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Pannonic salt marshes – important habitats for ground-active spider communities

Peter Gajdoš, Ľudmila Černecká, Pavol Purgat & Anna Šestáková

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Abstract. Three years of study (2016–2019) of endangered habitats of inland salt marshes and salt steppes have yielded several interesting and novel data about the araneofauna of Slovakia. Ground-active spider communities were studied at nine localities belonging to Natura 2000 sites in the Pannonian region. A total of 220 species were recorded, of which 28 species are listed in the Slovak Red List as threatened and 18 species as potentially threatened. The other 11 documented rare species were recorded only in the last decade and are known from only one or a few localities. During the first part of the study, six first records for our fauna from salt marshes (already published) were revealed. Moreover, the continuation of the research brought other new findings for the Slovakian araneofauna *Pardosa tenuipes* (Lycosidae), *Dactylopisthes digiticeps* (Linyphiidae) and *Ozyptila sanctuaria* (Thomisidae). Their characteristic features, photos of the habitus and genitalia, notes on their phenology, habitat, an overview of the currently known distribution, and the dominant species of spider assemblages are presented.

Keywords: faunistics, Natura 2000, new records, restoration habitats, saline habitats, south-west Slovakia

Zusammenfassung. Pannonische Salzwiesen – wichtige Lebensräume für bodenaktive Spinnengemeinschaften. In einer dreijährigen Studie (2016–2019) haben wir die bodenaktiven Spinnengemeinschaften gefährdeter Lebensräume in Binnensalzwiesen und Salzsteppen der Slowakei untersucht. Dafür wurden neun Lokalitäten in verschiedenen Natura 2000-Gebiete der pannonischen Region beprobt. Insgesamt wurden 220 Arten erfasst, von denen 28 Arten in der slowakischen Roten Liste als bedroht und 18 Arten als potenziell bedroht aufgeführt sind. Die anderen 11 dokumentierten seltenen Arten wurden erst in den letzten zehn Jahren erfasst und sind nur von einem oder wenigen Orten bekannt. Während des ersten Teils der Studie wurden sechs Erstnachweise für slowakische Fauna aus Salzwiesen (bereits veröffentlicht) erbracht. Darüber hinaus konnten neue Erkenntnisse für folgende Arten der slowakischen Spinnenfauna gewonnen werden: *Pardosa tenuipes* (Lycosidae), *Dactylopisthes digiticeps* (Linyphiidae) und *Ozyptila sanctuaria* (Thomisidae). Neben charakteristischen Merkmalen, Dokumentation des Habitus und der Genitalien, Informationen zur Phänologie und dem Lebensraum, geben wir einen Überblick über die derzeit bekannte Verbreitung und die vorherrschenden Arten der Spinnengemeinschaften.

Pannonic inland salt marshes and salt steppes (Natura 2000 habitat code 1340, 1530) belong to the priority habitats in Europe threatened by intensification of anthropogenic activities (Lubińska-Mielińska et al. 2022). These are, by definition, non-intertidal and this has a strong impact on local communities as compared to coastal salt marshes where tides act as a filter for non-resident species (as shown for example in Pétillon et al. 2004, 2010a, 2010b). In Europe, there were several studies on salt-marsh spiders, mainly in France, UK, Belgium and Germany (e.g. Ford et al. 2017, Baert & Maelfait 1999, Irmler et al. 2002). From the Pannonian biogeographical region, spiders of these habitat types were studied in Hungary (Szita et al. 1998a, 1998b, 1999, Dudás et al. 2001), Austria (Zulka et al. 1997), and at the border between Hungary and Romania (Lőrinczi et al. 2011). Only a few spider records are known from these habitats from Slovakia (Svatoň 1981, Jedličková 1988, Buchar 1999, Gajdoš 2010).

Generally, Pannonic inland salt marshes and steppes are highly influenced by the Pannonian climate with its extreme temperatures and arid summers. The enrichment of salt in the soil is due to intense evaporation of groundwater during the summer. These habitats are mostly of natural origin and partly influenced by grazing and drainage. The formation and evolution of lowland salty areas shows considerable variation in both space and time. This is strongly reflected in the present diverse morphology of salty areas – a result of the mutual effects of pedological, climatological and hydrogeological conditions (Šefferová & Stanová et al. 2008). In Europe, they are found in only a few countries in the Pannonian basin, with the largest and most diverse area in the Hortobágy in Hungary (EUNIS 2023). In Slovakia, they represent its northern enclave and are located in the Danube plain (Dítě et al. 2021). As a result of water regulation and changes in the use of the landscape since the 1960s, their area has been reduced to only 6 % (approx. 500 ha) of its previous total area (Sádovský et al. 2004, Šefferová & Stanová et al. 2008). Although only fragments remain, each of these has been declared a protected area included in the Natura 2000 framework. In recent years, they have begun to be restored by grazing, but due to the fragmentation and degradation of the vegetation, only a few sites have a high level of naturalness comparable to the sites in Hortobágy (Fehér 2017, Dítě et al. 2021).

The inventory of communities of ground-active spiders of inland salt marshes and salt steppes (habitat codes 1340, 1530) in Podunajská nížina lowland was part of the Vega Project "Research of specific landscape elements of biocultural landscape in Slovakia", which was undertaken after restoration of priority habitats (2011–2017; LIFE10 NAT/SK/000083 "Restoration of endemic Pannonic salt marshes and sand dunes in Southern Slovakia").

The study sites were located in nine protected salt marshes included in the Natura 2000 framework. In the period 2016–2019, we collected about 10,000 individuals of spiders. Initial results revealed six species new for our fauna (Gajdoš et al. 2019). The most interesting records of rare spider species are summarized here, including the discovery of three new species for the Slovak fauna: *Ozyptila sanctuaria* (O. Pickard-Cambridge, 1871) *Dactylopisthes digiticeps* (Simon, 1881) and *Pardosa tenuipes* L. Koch, 1882. The main goal of the project,

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based on the occurrence of rare and threatened species, was to evaluate whether the investigated Pannonian salt marshes can be islands of high biodiversity within intensively used agricultural landscapes.

