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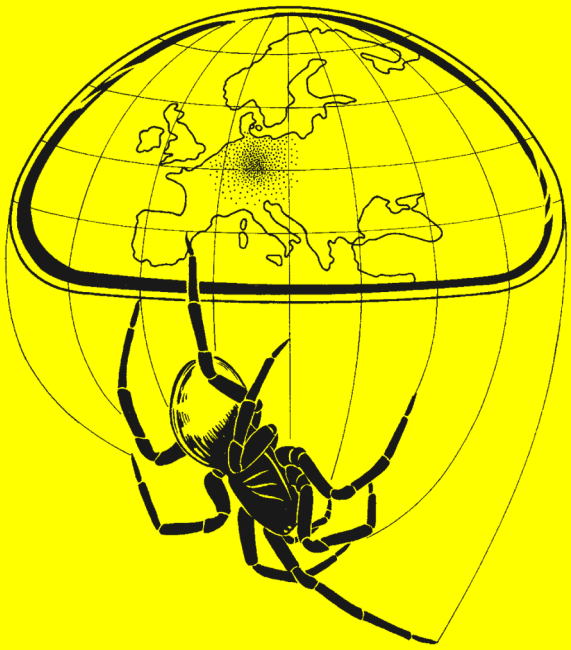

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First record from Italy of *Zatypota anomala* (Ichneumonidae, Ephialtini), a parasitoid of the cribellate spider *Dictyna pusilla* (Araneae, Dictynidae)

Stanislav Korenko

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Abstract. The polysphinctine wasp *Zatypota anomala* (Holmgren, 1860), a koinobiont ecto-parasitoid of spiders in the family Dictynidae, was recorded in Italy for the first time. Populations of both the wasp and its host, *Dictyna pusilla* Thorell, 1856, its host preference and the interaction between the parasitoid and the spider were documented in the field and by laboratory observations.

Keywords: ectoparasitoid, host parasitoid interaction, host range, host specialisation, spider web

Zusammenfassung. Erstnachweis von *Zatypota anomala* (Ichneumonidae, Ephialtini) für Italien, ein Parasitoid der cribellaten Spinne *Dictyna pusilla* (Araneae, Dictynidae). Die zu den Polysphinctinae gehörende Schlupfwespe *Zatypota anomala* (Holmgren, 1860), ein koinobionter Extoparasit von Spinnen der Familie Dictynidae, wurde erstmals für Italien nachgewiesen. Es werden Populationen der Wespe und ihres Wirtes, *Dictyna pusilla* Thorell, 1856, die Wirtspräferenz und Interaktionen zwischen Parasitoid und Spinne aus dem Freiland und dem Labor dokumentiert.

With 50 described species, the genus *Zatypota* comprises highly specialised koinobiont ecto-parasitoids of spiders and is the largest genus of the *Polysphincta*-group in the world (Gauld & Dubois 2006, Matsumoto & Takasuka 2010, Yu et al. 2012, Fritzén 2014). *Zatypota* probably includes as many species as in all other genera of the *Polysphincta* genus-group combined, and many undescribed species still exist in museum collections (e.g. Gauld & Dubois 2006). All *Zatypota* species are narrowly associated with a specific host spider species or a small group of closely related spider species. *Zatypota* wasps are mostly parasitoids of theridiid spiders (Nielsen 1923, Fitton et al. 1988, Gauld & Dubois 2006, Korenko & Pekár 2011, Korenko et al. 2011), but three *Zatypota* species are associated with spiders other than theridiids (Matsumoto & Takasuka 2010, Korenko et al. 2015, Vincent 1979).

Eight species from the genus *Zatypota* occur in Europe (de Jong et al. 2014, Fritzén 2010, 2014). Six of them – *Zatypota percontatoria* (Müller, 1776), *Z. bohemani* (Holmgren, 1860), *Z. discolor* (Holmgren, 1860), *Z. kerstinae* Fritzén, 2010, *Z. albicoxa* (Walker, 1874) and *Z. flamma* Fritzén, 2014) – are strictly associated with tangle web weavers from the family Theridiidae. *Zatypota percontatoria, Z. bohemani, Z. discolor* and *Z. kerstinae* are associated with spiders from the genus *Theridion*, or closely-related genera (e.g. *Phylloneta*, *Neottiura*) with similar habitus and behaviour (Fitton et al. 1987, 1988, Korenko et al. 2011, Korenko & Pekár 2011, Fritzén 2010, 2014). By contrast, *Z. albicoxa* and *Z. flamma* are associated with the genus *Parasteatoda* (e.g. Fitton et al. 1987, 1988, Fritzén 2014). *Zatypota picticollis* (Thomson, 1888) is associated with orb web weavers from the family Araneidae (Zwakhals 2006, Korenko et al. 2015), while the species studied here, *Zatypota anomala* (Holmgren, 1860), which is distributed across the Holarctic, is known to be associated with space web weavers from the family Dictynidae (Vincent 1979, Yu et al. 2012).

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The aim of this study was to analyse *Z. anomala* populations in the canopies of an ecological fruit orchard in northern Italy and to observe the interaction between the parasitoid larva and its spider host in the laboratory.

Material and methods

Web building spiders (Araneae, Orbicularia) and their ecto-parasitoids (Hymenoptera, Ichneumonidae, *Polysphincta* genus group) were collected from tree canopies (between 40 cm and 200 cm above ground) in an organic hazelnut orchard in Bottonasco (44°25'13.9"N 7°23'40.2"E, 642 m a.s.l.) in the province of Cuneo (Piedmonte region, northern Italy) on the 4th November 2009.

Spider hosts and parasitoids at the larval stage attached to them were collected by beating tree branches and catching the spiders in a square shaped beating net (1 m^2 area) placed beneath the tree crown. Three samples (each sample was collected by beating 30 trees) were taken and preserved in 70 % alcohol. The collected spiders were identified to genus level using Nentwig et al. (2017) and matched to species both on the basis of formerly known occurring species in the investigated localities (Isaia et al. 2010, Korenko unpubl. data) and by rearing the collected specimens to adulthood.

Live unparasitised and parasitized spiders were collected by the same method (described above) and reared in the laboratory. Parasitoid larvae were reared to imagines. Hatched wasps were identified using Fitton et al. (1988) and Zwakhals (2006). The nomenclature of the wasps follows Yu et al. (2012). Voucher specimens were deposited in the collection of the author and in the collection of Kees Zwakhals (Netherlands).

The web architecture of non-parasitised (n = 12) and parasitised (n = 44) spiders was studied by placing spiders individually in square glass experimental arenas (100 × 100 mm base, 130 mm height) with an installed tree twig that provided three-dimensional space for the spider's webbing. Spiders were kept at room temperature (22 ± 3 °C) under a natural L:D regime and fed with a surplus of *Drosophila* flies. The webs of both unparasitised and parasitised spiders were recorded using a Canon EOS 500D digital camera with an EF-S 18–55 mm lens or a macro EF 100 mm f/2,8L IS USM lens.

Results

Host community and incidence of parasitism. The family Dictynidae consisted almost exclusively of spiders of the genus *Dictyna* (reared adults identified as *D. pusilla*); only 1 % belonged to the genus *Nigma*. The space web weaver *D. pusilla* was one of the most abundant spider species in the investigated fruit orchard, representing 17.8 % of all collected spider individuals (from *n* = 1.069). The average incidence of parasitism of *D. pusilla* was 12 % (Tab. 1). The larvae were typically attached antero-dorsally close to the petiolus hidden between the abdomen and prosoma of the spider host. All parasitised spiders were juveniles with an average prosoma length of 0.64 mm (SD = 0.12, n = 44). Fifty-one percent of wasps reared in the laboratory reached the imaginal stadium. Mortality during ontogeny occured when the spider-hosts died (43 %), when the parasitoid died at the larval stage (33 %) and when the parasitoid died at the pupal stage (24 %). All parasitoid wasps reared from *D. pusilla* were *Zatypota anomala* (*n* = 22). The pupal stage in laboratory rearing lasted on average 11.9 days (SD = 1.39, n = 22). During this study, *Z. anomala* was recorded in Italy for the first time.

Reared material. Province of Cuneo: Bottonasco, organic hazel nut orchard (Cascina Rosa), larva attached to *Dictyna pusilla*, leg. 4.XI.2009 adult emerged 15.XII.2009–30.I.2010 (11 males, 11 females), leg. S. Korenko, det. K. Zwakhals & S. Korenko.

Fig. 1: Normal web of an unparasitised spider *Dictyna pusilla*. Arrow shows the typical spider resting position in the centre of the tangle.

Host parasitoid interaction. Unparasitised spiders built a typical cribellate (sticky) space web with a retreat formed from an aggregation of threads (Fig. 1). There was no observed modification of the spider web under the influence of the final stage parasitoid larva. Parasitized spiders took a position inside their retreat (100 %), where the larva killed the host, spun a cocoon, and pupated (Fig. 2). Cocoons were diaphanous, white, and sub-cylindrical, with a springy and very open construction of sparse loose whorls.

Discussion

The community of arboreal spiders in the studied fruit orchard was dominated by space web building spiders, and Dictynidae represented 17.8 % of all collected spiders. Dictynid spiders were relatively frequently parasitised by polysphinctine parasitoids (12 % average incidence of parasitism). The incidence of parasitism by polysphinctines among various spider species was mostly found to be low (often below 1–5 %) in Central Europe (Korenko et al. 2011), in Central America (Barrantes et al. 2008) and in Japan (Tanaka 2007), but several studies from northern Italy found relatively high parasitism rates, i.e. above 10 % (Korenko et al. 2014, 2015).

Zatypota anomala is known to be associated with cribellate tangle web weaving spiders belonging to the family Dictynidae (Aubert 1969). Vincent (1979) found this wasp to be associated with *Mallos pallidus* (Banks, 1904) in North America; and the species was repeatedly reared from *Dictyna* sp. and *D. pusilla* in Europe (Miller et al. 2013, this study). *Zatypota*

Tab. 1: Relative spider host abundance (Ab.), average incidence of parasitism (PR), and wasp species documented in the studied locality (Korenko et al. 2014, Korenko et al. 2015, Korenko unpubl. data, this study). Foraging guild classification follows Cardoso et al. (2011).

Host family	Foraging guild	n	Ab. (%)	PR (%)	Associated parasitoids
Araneidae	Orb web weavers	42	3,9	11	*Polysphincta tuberosa*, *P. boops*, *Zatypota picticollis*, *Sinarachna pallipes*
Tetragnathidae	Orb web weavers	12	1,1	0	
Dictynidae	Space web weavers	190	17,8	12	*Zatypota anomala*
Theridiidae	Space web weavers	611	57,2	4	*Zatypota percontatoria*
Linyphiidae	Sheet web weavers	2	0,2	0	
Mimetidae	Specialists	2	0,2	0	
Anyphaenidae	Hunters	52	4,9	0	
Clubionidae	Hunters	7	0,7	0	
Eutichuridae	Hunters	1	0,1	0	
Philodromidae	Hunters	139	13,0	0	
Salticidae	Hunters	1	0,1	0	
Thomisidae	Ambush hunters	10	0,9	0	
Total		**1069**	**100**	**5**	

Fig. 2: Web of a parasitised spider. Arrow shows wasp cocoon located at the spider's resting position.

anomala seems to be exclusively associated with the genus *Dictyna* in Europe (Miller et al. 2013, Gauld & Dubois 2006, Korenko unpubl. data, this study). A similarly narrow host specialisation can be found in *Z. kerstinae* known only from Finland, which is assumed to be associated only with *Theridion palmgreni* Marusik & Tsellarius, 1986 (Fritzén 2010). In contrast, *Zatypota percontatoria* attacks several closely related host species from the family Theridiidae (Korenko et al. 2011), while *Z. picticollis* from central and western Europe attacks three araneid species from three different genera, namely *Cyclosa conica* (Pallas, 1772), *Mangora acalypha* (Walckenaer, 1802) and *Zilla diodia* (Walckenaer, 1802) (Zwakhals 2006, Korenko et al. 2015).

Dictynids are cribellate spiders, i.e. spiders which use silk produced by a special silk spinning organ called the cribellum. Cribellate silk not only serves to capture prey, but could also protect the spider against predators or parasitoids. Presumable, *Zatypota anomala* developed a way to avoid this barrier and to use this silk mass for its own protection during the pupal stage. However, there is no other polysphinctine parasitoid which is known to be able to associate with any cribellate spider. The way in which *Zatypota albicoxa* lures the spider host, how it avoids being captured by the silk, and how it oviposits on the spider host hidden inside the tangle web was documented by Takasuka et al. (2009) and Takasuka & Matsumoto (2011). The related species *Z. albicoxa* decoys the spider out from its retreat by pulling on threads in such a way as to imitate prey captured on the edge of the web (Takasuka et al. 2009). This luring of the spider host, also called "ambush-style", would be expected in *Z. anomala*. Unfortunately, observation of oviposition by *Z. anomala* is missing and merits further investigation.

Zatypota species associated with space web weavers use the spider's innate 3D web as protection for their pupation. Some wasps are known to force their spider hosts to build an additional 3D structure and thereby to improve protection for wasp pupation (*Z. percontatoria* and *Z. discolor*) (Korenko & Pekár 2011, Korenko unpubl. data). Others, like *Z. kerstinae*, do not induce any changes in the host webbing (Fritzén pers. comm.). The studied species, *Z. anomala*, did not induce changes in web architecture, presumably because of the location of the parasitoid pupa inside the innate "sticky" space web of the *Dictyna* spider. The innate web of the dictynid host seems to provide sufficient protection for the parasitoid during its pupal stage, meaning that there is no reason to waste energy or resources on modifying it.

Acknowledgements

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Zodarion ohridense (Araneae: Zodariidae) – a new record for Central Europe

Tomáš Krejčí, Milan Řezáč & Tomáš Kadlec

doi: 10.5431/aramit5402

Abstract. *Zodarion ohridense* Wunderlich, 1973 was found to be introduced in an abandoned stone quarry near Kolín in the Czech Republic. The Central European species of *Zodarion* are discussed.

Keywords: Czech Republic, faunistics, introduced species, new record, quarry

Zusammenfassung. *Zodarion ohridense* (Araneae: Zodariidae) – ein Neunachweis für Mitteleuropa. *Zodarion ohridense* Wunderlich, 1973 wurde in einen aufgelassenen Steinbruch bei Kolín, Tschechische Republik, eingeschleppt. Die mitteleuropäischen *Zodarion*-Arten werden diskutiert.

The family Zodariidae comprises 1126 species in 84 genera. The most species-rich genus, *Zodarion*, comprises 158 species, 100 species of which occur in Europe (World Spider Catalog 2017). Representatives of *Zodarion* are obligatory ant-eaters (each species being specialized on a certain group of ants), shelter themselves in silken retreats camouflaged by soil particles and morphologically, chemically and behaviourally mimic ants (Pekár et al. 2005). The centre of the distribution area for this genus is the Mediterranean: so far only four species – *Zodarion germanicum* (C. L. Koch, 1837), *Zodarion hamatum* Wiehle, 1964, *Zodarion italicum* (Canestrini, 1868) and *Zodarion rubidum* Simon, 1914 – are known to extend into Central Europe (Nentwig et al. 2017). Here we present the record of a fifth species of *Zodarion* in Central Europe.

Material and methods

Zodarion ohridense Wunderlich, 1973. CZECH REPUBLIC, Elbe Lowland, Nová Ves I, 3 km northwest of Kolín, natural monument Lom u Nové Vsi (abandoned stone quarry), 50.0549°N, 15.1323°E (grid no. 5956), 220 m a.s.l., 1 male, pitfall trap, 1–30 June 2015, leg. Jiří Skala, det. Milan Řezáč & Tomáš Krejčí. The male was preserved in 75 % ethanol and photographed using a HIROX RH-2000 digital microscope. The material is deposited in the collection of the second author at the Crop Research Institute, Prague.

Results

Main morphological features. The male of *Zodarion ohridense* is characterised by the following morphological features (Bosmans 2009, Nentwig et al. 2017): Body length 2.5–3.2 mm. Prosoma (Fig. 1a) reddish brown, fovea and margin darker. Legs yellowish brown, femora dark brown. Opisthosoma dorsally dark sepia brown, ventrally with whitish oval spot. Palp (Fig. 1b, c) with rather short tibial apophysis, with broad base, terminally pointed; tegulum with angularity at base; median apophysis with two large prolateral teeth; embolus linear, with subterminal bend.

The colouration of *Z. ohridense* is very similar to *Z. germanicum*, *Z. italicum* and *Z. hamatum* but it is easy to distinguish these species according to the shape of the copulatory organs (Bosmans 1997, 2009). Only *Z. rubidum* distinctly differs in colouration from other species. It has a light brown prosoma and legs, and the opisthosoma is brown-violet (Bosmans 1997).

Natural history. *Zodarion ohridense* was described from the Ohrid region in Macedonia (Wunderlich 1973) and was considered an endemic species of the Balkan Peninsula. So far it is known from Croatia (Bosmans 2009), Bulgaria (Blagoev et al. 2001, Tzonev & Lazarov 2001, Deltshev 2004, Lazarov 2007), Greece (Bosmans 2009) and Macedonia (Komnenov 2002, 2003, Lazarov 2004, Bosmans 2009) (Fig. 2). In Macedonia it was found in the Shar Mountains (1200–1700 m) in *Acer* sp. and *Quercus cerris* forest and in *Picea abies* and *Fagus sylvatica* forests (Komnenov 2002) and in the Jakupica Mountains (1400–1900 m) on high mountain pastures or in *Fagus sylvatica* forests (Komnenov 2003). Deltshev (2004) found this species in southwestern Bulgaria in a *Pinus* forest (200–250 m). In Greece Bosmans (2009) found it in a riverine (430 m) and deciduous forest (600 m) and in grassland (1910 m).

Discussion

In Central Europe four species of the genus *Zodarion* have been found so far. The first, *Z. germanicum*, was described from Germany (Bosmans 1997) and is probably the only *Zodarion* species which can be considered an autochthonous component of the Central European fauna. The other three species are probably not native to Central Europe and because both ballooning ability and terrestrial migration are very low in *Zodarion* spiders, these species are believed to have been introduced into Central Europe via traffic (Bönsel et al. 2000, Pekár 2002, Pekár et al. 2005, Komposch 2009). The genus *Zodarion* is well preadapted for passive human transport thanks to its tolerance for dry environments and especially by attaching the silken shelters masked by soil particles (so-called igloos) to solid objects on the ground (Jocqué 1991). Spiders are thus transported with these objects and, if there are suitable conditions at their final destination, the spiders can establish new populations far from their continuous distribution area (Pekár 2002).

