27.6.2014 W6 2♂♂2♀♀; 16.7.2014 W6 1♂; 16.8.2014 W6 1♂.

Determination: MILLER 1947, LOKSA 1981, GNELITSA 2009.

Global distribution: Central to Eastern Europe.

Habitat: The species was found on the ground in a litter, grass and moss in xerothermic, steppe-like habitats but also in deciduous woods (GNELITSA 2009, KOMNENOV 2014, POLCHANINOVA *et al.* 2017) and in oak forest close to our sampling area in Hungary (BALI *et al.* 2017).

Note: Even if the female was described quite early (KULCZYŃSKI 1898) from Lower Austria and the male from the southern Czech Republic (MILLER 1947) it seems to be



**Fig. 9.** *Canariphantes nanus*, male left palp, retrolateral. Scale bar: 0.1 mm

collected only rarely (but see GNELITSA 2009, and BALI *et al.* 2017). In our investigation, we found it in high numbers (73 individuals), in all woody habitats, on a meadow and even in a field of *Carex spp.* *Canariphantes nanus* was described in detail by GNELITSA (2009) and may be easily identified by the typical lamella characteristica and paracymbium of the males (Fig. 9). This species appears only in the Red List of the Czech Republic in the category critically endangered.

### *Glyphesis taoplesius* Wunderlich, 1969

Material: 27.04.2014 W5 1♂; 18.05. 2014W5 1♂; 30.05.2014 W5 1♂1♀; 13.06.2014 W5 1♂2♀♀; 27.06.2014 W5 1♀.

Determination: WUNDERLICH 1969, ÉNEKESOVÁ *et al.* 2011, OLESZCZUK *et al.* 2011.

Global distribution: Europe.

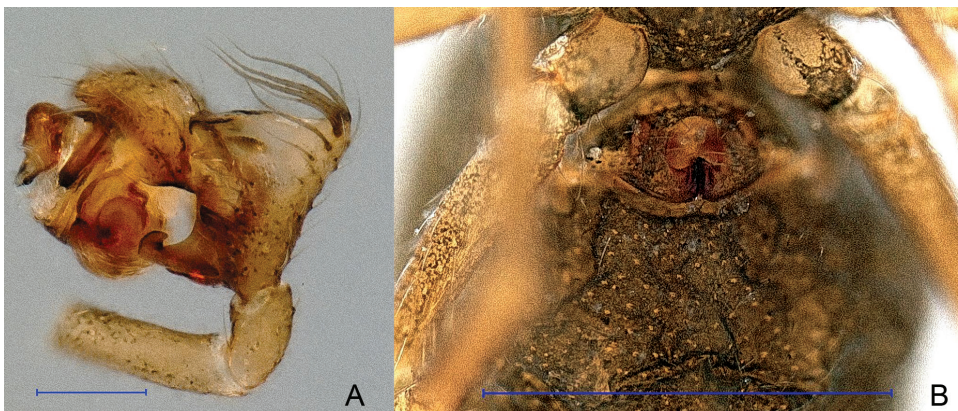
Habitat: Prefers humid conditions, in damp woodland and moss of bogs HÄNGGI *et al.* (1995), and the reed belts of Lake Velence (KANCSAL *et al.* 2010) and Lake Balaton (BLICK & SZINETÁR 1996) in Hungary.

Note: For comprehensive discussions of this rare, hygrophilous species see OLESZCZUK *et al.* (2011) and ÉNEKESOVÁ *et al.* (2011). In addition to the figure of the male palp in OLESZCZUK *et al.* (2011) and photos in ÉNEKESOVÁ *et al.* (2011) (male palp in unusual angles, epigyne as SEM only) we add photos of the male palp in retrolateral view and the epigyne in situ (Fig. 10).

In the Subotica Sandland *G. taoplesius* was recorded in the flooded forest of white and grey poplar (*Populus alba* + *Populus canescens*) (W5) with a high level of groundwater. This very stenoecious and rarely found species should be included in the list of Serbian protected spiders and monitored in the future. In Germany, the species is classified as critically endangered in the Red List of species.

### *Gongylidiellum murcidum* Simon, 1884

Material: 13.06.2014 M3 1♂; 27.04.2014 W5 2♂♂; 30.05.2014 W5 1♂; 27.06.2014 W5 1♂; 16.07.2014 W5 1♀.



**Fig. 10.** *Glyphesis taoplesius*: A = left male palp, retrolateral, B = epigyne in situ. Scale bars: 0.1 mm for A, 0.5 mm for B



Determination: WIEHLE 1960, ROBERTS 1987.

Global distribution: Palearctic.

Habitat: In moss and litter layer of lowland forests, in humid conditions.

Note: This species is widely distributed all over the lowlands of Europe yet relatively rarely found (NENTWIG *et al.* 2020). The species is widely distributed in Europe, but up to date (?) missing in the western Balkans. It is classified as vulnerable in the Czech Republic and England, but not endangered in other countries.

### *Hypsocephalus pusillus* (Menge, 1869)

Material: 30.05.2014 M3 1♀.

Determination: MILLER 1966, MILLIDGE 1978, GNELITSA 2009.

Global distribution: Europe (but missing in the western countries).

Habitat: Various dry habitats, from forest to steppe (GNELITSA 2009).

Note: *Hypsocephalus pusillus* (syn = *H. dahli*) is a very small (body length 1.1mm) linyphiid spider inhabiting xerothermic sites (FRICK 2008, FRICK & STAREGA 2009, GNELITSA 2009). The habitat of our specimen (M3, peat meadow) is not typical compared to data from the literature. In Germany and the Czech Republic, the species is listed as endangered in the Red List of species.

### *Mermessus trilobatus* (Emerton, 1882)

Material: 27.4.2014 M3 1♂; 13.6.2014 M3 1♂; 27.6.2014 M3 1♂.

Determination: HELSDINGEN VAN 1982, OGER & PICARD 2014, ŠESTÁKOVÁ *et al.* 2017.

Global distribution: North America, Europe, introduced to Azores.

Habitat: In nearly all open habitats.

Note: Originally from North America and widely distributed. It is assumed that it was imported into south-western Germany in the 1980s by the US Army (first records for Europe in Germany by DUMPERT & PLATEN 1985) and in Switzerland (HÄNGGI 1990) and dispersed from there (HIRNA 2017). *Mermessus trilobatus* was recorded in European countries equally in natural and non-natural ecosystems (HIRNA 2017). In our study, it was recorded at M3 habitat a lowland peat meadow. The potential influence of such an invasive species on the structure of native spider communities in the Subotica Sandland is unknown and should be monitored in future.

### *Panamomops mengei* Simon, 1926

Material: 27.04.2014 W1 2♂♂; 18.05.2014 W1 1♂; 30.05.2014 W1 1♂1♀; 30.05.2014 W2 1♂; 18.05.2014 W4 1♂; 13.06.2014 W4 2♂♂; 18.05.2014 W6 5♂♂.

Determination: WIEHLE 1960, MILLER 1971, NENTWIG *et al.* 2020.

Global distribution: Palearctic.

Habitat: In moss and litter of dry, rather clear forests.

Note: Rarely found (NENTWIG *et al.* 2020). Serbia is at the southern range of the distribution of *Panamomops mengei* that seems to prefer a temperate (continental) climate. The species is listed as not endangered in Germany, Sweden and the Czech Republic.

*Porrhomma oblitum* (O. P.-Cambridge, 1871)

Material: 30.05.2014 W5 2♀♀.

Determination: THALER 1968, ROBERTS 1987, RŮŽIČKA 2018.

Global distribution: Central Europe.

Habitat: In wet open and forest habitats (RŮŽIČKA 2018), but also in agricultural habitats, especially intensively used meadows (HÄNGGI *et al.* 1995).

Note: According to the European distribution range presented in NENTWIG *et al.* (2020) it was expected in Serbia. The species is listed as not endangered in Germany and the Czech Republic.

*Sintula spiniger* (Balogh, 1935)

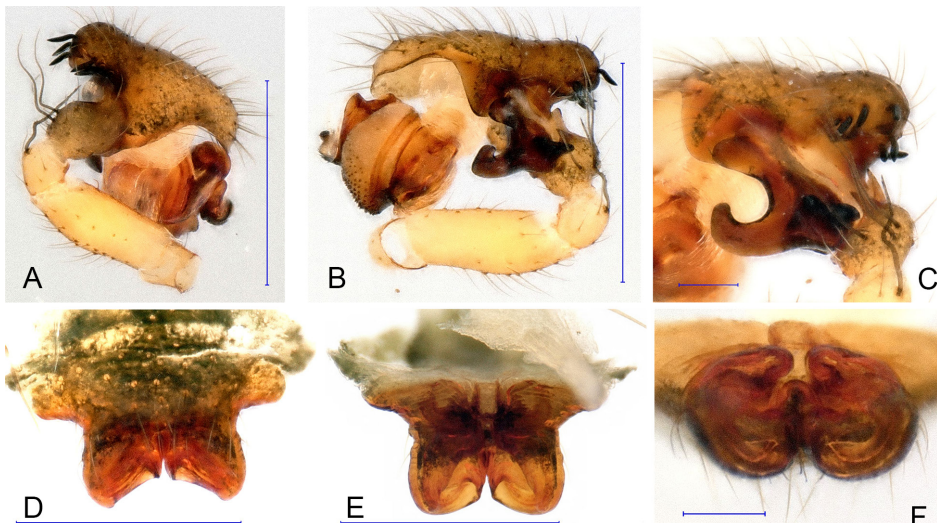
Material: 15.10.2014 F 1♀; 30.10.2014 F 2♂♂4♀♀; 27.4.2014 M1 1♀; 30.10.2014 M1 2♂♂; 30.09.2014 M2 1♀; 30.10.2014 M2 1♂1♀; 13.06.2014 M3 2♀♀; 16.09.2014 M3 1♀; 30.09.2014 M3 1♂1♀; 30.10.2014 M3 7♂1♀; 30.10.2014 W3 1♂; 27.04.2014 W4 2♀♀; 30.10.2014 W4 2♂♂.

Determination: BALOGH & LOKSA 1947, MILLER 1968, GNELITSA 2012.

Global distribution: Southern and eastern Europe.

Habitat: In leaf litter of open deciduous forests. On rock and sandy steppes.

Note: Very rarely found (NENTWIG *et al.* 2020). The habitat preference and biology of this species is still not clear. In Bulgaria, it could be found in mountains up to 1000 m (habitats Quercetum, Carpinetum) and is considered very rare, but in Slovakia, it is not rare in dry calcareous grassland with shrubs (GNELITSA 2012). In Hungary, the species was found in sandy steppes (*Festucetum vaginatae danubiale*) (SZINETÁR *et al.* 2009). In Ukraine, *Sintula spiniger* was found in a mixed forest, pine forest, at a river bank and flood-land forest (GNELITSA 2012). In our study, this species was found in 5 different habitats: (F), (M3), (M1),



**Fig. 11.** *Sintula spiniger*, A–C male left palp, A = prolateral, B = retrolateral, C = paracymbium, D–F = female epigyne, D = ventral, E = dorsal, F = aboral. Scale bars: 0.5 mm for A–B, 0.1 mm for C, 0.4 mm for D–E, 0.1 mm for F

(M2), and (W3) (W4). According to NENTWIG *et al.* (2019), it is distributed around Serbia, but in total, just in a few countries of central and Eastern Europe. *S. spiniger* is well described by GNELITSA (2012), and we just add some photos of this very characteristic species (Fig. 11). The species is listed as endangered species in the Czech and Slovakian Red List of species.