Material and methods

Spiders were sampled over a period of three years by pitfall trapping using five traps in one transect per single study plot. The first transect was installed at the end of 2016 (September to November) only in Bokrošské slanisko. In 2017–18 (from 3. Mar. 2017 to 15. Mar. 2018) we ran 45 pitfall traps in nine study plots (five Natura 2000 sites, Fig. 1) and in 2018–19 (Mar. 2018 to Apr. 2019) 35 pitfall traps in 7 study plots (four Natura 2000 sites, Fig. 1). The traps consisted of a plastic flower pot creating a hole in the ground, into which was fitted a removable plastic jar (diam. 11 cm) with the 4% formaldehyde solution. They were exposed throughout the whole year, also in the winter period. Specimens were identified to species level whenever possible following Nentwig et al. (2023) using the nomenclature in the WSC (2023). The importance of the localities was assessed based on the occurrence of species listed in Slovakian Red List (Gajdoš & Svatoň 2001) (Tab. 1). The list also included potentially rare species that are new to the Slovak fauna (new) and other rare species (R) with a very small area of distribution in Slovakia which were documented from Slovakia only in the last decade (i.e. after the publication of the Slovakian Red list in 2001).

Microphotographs were taken using a stereomicroscope Leica DVM6, Olympus SZX16, Nikon SMZ18 and iPhone 13mini connected to a Meopta microscope using reflected light. Digital images were combined with Zerene Stacker v. 1.04 and measurements were taken using AxioVision v. 4.6. The specimens collected by P. Gajdoš were deposited in 70% ethanol in the collection of the Institute of Landscape Ecology SAS in Nitra.

Characteristics of study area

The study sites were situated on Panonnic salt steppes, salt marshes (code 1530) and inland salt meadows (code 1340). The ground-active spider communities were investigated in nine study areas localized at eight Natura 2000 sites (Figs 1, 2):

Bokrošské slanisko saltmarsh (1340) – (47.7489°N, 18.2569°E, 110 m a.s.l., 10.2 ha). Remnants of the northernmost projections of Hungarian salt puztas. Saline vegetation is found only on a very small part of the site, usually in terrain depressions. The salt marshes are negatively affected by the nearby landfill.

Kamenínske slaniská saltmarshes (1340, 1530) – (47.8787°N, 18.6442°E, 110 m a.s.l., 119.44 ha). One of the largest salt meadows in Slovakia. The Pannonian endemic *Limonium hungaricum* Klokov and other protected flora species can be found here. The area is negatively affected by overgrowth of shrubs and non-native trees (black locust, ash) and drying of the soil. Study plot was in the Čistiny Nature Reserve.

Panské lúky meadows (1340, 1530) – (48.1028°N, 18.0397°E, 116 m a.s.l., 68.71 ha). The most extensive and best-preserved Pannonic salt marsh habitats in Slovakia.

Panské lúky meadows – Ráczovo jazierko (Rácz's pond) (1530) – (48.0951°N, 18.0517°E, 112 m a.s.l., 1 ha). Salt marsh near the pond with reeds. It is the only known locality of the rare halophyte *Crypsis aculeata* (L.) Aiton in Slovakia. It represents only a small part of the area of Panské lúky, but it is one of the most important localities of the Pannonic salt marshes in Slovakia.

Šurianske slaniská saltmarshes (1340) – (48.0810°N, 18.122304°E, 119 m a.s.l., 169.38 ha). Well-preserved salt marsh with typical "saline eyes", periodical pools and depressions. It is a mosaic of salt steppes, meadows and marshes, and an extensively managed hay meadow. *Cirsium brachycephalum*

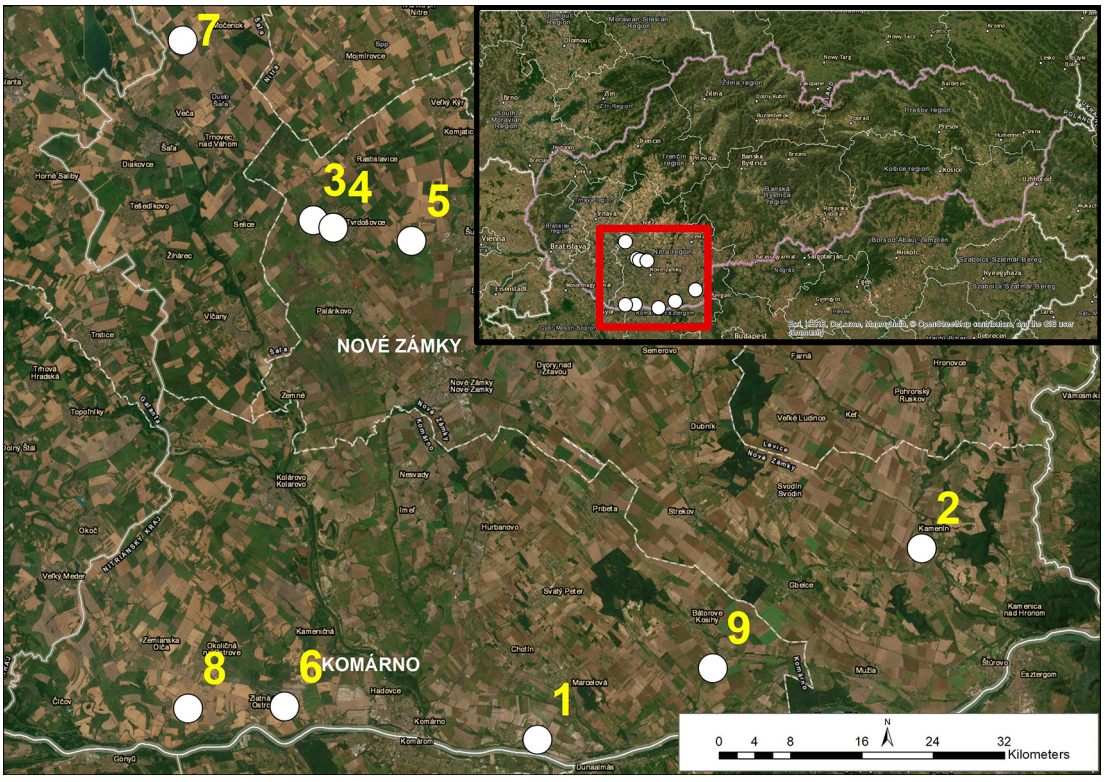

Fig. 1: Nine studied localities of the Pannonic salt marshes. **1.** Bokrošské slanisko; **2.** Kamenínske slaniská; **3.** Panské lúky; **4.** Panské lúky – Ráczovo jazierko; **5.** Šurianské slaniská; **6.** Pavelské slanisko; **7.** Síky; **8.** Mostové, **9.** Búčske slanisko (author: J. Černecký)