The most frequently found species in the vicinity of railways tracks is *Zodarion rubidum* (Pekár 2002). It was described from the south-eastern French Pyrenees (Simon 1914) and in 1971 it was found for the first time outside France, in central Austria (Wunderlich 1973). In 1979 this species

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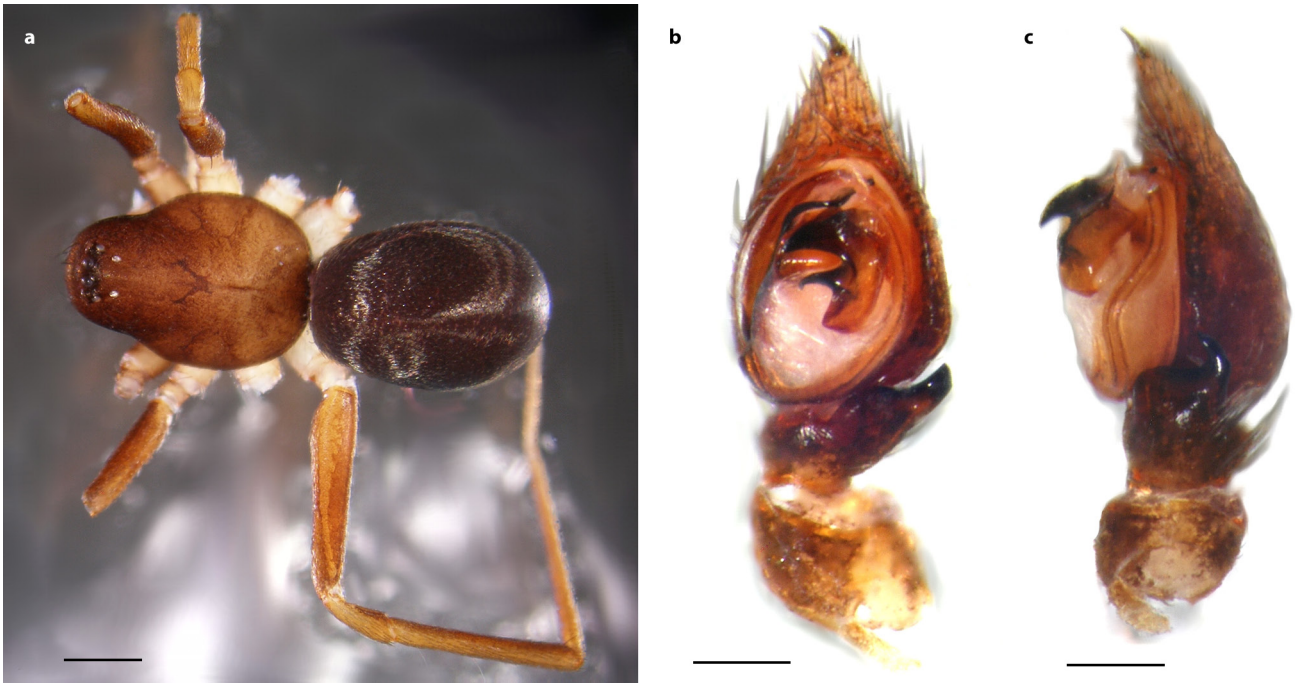

Fig. 1: *Zodarion ohridense* Wunderlich, 1973; **a.** Male, habitus, dorsal view; **b.** Male left palp, ventral view; **c.** Male left palp, retrolateral view. Scales: 500 µm (a), 100 µm (b, c)

was recorded in the Czech Republic (Kůrka 1981) and in the 1980s also in Germany (Broen & Moritz 1987, Renner 1992, Bosmans 1994), Belgium (Bara 1984, Hermanns & Bastin 1989, Couvreur 1990) and Spain (Bosmans 1994). Thereafter it has been spread across the other western, central and eastern European countries (Pekár 2002) up to the Baltic Sea in the north (Scharff et al. 2007) and Ukraine in the east (Fedoriak et al. 2010). It has been also introduced into the USA (Vogel 1968) and Canada (Paquin & Dupérré 2006).

Zodarion italicum and *Z. hamatum* are also often found close to railways (Horak & Kropf 1999, Pekár et al. 2005). *Zodarion hamatum* occurs in Italy, Slovenia and Croatia (Bosmans 1997) and in 1995 it was found for the first time in the southern part of Austria (Horak & Kropf 1999). *Zodarion italicum* was described from Italy (Canestrini 1868) from where it expanded into Western and Central Europe (Bosmans 1997). In the 1970s it was found in Germany (Misioch 1977) and in 2000 on the western boundary of the distribution area, in the Czech Republic (Řezáč 2002, Pekár et al. 2005). The distribution area of this species is still enlarging and nowadays it is also known from Spain, the Netherlands and Denmark (Nentwig et al. 2017). East European records from Bulgaria (Drensky 1936), Ukraine and Azerbaijan (Dunin 1984, Mikhailov 1997) are erroneous (Deltshev 1987, Bosmans pers. com.). It often occurs in abandoned stone quarries and sand pits (Harvey & Murphy 1985, Řezáč 2002, Heneberg & Řezáč 2014).

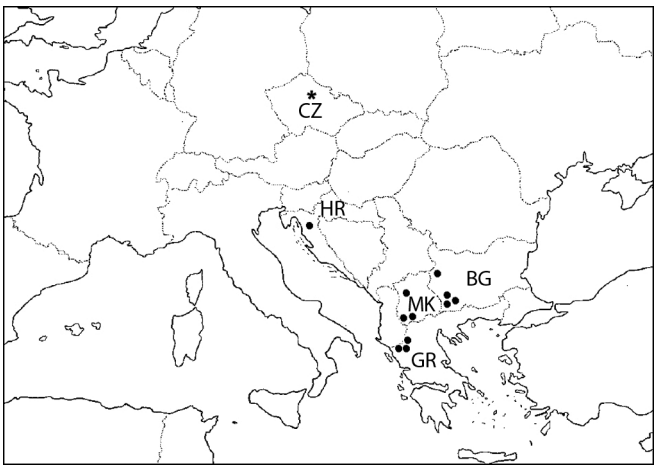

Fig. 2: Records of *Zodarion ohridense* Wunderlich, 1973. The new record is marked by asterisk. BG – Bulgaria, CZ – Czech Republic, GR – Greece, HR – Croatia, MK – Macedonia. Base map adopted from Bosmans (1997)

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First record of myrmecophyly in the scorpion *Birulatus israelensis* (Scorpiones: Buthidae)

Yoram Zvik

doi: 10.5431/aramit5404

Abstract. The buthid scorpion genus *Birulatus* Vachon, 1974 includes three species, endemic to the Levant, each from a different location in Jordan, Israel and Syria, and all described from a single specimen. Fewer than ten specimens of the genus were collected so far. Nothing is known regarding their biology and ecology. During three collecting expeditions in the summer of 2016 near Mehola in the Jordan Valley, Palestine, 31 individuals of *Birulatus israelensis* Lourenço, 2002 (Scorpiones: Buthidae) were collected, all found exclusively on active foraging trails of the ant species *Messor ebeninus* Santschi, 1927, around their nests or coming in and out of the nests. These findings suggest that *Birulatus* has a myrmecophilous relationship with *M. ebeninus* ants.

Keywords: Ants, Levant, *Messor*

Zusammenfassung: Erster Nachweis von Myrmekophilie beim Skorpion *Birulatus israelensis* (Scorpiones: Buthidae). Die Skorpiongattung *Birulatus* Vachon, 1974 (Buthidae) enthält drei in der Levante endemische Arten, die jeweils nach einem Einzelexemplar aus Jordanien, Israel und Syrien beschrieben sind. Nicht einmal 10 Exemplare der Gattung wurden bisher gesammelt und ihre Biologie und Ökologie ist unbekannt. Bei drei Sammelexpeditionen im Sommer 2016 nahe Mehola im Jordantal, Palästina, wurden 31 Exemplare von *Birulatus israelensis* Lourenço, 2002 (Scorpiones: Buthidae) gesammelt, alle ausschließlich gefangen an aktiven Futterstraßen der Ameisenart *Messor ebeninus* Santschi, 1927 im direkten Umfeld der Nester. Diese Funde legen nahe, dass *Birulatus* eine myrmekophile Beziehung zu *M. ebeninus* hat.

The buthid scorpion genus *Birulatus* Vachon, 1974 includes three species, all described from a single specimen (Vachon 1974, Lourenço 2002, Stathi & Lourenço 2003). Scorpions in this genus are characterized by their small size (~2 cm; Fig. 1). So far, all individuals were found only in the Levant. Vachon (1974) described *Birulatus haasi* Vachon, 1974 from a single female specimen collected in Schauback (Ash Shawbak), Jordan. Two more specimens of this species were recently collected (Amr et al. 2015).

Lourenço (2002) and Stathi & Lourenço (2003) described two more species of this genus: *B. israelensis* Lourenço, 2002, from north-eastern Israel, and *B. astartiae* Stathi & Lourenço, 2003 from Syria. In 2011, another female specimen of *B. israelensis* was collected in the Judean Desert, Palestine (Loria & Prendini 2014, Prendini pers. comm.).

During the summer and autumn of 2016, collecting expeditions to the area of Mehola in the Jordan Valley were conducted to find additional individuals of *Birulatus*. During these expeditions, 31 individuals were collected, all found exclusively on active foraging trails of the ant species *Messor ebeninus* Santschi, 1927 or around their nests. In at least six instances, scorpions were observed going in and out of the nest itself, disregarded by the ants. This report presents evidence that *Birulatus* may be myrmecophilous.

Methods

There were three expeditions during July, August and October 2016, each for two moonless nights and a total of six nights. The search was concentrated around Mehola, 14 km south of the town of Bét-She'an, in the Jordan valley, Israel. Long: 35.516 Lat: 32.365 (WGS84). The sites were between the altitudes of -200m to -50m. In the first expedition, six sites were checked around this location that appeared suitable for *Birulatus*. Each site (~250 m^2) was thoroughly searched after sunset by three or four people using ultraviolet flashlights. Twenty nests of the ant species *M. ebeninus* were subsequently marked by red & white tape attached to a nearby plant during daytime, and checked again after sunset (both around the nest and along the ant foraging trails). The more distant surroundings of the ant nests were searched as well.

Fig. 1: *Birulatus israelensis* Lourenço, 2002 (photo Rony Livne)

Ants were identified by Dr. Armin Ionescu of the Steinhardt Museum of Natural History, Tel Aviv University.

Scorpions were collected alive and maintained at ambient temperature. Dead scorpions where preserved in 96% ethanol. Identification was conducted using a dissecting microscope with the aid of taxonomic literature (Lourenço 1999, Lourenço 2002, Stathi & Lourenço 2003). Sex was determined by measuring the difference in the angle, position and length of the pectines between the sexes (Polis 1990, Stockmann & Ythier 2010) or by the presence of spermathecal plugs (Peretti 2010).

Results

Thirty-one scorpions were collected, all found along the foraging trails of *M. ebeninus* and around their nests between July and October 2016. The scorpions demonstrated the typical characters of the genus *Birulatus* as mentioned by Vachon (1974), Lourenço (1999), Lourenço (2002) and by Stathi & Lourenço (2003). They were morphologically similar to the *B. israelensis*, except with reduced lateral eyes, as observed previously by L. Prendini (pers. comm.) and Loria & Prendini (2014). Of the 31 individuals collected, three were males and 28 were females (1:9 ratio). Two of the 31 individuals collec-

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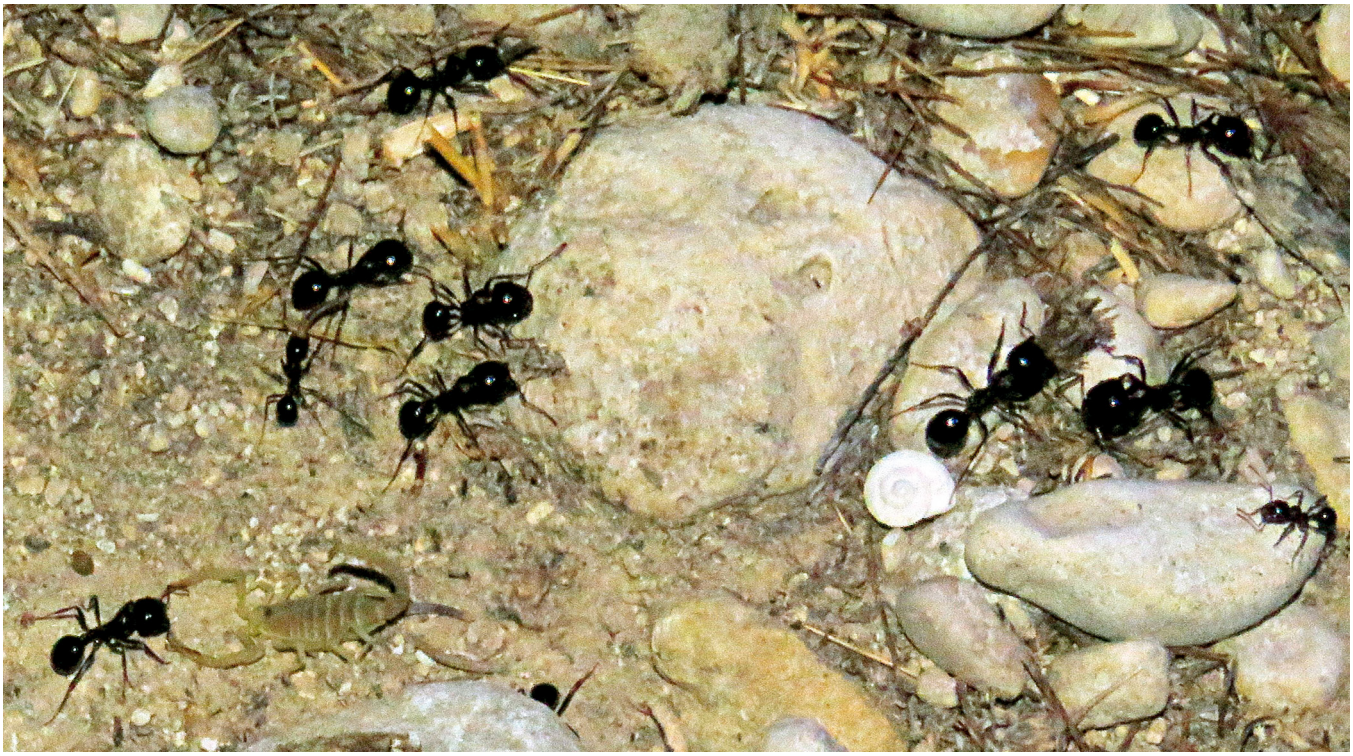

Fig. 2: *Birulatus israelensis* Lourenço, 2002 pauses on the ant trail and lets an ant examine it with her antennae (photo Yoram Zvik)

ted were immature under 1 cm long and the rest where subadults and adults with a maximum length of 2.1 cm (anterior carapace margin to tip of telson).

All individuals of *Birulatus* were found exclusively around *Messor ebeninus* nest openings, or on their active foraging trails, and demonstrated a unique behaviour of pausing and allowing the ants to check them frequently (Fig. 2). In at least six instances, scorpions were observed going in and out of the nest itself, disregarded by the ants. Beside scorpions of the genus *Birulatus*, six other scorpion species where found regardless the presence or absence of *Birulatus*: *Androctonus crassicauda* Olivier, 1807 (20 individuals), *Leiurus hebraeus* (Birula, 1908) (~300 individuals), *Compsobuthus schmiedeknechti* Vachon, 1949 (10 individuals), *Compsobuthus carmelitis* Levy, Amitai & Shulov, 1973 (6 individuals), *Scorpio palmatus* Ehrenberg, 1828 (~150 individuals) and *Nebo hierichonticus* Simon, 1872 (10 individuals). The scorpions from the different species observed in the field appeared to avoid close encounters with the ants, and in one case a young *L. hebraeus* that approached the nest was immediately attacked by the ants.

Of 20 ant nests observed, ten contained remains of dead *Birulatus* or parts of their exuvia, even at times when live specimens were not found around the nest. In two incidents, ants were observed carrying a dead, dry body of *Birulatus* out of the nest. Most of the scorpion remains were recovered from organized piles of dead ant bodies, suggesting that the ants treat the scorpions the same as they treat other nest member ants.

Discussion

These observations offer some primary evidence for a myrmecophilous relationship between *Birulatus* sp. and *Messor ebeninus*, the first such relationship ever recorded. During the field observations, no aggressive or negative interactions were observed between the *Birulatus* scorpions and the ants. The ants neither attack, nor serve as prey for the scorpions. How the scorpion avoids being attacked by the ants remains to be determined. Possible benefits to the scorpions from the relationship might include the following:

1. The *Messor* nest is a well-protected, environmentally-stable and resource-rich space, which may provide a suitable shelter (Kronauer & Pierce 2011). Large colonies provide a greater variety of microhabitats and can sustain larger and more stable populations of guests over longer time periods (Kronauer & Pierce 2011).
2. Ant colonies are well defended, so from the perspective of a myrmecophile, they provide an 'enemy free space' (Kronauer & Pierce 2011).
3. Colonies of *M. ebeninus* can persist for a long time, as some queen ants are known to live up to 30 years (Jemielity et al. 2005), perhaps offering a long-term environment for the scorpions. Although it is unlikely that individual *Birulatus* scorpions live for more than a few years, the possibility of successive generations cohabiting a single ant nest should be investigated.
4. Ant species with large colonies can harbour a high diversity of myrmecophiles (Pérez-Lachaud & Lachaud 2014), which in turn may serve as potential prey for the scorpions. The scorpions may also feed on the ant eggs and larvae as with some other myrmecophiles (Kronauer & Pierce 2011, Hölldobler & Wilson 1994).

Possible advantages to the ants from this relationship remain unclear, but perhaps the scorpions control the number of parasitic myrmecophiles or predators in the nest.

The observations described above suggest the existence of a positive interaction between *B. israelensis* scorpions and *M. ebeninus* ants. Further research is required to explore the nature of the relationship and whether other *Birulatus* species are also associated with ants or with other burrowing organisms.

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Further spider (Arachnida: Araneae) material deposited in the Agricultural Zoology Museum of Iran (AZMI), Iranian Research Institute of Plant Protection

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Abstract. The results of the examination of further spider material deposited in the Agricultural Zoology Museum of Iran, Iranian Research Institute of Plant Protection (Tehran, Iran), are reported, most of them from cereal fields and fruit orchards. A total of 634 specimens were studied, out of which, 106 species belonging to 70 genera and 27 families were identified. Five species are recorded for the fauna of Iran for the first time and documented by photos: *Brigittea civica* (Lucas, 1850) (Dictynidae), *Pardosa roscai* (Roewer, 1951) (Lycosidae), *Tetragnatha isidis* (Simon, 1880) (Tetragnathidae), *Trachyzelotes miniglossus* Levy, 2009 and *Zelotes tenuis* (L. Koch, 1866) (both Gnaphosidae). New provincial records are provided for additional 64 species. Earlier records of *Heliophaneus aeneus* (Hahn, 1832) in Iran are corrected to *Heliophanus flavipes* (Hahn, 1832) based on the re-examination of original material. Subsequently, *H. aeneus* has to be removed from the Iranian Checklist.