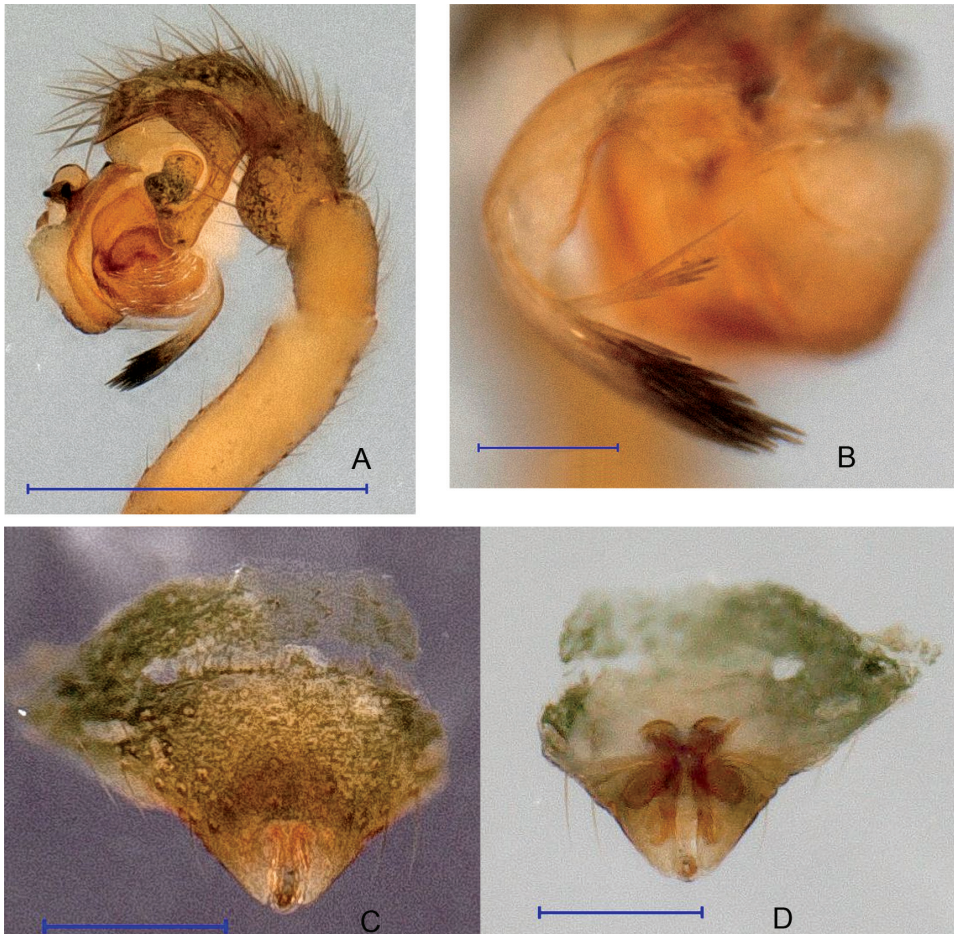
### *Syedra apetlonensis* Wunderlich, 1992

Material: 18.05.2014 M2 1♂.

Determination: WUNDERLICH 1992.

Global distribution: Austria, Slovakia, Russia.

Habitat: In non-pastured meadow.



**Fig. 12.** *Tallusia vindobonensis*, A–B = male left palp, A = retrolateral, B = detail of the lamella characteristic, C = female epigyne, D = vulva dorsal. Scale bars: 0.5 mm for A, 0.1 mm for B, 0.2 mm for C–D

Note: Very similar to the species *Syedra myrmicarum* (Kulczyński, 1882), and sometimes misidentified (AAKRA *et al.* 2016). According to the literature listed in AAKRA *et al.* (2016), this species can be found in dry non-pastured meadows, steppe and meadows but also in bird nests, and has been considered to be a Central European endemic. Its similarity in habitus to other known myrmecophile linyphiids (i.e. pale brownish overall color, unmodified carapace, etc.) suggest that this species could exhibit this lifestyle too, even if this has not been recorded in the literature (AAKRA *et al.* 2016). In our material, it was found in meadows. This species is not treated in any of the consulted Red List of species.

### *Tallusia vindobonensis* (Kulczyński, 1898)

Material: 30.10.2014 M2 1♀; 30.10.2014 M3 1♂1♀.

Determination: POLENEC & THALER 1980, THALER 1997, GAJDOŠ *et al.* 2019.

Global distribution: Europe.

Habitat: Various types of habitats, from lowland to upland (GAJDOŠ *et al.* 2019).

Note: Very rarely found, reproduction period in winter (NENTWIG *et al.* 2020). GAJDOŠ *et al.* (2019) summarise the known ecological data: males adult in winter, females through all the year; different types of meadows (nutrient-poor, karst meadows and but also salt marshes. In our material *Tallusia vindobonensis* was found in the wet meadows (M2, M3). For the determination and separation from *Tallusia pindos* Thaler, 1997 (see POLENEC & THALER 1980 and THALER 1997). Some photos of the male palp and the female epigyne/vulva underline the identification (Fig. 12). This species is not treated in any of the consulted Red List of species.

### *Walckenaeria atrotibialis* (O. P.-Cambridge, 1878)

Material: 27.6.2014 W5 1♂1♀.

Determination: WIEHLE 1960, WUNDERLICH 1972, PAQUIN & DUPÈRRE 2003.

Global distribution: Holarctic.

Habitat: Found in a very large range of habitats.

Note: According to NENTWIG *et al.* (2020) this species is „relatively rarely found”, but see HÄNGGI *et al.* (1995) with more than 50 citations for the species from many habitats. The fact that the species is hardly known from the Balkans is probably due to less frequent investigations compared to Central Europe. The species is not endangered in Germany and the Czech Republic.

## Family Miturgidae

### *Zora armillata* Simon, 1878

Material: 18.05.2014 F 1♀; 13.06.2014 F 1♀; 16.07.2014 F 4♀♀; 30.07.2014 F 1♀; 16.08.2014 F 4♀♀; 27.04.2014 M3 1♀; 27.06.2014 M3 1♂; 16.07.2014 W1 2♀♀; 16.08.2014 W1 1♀; 27.04.2014 W2 1♂; 16.07.2014 W2 1♀; 27.04.2014 W4 1♂; 18.05.2014 W4 1♂.

Determination: ALMQUIST 2006, HEIMER & NENTWIG 1991, TULLGREN 1946.

Global distribution: Palearctic.

Habitat: Wet and moist habitats (ALMQUIST 2006), dwarf shrub heath.

Note: According to ALMQUIST (2006) and AAKRA *et al.* (2016) this species is usually associated with wet and moist habitats. However, in our material, it was found equally at

wet (habitats F, M3) and in rather dry (habitats W1, W2, W4) areas. *Zora armillata* is listed as nearly threatened in Sweden, endangered in Germany but critically endangered in England and the Czech Republic.

### *Zora parallela* Simon, 1878

Material: 18.05.2014 W1 1♂; 18.05.2014 W2 1♂.

Determination: HEIMER & NENTWIG 1991, POZZI & HÄNGGI 1998, ALMQUIST 2006, ZAMANI & MARUSIK 2017.

Global distribution: Palaearctic.

Habitat: Xerothermic open habitats.

Note: There are some different habitat records: peat bogs (HÄNGGI *et al.* 1995), in old wastelands covered with bushes (POZZI & HÄNGGI 1998) or grasslands and overgrowth of limestone karst plateaus (GREGORIČ & KUNTNER 2009). Recently it was reported from Bulgaria (NAUMOVA *et al.* 2017) with no habitat description. Adults were found in May and June, females until October (SVATOŇ *et al.* 2009). In our material, this species was recorded in fragments of wood (habitats W1 and W2). In the Red List of species this species is classified in several different categories: near threatened (Sweden), endangered (Czech Republic), vulnerable (Finland), and critically endangered (Germany).

### Family Philodromidae

#### *Pulchellodromus ruficapillus* (Simon, 1885)

Material: 13.06.2014 M3 1♂; 16.07.2014 M3 1♀.

Determination: MUSTER *et al.* 2007, KASTRYGINA & KOVBLYUK 2014, MEZŐFI & MARKÓ 2018.

Global distribution: Mediterranean to Kazakhstan.

Habitat: Usually in wetlands or along riverbanks and also on seashores (MUSTER *et al.* 2007).

Note: This species was thoroughly redescribed by MUSTER *et al.* (2007) as *Philodromus ruficapillus* in the revision of the *P. pulchellus* species-group, but 7 years later (KASTRYGINA & KOVBLYUK 2014) it was redirected into the *Pulchellodromus* species group. According to MUSTER *et al.* (2007) in contrast to most other running crab-spiders that live on stems or foliage of woody plants, this spider is predominantly a ground-living predator. Some of the old records that MUSTER *et al.* (2007) rechecked suggested a preference for wetlands, but KASTRYGINA & KOVBLYUK (2014) found the species in semi-desert steppe in the Crimea. In our material, *P. ruficapillus* was found in lowland peat meadows situated along the border with Hungary and the Körös River, with the dominant plant association being *Molinietum caeruleae*. This species is not treated in any of the consulted Red List of species.

#### *Thanatus striatus* C. L. Koch, 1845

Material: 27.06.2014 F 1♂.

Determination: LOGUNOV 1996, SZITA & SAMU 2000, MUSTER & THALER 2003.

Global distribution: Holarctic.

Habitat: Often relatively frequent in damp meadows, on sea coasts and in swamps.

Note: Considered as endangered in the British and Slovakian Red List of species, but of least concern in other countries.

## Family Salticidae

*Aelurillus v-insignitus* (Clerck, 1757)

Material: 27.04.2014 M1 1♂, 30.05.2014 M1 1♂; 30.07.2014 M1 1♀.

Determination: HARM 1977, WEISS 1979, ROBERTS 1998, METZNER 1999.

Global distribution: Palaearctic.

Habitat: Xerothermic sunny, dry slopes, in sandy habitats, dunes and open woods.

Note: It is listed as not endangered in Sweden, Germany and the Czech Republic.

## Family Theridiidae

*Theridion uhligi* Martin, 1974

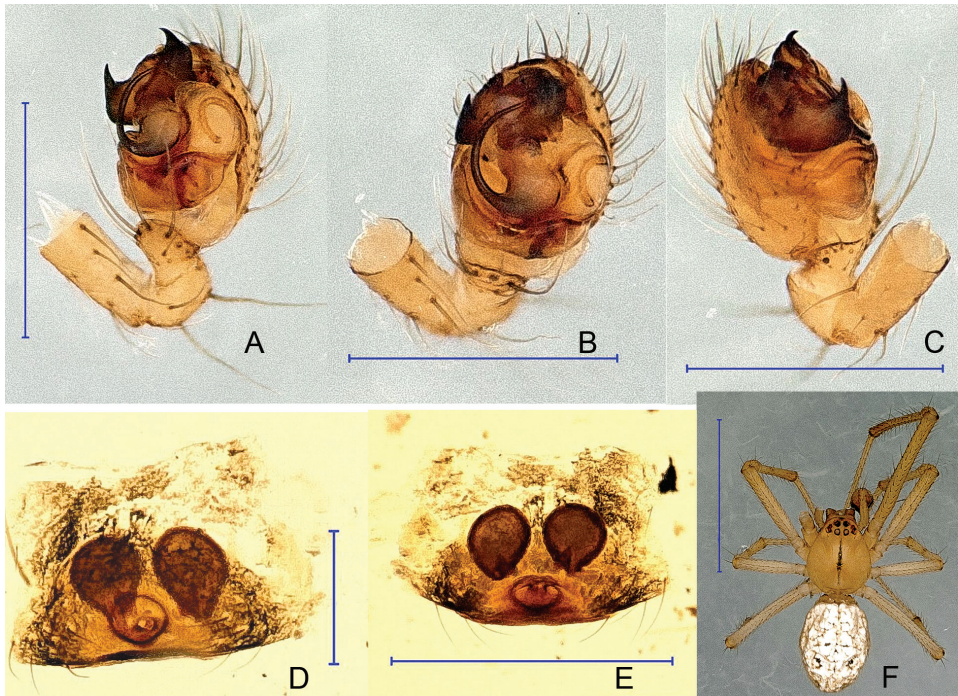
Material: 13.06.2014 M2 1♀; 16.07.2014 M2 1♂.

Determination: MARTIN 1974, JOCQUÉ 1977, DUMA 2008, 2009.

Global distribution: Europe.

Habitat: In dry, sandy areas, with heather or pines (NENTWIG *et al.* 2020), in xerothermic grassland (DÉJEAN 2012), the Pannonian calcareous sand steppes (cited in GAJDOŠ *et al.* 2019).

Note: In contrast to most known habitats, in our material, this species was found in a meadow (habitat M2). Wherever the species was found, it was captured in low numbers,



**Fig. 13.** *Theridion uhligi*, A–C male left palp, A = retrolateral, B = ventral, C = prolateral, D–E = female epigyne in clove oil, D = ventral, E = dorsal, F = male habitus. Scale bars: 0.5 mm for A–C, 0.2 mm for D, 0.5 mm E, 1 mm for F

and it is considered a rare spider (DUMA 2008). Determination seems to be no problem in the male but for the female there exist drawings and photos with a quite different appearance, especially for the epigyne and the form of the receptacula. We, therefore, add some photos underlying our identification (Fig. 13). In Germany, the species is classified as critically endangered, but data on this species are very rare (BLICK *et al.* 2016), so a thorough evaluation is difficult.

### Family Thomisidae

#### *Bassaniodes robustus* (Hahn, 1832)

Material: 13.6.2014 M1 1♀; 27.6.2014 M1 3♂♂; 16.7.2014 M1 4♂♂; 30.7.2014 M2 1♀; 13.6.2014 M3 1♂; 27.6.2014 M3 3♀♀; 16.7.2014 M3 7♂♂; 30.7.2014 M3 1♂2♀♀; 16.7.2014 W4 1♂; 30.7.2014 W4 2♂♂.