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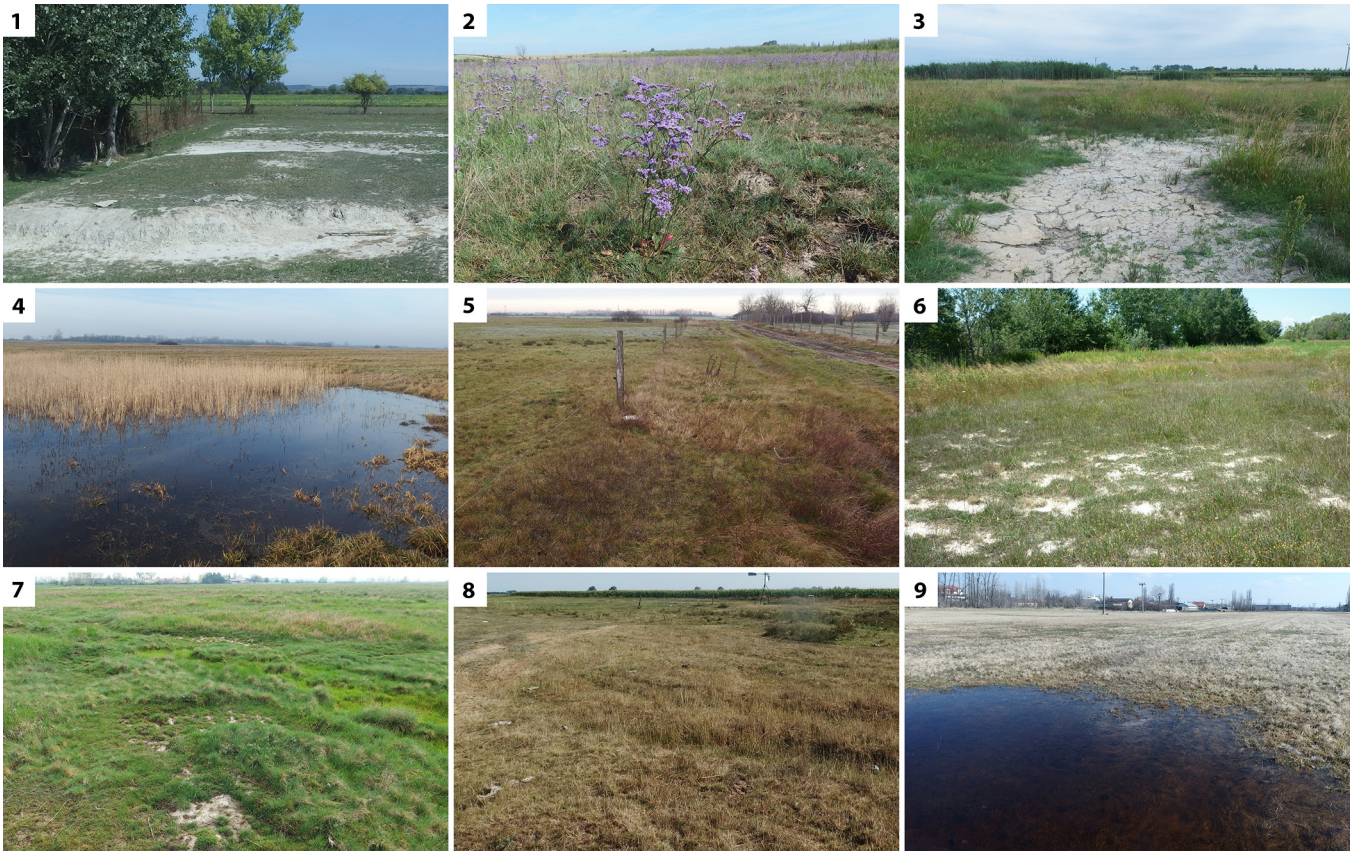

Fig. 2: Habitat photos. **1.** Bokrošské slanisko; **2.** Kamenínske slaniská; **3.** Panské lúky; **4.** Panské lúky – Ráczovo jazierko; **5.** Šurianské slaniská; **6.** Pavelské slanisko; **7.** Síky; **8.** Mostové; **9.** Búčske slanisko (photos: O. Majzlan)

Juratzka and other protected plant species are found here. The site is surrounded by intensively managed agricultural land. Study plot was in the part Akomáň.

Pavelské slanisko saltmarsh (1340) (47.7715°N, 18.0019°E, 109 m a.s.l., 18.48 ha). Salt marshes of steppe character. From one side overgrown by reed, willows, and poplars. It used to be one of the better-preserved saltmarshes, but the area has been significantly disturbed by ploughing.

Síky (1340, 1530) (48.2214°N, 17.8981°E, 120 m a.s.l., 40.17 ha) – Western Pontic, saltmarsh sandspurrey with *Plantago tenuiflora* Waldst. et Kit. and wall barley (largest population in Slovakia). One of the best-preserved salt marshes, managed long-term as pastures in Slovakia.

Mostové (1340) (47.7689°N, 17.9050°E, 110 m a.s.l., 22.50 ha) – A site of western Pontic steppe character, soil layers typical for undisturbed salt marshes. Halophytic vegetation of steppe character, e.g. *Lythrum tribracteatum* Salzm. ex Spreng (one of two sites in Slovakia). "Saline eyes" occur at the site without vegetation. It is negatively affected by gradual desalination and invasive plant species from the surrounding intensively used agricultural land.

Búčske slanisko saltmarsh (1340) (47.7928°N, 18.4250°E, 114 m a.s.l., 44.60 ha) – halophyte vegetation of steppe character; geese used to graze here in the past. It is the habitat of *Apium repens* (Jacq.).

Results and discussion

During the research period 2016–2019, we recorded 220 spider species belonging to 24 families (9701 ex.), which represents almost 22% of the Slovak araneofauna. Our results indicated that salt marshes are not only important for their high species richness, but also because they are inhabited by many rarely recorded and endangered species. We revealed the occurrence of 28 threatened and 18 potentially threatened species listed in the Red list of Slovakia (Gajdoš & Svatoň 2001). Another 11 faunistically important species were documented from Slovakia only recently, six of them from salt marshes (Gajdoš et al. 2019). We also collected three new species for the Slovak fauna (*Dactylopisthes digiticeps*, *Ozyptila sanctuaria* and *Pardosa tenuipes*). It is likely that the species *P. tenuipes* was merely overlooked and confused with *P. proxima* (C. L. Koch 1847) in Slovakia in the past. Therefore, a revision of historical collections of *P. proxima* is necessary.