Keywords: fauna, Middle East, museum collection, new records, range extensions

Zusammenfassung. Weiteres Spinnenmaterial (Arachnida: Araneae) aus dem Agricultural Zoology Museum of Iran (AZMI), Iranian Research Institute of Plant Protection. Ergebnisse der Untersuchung weiteren Spinnenmaterials aus dem Agricultural Zoology Museum of Iran, Iranian Research Institute of Plant Protection (Tehran, Iran), werden vorgestellt, der Großteil von Getreidefeldern und Obstplantagen. Insgesamt wurden 634 Individuen aus 106 Arten, 70 Gattungen und 27 Familien bestimmt. Fünf Arten wurden erstmals für den Iran nachgewiesen und werden mithilfe von Fotos dokumentiert: *Brigittea civica* (Lucas, 1850) (Dictynidae), *Pardosa roscai* (Roewer, 1951) (Lycosidae), *Tetragnatha isidis* (Simon, 1880) (Tetragnathidae), *Trachyzelotes miniglossus* Levy, 2009 und *Zelotes tenuis* (L. Koch, 1866) (beide Gnaphosidae). Für weitere 64 Arten werden Neunachweise für iranische Provinzen vorgelegt. Frühere Nachweise von *Heliophanus aeneus* (Hahn, 1832) aus dem Iran stellten sich nach einer Untersuchung des Originalmaterials als fehlbestimmte Exemplare von *Heliophanus flavipes* (Hahn, 1832) heraus. *H. aeneus* muss dementsprechend von der iranischen Checkliste entfernt werden.

The department of Agricultural Zoology, Iranian Research Institute of Plant Protection houses a museum with collections of different groups of animals, including a collection of spiders. The collection was originally made by Fariba Mozaffarian in 1996 and was partly studied by the subsequent curators (e.g. Mozaffarian et al. 2000, Mozaffarian 2000, Mozaffarian & Tirgari 2000, Ghavami 2006). Further study was made by Zamani (2015), as a result of which, a total of 180 specimens, belonging to 25 families, 60 genera and 77 species was identified, including nine new species records for the fauna of Iran. In the present paper, we aim to report the results of an investigation on a larger bulk of the material deposited in this museum, which was not included in the previous studies. A total of 634 specimens were examined. A small portion of these specimens containing undetermined and undescribed species will be dealt with in future publications.

Material and methods

The collection was thoroughly revised between January and March 2017. The epigynes were removed, cleared and cleaned with 10 % KOH. Nomenclature and distribution information follow Zamani et al. (2017). Information on the previous Iranian records of the species (and not including the new provincial records) are mentioned as "Iranian provinces" (Fig. 1) and are based on Zamani et al. (2017). Taxonomic references with reliable illustrations were used for identification of the material, and are cited throughout the text for each species, but the full list of taxonomic references can be found at World Spider Catalog (2017). Collection data are given in as much detail as possible, but still, for some records even the year or province is unknown, or only the province is known (those studied specimens without any labels are not included in this paper, but deposited in the collection). Photographs were made using an Olympus SC100 camera attached to an Olympus SZ-61 stereomicroscope at the entomology lab of the Shiraz University of Medical Sciences. Depositories (including those for re-examined and comparative material) involve the following institutions and abbreviations: Agriculture Zoology Museum, Iranian Research Institute of Plant Protection (AZMI), Jalal Afshar Zoological Museum of University of Tehran (JAZM).

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List of species

Family Agelenidae C. L. Koch, 1837
***Agelescape gideoni* Levy, 1996**
Identification. Levy (1996)
Material. Tehran Province: 1♂ (AZMI), Shahriar, Andisheh, apple garden, 8 May 2001 (A. Bahramishad).
Distribution. Turkey to Iran. Iranian provinces: Alborz, Mazandaran and Tehran.

Family Araneidae Clerck, 1757
***Aculepeira talishia* (Zawadsky, 1902)**
Identification. Levi (1977)
Material. Tehran Province: 2♂♂2♀♀ (AZMI), Varjin Conserved Area, 35°55'30"N, 51°36'41"E, alt. 253 m. (F. Mozaffarian); Zanjan Province: 1♂3♀♀1j (AZMI), Khanchay, field by the river.
Distribution. Turkey, Russia, Georgia, Azerbaijan, Iran. Iranian provinces: Mazandaran and Azerbaijan-e Gharbi. Our new record from Tehran (southern slopes of Central Alborz Mountains) is the easternmost in the whole known range.

***Argiope bruennichi* (Scopoli, 1772)**
Identification. Bjørn (1997), Jäger (2012)

Fig. 1: Map of Iran with provincial boundaries

Material. Zanjan Province: 1♂ (AZMI), Abbar-Gilvan Rd.
Distribution. Palaearctic. Iranian provinces: Chahar Mahal & Bakhtiary, Azerbaijan-e Gharbi or Azerbaijan-e Sharghi, Fars, Gilan, Golestan, Mazandaran, Qazvin, Khorasan-e Razavi and Zanjan.

***Argiope lobata* (Pallas, 1772)**
Identification. Bjørn (1997), Jäger (2012)
Material. Yazd Province: 1♀ (with mating plug) (AZMI), Mehriz, pomegranate and citrus orchards.
Distribution. Old World. Iranian provinces: Ardabil, Fars, Kerman, Mazandaran, Khorasan-e Razavi, Khorasan-e Jonubi, Tehran and Zanjan.

***Hypsosinga pygmaea* (Sundevall, 1831)**
Identification. Levi (2002), Roberts (1995)
Material. Mazandaran Province: 1♀ (AZMI), surroundings of Amol, rice land, 21 July 1996 (F. Mozaffarian); Mazandaran Province: 2♀♀ (AZMI), surroundings of Amol, rice land, 21 July 1996 (F. Mozaffarian).
Distribution. Holarctic. Iranian provinces: Gilan, Golestan, Isfahan, Mazandaran and Zanjan.

***Larinioides cornutus* (Clerck, 1757)**
Identification. Šestáková et al. (2014)
Material. Zanjan Province: 1♀ (AZMI), Khanchay, field by the river.
Distribution. Holarctic. Iranian provinces: Golestan and Kerman.

***Leviellus caspicus* (Simon, 1889)**
Identification. Levi (1974)
Material. Tehran Province: 1♀ (AZMI), Tehran, Darband, October 1996 (F. Mozaffarian); Yazd Province: 1♀ (AZMI), Yazd, Taft, pomegranate orchard, 24 October 1998 (Ghayoomi, Jafari).
Distribution. Kazakhstan, Kyrgyzstan, Uzbekistan, Turkmenistan and Iran. Iranian provinces: Tehran. Our material from Yazd Province is the southernmost record in the whole known distribution range.

***Mangora acalypha* (Walckenaer, 1802)**
Identification. Levy (1987), Roberts (1995)
Material. Markazi Province: 25♀♀ (AZMI), Saveh, Yal Abad, pomegranate orchard, 19 April 1998 (F. Mozaffarian); Tehran Province: 1♀ (AZMI), Varamin, Yam village, pomegranate orchard (A. Bahramishad).
Distribution. West Palaearctic. Iranian provinces: Alborz, Gilan, Golestan, Mazandaran, Qazvin, Semnan and Tehran.

***Neoscona adianta* (Walckenaer, 1802)**
Identification. Ledoux (2008), Roberts (1995)
Material. Golestan Province: 1♀ (AZMI), Gonbad Kavoos, cotton field, summer 1999 (Khoramly).
Distribution. Palaearctic. Iranian provinces: Alborz, Ardebil, Gilan, Golestan, Isfahan, Kordestan, Mazandaran, Qazvin and Tehran.

***Neoscona subfusca* (C. L. Koch, 1837)**
Identification. Levy (1998)
Material. Yazd Province: 1♀ (AZMI), Mehriz, pomegranate and citrus orchards, 19 June 1998 (Ghayoomi, Jafari).
Distribution. Old World. Iranian provinces: Golestan, Kerman, Markazi and Mazandaran.

***Singa hamata* (Clerck, 1757)**
Identification. Roberts (1995)
Material. Mazandaran Province: 1 sub♀ (AZMI), surround-

ings of Tonekabon, rice land, 6 August 1996 (F. Mozaffarian); Mazandaran Province: 1♀ (AZMI), surroundings of Amol, rice land, 4 May 1996 (F. Mozaffarian).
Distribution. Palaearctic. Iranian provinces: Gilan.

Family Clubionidae Wagner, 1887
***Clubiona phragmitis* C. L. Koch, 1843**
Identification. Almquist (2006)
Material. Mazandaran Province: 1♂ (AZMI), surroundings of Tonekabon, rice land, 6 August 1996 (F. Mozaffarian).
Distribution. Palaearctic. Iranian provinces: Gilan and Mazandaran.

Family Corinnidae Karsch, 1880
***Castianeira arnoldii* Charitonov, 1946**
Identification. Marusik & Mikhailov (2010)
Material. Fars Province: 1♂ (AZMI), Shiraz, corn field, 19 June 2011; Markazi Province: 1♀ (AZMI), Saveh, Yal Abad, pomegranate orchard, 4 August 1999 (A. Bahramishad).
Distribution. Turkmenistan, Uzbekistan and Iran. Iranian provinces: Fars, Golestan, Markazi, Khorasan-e Razavi and Tehran.

Family Dictynidae O. Pickard-Cambridge, 1871
***Brigittea civica* (Lucas, 1850)** (Fig. 2)
Identification. Wiehle (1953: sub *Dictyna*)
Material. Fars Province: 1♀ (AZMI), Shiraz, olive orchard, 1999 (M. Fallahzadeh).
Distribution. Europe, North Africa, Turkey and North America. Iran: New record for the fauna, with our material representing its easternmost limit in the whole known range of distribution.

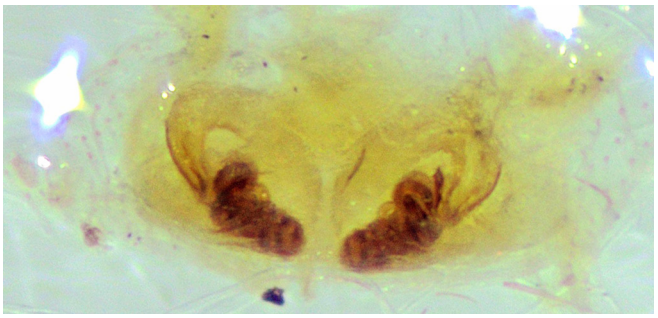


Fig. 2. *Brigittea civica*, dorsal view of vulva

Family Eresidae C. L. Koch, 1845
***Stegodyphus pacificus* Pocock, 1900**
Identification. Kraus & Kraus (1989)
Material. Markazi Province: 1j (AZMI), Saveh, Yal Abad, pomegranate orchard, 6 July 1999 (A. Bahramishad); Tehran Province: 2♂♂1♀ (AZMI), PPDRI park, autumn 2001 (A. Bahramishad); Tehran Province: 1♀ (AZMI), PPDRI park, 26 August 2000 (B. Habibian); Tehran Province: 3♀♀ (AZMI), PPDRI park, 23 September 2000; Tehran Province: 2♀♀ (AZMI), PPDRI park, 1999 (F. Mozaffarian); Tehran Province: 1♀ (AZMI), PPDRI park, 30 April 2000 (Cheraghian); Tehran Province: 6♀♀ (AZMI), PPDRI park, 5 August 2000 (A. Bahramishad).
Distribution. Jordan to India. Iranian provinces: Alborz, Gilan, Kerman, Qazvin, Khorasan-e Razavi, Khorasan-e Jonubi and Tehran.

Family Eutichuridae Lehtinen, 1967
***Cheiracanthium mildei* L. Koch, 1864**
Identification. Paquin & Dupérré (2003)
Material. Khorasan-e Razavi Province: 1♂1♀ (AZMI), Ferdows, pomegranate orchard, 30 May 1998 (Kamali); Semnan Province: 1♂ (AZMI), Shahrud, 12 May 2000; Azerbaijan-e Gharbi Province: 1♂ (AZMI), pome orchard, 24 May 1998 (A. Khalil Aria).
Distribution. West Palaearctic and Nearctic. Iranian provinces: Golestan, Kerman, Kohgiluyeh & Boyer-Ahmad and Tehran.

***Cheiracanthium pennyi* O. Pickard-Cambridge, 1873**
Identification. Almquist (2006)
Material. Alborz Province: 2♂♂ (AZMI), Mard Abad, Pol-e Ferdows, 8 May 2001 (A. Bahramishad); Tehran Province: 2♂♂1♀ (AZMI), Varamin, Yam village, pomegranate orchard, 8 May 2000 (F. Mozaffarian, A. Bahramishad).
Distribution. Palaearctic. Iranian provinces: Ardebil, Fars, Golestan, Khorasan-e Shomali, Khorasan-e Razavi, Semnan and Tehran.

Family Filistatidae Ausserer, 1867
***Zaitunia vahabzadehi* Zamani & Marusik, 2016**
Identification. Zamani & Marusik (2016)
Material. Tehran Province: 1♀ (AZMI), Velenjak, agricultural garden, 29 April 2001.
Distribution. This species was previously known only from the original description, from Tehran Province of Iran. This record is the northernmost in the known distribution range.

Family Gnaphosidae Pocock, 1898
***Drassodes lapidosus* (Walckenaer, 1802)**
Identification. Kovblyuk (2008), Roberts (1995)
Material. Semnan Province: 1♀ (AZMI), no further data available; Tehran Province: 1♂1♀ (AZMI), Velenjak, agricultural garden, 29 April 2001 (F. Mozaffarian).
Distribution. West and Central Palaearctic. Iranian provinces: Gilan, Azerbaijan-e Gharbi or Azerbaijan-e Sharghi, Gilan, Golestan, Kerman, Mazandaran, Khorasan-e Razavi and Tehran.

***Haplodrassus dalmatensis* (C. L. Koch, 1866)**
Identification. Lecigne (2016)
Material. Fars Province: 1♂3s♂♂1♀ (AZMI), Shiraz, corn field, 10 April 2011; Ilam Province: 1♂1j (AZMI), Shirvan, Chardavol, wheat field, 2 May 2001 (F. Mozaffarian).
Distribution. West Palaearctic. Iranian provinces: Khorasan-e Razavi, Semnan and Tehran.

***Nomisia conigera* (Spassky, 1941)**
Identification. Chatzaki (2010)
Material. Tehran Province: 1♀ (AZMI), Velenjak, agricultural garden, 29 April 2001 (F. Mozaffarian).
Distribution. Turkey to Tajikistan. Iranian provinces: Azerbaijan-e Sharghi or Azerbaijan-e Gharbi province. Our record is the southernmost known locality in the known distribution range.

***Nomisia ripariensis* (O. Pickard-Cambridge, 1872)**
Identification. Levy (1995)

Material. Tehran Province: 1♂ (AZMI), Varamin, Sharif Abad, Kolin village, wheat field, 8 May 2000 (A. Bahramishad, F. Mozaffarian)
Distribution. Greece to Iran. Iranian provinces: Golestan, Kerman, Mazandaran, Khorasan-e Razavi and Tehran.

***Talanites dunini* Platnick & Ovtsharenko, 1991**
Identification. Platnick & Ovtsharenko (1991)
Material. Markazi Province: 1♀ (AZMI), Saveh, Yal Abad, pomegranate orchard, 23 July 1999 (A. Bahramishad).
Distribution. Israel to Turkmenistan. Iranian provinces: Gilan and Mazandaran. This record is the southernmost in the known distribution range.

***Talanites fagei* Spassky, 1938**
Identification. Murphy (2007)
Material. Tehran Province: 3♂♂1♀ (AZMI), Jajrood, artificial wood, 28 May 2000 (Y. M. Marusik); Tehran Province: 1♀ (AZMI), Lavasanat, 12 August 2001 (A. Bahramishad).
Distribution. Southern Europe, Russia, Caucasus to Tajikistan and Iran. Iranian provinces: Khorasan-e Shomali and Khorasan-e Razavi.

***Trachyzelotes jaxartensis* (Kroneberg, 1875)**
Identification. Platnick & Murphy (1984), Zamani et al. (2016)
Material. Semnan Province: 1♀ (AZMI), Shahrud, 19 May 1999 (A. D. Shadmehri); Tehran Province: 1♀ (AZMI), PPDRI, inside building, 14 April 2001 (Gharaei); Tehran Province: 1♀ (AZMI), PPDRI, inside building, 11 April 2001 (F. Mozaffarian).
Distribution. Holarctic, Hawaii and South Africa. Iranian provinces: Mazandaran and Khorasan-e Razavi.

***Trachyzelotes miniglossus* Levy, 2009** (Fig. 3)
Identification. Levy (2009)
Material. Tehran Province: 1♀ (AZMI), Velenjak, agricultural garden, 29 April 2001 (F. Mozaffarian).
Distribution. Israel. Iran: New record for the fauna, with our material representing its easternmost limit in the whole known range.

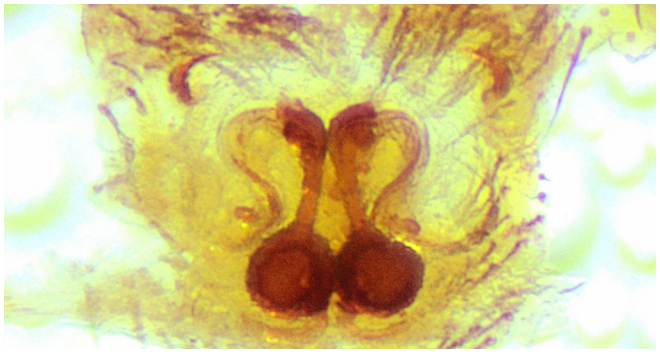


Fig. 3. *Trachyzelotes miniglossus*, dorsal view of vulva

***Zelotes longipes* (L. Koch, 1866)**
Identification. Almquist (2006), Marusik & Kovblyuk (2011)
Material. Mazandaran Province: 1♀ (AZMI), surroundings of Tonekabon, rice land, 19 August 1996 (F. Mozaffarian).
Distribution. Palaearctic. Iranian provinces: Gilan, Golestan, Isfahan, Markazi and Mazandaran.

***Zelotes tenuis* (L. Koch, 1866)** (Fig. 4)
Identification. Senglet (2011)
Material. Markazi Province: 1♀ (AZMI), Saveh, Yal Abad, pomegranate orchard, 4 August 1999 (A. Bahramishad); Markazi Province: 1♀ (AZMI), same locality, 6 June 1998 (F. Mozaffarian); Markazi Province: 1♀ (AZMI), same locality, 22 June 1998 (F. Mozaffarian); Tehran Province: 1♀ (AZMI), PPDRI, inside building, 1999 (F. Mozaffarian).
Distribution. Mediterranean to Ukraine, USA. Iran: New record for the fauna, with the material from Tehran representing its easternmost limit in the whole known range.