Determination: TULLGREN 1944, MILLER 1971, ROBERTS 1985.

Global distribution: Palaearctic.

Habitat: Xerothermic habitats, under stones, in short grass and moss, from lowlands up to the subalpine region.

Note: Based on barcode phylogenetic research, this species was recently transferred from *Xysticus* to *Bassaniodes* by BREITLING (2019). According to NENTWIG *et al.* (2020), this species is not frequent. It is noted in the Red lists as endangered (England) and vulnerable (Czech Republic), but not so (LC) in Sweden and Germany.

#### *Ozyptila brevipes* (Hahn, 1826)

Material: 13.06.2014 F 1♂; 27.06.2014 F 1♂; 18.05.2014 M3 1♂; 30.05.2014 M3 1♂; 16.07.2014 M3 1♂; 16.07.2014 W6 1♂.

Determination: MILLER 1971, ROBERTS 1985.

Global distribution: Palaearctic.

Habitat: Wet, swampy areas.

Note: According to the ecological and geographical distribution in Europe this species was to be expected in Serbia. The species is listed as endangered in the Czech Republic and vulnerable in Germany but category LC in Sweden.

#### *Ozyptila trux* (Blackwall, 1846)

Material: 30.05.2014 M3 13♂♂2♀♀; 13.06.2014 M3 8♂♂3♀♀; 27.06.2014 M3 12♂♂; 16.07.2014 M3 14♂♂2♀♀; 30.07.2014 M3 3♂♂; 16.08.2014 M3 3♀♀; 29.08.2014 M3 1♀; 18.05.2014 W5 1♂; 16.07.2014 W5 1♀; 27.06.2014 W6 1♂.

Determination: DONDALE & REDNER 1975, ROBERTS 1985, WUNDERLICH & SCHULTZ 1995.

Global distribution: Palaearctic. Introduced to Canada.

Habitat: In various, open habitats.

Note: Widely distributed and frequent in Europe. Its existence in Serbia could have to be expected. The species is listed as not endangered in Germany, Sweden and the Czech Republic.

## Family Titanoecidae

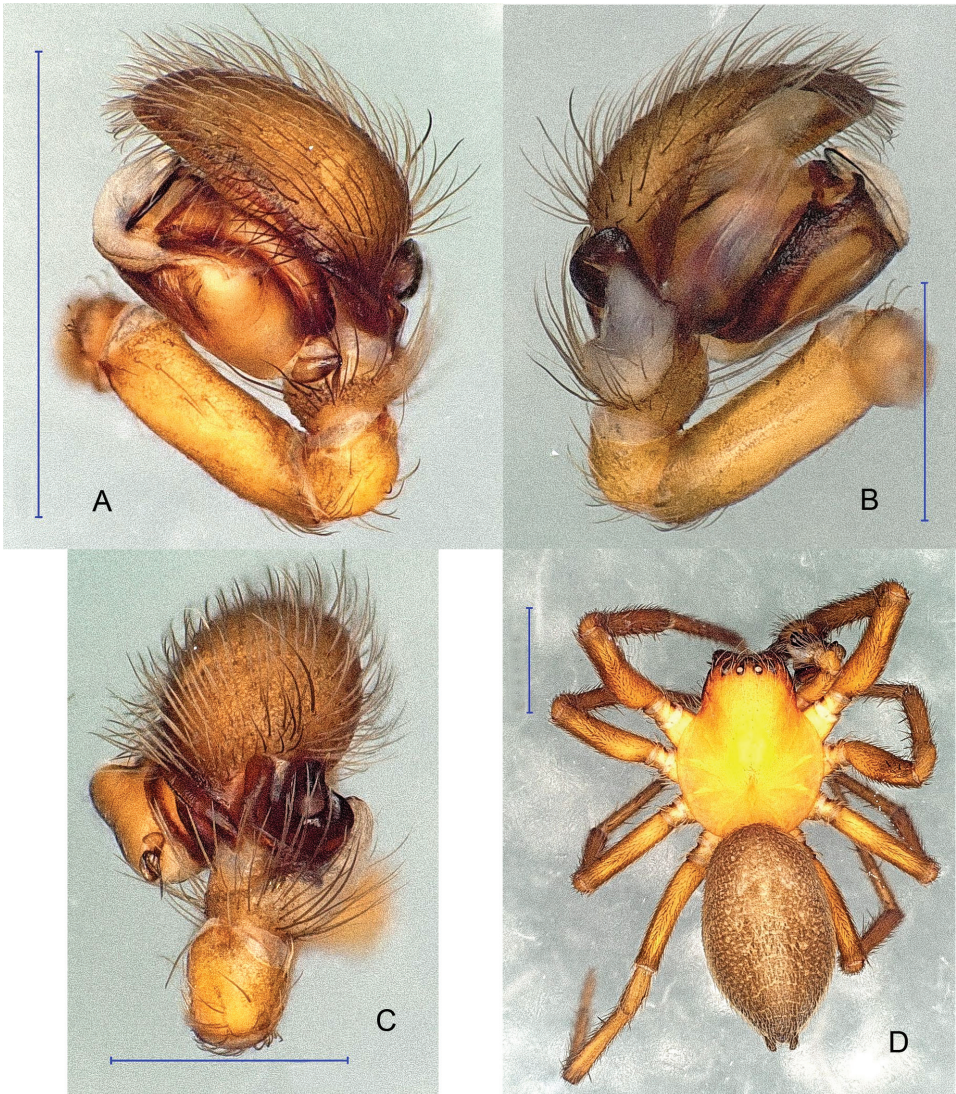
*Titanoeca spominima* (Taczanowski, 1866)

Material: 18.05.2014 M1 1♂; 30.05.2014 M1 1♂; 30.05.2014 M2 1♂; 13.06.2014 M1 1♂; 18.05.2014 M2 1♂; 13.06.2014 M2 1♂; 18.05.2014 W2 1♀.

Determination: WUNDERLICH 1993, ROBERTS 1998, ALQUIST 2006.

Global distribution: Europe.

Habitat: On sandy ground with scarce vegetation.



**Fig. 14.** *Titanoeca spominima*, A–C = male left palp, A = retrolateral, B = prolateral, C = dorsal, D = male habitus. Scale bars: 1 mm for A, 0.5 mm for B–C, 1 mm D



Note: WUNDERLICH (1993) described the species *Titanoeca psammophila* Wunderlich, 1993, indicating that the species lives mainly on sand. BREITLING *et al.* (2015) synonymised the species with *Titanoeca spominima*, even if the original description of *T. spominima* is very poor and without figures. BREITLING *et al.* (2015) also noted that sandy dunes and meadows in different regions of Europe are typical habitats for this species. In our material, this species was recorded at the xerophilic steppe vegetation on brown sand (habitat M1), but also in the wet meadow (habitat M2) and in a young wood (habitat W2). Our specimen fits very well to the drawings in WUNDERLICH (1993). No photos of this strikingly coloured species exist, so we add some photos of the male palp and habitus (Fig. 14). In the Red List of species, it is classified as vulnerable (Sweden), critically endangered (Czech Republic), endangered (Germany), but also as near threatened (Finland).

## ECOLOGICAL OVERVIEW

### *Species richness and composition*

The richest habitat in species was M3 at Locality 3 with 120 recorded species, while the poorest was W3 at Locality 1, with only 40 species recorded. The order of all habitats concerning their species richness is as follows: M3 (120 species), M2 (96), W6 (68), F (67), M1 (67), W5 (49), W4 (48), W1 (42), W2 (41), W3 (40 taxa). It has to be mentioned that sweep netting was done only in the meadows as to get additional information for the species list. However, for nature protection more important than the species numbers per habitat are species compositions and the ecological qualities of the species in the observed habitat.

Locality 1: The most interesting habitat at Locality 1 was the meadow M1 with 67 species (377 individuals) that represent almost 60% of all recorded species at this locality in only 5.7% of the total collected material here. A whole set of typical xerothermic species such as *Argiope lobata*, *Oxyopes heterophthalmus*, *Bromella falcigera*, *Carrhotus xanthogramma* and the typical sandland species *Berlandina cinerea*, *Titanoeca spominima* and *Gnaphosa mongolica* were recorded here. The last two are recorded for the first time in Serbia. Furthermore, two very rare species *Haplodrassus bohemicus* and *Lathys stigmatisata* were also recorded here. The dominant species in habitat M1 are *O. heterophthalmus* (31 individuals), *Xysticus kochi* (28), *B. cinerea* (28), *Zelotes longipes* (26) and *Pelecopsis parallela* (23). These are not the same dominant species as in the other habitats of this locality. This indicates the completely different environmental conditions of this habitat.

The other habitats of Locality 1 (W1-4) were more or less similar in species composition and diversity. Regular representatives of the forest habitats were *Anyphaena accentuata*, *Araneus angulatus*, *Episinus truncatus*, *Gibbaranea biturberculata*, *Harpactea rubicunda*, *Zilla diodia*. Furthermore, an invasive species *Ostearius melanopygius*, and a strictly protected species (by law) in Serbia (OFFICIAL GAZETTE OF RS, no. 5/2010, 47/2011, 32/2016, 98/2016) *Porrhomma mi-*

crops, were reported. Also, a small but interesting difference was found in the habitat W3, where *H. rubicunda* appears among the dominant species and suppresses *Zelotes apricorum* into 6th place by abundance. *Harpactea rubicunda* is a typical *Quercus* wood species (LOKSA 1969), and W3 is an autochthonous mixt wood with a quite different structure of ground litter, due to the *Quercus* trees, compared to the deciduous W1 and W2 habitat of only *Populus* trees.

Locality 2: In the habitats of Locality 2 a set of Lycosids that are characteristic for humid environments was recorded. Primarily, those are species *Pirata piraticus*, *Piratula tenuitarsis*, *Piratula hygrophila* and *Piratula latitans*. Followed by *Arctosa leopardus*, *Pardosa paludicola* and *Pardosa maisa*. This clearly distinguishes this locality from the previous one and underlines the different environmental conditions.

In the wet *Carex*-field (F2) further hydrophilic species of other families were recorded, such as *Dactylopiestes digiticeps* and *Mendoza canestrinii*. Two rare and, in the view of nature protection, important species were also recorded here: *Clubiona rosserae* is a very rare (DAWSON 2011) species for which Subotica Sandland is also the first known place in Serbia and *Dolomedes plantarius* which is considered rare e.g. in Germany (BLICK *et al.* 2016) and globally vulnerable according to the Red List (IUCN 2020).

With 96 species (573 individuals), the meadow (M2) is the most diverse habitat with 65% of all recorded species at this locality in only 12% of the total collected material here. The dominant species in this habitat are *Hogna radiata* (131 individuals), *Trochosa ruricola* (30), *Xysticus kochi* (25), *Thanatus formicinus* (25) and *Evarcha arcuata* (22). All these species are open land species that prefer warm habitats. So, the spider community in M2 is quite different from all other habitats. Two other rare species should be highlighted: *Syedra apetlonensis*, considered to be a Central European endemic species (AAKRA *et al.* 2016), and the poorly known *Theridion uhligi* (BLICK *et al.* 2016). The flooded wood (W5) shares some species with habitat F (*Carex*-field) indicating the very wet conditions. Two more species, both first records for Serbia, are very special for this locality: *Glyphesis taoplesius* that was only found in the wood W5 and *Haplodrassus moderatus* with 26 individuals in *Carex* field (F) and only one single female in the meadow (M2).

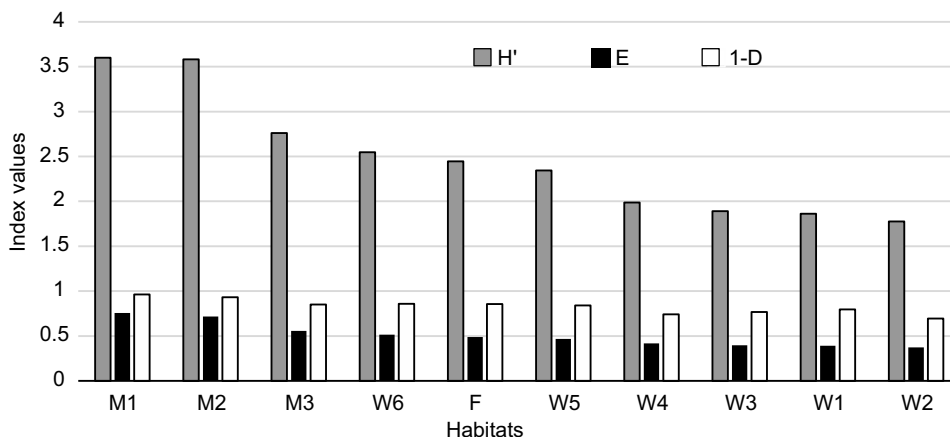
Locality 3: In the habitats of Locality 3 the dominant species mainly were hygrophilic, so-called wetland species: *Pachygnatha degeeri*, *Pardosa prativaga*, *Tetragnatha montana*, *Piratula hygrophila*, *P. latitans*, *Arctosa leopardus* and *Pardosa paludicola*. Furthermore, some species that are typical of sunny meadows near open water were recorded at the habitat M3 such as *Hypsosinga pygmaea*, *Larinioides cornutus* and *Singa lucina*. The latter is considered rare by LOKSA (1972). Also, the invasive species *Mermessus trilobatus* was recorded at habitat M3, while the legally strictly protected *Porrhomma microps* was caught at both

habitats (M3, W6). The two rare and poorly known species *Hypocephalus pusillus*, a species restricted to Central Europe (NENTWIG *et al.* 2020) and *Pulchellodromus ruficapillus*, a specialist of wet habitats (MUSTER *et al.* 2007), represent further species of this locality as new records for Serbia.