In wet habitats, *Pardosa tenuipes* L. Koch, 1882 was the most abundant. This species has also been found in surrounding countries such as Czechia (Řezáč & Rothová 2021), Austria and Hungary (Isaia et al. 2018). In drier habitats *Alopecosa mariae* (Dahl, 1908) was abundant, which is typical of xerothermic forest-steppe habitats (Buchar & Růžička 2002). Open habitats and "salty eyes" without vegetation were abundantly inhabited by *Micaria albovittata* (Lucas, 1846), which is known from Slovakia from only a few localities (Gajdoš et al. 1999, Svatoň & Gajdoš 2008, Svatoň et al. 2009). Faunistically important is also the finding of *Micaria rossica* Thorell, 1875, which was reported from only one locality in the Malá Fatra (Svatoň 1983, 1984). The recently published species *Gnaphosa rufula* (L. Koch, 1866) from Slovakia (Gajdoš et al. 2019) was found so far only in the Bokroš saltmarsh.

According to Zulka et al. (1997), we recorded three halophilic species, *Crustulina sticta* (O. Pickard-Cambridge, 1861), *Zelotes mundus* (Kulczyński, 1897) and *Argenna patula* (Simon, 1874). Interestingly, *Z. mundus* has also recently

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been reported from salt marshes on the Atlantic coast of southwestern France (Ridel et al. 2021). Two other species, *Metopobactrus deserticola* Loksa, 1981 (endemic of the Pannonian region) and *Gnaphosa rufula*, can be included in this group because they show a strong association to xerothermic saline habitats (Gajdoš et al. 2019). The species *Zodarion italicum* (Canestrini, 1868), only recently published for the first time from Slovakia (Gajdoš et al. 2023), shows spreading tendencies in Europe, therefore we expect its expansion in Slovakia as well. New findings near the railway line at the locality Panské lúky may indicate its spread. Another expanding species is *Zelotes tenuis* (L. Koch, 1866), firstly reported from salt marshes (Gajdoš et al. 2019). Currently it is known from several anthropogenic localities, e.g. landfill in Vrakuňa (Gajdoš et al. 2023). Both these expanding species are considered as vagrant for Pannonic salt marshes.

Overall, the rare and endangered species found represent a wide spectrum of species tied to different habitat types, which are related to the humidity, light conditions and the mosaic-like character of these habitats. Spiders occurred in the xerothermic open salty pans without vegetation, through to parts with sparse vegetation, grasslands and also more humid habitats with reed stands.

New records for Slovakia

Linyphiidae

Dactylopisthes digiticeps (Simon, 1881) (Figs 3-4)

Material. SLOVAKIA: Ráczovo jazierko: salt pans on salt marsh 22. Mar. – 28. Apr. 2018, 2 ♂♂; 28. Apr. – 3. May 2018, 3 ♂♂; 16. – 25. May 2018, 2 ♂♂; 25. May – 15. Jun. 2018, 2 ♂♂; 20. Jun. – 2. Jul. 2018, 1 ♂ (leg. P. Gajdoš, P. Purgat).

Diagnosis. It is similar to the genus *Savignia*, but can be identified by the position of trichobothria on metatarsus IV 0.50–0.59; males have half of the nose-shaped projection curved above the head, and palp with large sickle-shaped tibial apophysis, female epigyne with medial septum (Nentwig et al. 2023).

Measurements. Male. Body length 1.53 mm (1.66 mm with head projection). Carapace length 0.67 mm (0.8 mm with head projection), width 0.57 mm. Opisthosoma length 0.91 mm, width 0.62 mm.

Distribution. France, Austria, south-eastern Europe, Türkiye, Ukraine, Russia (Europe), Israel, Iran, Afghanistan (WSC 2023) and now Slovakia.

Habitat. In swampy areas and vegetation near water (Nentwig et al. 2023). It probably belongs to photophilic-hygrophilous and thermophilic species (Weiss & Schneider 1996). It is

Tab. 1: List of significant species from the conservation biology point of view (listed in Gajdoš & Svatoň 2001), rare species (R, not listed in Gajdoš & Svatoň 2001) and species new to the Slovak fauna (new), CR – critically, EN – endangered, EX – extinct, R – rare, RL – Red List, VU – vulnerable, *halophilic species

RL	Species / Localities	1	2	3	4	5	6	7	8	9
EX	**Argenna patula* (Simon, 1874)				2					
CR	*Clubiona juvenis* Simon, 1878			2						
CR	**Crustulina sticta* (O. P.-Cambridge, 1861)		4	1			1			
CR	*Dolomedes plantarius* (Clerck, 1757)		1				1			
CR	*Haplodrassus moderatus* (Kulczyński, 1897)		1							
CR	*Lessertia dentichelis* (Simon, 1884)		4				2			
CR	*Micaria rossica* Thorell, 1875	1								
CR	*Trichoncoides piscator* (Simon, 1884)			1				2	11	
CR	*Trichopternoides thorelli* (Westring, 1861)									1
CR	*Zelotes exiguus* (Müller & Schenkel, 1895)			2						
EN	*Agroeca lusatica* (L. Koch, 1875)							11		
EN	*Agyneta conigera* (O. P.-Cambridge, 1863)				1					
EN	*Civizelotes pygmaeus* (Miller, 1943)	1								
EN	*Micaria albovittata* (Lucas, 1846)	3		5	2	10	2	42	40	
EN	*Micaria guttulata* (C. L. Koch, 1839)	1		1						
EN	*Palliduphantes pillichi* (Kulczyński, 1915)	1	7				1			
EN	*Sintula spiniger* (Balogh, 1935)	1	1							
EN	*Zelotes segrex* (Simon, 1878)						6			
EN	*Zora armillata* Simon, 1878		1							
VU	*Agyneta simplicitarsis* (Simon, 1884)		9			3	6	6	1	
VU	*Attulus distinguendus* (Simon, 1868)	6	4	1	4					
VU	*Attulus dzieduszycki* (L. Koch, 1870)	16	11				6			
VU	*Euryopis quinqueguttata* Thorell, 1875	1	2							2
VU	*Geolycosa vultuosa* (C. L. Koch, 1838)	1							16	
VU	*Haplodrassus minor* (O. P.-Cambridge, 1879)	7		7	4	3	9	3	14	9
VU	*Mastigusa arietina* (Thorell, 1871)			1						
VU	*Syedra myrmicarum* (Kulczyński, 1882)	4	1							
VU	*Zelotes aeneus* (Simon, 1878)			2						
	Number of threatened species	**12**	**12**	**10**	**5**	**3**	**9**	**5**	**5**	**3**
LC	*Alopecosa mariae* (Dahl, 1908)	17	1	14		6	1	80	76	100
LC	*Civizelotes gracilis* (Canestrini, 1868)	6	1	1	1	1	16	4	17	10