Fig. 4. *Zelotes tenuis*, dorsal view of vulva

Family Linyphiidae Blackwall, 1859
***Frontinellina frutetorum* (C. L. Koch, 1834)**
Identification. Bosmans (2006)
Material. Gilan Province: 3♀♀ (AZMI), Rasht, mulberry garden, summer of 2000 (Hasheminia).
Distribution. Palaearctic. Iranian provinces: Alborz, Gilan, Golestan, Ilam, Mazandaran, Khorasan-e Shomali, Qazvin, Tehran and Zanjan.

***Prinerigone vagans* (Audouin, 1826)**
Identification. Tanasevitch (1990: sub *Erigone*).
Material. Gilan Province: 1♂1♀ (AZMI), Rasht, Rice Research Institute, rice land, 18 August 1996 (F. Mozaffarian); Kohgiluyeh & Boyer Ahmad Province: 1♂ (AZMI), Yasuj, Dehno, alt. 1100 m, 27 March 2001 (Saeedi); Mazandaran Province: 2♂♂ (AZMI), surroundings of Amol, rice land, 21 July 1996 (F. Mozaffarian).
Distribution. Old World. Iranian provinces: Chahar Mahal & Bakhtiari, Azerbaijan-e Sharghi, Fars, Gilan, Golestan, Ilam, Isfahan, Kerman, Kermanshah, Khuzestan, Kohgiluyeh & Boyer-Ahmad, Kordestan, Lorestan, Mazandaran, Khorasan-e Razavi, Tehran and Azerbaijan-e Gharbi.

Family Lycosidae Sundevall, 1833
***Alopecosa albofasciata* (Brullé, 1832)**
Identification. Fuhn & Niculescu-Burlacu (1971)
Material. Tehran Province: 1♂1♀ (AZMI), Velenjak, agricultural garden, 29 April 2001; Tehran Province: 1♀ (AZMI), PPDRI, inside building, 14 April 2001 (Gharaei); Tehran Province: 1♂ (AZMI), Varamin, Yam village, pomegranate orchard, 14 April 2001 (A. Bahramishad).
Distribution. Mediterranean to Central Asia. Iranian provinces: Golestan. Our record from Tehran Province is the southernmost locality in the known distribution range.

***Arctosa leopardus* (Sundevall, 1833)**
Identification. Almquist (2005)
Material. Gilan Province: 1♂ (AZMI), Rasht, Rice Research Institute, rice land, 28 June 1996 (F. Mozaffarian); Gilan

Province: 2♀♀ (AZMI), Rasht, Rice Research Institute, rice land, 28 June 1996 (F. Mozaffarian); Mazandaran Province: 1♀ (AZMI), surroundings of Tonekabon, rice land, 6 August 1996 (F. Mozaffarian); Mazandaran Province: 1♀ (AZMI), surroundings of Tonekabon, rice land, 6 August 1996 (F. Mozaffarian); Mazandaran Province: 1♂ (AZMI), surroundings of Tonekabon, rice land, 6 August 1996 (F. Mozaffarian).
Distribution. West and Central Palaearctic. Iranian provinces: Gilan, Golestan, Ilam, Mazandaran and Khorasan-e Razavi.

***Arctosa tbilisiensis* Mcheidze, 1946**
Identification. Kunt et al. (2012)
Material. Ilam Province: 2♂♂ (AZMI), Darreh Shahr, wheat field, 25 April 2001; Isfahan Province: 1♀ (AZMI), Natanz, 22 May 2000; Markazi Province: 1♀ (AZMI), Saveh, Yal Abad, pomegranate orchard, 16 June 1998 (F. Mozaffarian); Markazi Province: 1♀ (AZMI), Saveh, Yal Abad, pomegranate orchard, 16 June 1998 (F. Mozaffarian); Markazi Province: 4♂♂18♀♀ (AZMI), Saveh, Yal Abad, pomegranate orchard, 15 June 1999 (F. Mozaffarian); Tehran Province: 6♂♂6♀♀ (AZMI), Varamin, Yam village, pomegranate orchard, 8 May 2000 (F. Mozaffarian, A. Bahramishad).
Distribution. Eastern Mediterranean to Iran. Iranian provinces: Alborz, Gilan, Golestan, Ilam, Markazi, Mazandaran, Khorasan-e Shomali, Qazvin, Qom, Khorasan-e Razavi and Tehran.

***Aulonia kratochvili* Dunin, Buchar & Absolon, 1986**
Identification. Zonstein et al. (2015)
Material. Markazi Province: 8♂♂ (AZMI), Saveh, Yal Abad, pomegranate orchard, 19 April 1998 (F. Mozaffarian).
Distribution. West Palaearctic. Iranian provinces: Alborz, Golestan and Markazi.

***Hogna radiata* (Latreille, 1817)**
Identification. Brady (2012), Loksa (1972)
Material. Fars Province: 2s♀♀1s♂1J (AZMI), Shiraz, corn field, 19 June 2011; Fars Province: 1♀1s♂2j (AZMI), Shiraz, corn field, 30 August-16 November 2011; Tehran Province: 1♂ (AZMI), Tehran, PPDRI, inside building, 1999 (F. Mozaffarian); Tehran Province: 1♀ (AZMI), Tehran, PPDRI, 7 November 2000 (A. Bahramishad); Tehran Province: 1♀ (AZMI), Tehran, PPDRI, 2 January 2001 (A. Bahramishad); Azerbaijan-e Gharbi Province: 1♀ (AZMI), surroundings of Piranshahr, pome orchard, 12 October 1998 (A. Khalil Aria).
Distribution. Central Europe to Central Asia and Central Africa. Iranian provinces: Alborz, Fars, Golestan, Kermanshah, Kordestan, Markazi, Mazandaran, Khorasan-e Shomali, Khorasan-e Razavi, Tehran and Zanjan.
Comment. *Hogna radiata* is in desperate need of a revision. It's very likely that there are several species identified under this name across the wide range of distribution currently considered for this species, for details see Brady (2012).

***Lycosa praegrandis* C. L. Koch, 1836**
Identification. Zyuzin & Logunov (2000).
Material. Ilam Province: 1♂ (AZMI), wheat field.
Distribution. West Palaearctic. Iranian provinces: Alborz, Golestan, Khuzestan, Khorasan-e Razavi, Mazandaran and Tehran.

***Pardosa aenigmatica* Tongiorgi, 1966**
Identification. Tongiorgi (1966), Zamani (2015)
Material. Fars Province: 3♀♀ (AZMI), Shiraz, corn field, 7 September 2011; Ilam Province: 3♀♀ (AZMI), Darreh Shahr, wheat field, 25 April 2001; Markazi Province: 2♀♀ (AZMI), Saveh, Yal Abad, pomegranate orchard, 19 April 1998 (F. Mozaffarian).
Distribution. Italy, Turkey, Azerbaijan, Israel and Iran. Iranian provinces: Ilam. The current material from Markazi Province represents its easternmost limit in the whole known distribution range.

***Pardosa azerifalcata* Marusik, Guseinov & Koponen, 2003**
Identification. Marusik et al. (2003)
Material. Markazi Province: 2♀♀ (AZMI), Saveh, Yal Abad, pomegranate orchard, 19 April 1998 (F. Mozaffarian); Markazi Province: 1♂ (AZMI), Saveh, Yal Abad, pomegranate orchard, 19 April 1998 (F. Mozaffarian); Markazi Province: 1♂ (AZMI), Saveh, Yal Abad, pomegranate orchard, 16 June 1998 (F. Mozaffarian); Tehran Province: 42♀♀ (AZMI), Varamin, Sharif Abad, Kolin vil., wheat field, 8 May 2000 (F. Mozaffarian, A. Bahramishad).
Distribution. This species has been described from Azerbaijan and later recorded from northeastern Iran by Namaghi et al. (2014). The re-examined material of the previous Iranian record of this species from Khorasan-e Razavi Province (deposited in JAZM) turned out to be a misidentified *Pardosa italica* Tongiorgi, 1966. Thus, our record from Markazi Province is the first record of this species from Iran, and the easternmost in the whole distribution range.

***Pardosa* cf. *buchari* Ovtsharenko, 1979**
Identification. Marusik et al. (2012)
Material. Kohgiluyeh & Boyer-Ahmad Province: 1♀ (AZMI), Yasooj, wheat field, 1 May 2001 (Saeedi); Kohgiluyeh & Boyer-Ahmad Province: 3♀♀ (AZMI), Kord Laghari, wheat field, 4 May 2000 (Saeedi); Markazi Province: 1♀ (AZMI), Saveh, Yal Abad, pomegranate orchard, 16 June 1998 (F. Mozaffarian); Mazandaran Province: 1♀ (AZMI), Tonekabon, inside building, 1996 (F. Mahmoud Asl); Tehran Province: 2♀♀ (AZMI), Varamin, Yam village, wheat field, 18 May 2000 (F. Mozaffarian, A. Bahramishad).
Distribution. *Pardosa buchari* has been recorded in southern Ukraine, Caucasus and Iran. Iranian provinces: Golestan and Mazandaran. Our record from Kohgiluyeh & Boyer-Ahmad Province is the southeasternmost in the known distribution range (although, our identification of this material can be confirmed only by collection of males).

***Pardosa italica* Tongiorgi, 1966**
Identification. Fuhn & Niculescu-Burlacu (1971), Tongiorgi (1966)
Material. Fars Province: 1♀ (AZMI), Shiraz, corn field, 7 September 2011; Fars Province: 2♂♂2♀♀ (AZMI), Kovar, 12 April 2011; Fars Province: 1♂ (AZMI), Shiraz, corn field, 19 June 2011; Fars Province: 1♂ (AZMI), Hassan Abad, corn field, 3 July 2011; Isfahan Province: 4♂♂1♀ (AZMI), Isfahan, 2000 (Ghahari); Kohgiluyeh & Boyer-Ahmad Province: 1♀ (AZMI), Jalil Babakan, 1 May 2001; Tehran Province: 1♂25♀♀ (AZMI), Varamin-Pakdasht Rd., wheat field, Water Pump station, 16 April 2001 (F. Mozaffarian).

Distribution. Europe and Central Asia. Iranian provinces: Kohgiluyeh & Boyer-Ahmad, Khorasan-e Shomali and Khorasan-e Razavi. Our record from Fars Province is the southernmost in the known distribution range.

***Pardosa morosa* (C. L. Koch, 1870)**
Identification. Fuhn & Niculescu-Burlacu (1971)
Material. Semnan Province: 1♀ (AZMI), Bastam, 23 May 2000.
Distribution. Europe to Central Asia. Iranian provinces: Khorasan-e Shomali and Khorasan-e Razavi.

***Pardosa paludicola* (Clerck, 1757)**
Identification. Fuhn & Niculescu-Burlacu (1971)
Material. Tehran Province: 1♀ (AZMI), PPDRI park, 1998 (F. Mozaffarian); West Azerbaijan Province: 1♂ (AZMI), Uromieh, Kahriz, pome orchard, 20 April 1997 (A. Khalil Aria).
Distribution. Palaearctic. Iranian provinces: Mazandaran.

***Pardosa pontica* (Thorell, 1875)**
Identification. Marusik et al. (2012)
Material. Markazi Province: 2♂♂11♀♀ (AZMI), Saveh, Yal Abad, pomegranate orchard, 23 May 1999 (A. Bahramishad); Markazi Province: 1♀ (AZMI), Saveh, Yal Abad, pomegranate orchard, 15 June 1999 (F. Mozaffarian).
Distribution. Eastern Europe to Central Asia. Iranian provinces: Golestan, Khorasan-e Razavi and Tehran.

***Pardosa roscai* (Roewer, 1951)** (Fig. 5)
Identification. Fedoriak et al. (2016)
Material. Khuzestan Province: 1♂4♀♀2j (AZMI), Ahvaz, wheat field, 15 April 2001.
Distribution. Bulgaria, Romania and Turkey. Iran: New record for the fauna, with the current material representing its southeasternmost limit in the whole known distribution range.

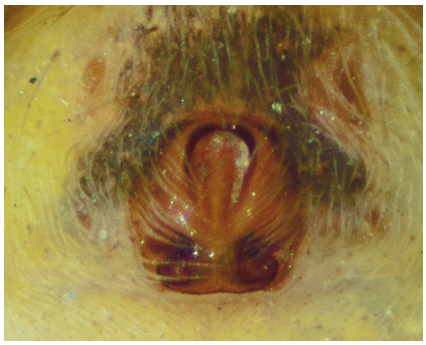


Fig. 5. *Pardosa roscai*, ventral view of epigyne

***Pirata piraticus* (Clerck, 1757)**
Identification. Nadolny & Kovblyuk (2011)
Material. Gilan Province: 1♂ (AZMI), Rasht, Rice Research Institute, rice land, 28 June 1996 (F. Mozaffarian); Mazandaran Province: 1♀ (AZMI), surroundings of Amol, rice land, 21 July 1996 (F. Mozaffarian); Mazandaran Province: 1♀ (AZMI), surroundings of Amol, rice land, 21 July 1996 (F. Mozaffarian); Mazandaran Province: 1♀ (AZMI), surroundings of Tonekabon, rice land, 6 August 1996 (F. Mozaffarian); Mazandaran Province: 1♀ (AZMI), surroundings of Tonekabon, rice land, 19 August 1996 (F. Mozaffarian); Mazandaran Province: 1♂ (AZMI), Tonekabon, Chaparsar, rice land, May 1996 (F. Mozaffarian).
Distribution. Holarctic. Iranian provinces: Azerbaijan-e Gharbi or Azerbaijan-e Sharghi, Gilan, Golestan, Isfahan, Mazandaran and Khorasan-e Razavi.

***Trochosa altera* (Roewer, 1955)**
Identification. Logunov (2012)
Material. Alborz Province: 1♀ (AZMI), Karaj, Mehrshar, pome orchard, 2 October 1998 (F. Mozaffarian); Tehran Province: 2♀♀ (AZMI), PPDRI park, 1999 (F. Mozaffarian).
Distribution. Iran (endemic): from provinces Fars, Mazandaran and Semnan.

***Trochosa ruricola* (De Geer, 1778)**
Identification. Fuhn & Niculescu-Burlacu (1971), Hepner & Milasowszky (2006)
Material. Alborz Province: 6♂♂8♀♀8J (AZMI), Karaj, pear garden, 1 May 2001 (F. Mozaffarian).
Distribution. Holarctic. Iranian provinces: Mazandaran.

***Trochosa urbana* O. Pickard-Cambridge, 1876**
Identification. Saaristo (2010)
Material. Mazandaran Province: 1♀ (AZMI), surroundings of Tonekabon, rice land, 19 August 1996 (F. Mozaffarian); Mazandaran Province: 1♀ (AZMI), surroundings of Amol, rice land, 21 July 1996 (F. Mozaffarian).
Distribution. North and Central Africa to India. Iranian provinces: Alborz, Fars, Gilan, Kerman, Mazandaran and Khorasan-e Razavi.

***Wadicosa fidelis* (O. Pickard-Cambridge, 1872)**
Identification. Kronestedt & Zyuzin (2009)
Material. Ilam Province: 1♂1♀ (AZMI), Darreh Shahr, wheat field, 25 April 2001.
Distribution. Europe to Japan. Iranian provinces: Golestan, Khuzestan, Kordestan and Khorasan-e Razavi.

Family Miturgidae Simon, 1886
***Prochora lycosiformis* (O. Pickard-Cambridge, 1872)**
Identification. Zamani et al. (2016)
Material. Ilam Province: 1♂ (AZMI), Mehran, wheat fields (F. Mozaffarian).
Distribution. Sicily, Israel and Iran. Iranian provinces: Kerman.

Family Oecobiidae Blackwall, 1862
***Oecobius putus* O. Pickard-Cambridge, 1876**
Identification. Zamani et al. (2016)
Material. Fars Province: 23♂♂ 48♀♀+j (AZMI), Shiraz, inside building, fall 1996 (F. Mozaffarian).
Distribution. from Egypt to India. Iranian provinces: Hormozgan and Tehran.

***Uroctea thaleri* Rheims, Santos & van Harten, 2007**
Identification. Rheims et al. (2007)
Material. Semnan Province: 1♀ (AZMI), 7 June 2000.
Distribution. Turkey, Israel, Iran, Yemen and India. Iranian provinces: Khuzestan and Khorasan-e Razavi.

Family Oxyopidae Thorell, 1870
***Oxyopes globifer* Simon, 1876**
Identification. Levy (1999)

Material. Tehran Province: 3♀♀ (AZMI), Varamin, wheat field, April 1998 (Sheikhi); Tehran Province: 1♀ (AZMI), Varamin, Yam village, pomegranate orchard, 15 April 2001 (A. Bahramishad).
Distribution. Mediterranean to Tajikistan. Iranian provinces: Markazi and Mazandaran.

***Oxyopes heterophthalmus* (Latreille, 1804)**
Identification. Levy (1999)
Material. Tehran Province: 1♂ (AZMI), Varamin, wheat field, April 1998 (Sheikhi).
Distribution. Palaearctic. Iranian provinces: Golestan and Mazandaran.

***Oxyopes lineatus* Latreille, 1806**
Identification. Levy (1999), Weiss (1989)
Material. Fars Province: 1♂ (AZMI), Shiraz, corn field, 19 June 2011; Isfahan Province: 1♂ (AZMI), apple garden, 2001 (Emami); Tehran Province: 1♀ (AZMI), PPDRI, inside building, 25 July 1997 (Farrokhi); Zanjan Province: 1♂ (AZMI), Zarrin Abad, near the river, 13 July 2006 (F. Mozaffarian); Zanjan Province: 1♂ (AZMI), Abbar-Gilvan Rd.
Distribution. West Palaearctic. Iranian provinces: Alborz, Azerbaijan-e Gharbi or Azerbaijan-e Sharghi, Golestan, Kohgiluyeh & Boyer-Ahmad, Khorasan-e Razavi and Tehran.

Family Philodromidae Thorell, 1870
***Philodromus cespitum* (Walckenaer, 1802)**
Identification. Ono & Martens (2005)
Material. Markazi Province: 1♀ (AZMI), Saveh, Yal Abad, pomegranate orchard, 23 May 1999 (A. Bahramishad); Azerbaijan-e Gharbi Province: 1♀ (AZMI), Nazloo, pome orchard, 19 June 1998 (A. Khalil Aria).
Distribution. Holarctic. Iranian provinces: Ardebil, Golestan, Mazandaran and Tehran.
Comment. Since there are considerable differences between the drawings of the Iranian material described in Ono & Martens and the European *P. cespitum* in Muster & Thaler (2004), a future investigation should target the true identity of *P. cespitum* in Iran.