### Habitat diversity and similarity

The calculated diversity measures for all habitats (Fig. 15) showed that very high values of H', E and 1-D indexes were registered for the sandy, xerothermic meadow M1 (Locality 1) and the meadow M2 (Locality 2). The peat meadow (M3), the wet shrubby habitat (W6), the *Carex* meadow (F) and the flooded wood (W5) showed medium values for H', E and 1-D. The lowest values are found in the xerothermic woods at Locality 1 (W1-4).

Ten habitats were chosen to represent different habitat types with different plant associations and ecological characteristics, especially ground humidity. The spider communities accordingly show apparent differences in species composition. A dendrogram of the similarities between the habitats based on a similarity index taking into account the abundances of the species (Renkonen index) is presented at Fig. 16. The four woods of the dry Locality 1 clearly group together (W1-4) while the flooded wood (W5) and the shrubbery near the pond (W6) are somewhat isolated. The open habitats that all differ quite a lot according to ground humidity and plant structure are clustering in two groups at a rather low level, indicating that the spider fauna of each open habitat is very specialised, but also clearly separated from the wooded habitats.

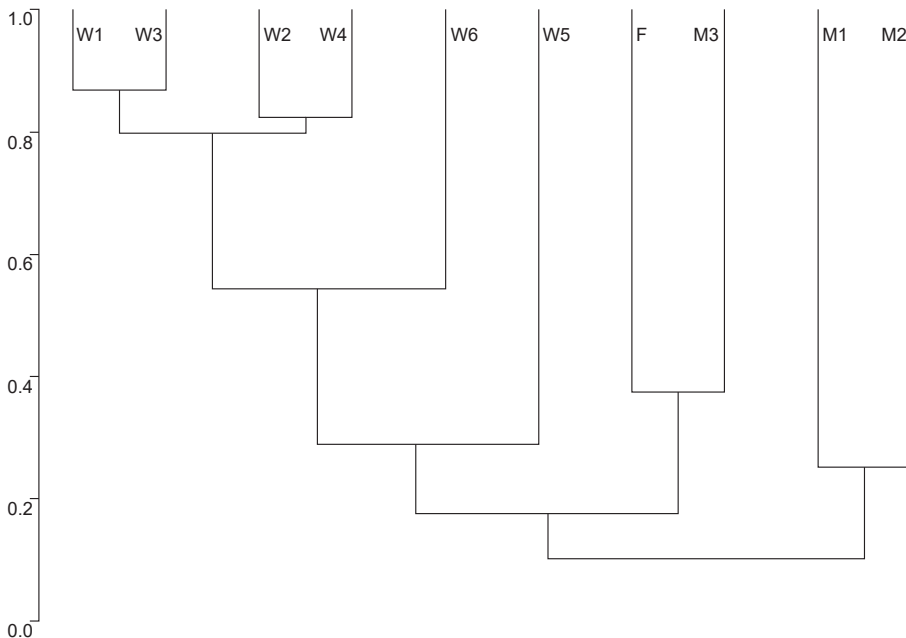


**Fig. 15.** Diversity indexes for the habitats at Subotica Sandland investigated in 2014. Shannon-Weaver's Diversity Index (H'), Shannon's Equality Index of Species (E), the complement value of Simpson's Diversity Index (1-D); Locality 1 (habitats M1,W1-4), Locality 2 (M2, F, W5), Locality 3 (M3, W6)

## DISCUSSION

*Discussion of the faunistic findings*

The number of spider species (225) collected at Subotica Sandland in only ten habitats is quite high. According to the literature available from Serbia (DELTSHEV *et al.* 2003, TOMIĆ & GRBIĆ 2008, GRBIĆ & SAVIĆ 2010, GRBIĆ *et al.* 2011, 2015, 2019, DUDIĆ *et al.* 2013, GAJIĆ & GRBIĆ 2016) this is the most species-rich study site yet known in this country. Furthermore, compared with Kiskunság National Park in Hungary (LOKSA 1987, KERÉKES 1988, SZITA *et al.* 2005, BALI *et al.* 2017) whose sands extend from the border with Subotica Sandland to Budapest, our habitats share 143 spider species with the Hungarian part of the landscape. However, in our study, we did not find *Dictyna szaboi* Chyzer, 1891, identified by LOKSA (1987) as typical sandy and saline species of the Great Plane, nor the giant European wolf spider *Lycosa singoriensis* (Laxmann, 1770) recorded by LOKSA (1987) and KERÉKES (1988). The recording of both species in further investigations in this area is predicted. Furthermore, we already have (undocumented) information that *L. singoriensis* lives here (pers.com. Szekeres Ottó, P.C "Palić-Ludaš"). If that species is recorded, it



**Fig. 16.** Dendrogram (UPGMA-clustering) of the Renkonen indexes for the habitats at Subotica Sandland investigated in 2014. Locality 1 (habitats M1,W1-4), Locality 2 (M2, F, W5), Locality 3 (M3, W6)

may be suggested as flagship species following the recommendations of MİR-LASOWSKY and ZULKA (1998).

The large number of new species records for Serbia (30) indicates the high specificity of the Subotica Sandland even if we accept that the Serbian spider fauna is still insufficiently known. Data of DELTSHEV *et al.* (2003), subsequent publications up until 2019 listed above, together with our new species records have increased the total number of species in Serbia to 750. However, compared to neighbouring countries this number is rather moderate because the known number of species are in Hungary are 812 (PFLIEGLER *et al.* 2012, NENTWIG *et al.* 2020), Albania 569 (KŪRKA *et al.* 2020), and Montenegro 289 (NAUMOVA *et al.* 2019). For Bulgaria (1046) (NAUMOVA *et al.* 2017, BLAGOEV *et al.* 2018, NENTWIG *et al.* 2020) and Romania (973) (WEISS & PETRIȘOR 1999) the situation is somewhat better. If we bear in mind that Serbia is part of the Balkans, which is a European centre of biodiversity, it is reasonable to expect that future intensive research all over Serbia will increase this number significantly.

About half of those species which are “new to Serbia” could have been expected because of their European distribution and ecological demands. However, some of these records are still notable. For example, findings of *Haplodrassus moderatus* are important in terms of geographical distribution, since this is the most southerly record in Europe. From a nature conservation point of view, *Panamomops menzei* is important because it is considered as a rare species (NENTWIG *et al.* 2020). *Lathys stigmatisata* and *Bassaniodes robustus* are considered “not very common” (NENTWIG *et al.* 2020); thus, it is favourable that these first records are in a protected area.

Unfortunately, the future of all those newly discovered species is uncertain. According to the literature (INPS 2003) human activities such as the development of irrigation canals without supervision, influences the network of underground water and changes the hydrological regime of such habitats which can result in biodiversity loss. Thus, in the near future, a paradoxical situation could occur: recently discovered spider species in the Subotica Sandland might be lost forever. It is important to continue with special measures related to the conservation and enhancement of natural species to avoid this situation. Those measures (clear-cutting, mowing, grazing with a special plan and program) as actually conducted by the Public company “Palic-Ludas” should be continued or even intensified, as should the prevention of illegal human activities by other competent institutions.

Lastly, since Serbia will not be able to provide a Red List of spider species based on very detailed knowledge for quite some time due to insufficiency of data, an update of the current List of protected species (“OFFICIAL GAZETTE OF RS”, no. 5/2010, 47/2011, 32/2016) and 98/2016) should be considered, so that the paradoxical “new-but lost forever” situation will not happen.

### Discussion of ecological findings

A lot of typical representatives for the given environmental conditions were found in the studied habitats. Additionally, two other invasive species were found too e.g. *Ostearius melanopygius* (ROZWALKA & STACHOWICZ 2010, EL-HENNAWY *et al.* 2016), originally from New Zeland and *Mermessus trilobatus* (HELSDINGEN & IJLAND 2007, HIRNA 2017) originally from USA. These are not unexpected findings, since they have been present in Europe for several decades (HIRNA 2017), but their influence on the autochthonous population is unknown. Also, the strictly protected species *Porrhomma microps* (by Serbian law) has been recorded. Furthermore, we found some species that are very rare all over Europe and difficult to collect, such as *Syedra apertlonensis* and *Clubiona rosserae*. Apart from *C. rosserae* all these species are very small, and sometimes difficult to identify. In contrast, there are also some larger species which are highly specialised relating to ecological conditions. These are the xerothermic *Argiope lobata* or the hygrophilic *Dolomedes plantarius*.

The selection of the investigated areas included xerothermic/steppe-like habitats as well as humid ones. The humid ones are well documented by species such as *Dicymbium nigrum*, *Pachygnatha degeeri*, *Pardosa prativaga*, *Piratula hygrophilus*, *Pirata piraticus* and *Trochosa ruricola*. All these species, typical for humid meadows (HÄNGGI *et al.* 1995) indicate that the habitats of localities 2 and 3 have adequate hydrological characteristics for wetland species. However, the appearance of species such as *Alopecosa cuneata*, *A. mariaae*, *Arctosa figurata*, *Berlandina cinerea*, *Thanatus formicinus*, *Trachyzelotes pedestris*, *Trochosa hispanica*, *Titanoeca spominima*, *Ozyptila praticola* and *Zelotes electus* in these wet habitats and sometimes in quite high abundance, are the first signal of water loss. It is known that the hydrology of the Subotica Sandland is changing rapidly (INPS 2003). The composition of the spider community at these habitats shows that as soon as the environment becomes drier, xerothermophilic species will invade and probably out-compete the typical hygrophilic species. The result would be a significant loss of all kind of invertebrate diversity. We suggest that these changes should be carefully observed and that the water regime should be directed in a way to take care of the hygrophilic species some of which are rare and/or even the only records for Serbia.

The dry habitats were characterised by a high number of xerothermophilic species of the family Gnaphosidae, and this strongly indicates an entirely different ecological entity. The numerous *Drassyllus villicus*, *D. praeficus*, *Zelotes apricorum*, *Z. erebeus* and *Z. electus* as typical dry meadow species (HÄNGGI *et al.* 1995) together with the sandy species *Titanoeca spominima* and *Berlandina cinerea* indicate that Locality 1 (especially habitat M1) has adequate sunny and dry characteristics. This is supported by data for the species *Gnaphosa*

*mongolica* which is very numerous at sandy meadows in Hungary (SZITA *et al.* 2005). These specific “Mediterranean-like” conditions (CHATZAKI 2008) where thermophilic species like *Oxyopes heterophthalmus*, *Bromella falcigera*, *Carrhotus xanthogramma* can be found, seem to be a direct result of the implementation of clear-cutting measures that began in 2008 intending to preserve the indigenous sandy steppe vegetation. Although there are no data on spider fauna before 2008, it can be clearly seen that species composition is different from other habitats and thus can be positively related to these measures.

The habitats M1 and M2, both open meadows but with very different humidity conditions, show the highest diversity values. According to MAGURRAN (2004), usually, the Shannon indexes in ecological studies are between 1.5–3.5, rarely reaching 4, so these high values for  $H'$  (3.60 M1 and 3.58 M2) are exceptional and show the importance of the open habitats in the study site Subotica Sandland. Relatively high values of  $H'$ ,  $E$  and  $1-D$  indexes were also found in the habitats M3, F, W5 and W6, indicating that these habitats are of particular importance considering nature (biodiversity) protection. In contrast, the woody, dry habitats W4, W3, W1 and W2 have lower values of  $H'$ ,  $E$  and  $1-D$  indexes. The reason could be the fact that those are not large forest areas, but only small patches of young woodland that are not (yet) well structured. Species that dominate here are clearly different from the species that dominate the open sandy meadow M1 and therefore contribute a lot to the overall diversity of the whole study site. These habitats actually show, what will happen in the near future if M1 becomes overgrown by hawthorn bushes. Species adapted to the sandy, rather steppe-like conditions will disappear, and forest species will emerge. According to all the above, M1, M2 and M3 should be priority habitats from a conservation point of view, and W6, W5 and F should be evaluated as important habitats too. However, the habitats W4, W3, W1 and W2 should not be considered very important.