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RL	Species / Localities	1	2	3	4	5	6	7	8	9
LC	*Lasaeola coracina* (C. L. Koch, 1837)	3								
LC	*Phaeocedus braccatus* (L. Koch, 1866)		2			1		5		
LC	*Zelotes longipes* (L. Koch, 1866)	1	5	56		12	2	48	36	8
NT	*Attulus saltator* (O. P.-Cambridge, 1868)	2								
NT	*Erigonoplus globipes* (L. Koch, 1872)	1								
NT	*Haplodrassus dalmatensis* (L. Koch, 1866)			1					45	
NT	*Metopobactrus ascitus* (Kulczyński, 1894)			4						
NT	*Micaria nivosa* L. Koch, 1866							1		2
NT	*Mioxena blanda* (Simon, 1884)	1							5	
NT	*Pelecopsis parallela* (Wider, 1834)		1							
DD	*Cheiracanthium campestre* Lohmander, 1944	1						1		
DD	*Mecopisthes peusi* Wunderlich, 1972		1							
DD	*Pocadicnemis juncea* Locket & Millidge, 1953		1							4
DD	*Silometopus bonessi* Casemir, 1970							1		1
DD	*Syedra apetlonensis* Wunderlich, 1992	3						21	25	
DD	*Talavera aperta* Miller, 1971	1	2							
	Number of potentially threatened species	**10**	**8**	**5**	**1**	**4**	**3**	**8**	**6**	**6**
R	*Clubiona pseudoneglecta* Wunderlich, 1994							1		
R	*Micaria coarctata* (Lucas, 1846)	1	1			1				
R	**Zelotes mundus* (Kulczyński, 1897)		1	1	16		3			
R	*Zora parallela* Simon, 1878	1				2				
R	**Gnaphosa rufula* (L. Koch, 1866)	94								
R	**Metopobactrus deserticola* Loksa, 1981	3	5	13		3				
R	*Pardosa maisa* Hippa & Mannila, 1982			1			1			
R	*Tallusia vindobonensis* (Kulczyński, 1898)	1		26						
R	*Theridion uhligi* Martin, 1974					1			2	
R	*Zelotes tenuis* (L. Koch, 1866)	6	1				2		4	
R	*Zodarion italicum* (Canestrini, 1868)	-	-	4	-	-	-	-	-	-
new	*Dactylopisthes digiticeps* (Simon 1881)				10					
new	*Ozyptila sanctuaria* (O. P.-Cambridge, 1871)								1	
new	*Pardosa tenuipes* L. Koch, 1882	80	16		259	1	119		4	
	Number of other very rare species	**7**	**5**	**5**	**3**	**5**	**4**	**1**	**4**	**0**
	Total number of captured threatened and rare specimens	**265**	**84**	**148**	**299**	**44**	**178**	**226**	**297**	**137**
	Total number of captured specimens	**1745**	**1537**	**885**	**378**	**951**	**2372**	**282**	**407**	**1144**
	Number of study plots at the study sites	**3**	**2**	**3**	**1**	**1**	**2**	**1**	**2**	**1**

questionable whether it is halophilic species, as a summary of many published findings indicates that its occurrence depends more on the marshy character of localities (e.g. Keer et al. 2010, Gajić & Grbić 2016, Bosmans et al. 2019, Lecigne 2021). However, according to Zulka (2001) it may be more widespread in inland saline habitats in central Europe. It was collected at several saline localities, such as the shore of a salt lake and saltmarsh in Austria (Kritscher 1958, Zulka 2001) and now in a saltmarsh in Slovakia. However, our study site was densely overgrown with reed.

Phenology. According to the data available so far, the maturing period of adult males falls in early summer (we recorded adult males between March and July), while females were found in April, June, and August (Weiss & Schneider 1996, Keer et al. 2010, Gajić & Grbić 2016, Bosmans et al. 2019, Lecigne 2021).

Red list. This species is not yet included in any Red List in Europe, but according to Gajić & Grbić (2016) it may be endangered in Serbia due to the high possibility of habitat loss.

Fig. 3: *Dactylopisthes digiticeps* male from Slovakia, prosoma, lateral view (photo A. Šestáková)

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Fig. 4: *Dactylopisthes digiticeps*, male, left palp, prolateral and ventral view (photo A. Šestáková)

Lycosidae

Pardosa tenuipes L. Koch, 1882 (Figs 5-8)