***Thanatus formicinus* (Clerck, 1757)**
Identification. Kastrygina & Kovblyuk (2013)
Material. Tehran Province: 1♀ (AZMI), Velenjak, agricultural garden, 29 April 2001 (F. Mozaffarian).
Distribution. Holarctic. Iranian provinces: Fars, Golestan, Khorasan-e Razavi and Tehran.

***Thanatus vulgaris* Simon, 1870**
Identification. Kastrygina & Kovblyuk (2013)
Material. Alborz Province: 2♀♀ (AZMI), Karaj, wheat field (A. Bahramishad); Alborz Province: 1♂ (AZMI), Karaj, wheat field, 5 June 2000 (A. Nazari); Alborz Province: 1♀ (AZMI), Karaj, wheat field, 5 June 2000 (A. Nazari); Alborz Province: 1♂2♀♀ (AZMI), Karaj, wheat field, 31 May 2000 (A. Nazari); Fars Province: 1♀ (AZMI), Hassan Abad, 3 July 2011; Fars Province: 1♀ (AZMI), Shiraz, corn field, 7 September 2011; Isfahan Province: 1♂ (AZMI), Isfahan, corn field, summer 2000 (M. Nematollahi); Qazvin Province: 1♀ (AZMI), Takestan, alfalfa field, 5 July 2006 (F. Mozaffarian); Tehran Province: 1♀ (AZMI), Velenjak, agricultural garden, 29 April 2001 (F. Mozaffarian); Tehran Province: 17♀♀ (AZMI), Varamin, wheat field, April 1998 (Sheikhi).
Distribution. Holarctic. Iranian provinces: Alborz, Fars, Golestan, Hormozgan, Mazandaran and Tehran.

***Tibellus oblongus* (Walckenaer, 1802)**
Identification. Almquist (2006)
Material. Alborz Province: 1♂ (AZMI), Karaj, wheat field, 5 May 1999 (A. Tatri); Alborz Province: 4♂♂9♀♀1s♀1s♂ (AZMI), Karaj, Mehrshahr, pear garden, 1 May 2001 (F. Mozaffarian); Gilan Province: 1j (AZMI), Rasht, Rice Research Institute, rice land, 28 June 1996 (F. Mozaffarian); Gilan Province: 1♀ (AZMI), Rasht, rice land, 28 June 1996 (F. Mozaffarian); Gilan Province: 3♀♀ (AZMI), Rasht, rice land, 24 June 1996 (Karimian); Mazandaran Province: 1♂1♀ (AZMI), surroundings of Tonekabon, rice land, 19 August 1996 (F. Mozaffarian); Mazandaran Province: 1♀ (AZMI), surroundings of Amol, rice land, 21 July 1996 (F. Mozaffarian).
Distribution. Holarctic. Iranian provinces: Gilan, Golestan, Mazandaran, Khorasan-e Razavi and Tehran.

Family Pholcidae C. L. Koch, 1850
***Artema doriae* (Thorell, 1881)**
Identification: According to unpublished photos of type specimens.
Material. Tehran Province: 1♀ (AZMI), PPDRI, inside building, 1999 (F. Mozaffarian); Tehran Province: 1♂ (AZMI), Velenjak, inside building, 12 February 2001 (A. Bahramishad); Tehran Province: 2♂♂ (AZMI), Tehran, inside building, 1999 (F. Mozaffarian).
Distribution. This species is currently known from Iran only. It has been previously recorded in Alborz, Kerman, Kohgiluyeh & Boyer-Ahmad, Mazandaran, Semnan and Tehran provinces.

Family Phrurolithidae Banks, 1892
***Orthobula charitonovi* (Mikhailov, 1986)**
Identification. Marusik et al. (2013)
Material. Markazi Province: 1♀ (AZMI), Saveh, Yal Abad, pomegranate orchard, 19 April 1998 (F. Mozaffarian).
Distribution. Eastern Mediterranean to Central Asia. Iranian provinces: Alborz, Fars and Tehran.

Family Pisauridae Simon, 1890
***Pisaura mirabilis* (Clerck, 1758)**
Identification. Esyunin & Sozontov (2015)
Material. Gilan Province: 1♀ (AZMI), Rasht, Rice Research Institute, rice land, 28 June 1996 (F. Mozaffarian).
Distribution. West Palaearctic. Iranian provinces: Ardebil, Fars, Gilan, Golestan, Mazandaran, Khorasan-e Razavi, Semnan and Tehran.

***Pisaura novicia* (L. Koch, 1878)**
Identification. Esyunin & Sozontov (2015)
Material. Golestan Province: 1♂ (AZMI), Gorgan, wheat field, 2000 (Mobasheri).
Distribution. Mediterranean to Central Asia. Iranian provinces: Gilan.

Family Salticidae Blackwall, 1841
***Aelurillus marusiki* Azarkina, 2002**
Identification. Azarkina (2002)
Material. Markazi Province: 1♀ (AZMI), Saveh, Yal Abad, pomegranate orchard, 23 May 1999 (A. Bahramishad).
Distribution. This species is endemic to Iran, previously recorded in Fars and Tehran provinces

***Bianor albobimaculatus* (Lucas, 1846)**
Identification. Logunov (2001)
Material. Gilan Province: 1♂ (AZMI), Rasht, Rice Research Institute, rice land, 18 August 1996 (F. Mozaffarian); Gilan Province: 1♀ (AZMI), Rasht, Rice Research Institute, rice land, 28 June 1996 (F. Mozaffarian); Mazandaran Province: 1♀ (AZMI), surroundings of Amol, rice land, 4 May 1996 (F. Mozaffarian); Zanjan Province: 1♂ (AZMI), Abbar-Gilvan Rd.
Distribution. Africa, Mediterranean to Russia, Central Asia and India. Iranian provinces: Fars, Gilan, Golestan, Khuzestan, Mazandaran, Khorasan-e Razavi and Zanjan.

***Cyrba ocellata* (Kroneberg, 1875)**
Identification. Wesołowska (1996)
Material. Tehran Province: 1♀ (AZMI), Velenjak, agricultural garden, 9 May 2001.
Distribution. Sudan to China, Australia. Iranian provinces: Golestan, Mazandaran, Khorasan-e Razavi and Tehran.

***Heliophanus equester* L. Koch, 1867**
Identification. Metzner (1999)
Material. Alborz Province: 1♀ (AZMI), Mard Abad, Pol-e Ferdows, 8 May 2001 (A. Bahramishad); Zanjan Province: 1♀ (AZMI), Zarrin Abad, near the river, 13 July 2006 (F. Mozaffarian).
Distribution. Italy to Iran. Iranian provinces: Fars, Tehran and Azerbaijan-e Gharbi.

***Heliophanus flavipes* (Hahn, 1832)**
Identification. Metzner (1999)
Material. Alborz Province: 1♀ (AZMI), Mard Abad, Pol-e Ferdows, 8 May 2001 (A. Bahramishad); Zanjan Province: 1♀ (AZMI), Zarrin Abad, near the river, 13 July 2006 (F. Mozaffarian).
Distribution. Palaearctic. Iranian provinces: Azerbaijan-e Sharghi, Golestan, Mazandaran, Khorasan-e Razavi and Tehran. A re-examination of the material reported as *Heliophanus aeneus* (Hahn, 1832) from Khorasan-e Razavi Province by Namaghi et al. (2014) (deposited in JAZM) confirms that this record should belong to *H. flavipes*, thus, the presence of the former species in Iran is rejected.

***Heliophanus mordax* (O. Pickard-Cambridge, 1872)**
Identification. Rakov & Logunov (1997)
Material. Qazvin Province: 1♀ (AZMI), Takestan, alfalfa field, 5 July 2006 (F. Mozaffarian); 1♀ (AZMI), same date and locality.
Distribution. Greece to Central Asia. Iranian provinces: Alborz, Fars, Lorestan, Mazandaran, Khorasan-e Razavi and Tehran.

***Heliophanus verus* Wesołowska, 1986**
Identification. Wesołowska (1986)
Material. Golestan Province: 1♀ (AZMI), Gonbad Kavoos, cotton field, 1999 (Khoramly).
Distribution. Azerbaijan, Turkey and Iran. Iranian provinces: Golestan, Kerman, Mazandaran and Tehran.

***Mendoza canestrinii* (Ninni, 1868)**
Identification. Metzner (1999)
Material. Mazandaran Province: 1♀ (AZMI), surroundings of Tonekabon, rice land, 6 August 1996 (F. Mozaffarian); Mazandaran Province: 1♂ (AZMI), surroundings of Tonekabon, rice land, 19 August 1996 (F. Mozaffarian); Mazandaran Province: 1♂ (AZMI), surroundings of Tonekabon, rice land, 19 August 1996 (F. Mozaffarian).
Distribution. West and Central Palaearctic. Iranian provinces: Gilan, Golestan and Mazandaran.

***Pellenes geniculatus* (Simon, 1868)**
Identification. Prószyński (2003)
Material. Kohgiluyeh & Boyer-Ahmad Province: 1♀ (AZMI), Kalus, wheat field, 4 June 2000 (Saeedi).
Distribution. West Palaearctic. Iranian provinces: Khorasan-e Razavi.

***Philaeus chrysops* (Poda, 1761)**
Identification. Prószyński (2003)
Material. Mazandaran Province: 1♀ (AZMI), surroundings of Tonekabon, rice land, 6 August 1996 (F. Mozaffarian); Tehran Province: 1♀ (AZMI), Velenjak, agricultural garden, 9 May 2001.
Distribution. Palaearctic. Iranian provinces: Alborz, Chahar Mahal & Bakhtiary, Fars, Golestan, Ilam, Kermanshah, Khuzestan, Kohgiluyeh & Boyer-Ahmad, Kordestan, Lorestan, Markazi, Mazandaran, Qom, Khorasan-e Razavi, Semnan and Tehran.

***Phintella castriesiana* (Grube, 1861)**
Identification. Metzner (1999)
Material. Mazandaran Province: 1♀ (AZMI), surroundings of Tonekabon, rice land, 19 August 1996 (F. Mozaffarian).
Distribution. Palaearctic. Iranian provinces: Gilan and Mazandaran.

***Plexippus paykulli* (Audouin, 1826)**
Identification. Prószyński (2003)
Material. Isfahan Province: 1♂ (AZMI), corn field, 2000 (M. Nematollahi).
Distribution. Cosmopolitan. Iranian provinces: Golestan, Hormozgan, Isfahan, Kerman, Khuzestan, Mazandaran and Tehran.

***Rudakius cinctus* (O. Pickard-Cambridge, 1885)**
Identification. Prószyński (2016)
Material. Qazvin Province: 1♀ (AZMI), Zibashahr, 21 November 2000 (A. Bahramishad).
Distribution. Azerbaijan to China. Iranian provinces: Tehran.

***Rudakius spasskyi* (Andreeva, Heciak & Prószyński, 1984)**
Identification. Wesolowska (1996: sub *Pseudicius*)
Material. Alborz Province: 1♀ (AZMI), Karaj, wheat field, 9 April 2000 (A. Nazari).
Distribution. Azerbaijan to Central Asia. Iranian provinces: Gilan, Mazandaran and Khorasan-e Razavi.

***Thyene imperialis* (Rossi, 1846)**
Identification. Metzner (1999)
Material. Fars Province: 1♂ (AZMI), Shiraz, corn field, 27 September 2011; Golestan Province: 1♂3♀♀ (AZMI), Gonbad Kavoos, cotton field, 1999 (Khoramly); Markazi Province: 1♀ (AZMI), 10 September 2000 (Baradaran); Tehran Province: 2♂♂ (AZMI), Varamin, Yam village, pomegranate orchard, 16 April 2001 (A. Bahramishad).
Distribution. Old World. Iranian provinces: Alborz, Ardebil, Fars, Gilan, Golestan, Hamedan, Khuzestan, Kordestan, Markazi, Mazandaran, Qazvin, Qom, Khorasan-e Razavi, Tehran and Zanjan.

Family Scytodidae Blackwall, 1864
***Scytodes strandi* Spassky, 1941**
Identification. Özkütük et al. (2013), Spassky (1941)
Material. Tehran Province: 1♂1♀ (AZMI), Tehran, PPDRI, 17 June 2000 (Y. M. Marusik).
Distribution. Azerbaijan to Central Asia. Iranian provinces: Mazandaran and Tehran.

***Scytodes univittata* Simon, 1882**
Identification. Brescovit & Rheims (2000), Özkütük et al. (2013)
Material. Tehran Province: 1♀ (AZMI), Tehran, inside building, 1999 (F. Mozaffarian).
Distribution. Spain, from Canary Is. to Myanmar and synanthropic in the Neotropics. Iranian provinces: Bushehr, Fars, Isfahan, Mazandaran, Qom and Tehran.

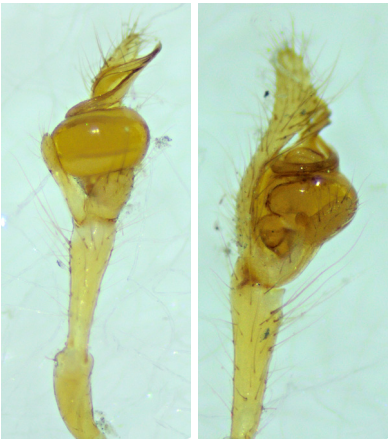
Family Sicariidae Keyserling, 1880
***Loxosceles rufescens* (Dufour, 1820)**
Identification. Zamani et al. (2014)
Material. Mazandaran Province: 1♀ (AZMI), Qaem Shahr, June 2004 (M. Jamal); Mazandaran Province: 3♀♀ (AZMI), Sari, Esfivard-e Shurab, Kord Kheil, 36°30'N, 53°00'E, August 1999 (A. Bahramishad).
Distribution. Cosmopolitan. Iranian provinces: Alborz, Fars, Hormozgan, Qom, Khorasan-e Razavi, Mazandaran and Tehran.

Family Sparassidae Bertkau, 1872
***Olios sericeus* (Kroneberg, 1875)**
Identification. Moradmand et al. (2015)
Material. Semnan Province: 1♀ (AZMI), Shahrud, 2 June 2000.
Distribution. Caucasus, Central Asia and Iran. Iranian provinces: Isfahan, Khorasan-e Razavi and Tehran.

Family Tetragnathidae Menge, 1866
***Tetragnatha extensa* (Linnaeus, 1785)**
Identification. Russell-Smith (2011)
Material. Mazandaran Province: 1♂ (AZMI), surroundings of Tonekabon, rice land, 6 August 1996 (F. Mozaffarian).
Distribution. Holarctic. Iranian provinces: Ardebil, Azerbaijan-e Gharbi or Azerbaijan-e Sharghi, Gilan, Golestan, Kohgiluyeh & Boyer-Ahmad, Mazandaran and Qazvin.

***Tetragnatha isidis* (Simon, 1880)** (Fig. 6-8)
Identification. Picard et al. (2014)
Material. Mazandaran Province: 1♂ (AZMI), surroundings of Tonekabon, rice land, 19 August 1996 (F. Mozaffarian).

Fig. 6. *Tetragnatha isidis*, habitus of a male



Figs 7-8: *Tetragnatha isidis*, ventral and retrolateral views of male palp

Distribution. Europe to Sumatra. Iran: New record for the fauna.

***Tetragnatha javana* (Thorell, 1890)**
Identification. Yin et al. (2012)
Material. Gilan Province: 1♂ (AZMI), Rasht, Rice Research Institute, rice land, 18 August 1996 (F. Mozaffarian); Gilan Province: 1♂ (AZMI), Rasht, Rice Research Institute, rice land, 18 August 1996 (F. Mozaffarian).
Distribution. Africa to Japan, Philippines and Indonesia. Iranian provinces: Gilan, Golestan and Mazandaran.

***Tetragnatha nigrita* Lendl, 1886**
Identification. Almquist (2005)
Material. Gilan Province: 1♂ (AZMI), Rasht, Tootestan, 2000 (Hasheminia).
Distribution. Palaearctic. Iranian provinces: Golestan and Mazandaran.

Family Theridiidae Sundevall, 1833
***Enoplognatha thoracica* (Hahn, 1833)**
Identification. Lecigne (2016), Roberts (1995)
Material. Ilam Province: 13♀♀ (AZMI), Eyvan, wheat field, 9 April 2001 (F. Mozaffarian).
Distribution. Holarctic. Iranian provinces: Isfahan.

***Heterotheridion nigrovariegatum* (Simon, 1873)**
Identification. Knoflach et al. (2009)
Material. Khorasan-e Razavi Province: 1♀ (AZMI), Kashmar, pomegranate orchard, 4 July 1999 (Kamali); Yazd Pro-

vince: 1♂ (AZMI), Yazd, Meibod, pomegranate orchard, 19 June 1998 (Ghayoomi, Jafari).
Distribution. West Palaearctic. Iranian provinces: Golestan, Mazandaran and Tehran.

***Neottiura bimaculata* (Linnaeus, 1767)**
Identification. Almquist (2005)
Material. Markazi Province: 1♂ (AZMI), Saveh, Yal Abad, pomegranate orchard, 19 April 1998 (F. Mozaffarian).
Distribution. Holarctic. Iranian provinces: Mazandaran and Tehran.

***Parasteatoda tepidariorum* (C. L. Koch, 1841)**
Identification. Almquist (2005)
Material. Gilan Province: 1♂ (AZMI), Rasht, Rice Research Institute, inside building, May 1996 (F. Mahmoud Asl); Mazandaran Province: 2♀♀ (AZMI), Tonekabon, inside building, 1996 (F. Mahmoud Asl).
Distribution. Cosmopolitan. Iranian provinces: Gilan, Golestan, Isfahan and Mazandaran.

***Phylloneta impressa* (L. Koch, 1881)**
Identification. Kaya & Uğurtas (2011), Roberts (1995)
Material. Mazandaran Province: 1♀ (AZMI), surroundings of Amol, rice land, 21 July 1996 (F. Mozaffarian); Azerbaijan-e Gharbi Province: 1♀ (AZMI), Bazargan-Makoo Rd., pome orchard, 2 August 1997 (A. Khalil Aria); Azerbaijan-e Gharbi Province: 1♂ (AZMI), Vazir Abad, pome orchard, 23 June 1998 (A. Khalil Aria).
Distribution. Holarctic. Iranian provinces: Ardebil, Fars, Golestan, Khorasan-e Razavi and Tehran.

***Steatoda albomaculata* (De Geer, 1778)**
Identification. Kaya & Uğurtaş (2011), Roberts (1995)
Material. Alborz Province: 1♀ (AZMI), Chendar, wheat field, 17 July 2001 (A. Bahramishad).
Distribution. Holarctic. Iranian provinces: Alborz, Gilan, Golestan, Kerman, Mazandaran, Qazvin, Khorasan-e Razavi, Tehran and Zanjan.