From a conservation point of view, we prioritised the habitats as follows: M1, M2, M3, F, W5 and W6. This corresponds fully with conclusions made earlier about their quality (INPS 2003) based on other groups of organisms (plants, birds and amphibians).

According to the study (INPS 2003), Localities 2 and 3 with habitats M2, M3, F, W5 and W6, are areas under Level I of the protection regime, and our study confirms their significance. However, according to our study, some additional conservation measures could help substantially to preserve the unique fauna of all small invertebrates, not only spiders. For example, the corridors left behind as re-colonisation sites after mowing are approximately 50 cm wide. Although mowing is very beneficial for the spider fauna (POZZI *et al.* 1998, POZZI & BORCARD 2001, SZMATONA-TURI & VONA-TURI 2016) these corridors should be wider and not less than 1m. The actions to improve the

hydrological regime of the area and stopping illegal melioration should be more intensive because many species depend on wet conditions, and the spider fauna already indicates the first signs of disturbance.

Since most investigations on spiders, (as with this one) are time-consuming and costly, we would like to suggest a different approach for conservation management measures. There is the possibility to select some umbrella species that are easier to monitor. For the wet habitats, we suggest *Dolomedes plantarius*, quite large and easy to find. Besides, the species has an impressive appearance and could also be used as flagship species. The flagship species or an umbrella species, in general, will be recognised by law on Nature Protection ("OFFICIAL GAZETTE OF RS", No. 36/2009, 88/2010, 91/2010-ed., 14/2016 and 95/2018 – Act). In this way a large number of other species in the same habitats, which are less known and otherwise difficult to document, will be monitored too.

Locality 1 is under Level II of the protection regime. According to our spider study, habitat M1 (meadow steppe) is very important, with typical xerothermophilic species. A lot of these species are adapted to sandy soil and so demonstrate the speciality of the nature protection reserve at Subotica Sandland. We think that this important site should be in the Level I category of the protection regime. However, since this could be legally very difficult and time-consuming, the pending situation could be more damaging than helpful. Therefore, we recommend some additional measures that could be applied at the level of the company that manages the area. For example, clear-cutting should be a mandatory measure for the locality. The revitalisation of the sandsteppe habitat should continue to be a priority over the cultivation of forest habitats. Furthermore, we would suggest that the surface of the open sandy area should be enlarged, for example, by the part of the habitat W2 that has been identified as least valuable concerning spiders. Additionally, following the same proposal as for Localities 2 and 3, we would suggest *Argiope lobata* as umbrella species and once again also potential flagship species for this xerothermic habitat, in order to monitor the ecological development of the place.

\*

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**Supplement.** The list of 225 spider species at Subotica Sandland recorded in 2014 with 30 new species for Serbia marked with \*. Locality 1 (Krčevine), Locality 2 (Livada kod Djavolovog kanala), Locality 3 (Livada kod stare škole). Habitats: M1 (*Chrysopogonietum pannonicum*), W1 (*Populus alba*), W2 (*P. alba* + *P. nigra*), W3 (*Quercus robur* + *P. alba*), W4 (*Robinia pseudoacacia*), M2 (*Festucetum vaginata danubiale*), W5 (*P. alba* + *P. canescens*), F (*Carex spp.*), M3 (*Molinietum caeruleae*), W6 (*Celtis occidentalis*). M = male, F = female

| Habitat  | Locality 1 |     |     | Locality 2 |     |     | Locality 3 |     |     |     |      |      |
|--|------------|-----|-----|------------|-----|-----|------------|-----|-----|-----|------|------|
|  | M1         | W1  | W6  | W2         | W3  | W4  | F          | M2  | W5  | M3  | W6   |      |
| Sex  | M/F        | M/F | M/F | M/F        | M/F | M/F | M/F        | M/F | M/F | M/F | M/F  |      |
| <b>Agelenidae</b>                                  |            |     |     |            |     |     |            |     |     |     |      |      |
| <i>Agelena labyrinthica</i> (Clerck, 1757)         | /          | /   | /   | /          | /   | /1  | 1/         | /   | /   | /   | 1/   | 3/   |
| <i>Allagena gracilis</i> (C. L. Koch, 1841)        | /          | /   | /   | /          | /   | /   | 1/         | /4  | /   | /   | 1/2  | /    |
| <i>Tegenaria lasperi</i> Chyzer, 1897              | /          | /   | /   | /          | /   | /   | /          | /   | /   | /   | 4/1  | 14/6 |
| <b>Anyphaenidae</b>                                |            |     |     |            |     |     |            |     |     |     |      |      |
| <i>Anyphaena accentuata</i> (Walckenaer, 1802)     | /1         | /   | /   | /          | 1/  | /   | /          | /   | /   | /   | /    | /    |
| <b>Araneidae</b>                                   |            |     |     |            |     |     |            |     |     |     |      |      |
| <i>Agalenatea redii</i> (Scopoli, 1763)            | 1/1        | /   | /   | /          | /   | /   | /          | /1  | /   | /   | /    | /    |
| <i>Araneus angulatus</i> Clerck, 1757              | /          | /   | /   | /          | 1/  | /   | /          | /   | /   | /   | /    | /    |
| <i>Araneus diadematus</i> Clerck, 1757             | /          | /   | /   | /          | /   | /   | /          | 1/1 | /   | /   | /    | /    |
| <i>Araneus quadratus</i> Clerck, 1757              | /          | /   | /   | /          | /   | /   | /          | 1/  | /   | /   | /    | /    |
| <i>Araniella opisthographa</i> (Kulczyński, 1905)  | /          | /   | /   | /          | /   | /   | /          | 2/  | /   | /   | /    | /    |
| <i>Argiope bruennichi</i> (Scopoli, 1772)          | 3/2        | /   | /   | /          | /   | /   | /          | 3/5 | /   | /   | 3/   | /    |
| <i>Argiope lobata</i> (Pallas, 1772)               | /1         | /   | /   | /          | /   | /   | /          | /   | /   | /   | /    | /    |
| <i>Cyclosa oculata</i> (Walckenaer, 1802)          | /          | /   | /   | /          | /   | /   | /          | /   | /   | /   | 1/   | /    |
| <i>Gibbaranea bituberculata</i> (Walckenaer, 1802) | /1         | /   | /   | /          | 2/  | /   | /          | /1  | /   | /   | /    | /    |
| <i>Hypsosinga heri</i> (Hahn, 1831)                | /          | /   | /   | /          | /   | /   | 1/2        | /   | /   | /   | /    | /    |
| <i>Hypsosinga pygmaea</i> (Sundevall, 1831)        | /          | /   | /   | /          | /   | /   | /          | /1  | /   | /   | /    | /    |
| <i>Larinioides cornutus</i> (Clerck, 1757)         | /          | /   | /   | /          | /   | /   | /          | /   | /   | /   | 1/   | /    |
| <i>Mangora acalypha</i> (Walckenaer, 1802)         | 9/7        | /   | /   | /          | 1/  | /   | /          | 3/3 | /   | /   | 4/10 | /    |
| <i>Neoscona adianta</i> (Walckenaer, 1802)         | /1         | /   | /   | /          | /   | /   | /          | 1/  | /   | /   | 1/   | /    |
| <i>Singa hamata</i> (Clerck, 1757)                 | /          | /   | /   | /          | /   | /   | /1         | /   | /   | /   | 1/1  | /    |
| <i>Singa lucina</i> (Audouin, 1826) *              | /          | /   | /   | /          | /   | /   | /          | /   | /   | /   | /    | /    |
| <i>Singa trifidula</i> C. L. Koch, 1844            | /          | /   | /   | /          | /   | /   | /          | /   | /   | /   | /    | /    |
| <i>Zilla diodia</i> (Walckenaer, 1802)             | /1         | /   | /   | /          | /1  | /   | /          | /   | /   | /   | /    | /    |
| <b>Cheiracanthiidae</b>                            |            |     |     |            |     |     |            |     |     |     |      |      |
| <i>Cheiracanthium punctiorum</i> (Villers, 1789)   | /          | /   | /   | /          | /   | /   | /          | /1  | /   | /   | /    | /    |
| <b>Clubionidae</b>                                 |            |     |     |            |     |     |            |     |     |     |      |      |
| <i>Clubiona brevipes</i> Blackwall, 1841           | /          | /   | /   | /          | /   | /   | /          | /   | /   | /   | /    | /    |
| <i>Clubiona comta</i> C. L. Koch, 1839             | /          | 3/6 | /   | 2/7        | 1/4 | /4  | /          | /   | /   | /   | /    | /    |
| <i>Clubiona pallidula</i> (Clerck, 1757)           | /          | /   | /   | /          | /   | /   | /          | /   | 3/1 | /   | /    | 2/   |
| <i>Clubiona pseudoneglecta</i> Wunderlich, 1994    | /          | /   | /   | /          | /   | /   | /          | 1/  | /   | /   | 1/4  | /    |
| <i>Clubiona rosseae</i> Locket, 1953 *             | /          | /   | /   | /          | /   | /   | 1/         | /   | /   | /   | /    | /    |
| <i>Clubiona terrestris</i> Westring, 1851          | /          | /   | /   | /          | 1/  | 1/  | /          | /   | /   | /   | /    | 1/   |

| Habitat   | Locality 1 |           | Locality 2 |           |           |          | Locality 3 |           |           |           |
|---|------------|-----------|------------|-----------|-----------|----------|------------|-----------|-----------|-----------|
|   | M1<br>M/F  | W1<br>M/F | W2<br>M/F  | W3<br>M/F | W4<br>M/F | F<br>M/F | M2<br>M/F  | W5<br>M/F | M3<br>M/F | W6<br>M/F |
| <b>Dictyidae</b>  |            |           |            |           |           |          |            |           |           |           |
| <i>Argemina pattula</i> (Simon, 1874) *                     | /          | /         | /          | /         | /         | 6/       | /          | 2/        | /         | /         |
| <i>Argemina subnigra</i> (O. Pickard-Cambridge, 1861)       | /          | /         | /          | /         | /         | /        | 9/1        | 2/        | 6/        | /         |
| <i>Brommella falcigera</i> (Balogh, 1935)                   | /          | /         | /          | /         | /1        | /        | /          | /         | /         | /         |
| <i>Dictyna arundinacea</i> (Linnaeus, 1758)                 | /          | /         | /          | /         | /         | /        | /1         | /         | 1/4       | /         |
| <i>Dictyna heterophthalma</i> Kulczyński, 1891              | /          | /         | /          | /         | /         | /        | /1         | /         | /         | /         |
| <i>Lathys humilis</i> (Blackwall, 1855)                     | /          | /         | /          | /         | /         | /        | /1         | /         | /         | /         |
| <i>Lathys stigmatistata</i> (Menge, 1869) *                 | /2         | /         | /          | /         | /         | /        | /          | /         | /         | /         |
| <b>Dysderidae</b>   |            |           |            |           |           |          |            |           |           |           |
| <i>Dysdera hungarica</i> Kulczyński, 1897                   | /          | /         | /          | /         | /         | /        | /          | /         | /2        | /33       |
| <i>Harpactea rubicunda</i> (C. L. Koch, 1838)               | 1/         | 26/8      | 32/17      | 28/14     | 16/2      | /        | /          | /         | /         | /         |
| <b>Eresidae</b>   |            |           |            |           |           |          |            |           |           |           |
| <i>Eresus</i> sp.   | 1/         | /         | /          | /         | /         | /        | 2/         | /         | 2/        | /         |
| <b>Gnaphosidae</b>  |            |           |            |           |           |          |            |           |           |           |
| <i>Aphantaulax trifasciata</i> (O. Pickard-Cambridge, 1872) | /          | /         | /          | /         | /         | /        | /          | /         | /1        | /         |
| <i>Berlandina cinerea</i> (Menge, 1872) *                   | 23/4       | /         | /          | /         | /1        | /1       | 4/2        | /         | 1/1       | /         |
| <i>Drassodes lapidosus</i> (Walckenaer, 1802)               | 1/         | /         | 1/1        | /         | 5/        | /        | 4/2        | 1/        | /         | /         |
| <i>Drassodes pubescens</i> (Thorell, 1856)                  | /          | 1/        | /          | /         | /         | 4/1      | 4/1        | /         | /         | 1/        |
| <i>Drassyllus luteitarsus</i> (L. Koch, 1866)               | /          | /         | /          | /         | /         | 119/47   | 1/         | 26/7      | 8/1       | /2        |
| <i>Drassyllus praeficus</i> (L. Koch, 1866)                 | 6/4        | 3/1       | /1         | /         | 4/        | /1       | /1         | /         | 20/7      | /2        |
| <i>Drassyllus pusillus</i> (C. L. Koch, 1833)               | /          | /         | /          | /         | /         | 3/       | /          | /         | 18/4      | /2        |
| <i>Drassyllus villicus</i> (Thorell, 1875)                  | 2/3        | 131/80    | 131/81     | 73/68     | 119/79    | 1/       | /          | 5/        | /         | 38/4      |
| <i>Gnaphosa mongolica</i> Simon, 1895 *                     | 3/1        | /         | /          | /         | /         | /        | /          | /         | /         | /         |
| <i>Gnaphosa muscorum</i> (L. Koch, 1866)                    | 7/4        | 2/        | /          | /         | 1/        | /        | /          | /         | 1/        | /         |
| <i>Haplodrassus bohemicus</i> Miller & Bucher, 1977 *       | 3/1        | /         | /          | /         | /         | /        | /1         | /         | /         | /         |
| <i>Haplodrassus minor</i> (O. Pickard-Cambridge, 1879)      | /          | /         | /          | 1/        | /         | /        | /          | /         | 4/1       | /         |
| <i>Haplodrassus moderatus</i> (Kulczyński, 1897) *          | /          | /         | /          | /         | /         | 18/8     | /1         | /         | /         | /         |
| <i>Haplodrassus signifer</i> (C. L. Koch, 1839)             | 3/         | /         | /          | /         | /         | /1       | /2         | /         | 25/7      | /         |
| <i>Haplodrassus sitoestris</i> (Blackwall, 1833)            | 3/         | /         | 1/         | 7/1       | 1/1       | /        | /          | /1        | /         | 19/3      |
| <i>Micaria dives</i> (Lucas, 1846)                          | /          | /         | /          | /         | /         | /        | /          | /         | /         | /         |
| <i>Micaria formicaria</i> (Sundevall, 1831)                 | /          | /         | /1         | /         | /         | /        | /          | /         | /         | /         |
| <i>Micaria fulgens</i> (Walckenaer, 1802)                   | /          | /         | /          | /         | /         | /        | /          | /         | /         | /         |
| <i>Micaria pulicaria</i> (Sundevall, 1831)                  | /          | /         | 1/         | /         | /         | 1/5      | /          | /         | /         | /         |
| <i>Poecilohra varians</i> (C. L. Koch, 1839)                | /          | /         | /          | /         | /         | /        | 1/         | /         | /         | /         |
| <i>Trachyzelotes pedestris</i> (C. L. Koch, 1837)           | /          | 4/1       | 5/2        | /2        | /1        | 263/55   | 3/1        | 9/3       | 63/21     | 7/1       |
| <i>Zelotes apricorum</i> (L. Koch, 1876)                    | 1/2        | 21/32     | 33/46      | 18/18     | 57/49     | 5/7      | /          | 10/10     | 1/        | 44/28     |
| <i>Zelotes electus</i> (C. L. Koch, 1839)                   | 8/1        | 2/2       | /          | /         | 4/        | /        | 1/5        | /         | 15/17     | 1/        |
| <i>Zelotes erebeus</i> (Thorell, 1871)                      | /          | 1/1       | /          | /         | /         | /        | /          | /         | /         | /         |