Material. SLOVAKIA: Bokrošské slaniská: 9. – 11. Apr. 2017, 16 ♂♂; 11. – 21. Apr. 2017, 31 ♂♂, 5 ♀♀; 5. – 16. May 2017, 4 ♂♂, 3 ♀♀; 28. Jun. – 17. Jul. 2017, 3 ♂♂, 2 ♀♀, 1 s.♂; 9. – 23. Jul. 2016, 1 ♀; 23. Jul. – 4. Aug. 2016, 1 ♀; 4. – 18. Sep. 2016, 1 ♀; 16. Nov. – 15. Dec. 2017, 2 s.♀; Kamenínske slaniská: 28. Jun. – 17. Jul. 2017, 3 ♂♂, 3 ♀♀, 1 s.♂; 16. Aug. – 22. Sep. 2017, 1 ♀, 2 s.♀; 13. Sep. – 18. Oct. 2017, 1 ♀, 1 s.♂, 2 juv.; 22. Sep. – 15. Oct. 2017, 1 s.♂; 16. Nov. – 15. Dec. 2017, 1 s.♂; Ráczovo jazierko: 22. Mar. – 28. Apr. 2018, 82 ♂♂, 23 ♀♀, 1 s.♂, 2 s.♀; 17. Apr. – 3. May 2018, 18 ♂♂, 2 ♀♀; 28. Apr. – 14. May 2018, 12 ♂♂, 17 ♀♀, 2 s.♀; 16. – 29. May 2018, 29 ♀♀; 25. May – 15. Jun. 2018, 4 ♂♂, 4 ♀♀, 25. May – 15. Jun. 2018, 2 ♂♂, 8 ♀♀; 20. Jun. – 2. Jul. 2018, 7 ♂♂, 5 ♀♀, 1 s.♀, 4 juv.; 5. – 20. Jul. 2018, 18 ♂♂, 11 ♀♀; Šuranske slaniská: 13. Sep. – 18. Oct. 2017, 1 s.♀; Pavelské slanisko: 30. Mar. – 11. Apr. 2017, 37 ♂♂, 5 ♀♀; 11. – 21. Apr. 2017, 3 ♂♂, 1 ♀; 21. Apr. – 16. May 2017, 2 ♂♂, 5 ♀♀; 16. – 26. May 2017, 2 ♀♀; 26. May – 12. Jun. 2017, 1 ♀; 8. – 28. Jun. 2017, 1 ♂, 1 ♀, 6 s.♂, 10 s.♀, 3 juv.; 12. – 28. Jun. 2017, 2 ♂♂, 1 ♀; 28. Jun. – 31. Jul. 2017, 6 ♂♂, 10 ♀♀. 2 juv.; 31. Jul. – 16. Aug. 2017, 1 ♂, 3 ♀♀, 2 juv.; 16. Aug. – 22. Sep. 2017, 3 juv.; 16. – 28. Aug. 2017, 2 ♀♀, 2 s.♀, 2 juv.; 13. Sep. – 18. Oct. 2017, 2 s.♀, 4 juv.; 18. Oct. – 16. Nov. 2017, 3 ♂♂, 1 ♀; 16. Nov. – 16. Dec. 2017, 1 s.♀; Mostové: 14. Feb. – 8. Apr. 2019, 1 ♀; 12. Apr. – 11. May 2018, 1 ♀; 23. Jun. – 20. Jul. 2018, 1 ♂; 20. Jul. – 8. Aug. 2018, 1 ♂; Virt: 9. – 21. Apr. 2017, 1 ♂ (leg. P. Gajdoš, P. Purgat).

Diagnosis. Identification of the species was based on Isaia et al. (2018). Males have on the opisthosoma ventrally dense pale hairs with dark sparse ones, dorsally longer dark hairs noticeable especially on the edge of opisthosoma. Legs have irregular long hairs. Embolus as in Isaia et al. (2018). Females similar to males. Slovakian specimens have three colour variants, the darkest one (Fig. 5) best fits the description by Isaia et al. (2018). Lighter transitional (Fig. 6) and very pale (Fig. 7) variants have significantly fewer dark hairs ventrally on opisthosoma, and more or less unbroken wider pale lateral bands on carapace. We did not observe any differences in the palp between variants or in cymbium length (as reported for *P. proxima poetica* Simon, 1876, Isaia et al. 2018).

Measurements. Male. Body length 4.09–4.61 mm. Carapace length 2.05–2.30 mm, width 1.59–1.79 mm. Opisthosoma length 2.04–2.31 mm, width 1.42–1.52 mm. Female. Body length 5.80–6.56 mm. Carapace length 2.20–3.00 mm, width 1.73–2.53 mm. Opisthosoma length 3.60–3.56 mm, width 2.74–2.92 mm.

Distribution. Austria, Belgium, France, Germany, Great Britain, Hungary, Italy, Netherlands, Portugal and Spain (Isaia et al. 2018, Nentwig et al. 2023) and now Slovakia.

Habitat. Meadows, wet meadows, fields, swampy areas around lakes and ponds (Isaia et al. 2018). In Slovakia, it was found in salt marshes.

Phenology. Adults occur mostly in spring (April and May). Males can be found from March to September (occasionally in November). Females occur from April to September (Spider and Harvestman Recording Scheme website 2023, Isaia et al. 2018). It is interesting that we collected the dark specimens in spring, and the paler and transitional forms were collected in summer and autumn. Whether the colour variants depend on the generation has not been tested.

Red List. Status in Europe is questionable, because it seems to be easily confused with *P. proxima*.

Thomisidae

Ozyptila sanctuaria (O. Pickard-Cambridge, 1871) (Figs 9-10)

Material. SLOVAKIA: Mostové: salt eyes on salt marsh, 1.–24. Oct. 2018, 1 ♂ (leg. P. Gajdoš, P. Purgat).

Diagnosis. Compared to other *Ozyptila* species from Europe this species is closely related to the Italian species *O. salustri* Wunderlich 2011, but in *O. sanctuaria* the tegular apophysis is pointed with a subterminal bulge (visible laterally, Fig. 6b). The basal-ventral outgrowth of the palpal tibia is visible after partial removal of the patella. Due to its covering by the patella, it can be easily overlooked, thus its identification value is questionable.

Measurements. Male. Body length 2.14 mm. Carapace length 1.09 mm, width 1.14 mm. Opisthosoma length 1.04 mm, width 1.24 mm.

Distribution. Europe and Türkiye (Nentwig et al. 2023) and now Slovakia.

Habitat. This species is local and generally scarce, but in suitable habitats may be more frequent. It is xerophilous and occurs in open habitats preferring dry, nutrient-poor grasslands and overgrowth, mostly with short dense vegetation, sometimes on dunes and heathlands (Isaia et al. 2007, Gregorič & Kuntner 2009, Lambrechts et al. 2015, Spider and Harvestman Recording Scheme website 2022). Since pitfall trapping is the prevailing collecting method, mostly males used to be recorded. It is a night stalker, and during the day it can be found under stones and at the base of vegetation (Isaia et al. 2007, Spider and Harvestman Recording Scheme website 2022).

Phenology. Adult males occur in March and from June to November, females can be found throughout the year, but more often in early summer (Spider and Harvestman Recording Scheme website 2022, Isaia et al. 2007, Nentwig et al. 2023).

Red list. This species is red listed in Belgium (Endangered) and Germany (Extremely Rare) (Milano et al. 2021).