***Steatoda paykulliana* (Walckenaer, 1805)**
Identification. Kaya & Uğurtaş (2011), Levy & Amitay (1982)
Material. Fars Province: 1♂ (AZMI), Abadeh, 27 March 1998 (Farrokhi); Gilan Province: 1♀ (AZMI), Rasht, mulberry garden, summer of 2000 (Hasheminia); Qazvin Province: 1♀ (AZMI), Zibashahr, 21 November 2000 (F. Mozaffarian); Qazvin Province: 1♀ (AZMI), Nazarabad, 21 November 2000 (F. Mozaffarian); Tehran Province: 1♂ (AZMI), PPDRI park (Bahramishad); Fars Province: 1♂ (AZMI), Shiraz, corn field, 19 April 2011; Tehran Province: 1♀ (AZMI), Shahriar, apple garden, 8 May 2001 (A. Bahramishad); Tehran Province: 1♀ (AZMI), Sovojbolagh, apple garden, 21 November 2000 (F. Mozaffarian); Tehran Province: 1♂2♀♀ (AZMI), same data; Tehran Province: 1♀ (AZMI), Velenjak, agricultural garden, 18 April 2001 (A. Bahramishad).
Distribution. West Palaearctic. Iranian provinces: Alborz, Ardebil, Bushehr, Chahar Mahal & Bakhtiary, Fars, Gilan, Golestan, Hormozgan, Ilam, Khuzestan, Kohgiluyeh & Boyer-Ahmad, Kordestan, Markazi, Mazandaran, Qom, Khorasan-e Razavi, Semnan and Tehran.

***Steatoda triangulosa* (Walckenaer, 1802)**
Identification. Kaya & Uğurtaş (2011), Roberts (1995)
Material. Alborz Province: 1♀ (AZMI), Chendar, wheat field, 17 July 2001 (A. Bahramishad).
Distribution. Cosmopolitan. Iranian provinces: Alborz, Golestan, Isfahan, Mazandaran and Tehran.

***Theridion hemerobium* Walckenaer, 1805**
Identification. Almquist (2005)
Material. Mazandaran Province: 2♀♀ (AZMI), surroundings of Amol, rice land, 21 July 1996 (F. Mozaffarian).
Distribution. Nearctic and West Palaearctic. Iranian provinces: Gilan and Mazandaran.

Family Thomisidae Sundevall, 1833
***Ebrechtella tricuspidata* (Fabricius, 1775)**
Identification. Lehtinen & Marusik (2008), Roberts (1995)
Material. Gilan Province: 1♀ (AZMI), Rasht, Rice Research Institute, rice land, 18 August 1996 (F. Mozaffarian); Zanjan Province: 1♂ (AZMI), Zarrin Abad, near the river, 13 July 2006 (F. Mozaffarian).
Distribution. Palaearctic. Iranian provinces: Gilan, Mazandaran and Tehran.

***Runcinia grammica* (C. L. Koch, 1837)**
Identification. Ono & Martens (2005)
Material. Gilan Province: 1♂ (AZMI), Rasht, Rice Research Institute, rice land, 18 August 1996 (F. Mozaffarian).
Distribution. Palaearctic. Iranian provinces: Alborz, Khuzestan, Mazandaran and Tehran.

***Thomisus onustus* Walckenaer, 1805**
Identification. Kiany et al. (2017), Roberts (1995)
Material. Tehran Province: 1♀ (AZMI), PPDRI park, 1999 (F. Mozaffarian); Yazd Province: 1♂ (AZMI), Yazd, pomegranate orchard, 28 July 1998 (Jafari); Yazd Province: 2♂♂ (AZMI), Yazd, Bafgh, pomegranate orchard, 12 July 1999 (Jafari).
Distribution. Palaearctic. Iranian provinces: Alborz, Ardebil, Fars, Gilan, Golestan, Hormozgan, Mazandaran, Khorasan-e Shomali, Qazvin, Khorasan-e Razavi, Khorasan-e Jonubi, Tehran and Zanjan.

***Thomisus zyuzini* Marusik & Logunov, 1990**
Identification. Kiany et al. (2017), Marusik & Logunov (1990, 1995)
Material. Isfahan Province: 1♂ (only palp) (AZMI), apple garden, 2002 (Emami); Qazvin Province: 1♂2♀♀ (AZMI), Abyek, Qarpuz Abad, 23 July 2006 (F. Mozaffarian); Tehran Province: 1♂ (AZMI), Fasham, Ziaran, near the river, 35°35'6"N, 51°21'40"E, alt. 230 m (F. Mozaffarian).
Distribution. Turkey and from Saudi Arabia to Central Asia. Iranian provinces: Alborz, Fars, Isfahan, Kerman and Khorasan-e Razavi.

***Tmarus piochardi* (Simon, 1866)**
Identification. Zamani (2015)
Material. Markazi Province: 1♂1♀ (AZMI), Saveh, Yal Abad, pomegranate orchard, 28 June 1998 (F. Mozaffarian); Markazi Province: 2♀♀ (AZMI), Saveh, Yal Abad, pomegranate orchard, 19 April 1998 (F. Mozaffarian); Markazi Province: 7♀♀ (AZMI), Saveh, Yal Abad, pomegranate orchard, 6 July 1999

(A. Bahramishad); Tehran Province: 2♂♂ (AZMI), Varamin, Pishva, 28 April 2001 (A. Bahramishad).
Distribution. Mediterranean. Iranian provinces: Markazi and Khorasan-e Razavi.

***Xysticus kochi* Thorell, 1872**
Identification. Almquist (2006)
Material. Alborz Province: 1♀ (AZMI), Karaj, pear garden, 1 May 2000 (F. Mozaffarian); Alborz Province: 1♀ (AZMI), Karaj, wheat field, 12 May 1999; Tehran Province: 1♂2♀♀ (AZMI), Damavand area, Firooz Kuh, pome orchard, 14 April 1998 (F. Mozaffarian).
Distribution. Europe to Turkmenistan. Iranian provinces: Azerbaijan-e Sharghi, Gilan, Golestan, Mazandaran, Khorasan-e Razavi and Tehran.

***Xysticus laetus* Thorell, 1875**
Identification. Logunov (2006)
Material. Unknown Province: 1♀ (AZMI), no data.
Distribution. Italy to Central Asia. Iranian provinces: Fars and Mazandaran.

***Xysticus striatipes* L. Koch, 1870**
Identification. Kiany et al. (2017), Roberts (1998)
Material. Fars Province: 2♂♂ (AZMI), Shiraz, corn field, 18 October 2011.
Distribution. Palaearctic. Iranian provinces: Fars, Mazandaran and Tehran.

Family Titanoecidae Lehtinen, 1967
***Nurscia albomaculata* (Lucas, 1846)**
Identification. Kovblyuk et al. (2016)
Material. Gilan Province: 1♂ (AZMI), Rasht, Rice Research Institute, rice land, 28 June 1996 (F. Mozaffarian).
Distribution. Mediterranean to Central Asia. Iranian provinces: Golestan, Mazandaran, Khorasan-e Razavi and Tehran.

***Titanoeca turkmenia* Wunderlich, 1995**
Identification. Wunderlich (1995)
Material. Gilan Province: 1♂ (AZMI), Rasht, Rice Research Institute, rice land, 28 June 1996 (F. Mozaffarian).
Distribution. Greece, Iran, Turkmenistan and Kazakhstan. Iranian provinces: Gilan, Kordestan and Mazandaran.

Family Trachelidae Simon, 1897
***Trachelas minor* O. Pickard-Cambridge, 1872**
Identification. Bosselaers et al. (2009), Zamani et al. (2016)
Material. Markazi Province: 1♀ (AZMI), Saveh, Yal Abad, pomegranate orchard, 14 August 1999 (A. Bahramishad); Mazandaran Province: 1♀ (AZMI), surroundings of Tonekabon, rice land, 6 August 1996 (F. Mozaffarian).
Distribution. Mediterranean to Central Asia. In Iran, it has been previously recorded from an unknown province (it was presumed by the authors that the specimens were collected in Fars Province). Our record from Markazi Province is the southernmost in the known distribution range.

Discussion

A total of 634 specimens was examined, out of which 106 species belonging to 70 genera and 27 families were identified. Five species are new records for the fauna of Iran – *Brigittea civica* (Lucas, 1850), *Pardosa roscai* (Roewer, 1951), *Tetragnatha isidis* (Simon, 1880), *Trachyzelotes miniglossus* Levy, 2009 and *Zelotes tenuis* (L. Koch, 1866), raising the number of species known from this country to 620. New provincial records were provided for an additional number of 64 species. Iran now comprises the easternmost known distribution limits for six species (*Aculepeira talishia*, *Brigittea civica*, *Pardosa aenigmatica*, *P. azerifalcata*, *Trachyzelotes miniglossus*, *Zelotes tenuis*), the southernmost record for six species (*Alopecosa albofasciata*, *Leviellus caspicus*, *Nomisia conigera*, *Pardosa italica*, *Talanites dunini*, *Trachelas minor*), the northernmost record for one species (*Zaitunia vahabzadehi*) and the southeasternmost record for two species (*Pardosa buchari*, *P. roscai*). Previous Iranian records of *Pardosa azerifalcata* and *Heliophanus aeneus* are attributed to *Pardosa italica* and *Heliophanus flavipes*, respectively, and *Pardosa azerifalcata* is re-recorded for the fauna of Iran based on the recently examined material.

It is also noteworthy that partial or whole material of a considerable number of species from a variety of different families (25 species from 13 families) were collected from rice lands, which is in agreement with the structure of spider communities observed in ecological studies of this agroecosystem (Bambaradeniya et al. 2004, Sebastian et al. 2005). The same holds true for our records from pomegranate, citrus and olive orchards (32 species from 13 families). Ecological studies carried out in olive (Picchi et al. 2016), citrus (Mestre et al. 2012), pear (Tavares et al. 2011) and apple (Bogya et al. 1999) orchards have shown relatively high species numbers (>50) in comparably small assemblages, which is quite similar to what we have observed on the basis of our current material.

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Public DNA barcoding data resolve the status of the genus *Arboricaria* (Araneae: Gnaphosidae)

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Abstract. An analysis of public DNA barcoding data confirms that the extraction of *Arboricaria* Bosmans, 2000 from the genus *Micaria* Westring, 1851 would require the division of *Micaria* into at least five (and probably more) individual genera, to restore the monophyly of *Micaria* sensu stricto. Such an excessive splitting of a homogenous and well-defined genus would be neither desirable nor practical, and consequently *Arboricaria* should be considered a subjective junior synonym of *Micaria*, as suggested earlier (**syn. conf.**).

Keywords: Araneae, DNA barcoding, cladistics, phylogenetic systematics, paraphyly, spider.

Zusammenfassung. Öffentliche DNA-Barcode-Daten klären den Status der Gattung *Arboricaria*. Eine Analyse von öffentlich zugänglichen DNA-Barcode-Daten bestätigt, dass die Herauslösung von *Arboricaria* Bosmans, 2000 aus der Gattung *Micaria* Westring, 1851 eine Aufteilung von *Micaria* in mindestens fünf Einzelgattungen erfordern würde, um die Monophylie der Restgattung *Micaria* im engeren Sinne wiederherzustellen. Diese exzessive Aufteilung einer homogenen und klar definierten Gattung wäre weder wünschenswert noch praktikabel, und folglich sollte *Arboricaria*, wie bereits früher vorgeschlagen, als subjektives jüngeres Synonym von *Micaria* behandelt werden (**syn. conf.**).

The genus *Arboricaria* was established by Bosmans (in Bosmans & Blick 2000) for the three species of the *subopaca* group of *Micaria* defined by Wunderlich (1980) and two newly described species. No explicit justification was provided for the decision to place this particular species group, but not others, in its own genus, and the status of the new genus has been controversial from the beginning. Platnick, as organizer of the World Spider Catalog and previous reviser of the Nearctic members of *Micaria* (Platnick & Shadab 1988), rejected the genus, "as [Bosmans] provided no evidence whatever that these taxa [included in *Arboricaria*] constitute the sister group of all other *Micaria*, or that the remaining *Micaria* do not constitute a paraphyletic group from which a relatively autapomorphic subgroup has been artificially extracted" (Platnick 2014), thus effectively synonymizing *Arboricaria* with *Micaria*. In this assessment he was followed by Wunderlich (2017), an earlier reviser of the Palaearctic *Micaria* species (Wunderlich 1980), who formalized the synonymy and concluded that *Arboricaria* should be considered as a "species-group of *Micaria* or as a subgenus". In contrast, Mikhailov (2016) argued with reference to the International Code of Zoological Nomenclature that "there are no formal grounds to reject the validity of *Arboricaria*", and consequently the genus is considered as valid in the latest version of the World Spider Catalog (WSC 2017).

However, just like Bosmans, Mikhailov failed to provide unambiguous synapomorphies for the remaining 100 or so species of *Micaria*, so that Platnick's concerns about the potential paraphyly of *Micaria* sensu stricto remain unresolved. The formalistic argument based on the regulations of the ICZN is obviously insufficient. As Minelli & Kraus (1999) as president and former president of the International Commission on Zoological Nomenclature explain in their Preface to the Fourth Edition of the Code "[t]he conventional Linnaean hierarchy [embodied in the Code] will not be able to survive alone: it will have to coexist with the ideas and terminology of phylogenetic (cladistic) systematics", stating explicitly that the traditional nomenclature can be perceived as "too permissive, in so far as it may be equally applied to paraphyletic as to monophyletic groups." This is exactly the issue at hand: while *Arboricaria* is quite likely to be a monophyletic group, the resulting truncated *Micaria* could equally likely be paraphyletic. As has been elaborated extensively, following the historical debate between Ernst Mayr (1974) and Willi Hennig (1975), paraphyletic taxa are non-monophyletic, differ only in subtle ways from polyphyletic ones (Platnick 1977), and have arguably no useful place in a phylogenetic taxonomy and nomenclature.

The recent availability of large amounts of DNA barcoding data for spiders (e.g., Astrin et al. 2016, Blagoev et al. 2013, 2016) now offers a unique opportunity to resolve this issue: a sufficiently large number of *Micaria* species, as well as sequences for an undisputed member of *Arboricaria*, *A. subopaca* (Westring, 1861), have been made publicly available for phylogenetic analysis to answer Platnick's key question: is *Arboricaria* the sister group of all other *Micaria*, or does its extraction leave *Micaria* sensu stricto as a paraphyletic group?

Material and methods

The results presented below are based entirely on the use of public datasets, analysed using freely available tools with easy and intuitive user interfaces, not requiring programming skills. While the correct use and interpretation of the output of these tools depends on some understanding of sequence alignments and molecular phylogeny, the type of analysis presented here should be widely accessible to practicing spider taxonomists in general.

All public DNA barcode sequences (based on the mitochondrial cytochrome c oxidase I gene, COI) for *Micaria* and *Arboricaria* species represented by Barcode Index Numbers (Ratnasingham & Hebert 2013) in the BOLD database (Ratnasingham & Hebert 2007) as of 21 February 2017 were downloaded in FASTA format, together with a random selection of single sequences for a diverse range of other gnaphosid species to be used as an outgroup (including representatives of *Callilepis, Cesonia, Drassyllus, Gnaphosa, Haplodrassus, Herpyllus, Nodocion, Nomisia, Orodrassus, Parasyrisca, Scotophaeus, Sergiolus, Sosticus* and *Zelotes*). Sequences were managed in BioEdit v7.2.5 (Hall 1999), which was also used for exploratory sequence alignment using ClustalW 1.4 (Larkin et al.

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2007) and initial phylogenetic analysis using the neighbor joining and parsimony algorithms implemented in PHYLIP 3.5c (Felsenstein 1989). Some particularly short or redundant (identical) barcodes were removed from the analysis, to minimize the computational effort. The resulting dataset contained barcodes for 144 specimens of 12 *Micaria* species, including representatives from a wide range of morphologically defined species groups. The final phylogenetic analysis was performed using phylogeny.fr (Dereeper et al. 2008), with twelve different workflows, using sequence alignment by MUSCLE version 3.8.31 (Edgar 2004) or ClustalW 2.1, curation using Gblocks 0.91b (Castresana 2000) or by removing positions with gaps, and phylogenetic inference using the Maximum Likelihood approach implemented in PhyML 3.1 (Guindon & Gascuel 2003), the Neighbor Joining method of BioNJ 3.66 (Gascuel 1997) or the Maximum Parsimony algorithm of TNT 1.1 (Goloboff et al. 2008), using default settings. Bootstrap support was estimated for each of the tree building methods in combination with MUSCLE alignment and gap removal. The nucleotide substitution model for the maximum-likelihood analysis was the very general default Generalised Time-Reversible (GTR) model, with Gamma shape parameter 0.725. Phylogenetic trees were visualized and explored in iTOL v3 (Letunic & Bork 2016). All the conclusions discussed below are independent of the exact choice of sequences, alignment method and tree inference algorithm.

No attempt was made to optimize the parameters of any of the methods or to optimize the alignments by manual editing. Also, the choice of tree building methods was dictated by a desire to cover a wide range of conceptually diverse methods (including the neighbour-joining approach, which is not strictly a phylogenetic inference method), rather than trying to use a few theoretically preferred inference approaches. Such an intentionally diversified strategy would be suboptimal in the context of a comprehensive phylogenetic analysis, where maximal resolution and careful assessment of the support of each node in the tree is the aim. It is, however, a suitable approach in the present analysis, which has a more focused ambition, namely to test if *any* of the methods tried would allow us to reject Platnick's hypothesis that *Arboricaria* is nested within a paraphyletic *Micaria* sensu stricto.

Results and discussion

The two different alignment methods resulted in identical alignments, and results were independent of the treatment of gaps in the alignments. Overall, relationships among the *Micaria* species were very similar in all three tree building approaches. A summary of the preferred majority-rule consensus tree resulting from the phylogenetic analysis is shown in Fig. 1 (the full trees for all methods are included in the electronic supplementary files, including sequence accession numbers, branch lengths and bootstrap support information). While this tree, based exclusively on mitochondrial COI data for a limited sample of species, should not be considered as a strongly supported and reliable phylogeny of *Micaria* in general, it allows a clear answer to Platnick's questions: while *Micaria* sensu lato is a consistently recovered monophyletic group, *Arboricaria subopaca*, as the representative member of *Arboricaria* (i.e., Wunderlich's *subopaca* group), is never recovered as sister to the remaining *Micaria* species, and *Micaria* sensu stricto would be paraphyletic. More specifically, in all analyses that provided sufficient phylogenetic resolution *A. subopaca* was found to be more closely related to, e.g., *M. aenea, M. longipes*, *M. alpina* and the species of the *pulicaria* species group than to the members of the *dives* or *scenica* groups. More diverse sequence data would be required to resolve the exact relationships: bootstrap support for the exact placement of *A. subopaca* is low, and different methods place it closer to either *M. aenea* (as suggested already by Wunderlich (1980)) or to *M. alpina/longipes*, and the entire clade containing these four species is nested within the *pulicaria* group in some of the analyses. The *pulicaria* group according to Wunderlich (1980) includes the type species of *Micaria* (*M. fulgens*). Obviously, no conclusion is possible regarding the monophyly of *Arboricaria*, as only one species is represented in the analysis, but this monophyly has not been contentious in earlier discussions of the status of the genus (Platnick 2001, Wunderlich 2017) and is irrelevant for the question at hand.