| Habitat  | Locality 1 |     |      | Locality 2 |     |      | Locality 3 |      |       |     |
|--|------------|-----|------|------------|-----|------|------------|------|-------|-----|
|  | M1         | W1  | W2   | W3         | W4  | F    | M2         | W5   | M3    | W6  |
| Sex  | M/F        | M/F | M/F  | M/F        | M/F | M/F  | M/F        | M/F  | M/F   | M/F |
| <b>Gnaphosidae</b>   |            |     |      |            |     |      |            |      |       |     |
| <i>Zelotes latreillei</i> (Simon, 1878)                        | /          | /   | /    | /          | /   | 6/16 | 4/6        | /    | 15/23 | /   |
| <i>Zelotes longipes</i> (L. Koch, 1866)                        | 23/4       | /   | /    | /          | /   | /    | 1/         | /    | /     | /   |
| <i>Zelotes segrexi</i> (Simon, 1878)                           | 2/6        | /   | /    | /          | /   | /    | /          | /    | /     | /   |
| <b>Hahniidae</b>   |            |     |      |            |     |      |            |      |       |     |
| <i>Hahnina nana</i> (Blackwall, 1841)                          | /          | /   | /    | /          | /   | /    | 2/1        | /    | /     | /   |
| <b>Linyphiidae</b>   |            |     |      |            |     |      |            |      |       |     |
| <i>Acartiauchenius scurrilis</i> (O. Pickard-Cambridge, 1873)  | /          | /   | /    | /          | /   | /    | /          | /    | /     | /   |
| <i>Agyneta mollis</i> (O. Pickard-Cambridge, 1871)             | /          | /   | /    | /          | /   | 2/   | 1/         | /    | 19/6  | /   |
| <i>Agyneta ruresstris</i> (C. L. Koch, 1836)                   | 2/1        | /   | /    | /          | /   | /    | 5/16       | 1/   | 18/13 | 6/  |
| <i>Agyneta simpliciteris</i> (Simon, 1884)                     | /          | /   | /    | /          | /   | /    | /          | /    | 7/1   | /   |
| <i>Araoncus humilis</i> (Blackwall, 1841)                      | 1/         | 1/  | 2/   | 1/         | /   | /    | 6/5        | 3/   | 5/12  | 1/1 |
| <i>Bathyphanes gracilis</i> (Blackwall, 1841)                  | /          | /   | /    | /          | /   | 1/   | 1/         | /    | 2/1   | /   |
| <i>Canariphantes nanus</i> (Kulczyński, 1898) *                | /          | 9/2 | 18/7 | 8/6        | 3/2 | 1/   | /          | 3/   | 1/2   | 8/3 |
| <i>Centromerus sylvaticus</i> (Blackwall, 1841)                | /          | /   | /    | /          | /   | 1/   | /          | 1/   | 3/3   | 7/3 |
| <i>Ceratinella brevipis</i> (Westring, 1851)                   | /          | /   | /    | /          | /   | /    | /          | 1/1  | /     | /   |
| <i>Ceratinella brevis</i> (Wider, 1834)                        | /          | /   | /    | /          | /   | /    | 2/1        | /    | 6/    | 1/1 |
| <i>Dactylopiethes digiticeps</i> (Simon, 1881)                 | /          | /   | /    | /          | /   | 8/3  | /          | /    | /     | /   |
| <i>Dicymbium nigrum</i> (Blackwall, 1834)                      | /          | 2/  | /    | /          | /   | 2/   | /          | /    | 32/21 | /   |
| <i>Diplocephalus pictus</i> (Blackwall, 1841)                  | /          | /   | /    | /          | /   | /    | /          | 3/1  | /     | 3/  |
| <i>Diplostyla concolor</i> (Wider, 1834)                       | /          | 2/  | /    | /          | /   | 21/9 | /          | 10/1 | 2/    | 1/  |
| <i>Erigone dentipalpis</i> (Wider, 1834)                       | /          | /   | /    | /          | /   | /    | /          | /    | 1/1   | 1/  |
| <i>Floroneta bucculenta</i> (Clerck, 1757)                     | /          | /   | /    | /          | /   | /    | /          | /    | /     | /   |
| <i>Glyphesis taoplesius</i> Wunderlich, 1969 *                 | /          | /   | /    | /          | /   | /    | 1/         | /    | /     | /   |
| <i>Gnatharium dentatum</i> (Wider, 1834)                       | /          | /   | /    | /          | /   | /    | /          | 4/4  | /     | /   |
| <i>Gongylidiellum murcidum</i> Simon, 1884 *                   | /          | /   | /    | /          | /   | 2/   | /          | 4/1  | /     | /   |
| <i>Hypocephalus pusillus</i> (Menge, 1869) *                   | /          | /   | /    | /          | /   | /    | /          | /    | 1/1   | /   |
| <i>Linyphia triangularis</i> (Clerck, 1757)                    | /          | /   | /    | /          | /   | /    | /          | 3/   | 7/    | /   |
| <i>Mermessus trilobatus</i> (Emerton, 1882) *                  | /          | /   | /    | /          | /   | /    | /          | /    | 3/    | /   |
| <i>Metopobatrachus ascitus</i> (Kulczyński, 1894)              | /          | /   | /    | /          | /   | /    | /          | 1/   | /     | /   |
| <i>Neritene clathrata</i> (Sundevall, 1830)                    | /          | /   | /    | /          | /   | 9/6  | 1/         | 11/2 | 1/    | 5/2 |
| <i>Oedothorax apicatus</i> (Blackwall, 1850)                   | /          | /   | /    | /          | /   | /    | /          | /    | 1/    | /   |
| <i>Osteareus melanopygus</i> (O. Pickard-Cambridge, 1879)      | /          | /   | /    | /          | /   | /    | /          | /    | 1/    | /   |
| <i>Palliduphantes pillichi</i> (Kulczyński, 1915)              | /          | /   | /    | /          | /   | /    | /          | /    | 2/1   | 3/  |
| <i>Panannomops mengei</i> Simon, 1926 *                        | /          | 4/1 | 1/   | /          | 3/  | /    | /          | /    | /     | 5/  |
| <i>Pelecopsis parallela</i> (Wider, 1834)                      | 9/13       | /   | 1/   | /          | /   | 21/7 | 2/         | 1/   | /     | 1/  |
| <i>Pocadicnemis juncea</i> Locket & Millidge, 1953             | /          | /   | /    | /          | /   | /    | 2/         | /    | 7/4   | 1/  |
| <i>Porrihonna microphthalma</i> (O. Pickard-Cambridge, 1871) / | /          | /   | /    | /          | /   | /    | 2/         | /    | /     | /   |
| <i>Porrihonna microps</i> (Roewer, 1931)                       | /          | /   | 2/   | /          | /   | /    | /          | /    | 1/    | 1/5 |