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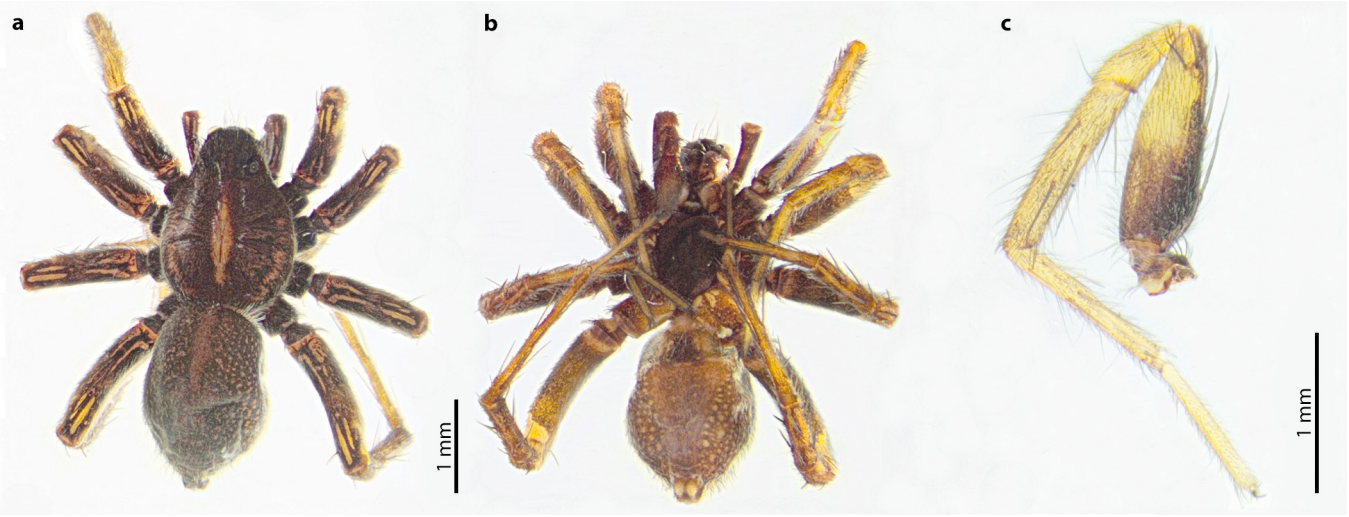

Fig. 5: *Pardosa tenuipes* male, dark-brown spring variant from Panské lúky – Ráczovo jazierko (Slovakia). **a.** dorsal view; **b.** ventral view; **c.** leg I, prolateral view (photo P. Purgat)

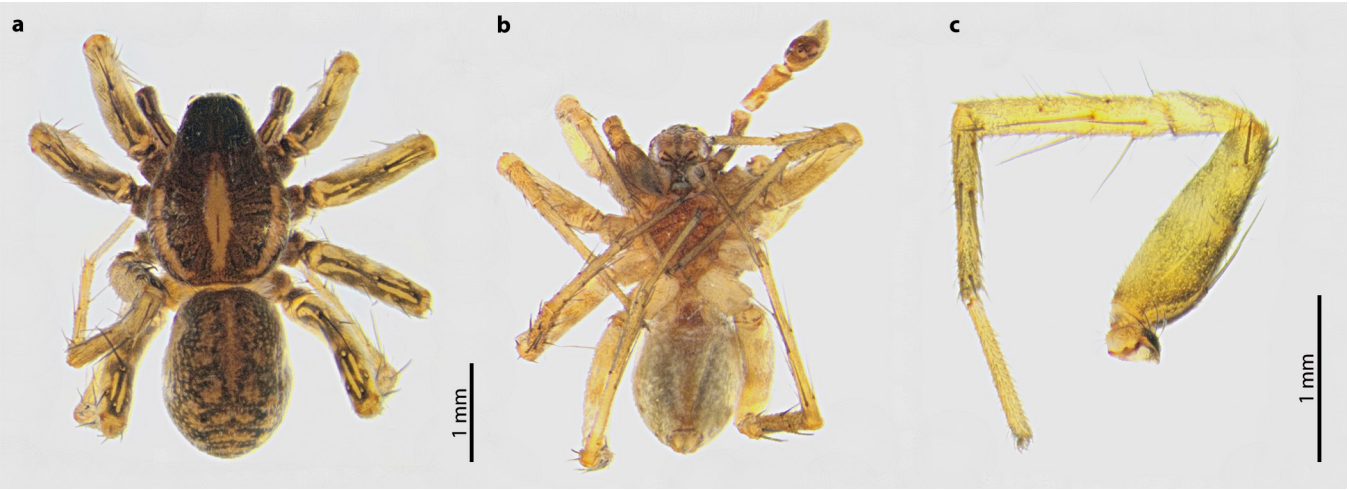

Fig. 6: *Pardosa tenuipes* male, transitional pale variant from Bokrošské slanisko (Slovakia). **a.** dorsal view; **b.** ventral view; **c.** leg I (photo P. Purgat)

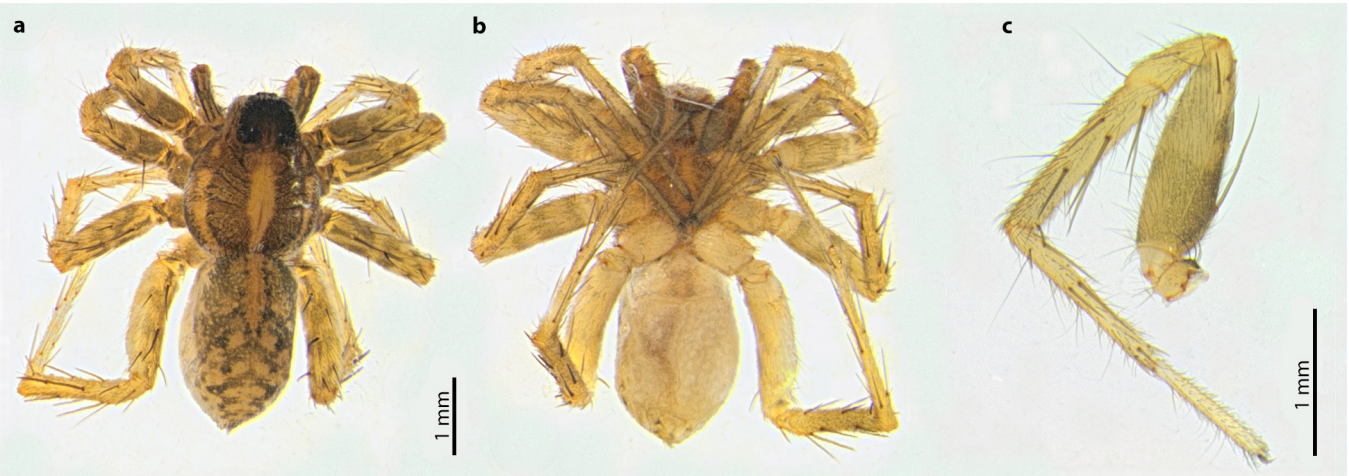

Fig. 7: *Pardosa tenuipes* male, pale summer and autumn variant from Pavelské slanisko (Slovakia). **a.** dorsal view; **b.** ventral view; **c.** leg I (photo P. Purgat)