Confidence in the phylogenetic results is provided not only by the stability of these findings towards the choice of analytical methodology, but also by the fact that all individual species represented by more than one specimen are robustly monophyletic (with bootstrap support between 66 and 100 %). A single exception is the closely related species pair

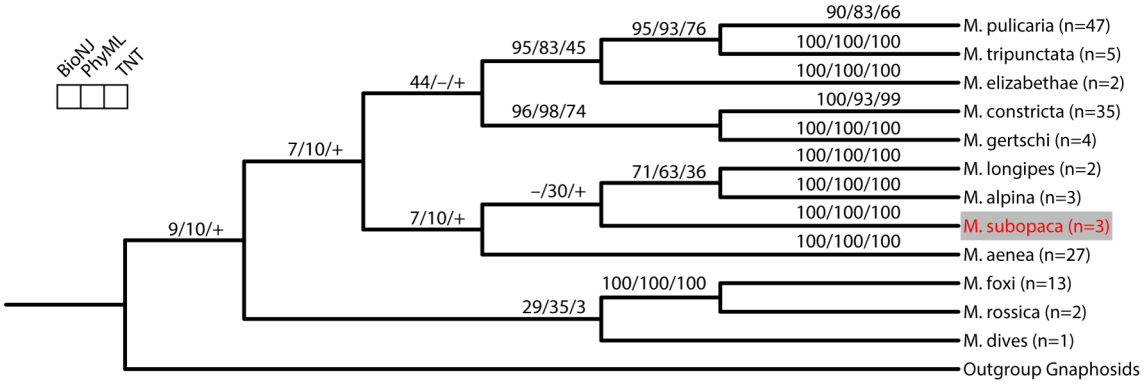

Fig. 1: Preferred phylogeny of barcoded *Micaria* species, based on a majority-rule consensus of analyses in phylogeny.fr, using three different phylogenetic inference algorithms (BioNJ, PhyML and TNT). The bootstrap support for each clade in each of the analyses is indicated above the branches (–: clade not recovered in this analysis, +: clade not consistently resolved in this analysis). A set of gnaphosid species from 14 genera was used as outgroup to root the tree. The number of sequences (n) included in the analysis is indicated for each species.

M. foxi/*M. rossica*, which is not distinguished by the barcode sequences. In this case, the two Alaskan *M. rossica* specimens may be misidentified (G. Blagoev pers. comm.), and two Russian specimens of *M. rossica* added to the database after the conclusion of this study are clearly distinct, but still sister to *M. foxi*. Most importantly, the species groups identified earlier, based on morphological analyses (Wunderlich 1980) and in the first morphology-based phylogenetic analysis of the genus (Platnick & Shadab 1988), are consistently recovered in the majority of the phylogenetic analyses whenever the necessary barcode sequences are available. This concerns the *pulicaria* group (represented by *M. pulicaria, M. elizabethae, M. gertschi, M. constricta* and *M. tripunctata;* only *M. aenea* seems to be misplaced in this group, and Wunderlich (1980) had already indicated a possible closer relationship to the *subopaca* group, as recovered here), as well as the *scenica* group (represented by *M. foxi* and *M. rossica*). Other consistently recovered clades, such as the one joining *M. constricta* and *M. gertschi* (bootstrap support 74 to 96%), and the one joining *M. longipes* and *M. alpina* (bootstrap support 36 to 71 %), indicate the value of DNA barcoding in highlighting potential relationships that are not immediately obvious morphologically.

Restoring the monophyly of *Micaria* with regard to *Arboricaria* as currently defined would require splitting the genus into at least five individual genera (for an extended *pulicaria* group [*Micaria* s. str.], an extended *dives* group [*Micariolepis*], the *subopaca* group [*Arboricaria*], and new genera for the *longipes* group and for *M. aenea*), and possibly more, as several species groups are not yet represented in the DNA dataset, nor in earlier morphological analyses. Given the notable morphological homogeneity of the genus *Micaria* s. lat., as well as its distinctive morphological and ecological synapomorphies pointed out by Wunderlich (2017) – e.g., squamose and iridescent hairs, diurnal life style and ant-mimicry – such an excessive splitting of the genus would be undesirable, turning a clearly differentiated genus into a complex of poorly resolved genera that would be very challenging to diagnose reliably.

One could, of course, argue that the results are weakened by the absence of the type species of *Arboricaria*, i.e. *A. cyrnea*, in the barcode dataset. However, as *Arboricaria* was explicitly established for "the species from the former *M. subopaca*-group" (Bosmans & Blick 2000), even if *A. cyrnea* would turn out to be the sister species of all the *Micaria* species considered here, the resulting drastic re-definition and relimitation of *Arboricaria* would seriously undermine its taxonomic usefulness.

It is noteworthy that the molecular phylogeny places *M. dives* close to the root of *Micaria*, compatible with *M. dives* (plus the *scenica* group) being the sister to all other *Micaria* species. *M. dives* could therefore with some justification be placed in its own genus *Micariolepis* Simon, 1879, as had been suggested by Simon (1878, sub *Chrysothrix*, preoccupied) and followed by numerous later authors (e.g., Reimoser 1937, Buchar 1962, Brændegård 1966, Miller 1971). But even then, the sequence analyses indicate that maintaining monophyly of *Micaria* would either require establishing an additional new genus for the *scenica* group or the extension of *Micariolepis* to include the *scenica* group at the cost of losing morphological diagnosability. Moreover, the morphological gap separating *Micariolepis* and the analysed representatives of the *scenica* group from the rest of *Micaria* is at best very narrow and the unambiguous diagnosis of *Micariolepis* so challenging (Wunderlich 1980) that such a formal separation would be hardly informative and is better avoided.

In conclusion, the molecular barcoding data fully vindicate the suspicions raised by Platnick (2001) and support Wunderlich's (2017) decision to formally treat *Arboricaria* as a subjective junior synonym of *Micaria* (**syn. conf.**).

The decision to perform analyses using non-optimized default parameters and to combine results from a diverse set of methods into a single consensus tree should alleviate concerns regarding the possibility of fine-tuning or cherry picking the results in favour of the preferred outcome. But it also means that there is considerable room for improvement should there be interest in a more comprehensive phylogenetic analysis of *Micaria* and gnaphosids in general: ideally, such a study would include an even wider range of species, additional genes (including nuclear ones), and carefully optimized alignments and parameters, while being restricted to the most appropriate phylogenetic inference methods, including Bayesian approaches, which because of computational constraints were not included in the present study.

The case of *Arboricaria* illustrates the value of barcoding information beyond its primary purpose of documenting biodiversity and assisting species identification and discovery (Hebert et al. 2003). While the molecular data in isolation will not be able to replace traditional, integrative taxonomy (Will et al. 2005, Ebach & de Carvalho 2010), they can provide highly valuable complementary information to resolve long-standing taxonomic problems in arachnology (Padial & de la Riva 2007). A systematic analysis of the publicly available data will certainly reveal numerous analogous cases in other spider taxa in the near future, and as the availability of data increases similar studies should soon become part of taxonomic routine in arachnology.

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Supplementary File 1: Supplement1.txt, phylogenetic trees in Newick format

Supplementary File 2: Supplement2.txt, consensus trees of 100 bootstrap replicates in Newick format

Supplementary File 3: Supplement3.pdf, phylogenetic trees in pdf format

Supplementary File 4: Supplement4.pdf, consensus trees of 100 bootstrap replicates in pdf format

Further records of two spider-parasitoids of the genus *Polysphincta* (Hymenoptera, Ichneumonidae, Ephialtini) from Central Europe, with notes on their host interactions

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Abstract. A polysphinctine wasp *Polysphincta longa*, associated with the orb web building spider *Araneus angulatus*, was recorded for the first time in Slovakia. Its congener *Polysphincta tuberosa* was recorded in association with a new spider host *Araneus sturmi*. New records of *Polysphincta* species from the Czech and Slovak Republics are presented. The final stage larvae of both, *P. longa* and *P. tuberosa*, induce a specific alteration in web architecture: the spider constructed a unique 3D tangle of silk – so called "cocoon web" – to protect the parasitoid during the pupal stage. The host range of wasps belonging to the genus *Polysphincta* in Europe is discussed.

Key words: behavioural alteration, diversity, spider host

Zusammenfassung. Neue Nachweise von zwei Spinnen-Parasitoiden der Gattung *Polysphincta* (Hymenoptera, Ichneumonidae, Ephialtini) aus Mitteleuropa, mit Beobachtungen ihrer Wirts-Interaktionen. Die Schlupfwespe *Polysphincta longa*, die mit der Radnetzspinne *Araneus angulatus* assoziiert ist, wurde erstmals in der Slowakei gefunden. *Polysphincta tuberosa* wurde erstmals an der Wirtsart *Araneus sturmi nachgewiesen*. Neue Vorkommen von *Polysphincta*-Arten in der Tschechischen Republik und der Slowakei werden präsentiert. Die Larven des letzten Stadiums von *P. longa* und *P. tuberosa* induzieren eine spezielle Veränderung der Netzarchitektur: die Spinnen bilden ein dreidimensionales ‚Kokonnetz' um die Puppe des Parasitoiden zu schützen. Die Wirtsspektren der *Polysphincta*-Arten in Europa werden diskutiert.

Polysphincta is a moderately large genus within the *Polysphincta* group of genera (Ephialtini, Ichneumonidae, Hymenoptera), which are koinobiont parasitoids (a parasitoid, whose host continues to feed and grow after parasitization) exclusively associated with spider hosts. The genus is presently represented by five valid species in Europe: *Polysphincta boops* Tschek, 1869, *P. longa* Kasparyan, 1976, *P. rufipes* Gravenhorst 1829, *P. tuberosa* Gravenhorst, 1829 and *P. vexator* Fitton, Shaw & Gauld, 1988 (Yu et al. 2012). All of them are known to be strictly associated with species of the family Araneidae (e.g. Fitton et al. 1988, Yu et al. 2012), but their host spectrum involves multiple species; with the exception of *P. longa* (see below) which uses a single host species (Fitton et al. 1988, Schmitt et al. 2012, Yu et al. 2012, Fritzén & Shaw 2014, Korenko et al. 2014). *Polysphincta longa* is probably widely distributed across Europe, but presumably is often misidentified as the morphologically similar species *P. boops* (Fritzén & Shaw 2014). *Araneus angulatus* Clerck, 1757 recently turned out to be an exclusive host of this species (Fritzén & Shaw 2014).

Interestingly, a host behavioural manipulation has evolved in the final stage larvae of these wasps. Shortly before killing the spider host, the final stage larvae of several polysphinctines manipulate the webbing behaviour of their hosts, which spin a special web structure called a 'cocoon web' in order to establish a safe place for pupation. The cocoon web, a term coined by Eberhard (2000), is a web construction which is built by the spider host under the influence of the parasitoid's final stage larva. The cocoon web is stronger than the normal web and presumably provides a more durable support for the wasp's cocoon (e.g. Eberhard 2000, Korenko et al. 2014). Some polysphinctine parasitoids make use of original structures of spider's normal web for protection during the pupal stage, as was documented for *P. rufipes* (Schmitt et al. 2012). No modification of spider web building behaviour of *P. longa* was observed by Fritzén & Shaw (2014).

Here we present new records for *P. longa* and *P. tuberosa* from Slovakia and the Czech Republic, the host records, and descriptions of web architecture modification induced by the parasitoid's final stage larva. The host range of wasps of the genus *Polysphincta* in Europe is also discussed.

Material and methods

Potential spider hosts for hymenopteran parasitoids of the genus *Polysphincta*, araneids from the genera *Araneus* and *Araniella*, were inspected for the presence of parasitoid larva during one to three hour excursions (1) in a beech forest at the Kováčová locality, in the province of Zvolen, Slovakia (48°34'41"N, 19°5'35"E, 490 m a.s.l.) on 12th September 2016, (2) at a forest edge of Veľké Lúky (Krásna Ves, in the province of Trenčín, Slovakia (48°51'33"N, 18°13'32"E, 400 m a.s.l.) on 13th September 2016 and (3) at a forest edge of Východná, in the province of Liptovský Mikuláš, Slovakia (49°02'53"N, 19°54'54"E, 750 m a.s.l.) on 16th September 2016. Further records from the Czech Republic are presented (4) from a forest ecotone in the Hradečno locality, in the province of Kladno (50°11'12"N, 13°58'48"E, 380 m a.s.l.) on 3rd October 2014, (5) from the Marschnerova louka Meadow locality in the Chřibská province, the Lužické hory Mts. (50°52'32"N, 14°28'28"E, 360 m a.s.l.) on 18th June 2015 and (6) from a peat bog Soumarské rašeliniště locality in the Volvary province (48°54'8"N, 13°49'51"E, 750 m a.s.l.) on 11th May 2016.

Spiders were collected by beating bushes and tree branches up to a height of two meters above ground. A square-shaped net (1 m^2 area) was used and each collected spider was inspected for the presence of parasitoid larva. A parasitized *Araneus angulatus* was reared in a glass arena with a 400 × 400 mm base, 550 mm height and with a Y-shaped twig installed across the arena to provide space for building a web. A parasitized *Araneus sturmi* (Hahn, 1831) was reared in glass arena with a 200 × 50 mm base and 200 mm height. Other parasitized spider hosts (*Araniella* spp. and *Araneus quadratus* Clerck, 1757) were reared in tubes with a 15 mm

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diameter and 100 mm height. Laboratory reared *Drosophila* flies or houseflies (*Musca domestica* Linnaeus, 1758) were provided every three days until the spiders were killed by the parasitoid final stage larvae. The web building behaviour of manipulated *A. angulatus* and *A. sturmi* was observed until the larvae killed and consumed the spiders and then pupated. Photographs were taken using an EOS 500D single-lens reflex digital camera (Canon Inc.). Microscopic observations of spider silk were performed in various parts of the cocoon web of *A. angulatus* (the wall of the silk chamber, threads in the chamber surroundings and the dragline thread). Specimens are deposited in the collection of S.K. (Department of Agroecology and Biometeorology, CULS, Czech Republic) and Kamil Holý (Department of Entomology, Crop Research Institute, Czech Republic).

Results

Field observation

The orb web weaving spider *A. angulatus* is a relatively rare arboreal species. During our excursions, we found only one specimen, and it was parasitized by a polysphinctine larva. After rearing of the parasitoid larva to adulthood in the laboratory, the parasitoid was identified as *P. longa*. The wasp is recorded for the first time in Slovakia. Other araneid hosts, *Araniella* spp., *A. quadratus*, *A. sturmi* were observed in higher numbers at several localities beyond that of *A. angulatus*, but the presence of parasitoid larvae was sporadic (N = 8). All eight larvae on these araneid spiders were *P. tuberosa*.

Reared material

CZECH REPUBLIC. Šumava Mts: Volvary province, peat bog Soumarské rašeliniště, larva attached to juvenile *Araneus quadratus*, leg. 11.V.2016, adult emerged – no data (one female *P. tuberosa*), leg. Dolejš P., det. Korenko S.; Lužické hory Mts: Chřibská province, Marschnerova louka locality, in a forest ecotone, larva attached to juvenile *Araniella* sp., leg. 18.VI.2015, adult emerged 7.VII.2015 (one female *P. tuberosa*), leg. Dolejš P., det. Korenko S.; province of Kladno, in a forest ecotone in the Hradečno locality, larvae attached to juvenile *Araniella* sp., leg. 3.X.2014, adults emerged 12.XII.2014–22.I.2015 (two females, one male *P. tuberosa*), leg. Korenko S., det. Korenko S.

SLOVAKIA. Province of Zvolen, Kováčová, beech forest, larva attached to *A. angulatus*, leg. Černecká Ľ. & Korenko S., 12.IX.2016, cocooned 25.X.2016, adult emerged 5.XI.2016 (1 male, *P. longa*), det. Korenko S., rev. Holý K.; province of Trenčín, locality Veľké lúky close to Motešice, larva attached to *Araniella* sp., leg. Štefánik M. & Korenko S., 13.IX.2016, cocooned 5. and 25.XI.2016, adult emerged 19.XI. and 9.XII.2016 (2 females, *P. tuberosa*), det. Korenko S.; province of Liptovský Mikuláš, Východná locality, larva attached to *Araneus sturmi*, leg. Šestáková A., 16.IX.2016, cocooned 25.X.2016, adult emerged 5.XI.2016 (1 female, *P. tuberosa*), det. Korenko S., rev. Holý K.