| Habitat  | Locality 1 |         |     | Locality 2 |         |         | Locality 3 |       |       |         |        |  |
|--|------------|---------|-----|------------|---------|---------|------------|-------|-------|---------|--------|--|
|  | M1         | W1      | M/F | W2         | W3      | W4      | F          | M2    | W5    | M3      | W6     |  |
| Sex  | M/F        | M/F     | M/F | M/F        | M/F     | M/F     | M/F        | M/F   | M/F   | M/F     | M/F    |  |
| <b>Linyphiidae</b>   |            |         |     |            |         |         |            |       |       |         |        |  |
| <i>Porriomma oblitum</i> (O. Pickard-Cambridge, 1871) *          | /          | /       | /   | /          | /       | /       | /          | /     | /2    | /       | /      |  |
| <i>Porriomma pygmaeum</i> (Blackwall, 1834)                      | /          | /       | /   | /          | /       | /       | /          | /     | 4/5   | /       | /      |  |
| <i>Sintula spiniger</i> (Balogh, 1935) *                         | 2/1        | /       | /   | /          | 1/      | 2/2     | 2/5        | 1/2   | /     | 8/5     | /      |  |
| <i>Styloctetor compar</i> (Westring, 1861)                       | /          | /       | /   | /          | /       | /       | /          | /     | /     | 7/1     | /      |  |
| <i>Syedra apetonensis</i> Wunderlich, 1992 *                     | /          | /       | /   | /          | /       | /       | /          | 1/    | /     | /       | /      |  |
| <i>Tallusia vindobonensis</i> (Kulczyński, 1898) *               | /          | /       | /   | /          | /       | /       | /          | /     | /     | 1/1     | /      |  |
| <i>Tenuiphantes flavipes</i> (Blackwall, 1854)                   | /          | 5/11    | /   | 2/2        | 6/4     | 3/1     | /          | /     | /1    | 1/      | 8/9    |  |
| <i>Tenuiphantes tenuis</i> (Blackwall, 1852)                     | /          | /       | /   | /          | /       | /       | 2/         | /     | /     | 1/      | 1/4    |  |
| <i>Trichoniscus hackmani</i> Millidge, 1955                      | /          | /       | /   | /          | /       | 1/      | /          | 13/3  | /     | 5/      | /      |  |
| <i>Trichopterna cito</i> (O. Pickard-Cambridge, 1873)            | 2/1        | /       | /   | /          | /       | /       | /          | 2/    | /     | 1/      | /      |  |
| <i>Walckenaeria alticeps</i> (Denis, 1952)                       | /          | /       | /   | /          | /       | /       | /          | /     | /11   | /       | /1     |  |
| <i>Walckenaeria antica</i> (Wider, 1834)                         | /          | /       | /   | /          | /       | /       | /          | /     | /2    | /       | /      |  |
| <i>Walckenaeria atrothibialis</i> (O. Pickard-Cambridge, 1878) * | /          | /       | /   | /          | /       | /       | /          | /     | 1/1   | /       | /      |  |
| <i>Walckenaeria capito</i> (Westring, 1861)                      | /          | /       | /   | /          | /       | /       | /          | /     | /     | /1      | /      |  |
| <i>Walckenaeria nudipalpis</i> (Westring, 1851)                  | /          | /       | /   | /          | /       | /       | 2/         | /     | 1/23  | /       | /      |  |
| <b>Liocranidae</b>   |            |         |     |            |         |         |            |       |       |         |        |  |
| <i>Agroeca cuprea</i> Menge, 1873                                | 1/         | 4/1     | /   | 7/2        | 3/1     | 6/1     | /          | /     | /     | 4/      | 13/2   |  |
| <i>Liocranoea striata</i> (Kulczyński, 1882)                     | /          | 1/      | /   | 1/         | /       | /       | 5/2        | /1    | 14/   | 2/      | /      |  |
| <b>Lycosidae</b>   |            |         |     |            |         |         |            |       |       |         |        |  |
| <i>Alopecosa aculeata</i> (Clerck, 1757)                         | /          | /       | /   | /          | /       | /       | /          | 2/    | /     | /       | /      |  |
| <i>Alopecosa cuneata</i> (Clerck, 1757)                          | 7/         | /       | /   | /          | 1/      | 2/      | /          | 11/3  | /     | 2/2     | /      |  |
| <i>Alopecosa mariae</i> (Dahl, 1908)                             | /          | 1/      | /   | /          | /       | 9/      | /          | 4/3   | /     | 2/3     | /      |  |
| <i>Alopecosa pulverulenta</i> (Clerck, 1757)                     | /2         | /       | /   | /          | /       | 1/4     | 1/1        | 9/2   | /1    | 107/33  | 4/     |  |
| <i>Alopecosa sulzeri</i> (Favasi, 1873)                          | 14/1       | 19/6    | /   | 13/4       | 7/7     | 31/5    | /          | /     | /     | 1/      | 1/     |  |
| <i>Arctosa figurata</i> (Simon, 1876)                            | 4/         | /       | /   | /          | /       | /       | /          | 6/3   | /     | 1/      | /      |  |
| <i>Arctosa leopardus</i> (Sundevall, 1833)                       | /          | /       | /   | /          | /       | /       | 191/70     | /     | /     | 1/      | 1/5    |  |
| <i>Arctosa lutetiana</i> (Simon, 1876)                           | 9/         | 132/13  | /   | 208/15     | 153/7   | 94/7    | 5/         | 3/    | /     | 136/29  | 161/6  |  |
| <i>Aulonia albimana</i> (Walckenaer, 1805)                       | /          | /       | /   | /          | /       | 1/      | /          | /     | /     | /       | /      |  |
| <i>Hogna radiata</i> (Latreille, 1817)                           | /1         | 2/      | /   | 1/1        | /1      | /       | 1/1        | 87/44 | /     | 6/3     | /      |  |
| <i>Pardosa agrestis</i> (Westring, 1861)                         | /          | /       | /   | /          | /       | /       | /          | /     | /     | 2/      | /      |  |
| <i>Pardosa alacris</i> (C. L. Koch, 1833)                        | 20/1       | 245/308 | /   | 487/394    | 193/314 | 466/260 | 22/4       | 6/    | 16/40 | 13/     | 302/91 |  |
| <i>Pardosa maia</i> Hippa & Mannila, 1982 *                      | /          | /       | /   | /          | /       | /       | 8/3        | 1/    | /     | /       | /      |  |
| <i>Pardosa mixta</i> (Kulczyński, 1887)                          | /          | /       | /   | /          | /       | /       | /          | /     | /     | 1/      | /      |  |
| <i>Pardosa paludicola</i> (Clerck, 1757)                         | /          | /       | /   | /          | /       | /       | 2/2        | /     | /     | 1/1     | /1     |  |
| <i>Pardosa palustris</i> (Linnaeus, 1758)                        | 1/1        | /       | /   | /          | /       | /       | /          | /     | /     | 1/      | /      |  |
| <i>Pardosa pratensis</i> (L. Koch, 1870)                         | /1         | /       | /   | /          | /       | /       | 360/390    | 1/1   | 1/2   | 578/175 | 10/4   |  |
| <i>Pardosa proxima</i> (C. L. Koch, 1847)                        | /          | /       | /   | /          | /       | /       | /          | /     | /     | 33/34   | /      |  |
| <i>Pirata piraticus</i> (Clerck, 1757)                           | /          | /       | /   | /          | /       | /       | 1/1        | /     | 10/9  | /       | /      |  |

| Habitat   | Locality 1 |       |      |     | Locality 2 |        |       |         | Locality 3 |        |  |  |
|---|------------|-------|------|-----|------------|--------|-------|---------|------------|--------|--|--|
|   | M1         | W1    | W2   | W3  | W4         | F      | M2    | W5      | M3         | W6     |  |  |
| Sex   | M/F        | M/F   | M/F  | M/F | M/F        | M/F    | M/F   | M/F     | M/F        | M/F    |  |  |
| <b>Lycosidae</b>  |            |       |      |     |            |        |       |         |            |        |  |  |
| <i>Pirata tenuitarsis</i> Simon, 1876                       | /          | /     | /    | /   | /          | /      | /     | /1      | /          | /      |  |  |
| <i>Piratula hygrophila</i> (Thorell, 1872)                  | /          | /     | /    | /   | /          | 66/77  | 3/    | 324/105 | 2/         | 5/4    |  |  |
| <i>Piratula latitans</i> (Blackwall, 1841)                  | /          | /     | /    | /   | /          | 299/95 | /     | 163/62  | 23/3       | 3/1    |  |  |
| <i>Trochosa hispanica</i> Simon, 1870                       | /          | 3/    | 1/   | 1/  | 5/         | 41/31  | /3    | 101/42  | 168/31     | 343/73 |  |  |
| <i>Trochosa ruricola</i> (De Geer, 1778)                    | /          | /     | /    | /   | /          | 100/63 | 20/10 | 72/21   | 84/21      | 11/3   |  |  |
| <i>Trochosa spiritalpis</i> (F. O. Pickard-Cambridge, 1895) | /          | /1    | /    | 1/  | /          | /      | /     | /       | /          | /      |  |  |
| <i>Trochosa terricola</i> Thorell, 1856                     | /          | 20/14 | 12/5 | 5/7 | 9/6        | 2/8    | 1/    | 30/6    | 6/4        | 5/4    |  |  |
| <i>Xerolycosa miniata</i> (C. L. Koch, 1834)                | /          | /     | /    | /   | /          | /      | 1/    | /       | 23/7       | 5/1    |  |  |
| <b>Mimetidae</b>  |            |       |      |     |            |        |       |         |            |        |  |  |
| <i>Ero aphanis</i> (Walckenaer, 1802)                       | /          | /     | /    | /   | 1/         | /      | /     | /       | /          | 1/     |  |  |
| <i>Ero furcata</i> (Villers, 1789)                          | /          | /     | /    | /   | /          | /      | /     | /       | /          | 1/1    |  |  |
| <b>Miturgidae</b>   |            |       |      |     |            |        |       |         |            |        |  |  |
| <i>Zora armillata</i> Simon, 1878 *                         | /          | /3    | 1/1  | /   | 2/         | /11    | /     | /       | 1/1        | /      |  |  |
| <i>Zora nemoralis</i> (Blackwall, 1861)                     | /          | /     | 1/   | 1/  | /          | /      | /     | /       | /          | /      |  |  |
| <i>Zora parallela</i> Simon, 1878 *                         | /          | 1/    | 1/   | /   | /          | /      | /     | /       | /          | /      |  |  |
| <i>Zora pardalis</i> Simon, 1878                            | 2/1        | /     | /    | /   | 1/         | /      | /     | /       | /          | /      |  |  |
| <i>Zora spinimana</i> (Sundevall, 1833)                     | /          | 8/2   | 3/2  | 1/  | 1/         | /      | 1/    | /       | 1/         | /      |  |  |
| <b>Oxyopidae</b>  |            |       |      |     |            |        |       |         |            |        |  |  |
| <i>Oxyopes heterophthalmus</i> (Latreille, 1804)            | 14/17      | /     | /    | /   | /          | /      | 6/14  | /       | 2/3        | /      |  |  |
| <b>Philodromidae</b>  |            |       |      |     |            |        |       |         |            |        |  |  |
| <i>Philodromus cespitum</i> (Walckenaer, 1802)              | /          | /     | /    | /   | /          | /      | 1/    | /       | 1/3        | /      |  |  |
| <i>Philodromus rufus</i> Walckenaer, 1826                   | /          | 1/    | /    | /   | /          | /      | /     | /       | /          | /      |  |  |
| <i>Pulchellodromus ruficapillus</i> (Simon, 1885) *         | /          | /     | /    | /   | /          | /      | /     | /       | 1/1        | /      |  |  |
| <i>Thanatus arenarius</i> L. Koch, 1872                     | 1/         | /     | /    | /   | /          | /      | 3/    | /       | 3/1        | /      |  |  |
| <i>Thanatus formicinus</i> (Clerck, 1757)                   | /          | /     | /    | /   | /          | 1/     | 19/6  | /       | 1/4        | /      |  |  |
| <i>Thanatus pictus</i> L. Koch, 1881                        | 10/2       | /     | /    | /   | /          | /      | /     | /       | /          | /      |  |  |
| <i>Thanatus striatus</i> C. L. Koch, 1845 *                 | /          | /     | /    | /   | /          | 1/     | /     | /       | /          | /      |  |  |
| <i>Tibellus macellus</i> Simon, 1875                        | 1/         | /     | /    | /   | /          | /      | /     | /       | /          | /      |  |  |
| <i>Tibellus oblongus</i> (Walckenaer, 1802)                 | /2         | /     | /    | /   | /          | /      | /     | /       | 1/5        | /      |  |  |
| <b>Phrurolithidae</b>                                       |            |       |      |     |            |        |       |         |            |        |  |  |
| <i>Phrurolithus festivus</i> (C. L. Koch, 1835)             | 1/         | 1/1   | /    | 1/  | 1/2        | 3/1    | /     | 6/3     | 2/1        | 13/1   |  |  |
| <i>Phrurolithus minimus</i> C. L. Koch, 1839                | /          | 1/    | 1/   | /   | 1/3        | /      | /     | /       | /          | 2/     |  |  |
| <b>Pisauridae</b>   |            |       |      |     |            |        |       |         |            |        |  |  |
| <i>Dolomedes plantarius</i> (Clerck, 1757)                  | /          | /     | /    | /   | /          | 2/     | /     | /       | /          | /      |  |  |
| <i>Pisaura mirabilis</i> (Clerck, 1757)                     | /          | 1/    | 2/   | 1/  | 1/         | 6/4    | 8/5   | 5/2     | 3/2        | 1/     |  |  |