Conclusion

Our research confirms the great importance of salt marshes and salt steppes in Slovakia as habitats with a specific composition of ground-active spider communities (presence of several rare halophilic spiders) with very high species richness. In total, we found 46 red listed species and 14 faunistically important species (three of them new for the Slovak fauna). In terms of biodiversity conservation, these habitats are located exclusively in intensely used agricultural landscapes of the Danube lowlands, therefore they are important refuge for biota including spiders (i.e., precious small islands in a sea of arable land). Although the legal protection of salt marshes is

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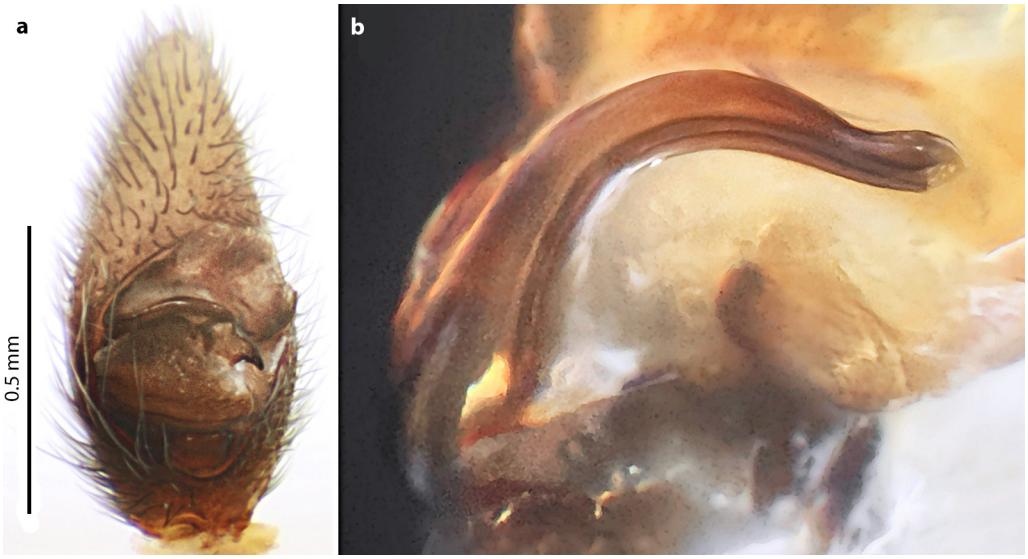

Fig. 8: *Pardosa tenuipes*, male palp. a. ventral view; b. detail of embolus after extraction (photo A. Šestáková)

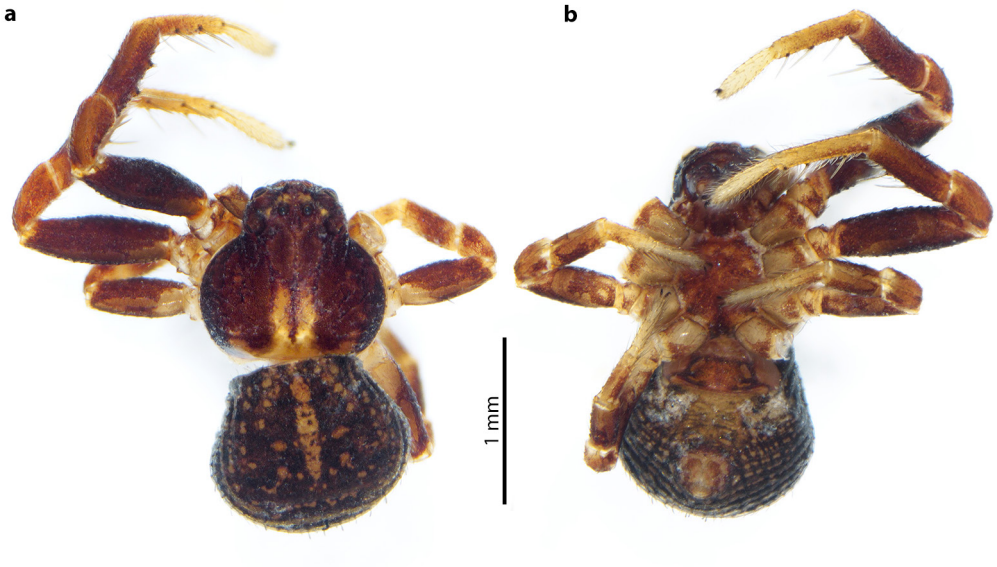

Fig. 9: *Ozyptila sanctuaria*, male from Slovakia. **a.** dorsal view; **b.** ventral view (photo A. Šestáková)

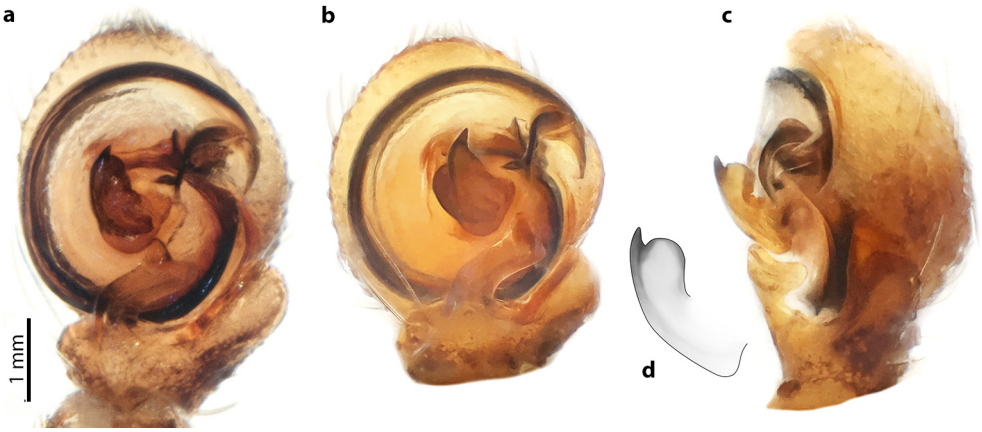

Fig. 10: *Ozyptila sanctuaria*, male left palp. **a.** ventro-lateral view; **b.** ventral view; **c.** retrolateral view; **d.** detail of tegular apophysis, retrolateral view. Scale is only for Fig. 10a (photo A. Šestáková)

substantial, that alone will not save them. Only active interventions, so-called ecological restoration, can help.

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