| Habitat   | Locality 1 |      |     |     | Locality 2 |     |     |    | Locality 3 |      |     |   |     |      |         |   |     |    |     |   |      |  |
|---|------------|------|-----|-----|------------|-----|-----|----|------------|------|-----|---|-----|------|---------|---|-----|----|-----|---|------|--|
|   | M1         |      | W1  |     | W2         |     | W3  |    | W4         |      | F   |   | M2  |      | W5      |   | M3  |    | W6  |   |      |  |
|   | M/F        |      | M/F |     | M/F        |     | M/F |    | M/F        |      | M/F |   | M/F |      | M/F     |   | M/F |    | M/F |   |      |  |
| <b>Salicidae</b>                                      |            |      |     |     |            |     |     |    |            |      |     |   |     |      |         |   |     |    |     |   |      |  |
| <i>Aelurillus v-insignitus</i> (Clerck, 1757) *       | 2/1        | /    | /   | /   | /          | /   | /   | /  | /          | /    | /   | / | /   | /    | /       | / | /   | /  | /   | / | /    |  |
| <i>Calositticus floricola</i> (C. L. Koch, 1837)      | 1/         | /    | /   | /   | /          | /   | /   | /  | /          | /    | /   | / | /   | /    | /       | / | /   | 2/ | /   | / | /    |  |
| <i>Carthotus xanthogramma</i> (Latreille, 1819)       | 1/         | /    | /   | /   | /          | /   | /   | /  | /          | /    | /   | / | /   | /    | 1/1     | / | /   | /  | /   | / | /    |  |
| <i>Euophrys frontalis</i> (Walckenaer, 1802)          | 1/         | /    | /   | /   | /          | /   | /   | /  | 1/         | 15/7 | /   | / | /   | /    | 2/3     | / | /   | /  | /   | / | /    |  |
| <i>Evarcha arcuata</i> (Clerck, 1757)                 | /          | /    | /   | /   | /          | /   | /   | /  | 3/         | /    | /   | / | /   | /    | /       | / | /   | /  | /   | / | /    |  |
| <i>Evarcha falcata</i> (Clerck, 1757)                 | /          | 1/   | /   | /   | /          | /   | /   | /  | /          | 1/1  | /   | / | /   | /    | /       | / | /   | /  | /   | / | 1/   |  |
| <i>Heliothamus auratus</i> C. L. Koch, 1835           | /          | /    | /   | /   | /          | /   | /   | /  | /          | /    | /   | / | /   | /    | /       | / | /   | /  | /   | / | /    |  |
| <i>Heliothamus cupreus</i> (Walckenaer, 1802)         | 6/3        | /    | /   | /   | /          | /   | /   | /  | /          | /    | /   | / | /   | /    | /       | / | /   | /  | /   | / | /    |  |
| <i>Heliothamus flavipes</i> (Hahn, 1832)              | /          | /    | /   | /   | /          | /   | /   | /  | /          | /    | /   | / | /   | /    | /       | / | /   | /  | /   | / | /    |  |
| <i>Macarocoris nidicolens</i> (Walckenaer, 1802)      | /          | /    | /   | /   | /          | /   | /   | /  | /          | /    | /   | / | /   | /    | /       | / | /   | /  | /   | / | /    |  |
| <i>Marpissa muscosa</i> (Clerck, 1757)                | /          | /    | /   | /   | /          | 1/1 | /   | /  | /          | /    | /   | / | /   | /    | /       | / | /   | /  | /   | / | 1/   |  |
| <i>Mendoza canestrinii</i> (Ninni, 1868)              | /          | /    | /   | /   | /          | /   | /   | /  | /          | /    | /   | / | /   | /    | /       | / | /   | /  | /   | / | /    |  |
| <i>Pellentes nigrociliatus</i> (Simon, 1875)          | 1/2        | /    | /   | /   | /          | /   | /   | /  | /          | /    | /   | / | /   | /    | /       | / | /   | /  | /   | / | /    |  |
| <i>Philetaeus chryseops</i> (Poda, 1761)              | /          | /    | /   | /   | /          | /   | /   | /  | /          | /    | /   | / | /   | /    | /       | / | /   | /  | /   | / | /    |  |
| <i>Phlegma fasciata</i> (Hahn, 1826)                  | 1/         | /    | /   | /   | /          | /   | /   | /  | /          | 1/3  | /   | / | /   | /    | 6/5     | / | /   | /  | /   | / | /    |  |
| <i>Talavera aequipes</i> (O. Pickard-Cambridge, 1871) | 2/         | /    | /   | /   | /          | /   | /   | /  | /          | /    | /   | / | /   | /    | /       | / | /   | /  | /   | / | /    |  |
| <i>Talavera aperta</i> (Miller, 1971)                 | /          | /    | /   | /   | /          | /   | /   | /  | /          | /    | /   | / | /   | /    | 1/1     | / | /   | /  | /   | / | /    |  |
| <b>Sparassidae</b>                                    |            |      |     |     |            |     |     |    |            |      |     |   |     |      |         |   |     |    |     |   |      |  |
| <i>Micrommata virescens</i> (Clerck, 1757)            | /          | /    | /   | /   | /          | /   | /   | /  | /          | 2/   | /   | / | /   | /    | 3/1     | / | /   | /  | /   | / | /    |  |
| <b>Tetragnathidae</b>                                 |            |      |     |     |            |     |     |    |            |      |     |   |     |      |         |   |     |    |     |   |      |  |
| <i>Pachygnatha clercki</i> Sundevall, 1823            | /          | /    | /   | /   | /          | /   | /   | /  | /          | /    | /   | / | /   | /    | 12/4    | / | /   | /  | /   | / | /    |  |
| <i>Pachygnatha degeeri</i> Sundevall, 1830            | /          | /    | /   | /   | /          | /   | /   | /  | /          | /    | /   | / | /   | 2/2  | 583/843 | / | /   | /  | /   | / | 18/9 |  |
| <i>Tetragnatha extensa</i> (Linnaeus, 1758)           | /          | /    | /   | /   | /          | /   | /   | /  | /          | /    | /   | / | /   | /    | /       | / | /   | /  | /   | / | /    |  |
| <i>Tetragnatha montana</i> Simon, 1874                | /          | /    | /   | /   | /          | /   | /   | /  | /          | /    | /   | / | /   | /    | /       | / | /   | /  | /   | / | 1/   |  |
| <b>Theridiidae</b>                                    |            |      |     |     |            |     |     |    |            |      |     |   |     |      |         |   |     |    |     |   |      |  |
| <i>Asagena meridionalis</i> Kulczyński, 1894          | /          | 1/   | /   | /   | /          | /   | /   | /  | 4/         | /    | /   | / | /   | /    | /       | / | /   | /  | /   | / | /    |  |
| <i>Asagena phalerata</i> (Panzer, 1801)               | /          | /    | /   | /   | /          | 1/  | /   | /  | /          | /    | 2/  | / | /   | 10/2 | 1/      | / | /   | /  | /   | / | 2/1  |  |
| <i>Cryptachaea riparia</i> (Blackwall, 1834)          | /          | /    | /   | /   | /          | /   | /   | /  | /          | /    | /   | / | /   | /    | /       | / | /   | /  | /   | / | 6/4  |  |
| <i>Enoplognatha thoracica</i> (Hahn, 1833)            | 1/         | 26/1 | /   | 17/ | 1/         | 1/  | 17/ | 7/ | 7/         | /    | /   | / | /   | /    | 1/      | / | /   | /  | /   | / | 8/   |  |
| <i>Epistinus truncatus</i> Latreille, 1809            | /          | /    | /   | /   | /          | 1/1 | /   | /  | /          | /    | /   | / | /   | /    | /       | / | /   | /  | /   | / | 5/   |  |
| <i>Euryopis flaccumaculata</i> (C. L. Koch, 1836)     | /          | /    | /   | /   | /          | /   | /   | /  | /          | /    | /   | / | /   | /    | /       | / | /   | /  | /   | / | /    |  |
| <i>Euryopis quinqueuttata</i> Thorell, 1875           | 1/         | /    | /   | /   | /          | /   | /   | /  | /          | /    | 1/  | / | /   | 11/5 | /       | / | /   | /  | /   | / | /    |  |
| <i>Heterotheridium nigrovirgatatum</i> (Simon, 1873)  | /          | /    | /   | /   | /          | /   | /   | /  | /          | /    | 1/  | / | /   | /    | /       | / | /   | /  | /   | / | /    |  |
| <i>Parasatoda lunata</i> (Clerck, 1757)               | /          | /    | /   | /   | /          | /   | 1/  | /  | /          | /    | /   | / | /   | /    | /       | / | /   | /  | /   | / | /    |  |
| <i>Phylloneta impressa</i> (L. Koch, 1881)            | 1/4        | /    | /   | /   | /          | /   | /   | /  | /          | /    | /   | / | /   | 1/1  | /       | / | /   | /  | /   | / | /    |  |
| <i>Platnickina tincta</i> (Walckenaer, 1802)          | /          | /    | /   | /   | /          | /   | 1/  | /  | /          | /    | /   | / | /   | /    | /       | / | /   | /  | /   | / | /    |  |
| <i>Robertus lividus</i> (Blackwall, 1836)             | /          | 1/   | /   | /   | /          | /   | /   | /  | /          | /    | 1/  | / | /   | /    | /       | / | /   | /  | /   | / | /    |  |
| <i>Theridion uhligi</i> Martin, 1974 *                | /          | /    | /   | /   | /          | /   | /   | /  | /          | /    | /   | / | /   | 1/1  | /       | / | /   | /  | /   | / | /    |  |

| Habitat  | Locality 1 |         |          | Locality 2 |          |          | Locality 3 |          |          |          |
|--|------------|---------|----------|------------|----------|----------|------------|----------|----------|----------|
|  | M1         | W1      | W2       | W3         | W4       | F        | M2         | W5       | M3       | W6       |
| Sex  | M/F        | M/F     | M/F      | M/F        | M/F      | M/F      | M/F        | M/F      | M/F      | M/F      |
| <b>Thomisidae</b>                                    |            |         |          |            |          |          |            |          |          |          |
| <i>Bassaniodes robustus</i> (Hahn, 1832) *           | 7/1        | /       | /        | /          | 4/       | /        | /1         | /        | 9/5      | /        |
| <i>Ebrechtella tricuspidata</i> (Fabricius, 1775)    | /          | /       | /        | /          | /        | /        | 1/         | /        | 2/       | /        |
| <i>Misumena vatia</i> (Clerck, 1757)                 | /          | /       | /        | /          | /        | /        | /2         | /        | 3/3      | /        |
| <i>Ozyptila atomaria</i> (Panzer, 1801)              | /          | /       | /        | /          | /        | /        | 1/         | /        | /1       | /        |
| <i>Ozyptila brevipes</i> (Hahn, 1826) *              | /          | /       | /        | /          | /        | 2/       | /          | /        | 3/       | 1/       |
| <i>Ozyptila praticola</i> (C. L. Koch, 1837)         | /          | 257/12  | 96/5     | 350/12     | 188/29   | /        | /          | 371/17   | /        | 265/10   |
| <i>Ozyptila scabrlicula</i> (Westring, 1851)         | /          | /       | /        | /          | /        | /        | 3/3        | /        | /        | /        |
| <i>Ozyptila simplex</i> (O. Pickard-Cambridge, 1862) | /          | /       | /        | /          | /        | 1/       | /          | /        | /        | /        |
| <i>Ozyptila trux</i> (Blackwall, 1846) *             | /          | /       | /        | /          | /        | 3/       | /          | 1/1      | 47/15    | 1/       |
| <i>Pisidium truncatus</i> (Pallas, 1772)             | /          | /       | /        | /          | /        | /        | 1/         | /        | /        | /        |
| <i>Psammittis sabulosus</i> (Hahn, 1832)             | /          | /       | /        | /          | /        | /        | /          | /        | 1/       | /        |
| <i>Runcinia grammica</i> (C. L. Koch, 1837)          | 1/         | /       | /        | /          | /        | /        | 1/1        | /        | 5/3      | /        |
| <i>Spiracme striatipes</i> (L. Koch, 1870)           | /          | /       | /        | /          | /        | /        | 1/         | /        | /1       | /        |
| <i>Synema globosum</i> (Fabricius, 1775)             | /          | /       | /        | /          | /        | /        | /          | /        | /        | /        |
| <i>Thomisus onustus</i> Walckenaer, 1805             | 3/1        | /       | /        | /          | /        | /        | 1/         | /        | /        | /        |
| <i>Tharua piger</i> (Walckenaer, 1802)               | 2/4        | /       | /1       | /          | /        | /        | /          | /        | 1/1      | /        |
| <i>Xysticus cristatus</i> (Clerck, 1757)             | /          | /       | /        | /          | /        | /        | /          | /        | 1/       | /        |
| <i>Xysticus erraticus</i> (Blackwall, 1834)          | /          | /       | /        | /          | /        | /        | 4/2        | /        | 1/       | /        |
| <i>Xysticus kempeleni</i> Thorell, 1872              | /          | /       | /        | /          | /        | /        | 4/         | /        | 1/1      | /        |
| <i>Xysticus kochi</i> Thorell, 1872                  | 20/7       | /       | /        | /          | 5/       | 2/       | 15/10      | /        | 18/14    | 1/       |
| <i>Xysticus lactator</i> L. Koch, 1870               | /          | 5/      | 3/       | 6/         | 22/      | 2/       | 7/         | 7/       | 2/       | 19/1     |
| <i>Xysticus ulmi</i> (Hahn, 1831)                    | /          | /       | /        | /          | /        | 1/       | /          | /        | 2/       | /        |
| <b>Titanoecidae</b>                                  |            |         |          |            |          |          |            |          |          |          |
| <i>Titanoeca schineri</i> L. Koch, 1872              | /          | 23/1    | 16/4     | 8/         | 13/5     | /        | /          | /        | /        | 2/       |
| <i>Titanoeca spominima</i> (Taczanowski, 1866) *     | 3/         | /       | /1       | /          | /        | /        | 3/         | /        | /        | /        |
| <b>Uloboridae</b>                                    |            |         |          |            |          |          |            |          |          |          |
| <i>Uloborus walckenaerius</i> Latreille, 1806        | 2/1        | /       | /        | /          | /        | /        | /1         | /        | /        | /        |
| <b>Zodariidae</b>                                    |            |         |          |            |          |          |            |          |          |          |
| <i>Zodariion germanicum</i> (C. L. Koch, 1837)       | 2/         | 7/2     | 11/1     | 1/         | 4/2      | 17/3     | 3/         | /        | 3/       | 37/4     |
| <b>Grand total = 16304</b>                           | 259/118    | 976/512 | 1098/607 | 897/475    | 1098/475 | 1647/954 | 353/220    | 1234/393 | 2252/969 | 1425/342 |