Laboratory observation

The parasitized *Araneus angulatus* (body length 8 mm) was placed in an experimental arena containing a Y-shaped twig (20th September 2016). The larva sat transversely at the anterior apex of the spider's opisthosoma just above the pedicel (Fig. 1). The spider built only one strong silk line between the ends of the arms of the Y-shaped twig at an early stage. Most of the time, the spider sat on the bark at the end of a twig. Only one orb web was built (11th October 2016), when the spider captured prey and fed. The spider's capture web was 42 cm wide with 16 radial lines and 25/24 spiral lines in the upper/lower part of the orb. The web was kept by the spider for two days, then the fly was provided as prey and the web was damaged by the spider. After feeding, the spider did not build any other orb web. After two weeks (24th October 2016), the larva doubled its body length to

Fig. 1: *Araneus angulatus* parasitized by *P. longa*. The larva is located transversely at the anterior apex of the spider's opisthosoma just above the pedicel. Scale: 2 mm

Fig. 2: Cocoon web built by the *A. angulatus* under the influence of *P. longa* larva. Scale: 5 mm

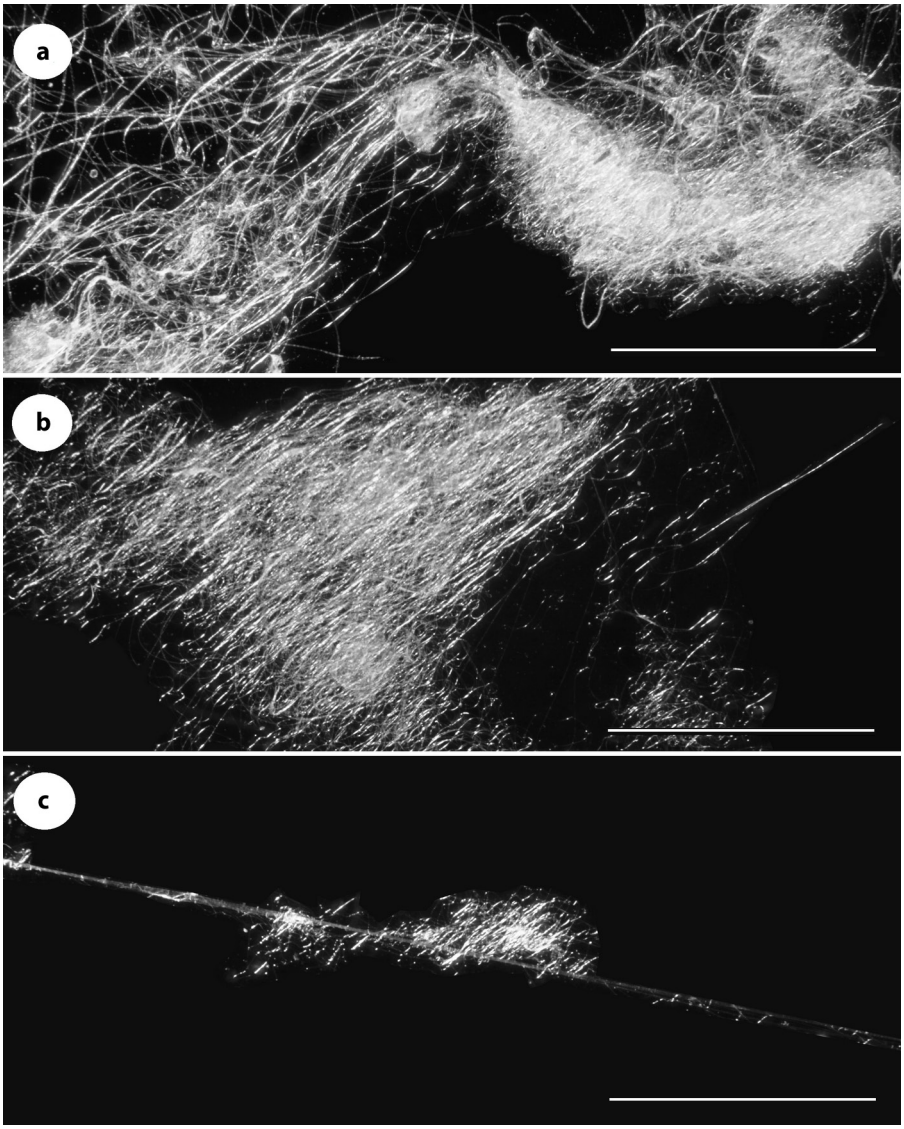

Fig. 3: Silk tufts produced by the spider under the influence of *P. longa* larva **a.** on the wall of the silk retreat; **b.** on threads in the surroundings of the retreat; **c.** on the dragline thread; Scales: 2 mm

9 mm and reached the final stage and induced changes in spider behaviour. Parasitized *A. angulatus* constructed a 3D tangle of silk (the cocoon web) at the end of the strong silk line in the top corner of the experimental arena (Fig. 2). The cocoon web of *P. longa* was decorated by various forms of silk tufts (Fig. 3), which were produced after modification of the spider's behaviour presumably induced by the larval effect. The tufts were produced in various parts of the cocoon web. The highest number of tufts was on a wall of the silk chamber, which surrounded the parasitoid pupa (Fig. 3a), on threads in the surroundings of the chamber (Fig. 3b) and on a frame thread (Fig. 3c).

The parasitoid larva paralysed and killed the spider, and built its cocoon at the centre of this 3D tangle. The cocoon was fusiform, white, sparsely spun with an opening at a distal end and oriented horizontally at an angle of 40°. On the next day (25th October 2016), the larva pupated and three days later meconium (the first excrement after pupation) appeared in the lower part of the cocoon (27th October 2016). One adult female emerged after 8 days (5th November 2016).

Araneus sturmi (body length 4.5 mm) had a parasitoid larva sitting transversely at the dorsal and posterior side of the spider's opisthosoma (Fig. 4). Under the influence of the final stage larva of *P. tuberosa* the spider built a unique three-dimensional (3D) structure in the upper corner of the experimental arena with a high density of threads (Fig.5). No tuft-like structure was observed. The cocoon was fusiform, yellowish white, sparsely spun with an opening at a distal end and oriented horizontally as for *P. longa*.

Discussion

Host utilisation and specificity of European *Polysphincta*

Our study supports the view of Fritzén & Shaw (2014) that *P. longa* is exclusively associated with *A. angulatus*. This arboreal spider is a relatively rare species and prefers natural forest habitats, where it builds a large orb web mostly in the higher strata of canopies. The host's rareness seems to be one of the reasons why *P. longa* has been seldom reared from hosts. In addition, *P. longa* is potentially more abundant in Europe than previously thought because Fritzén & Shaw (2014) re-examined material from several parts of Europe and revealed that *P. longa* was misidentified as *P. boops*, which is also associated with arboreal araneid spiders but attacks only the genus *Araniella* (e.g. Fitton et al. 1988, Fritzén & Shaw 2014, Korenko et al. 2014).

The hosts of both parasitoids occur in tree crowns but their microhabitat preferences, the sizes and orientations of their orb webs, and their body sizes differ considerably. Large

Fig. 4: *Araneus sturmi* parasitized by *P. boops*. The larva is attached at the dorsal side of the spider's opisthosoma. Scale: 2 mm

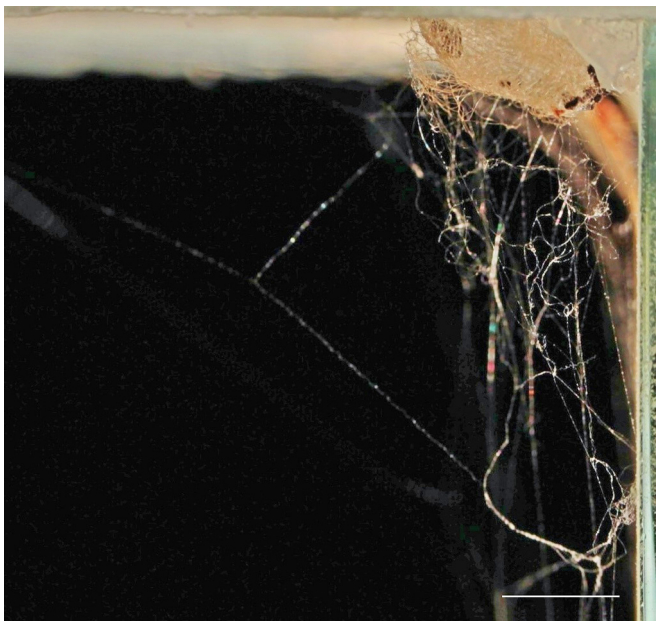

Fig. 5: Cocoon web built by *A. sturmi* under the influence of *P. tuberosa* larva. Scale: 5 mm

vertical orb webs of *A. angulatus* were located in high strata of the tree crown and were often constructed across two trees. In contrast, the much smaller *Araniella* species build a relatively small, mostly horizontally oriented orb web between tree twigs, sometimes covering only one tree leaf (Kůrka et al. 2015). Both parasitoids, *P. longa* and *P. boops*, share forest canopy habitats sympatrically, possibly causing the confusion. These two related parasitoid species presumable evolved their own host-searching behaviour towards closely-related but slightly different spider lineages.

The Holarctic *P. tuberosa*, morphologically similar to the Palaearctic *P. boops*, also prefers small arboreal araneid spiders, but its host range is much wider than that of *P. boops* (e.g. Fitton et al. 1988, Korenko et al. 2014). Although it attacks various taxa, their ecology (web architecture, habitat preference) is similar (Kůrka et al. 2015). Another *Polysphincta* occurring in Europe, *P. rufipes*, is widely distributed across the Palaearctic (Yu et al. 2012). The species attacks araneid spiders such as *Larinioides* or *Zygiella*, which build a protection chamber at the side of the orb web (e.g. Fitton et al. 1988, Schmitt et al. 2012). Another congener is *P. vexator* distributed in the British Isles and Scandinavia (Yu et al. 2012), which seems to be associated with grassy peat bogs and mosses, where its major host spider *A. quadratus* is common (Fitton et al. 1988). A single record reared from *Larinioides cornutus* (Clerck, 1757) is also present (Fitton et al. 1988).

In total, five wasp species of the genus *Polysphincta* occur so far in Europe. Their host range is restricted to the spider family Araneidae, but each host preference is varied (Tab. 1). The widest host range is documented in *P. tuberosa*, which attack three araneid genera (Fitton et al. 1988, Korenko et al. 2014). In contrast, *P. boops* seems to be strictly associated only with spiders of the genus *Araniella* (Korenko et al. 2014). *Polysphincta longa* seems to attack only *A. angulatus* (Fritzén & Shaw 2014, this study).

Manipulation of web-building behaviour

We observed, although only once, that the web-building behaviour of *A. angulatus* was modified by the final stage larva of *P. longa*. The spider built a unique structure corresponding to a cocoon web (a 3D tangle produced by the manipulated spider), which seems to serve to protect the parasitoid during the pupal stage. Our observation did not agree with Fritzén & Shaw (2014), who saw no modification of spider web building

Tab. 1: Host association of European spider-parasitoids of the genus *Polysphincta*. Values are percentage of host records (%) from reliable recent sources: Fitton et al. (1988), Schmitt et al. (2012), Fritzén & Shaw (2014), Korenko et al. (2014), Korenko (unpubl. data) and this study. *N* means total number of host records.

	Araniella		*Araneus*				*Larinioides*		*Zygiella*		
Polysphincta	*cucurbitina*	*ophistographa*	*angulatus*	*diadematus*	*quadratus*	*sturmi*	*sclopetarius*	*cornutus*	*x-notata*	*atrica*	N
boops Tschek, 1869	80	20									5
tuberosa Gravenhorst, 1829	43	19		31	4	1				1	70
longa Kasparyan, 1976			100								3
rufipes Gravenhorst 1829							22	70	9		23
vexator Fitton, Shaw & Gauld, 1988					96			4			26

behaviour. The explanation for this difference seems to lie in the size of the experimental arena. Fritzén & Shaw (2014) used a rearing arena of small size, whereas our observation was conducted in a large arena where the spider had enough space to build both a normal and a cocoon web.

The utilisation of spider web structures by a parasitoid was also documented in *P. rufipes* (the parasitoid uses the normal web structure – spider shelter built at the side of normal web) (Schmitt et al. 2012) and in *P. boops* and *P. tuberosa* (parasitoid induces building of unique cocoon web) (Korenko et al. 2014). Similar cocoon web architecture could also be expected in the other European species of this genus, *P. vexator*.

Considering all available data, the utilisation of a 3D web structure (for protection during pupal stage) seems to be typical for wasps of the genus *Polysphincta* in Europe. These protecting constructions can make use of the spider's normal structures (the spider retreat of *P. rufipes*) or can be achieved via a set of unique spider behaviours newly induced by the parasitoids (the 3D tangle of *P. boops*, *P. tuberosa* and *P. longa*). The cocoon web of *P. longa* uniquely contained many silk tufts of various forms which were produced by the spider after the parasitoid larva reached its final stage and modified the spider's behaviour. These structures were never observed in *P. boops* and *P. tuberosa* (Korenko et al. 2014, unpubl. data). Takasuka et al. (2015) found similar silk tufts on the cocoon webs of *Cyclosa argenteoalba* Bösenberg & Strand, 1906 under the influence of the parasitoid ichneumonid *Reclinervellus nielseni* (Roman, 1923). Takasuka et al. (2015) showed that tuft decoration reflects UV light, possibly to prevent damage caused by collision of large insects and birds. The same function is expected in the tufts present on the cocoon web induced by *P. longa*.

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Dolomedes plantarius (Araneae, Pisauridae) in Belarus: records, distribution and implications for conservation

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Abstract. *Dolomedes plantarius* (Clerck, 1757) is becoming another iconic species within European conservation programmes. It is commonly accepted that the densest populations of this species are situated in Western Europe and many records confirm this. At the same time Eastern European populations are often not taken into account when assessing future dynamics of species distribution due to climate change. Here we provide data about *D. plantarius* in Belarus, which includes both an extensive literature survey and our own records in different parts of the country. The evidence provided suggest that Belarus is currently a large refugium for the fen raft spider, which was found during the last 30 years practically everywhere where specialists were interested in its study. We suggest that involvement of international research teams in studies of *D. plantarius* in Belarus will ensure the most efficient population management in Europe.

Keywords: protected areas, Red List, spiders, vulnerable species

Zusammenfassung. *Dolomedes plantarius* (Araneae, Pisauridae) in Weißrussland: Nachweise, Verbreitung und Folgerungen für ihren Schutz. *Dolomedes plantarius* (Clerck, 1757) wird als relevante Art in europäischen Naturschutzprogrammen zunehmend berücksichtigt. Dabei wird allgemein angenommen, dass der Schwerpunkt der Verbreitung der Art in Westeuropa liegt, was auf der Vielzahl der Nachweise von dort beruht. Die osteuropäischen Vorkommen wurden bisher meist nicht beachtet, wenn klimabedingte Verbreitungsveränderungen der Art modelliert wurden. Daten zu *D. plantarius* aus Weißrussland werden vorgestellt, einerseits aus intensiver Literaturarbeit und andererseits aus eigenen Nachweisen in verschiedenen Teilen des Landes. Damit wird deutlich, dass Weißrussland ein bedeutendes Reservoir für die Art darstellt. Sie wurde in den letzten 30 Jahren fast immer gefunden, wenn gezielt nach ihr gesucht wurde. Wir empfehlen dass die Vorkommen in Weißrussland in die internationale Forschung einbezogen werden, um die Schutzprogramme für die Art zu optimieren.

Dolomedes plantarius (Clerck, 1757) is the only protected spider in Belarus. It has conservational status III in the Red Book of Belarus (2006) and is considered as vulnerable (VU) according to the IUCN (World Conservation Monitoring Centre 1996). Despite its important status *D. plantarius* was not studied in Belarus in any detail and our current work is an attempt to put together all known records about this species as well as to present our own data. The distribution and status of *D. plantarius* in Europe was nicely discussed by Duffey (2012) and one of the points we also would like to emphasize is that this species is quite likely to have considerably more dense populations in various parts of Europe than was believed before. Recent discoveries in various countries confirm this idea (Duffey 2012). The information provided here about earlier records of *D. plantarius* in Belarus might seem to be excessive but most of the publications on which we based our research are in Belarusian or Russian and many of these works are conference presentations, hence unavailable for most of the arachnologists in the world. Also data about habitats and types of water bodies where this spider species was found might be of additional interest to ecologists and conservation biologists. We hope that provided data will be useful when planning conservation activities as well as will help to create more reliable models of *D. plantarius* population dynamics in Europe.

History of records of *D. plantarius* in Belarus

The first mention of *D. plantarius* in Belarus dates back to 1986 (Shlakhtyonok 1986). In his study the author claimed to have found this species in a dry (!) meadow with the help of a Barber trap. The meadow was located in the territory of the Biarezinski Biosphere Reserve, in the middle and north of the country. The identification was confirmed by the Russian arachnologist V. I. Ovcharenko. It is believed to be the first record of *D. plantarius* in Belarus, however, the close relative *D. fimbriatus* is known from previous work by Litvinova et al. (1980) where all the data about spiders of Belarus ever collected up to that time were systematized. It is quite possible that *D. plantarius* was caught earlier but identified as *D. fimbriatus* which used to be the typical situation in the first half of the 20th century (Helsdingen 1994). Unfortunately, the specimen collected by Shlyakhtyonok (1986) is not available so we could not examine it. In the Red Book of Belarus (2006) there is also a mention of a site in the territory of national park "Prypiacki" where *D. plantarius* was collected sometime between 1986 and 2006 (the date when the Red Book was issued). The observation was most probably made by J. Zhukovets and there is no specimen available to check it.

It is very strange that such an interesting and large species was missed by specialists in Belarus so, in fact, there is a gap in the records that lasted for almost 20 years. We doubt that this was connected with rarity of the *D. plantarius* because our own investigations showed rather dense populations at different sites in this country.

The third record was in 2002-2003, but the data was published only in 2007 which meant it was not included into Red Book of Belarus published in 2006 (Moroz & Shavanova 2007). *Dolomedes plantarius* was collected with help of a hydrobiological net in two of eight sites. Both of the sites were lakes (Lubień and Karosina) in the territory of the National Park "Prypiacki". The first lake, Lubeń (52°03'49.2"N 28°12'35.2"E), where *D. plantarius* was present was flooded during the spring time. The shores were overgrown with *Typha*, *Phragmites* and *Carex*. The second lake, Karosina (52°04'09.9"N 28°11'58.7"E), was also flooded during snow

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melting in spring and its shore was also overgrown with *Typha*, *Phragmites* and *Carex*, however at the very water line *Stratiotes* was present as well. Moroz & Shavanova (2007) did not provide the exact number of specimens collected and just show the percentage of *D. plantarius* among other spiders sampled in all sites and within the two where it was present (2.8, 4.76 and 3.9 % respectively). In total, 14 species of 6 families were collected at all 8 sites. No specimens of *D. plantarius* are available now.

The next unequivocal record comes from V. Lukin (Lukin 2006a). *Dolomedes plantarius* was found on the bank of an irrigation channel, two kilometres to the north of the village of Bahušoŭka in 09.07.2004, 53°46'27.7"N 23°55'59.8"E. There were two females with egg sacs. One of them was taken to the laboratory and died within 5 days; no spiders emerged from the egg sac. In 2005, V. Lukin visited the same channel, but after the channel had been cleaned there were no *Dolomedes* at all (Lukin 2006b). We examined the specimen collected by Lukin and confirm its identity as *D. plantarius*; we also provide a photo of its epigyne (Fig. 1 a).

In the Brest region, in the south-western part of Belarus, Demjanczik (2006) reported the presence of *D. plantarius* within the reserve "Prybužskaje Paleśsie", but no further information was provided. We decided not to include this record on our map as it is very doubtful. No known arachnologist from Belarus or abroad has worked at this site or has at least published anything on the matter. The record exists as part of a list with no exact site, picture or other evidence.

The next site where *D. plantarius* was definitely present was in the near vicinity of the Pyški forest, in the Hrodna region on the bank of the river Nioman, 2006, coordinates 53°40'40.5"N 23°46'52.9"E (Ryzhaya & Kopysova 2007). We could not examine the specimen, however it might still be preserved in the personal collection of Ryzhaya at the Hrodna State University.

The only record from National Park "Brasłaŭskija lakes" dates back to 2007. *Dolomedes plantarius* was mentioned in a preliminary report of the project devoted to development of the National Park (Maksimienkaŭ 2011). The site mentioned is the shore of lake Ryčy in the vicinity of the village of Mikałajuncy, 55°40'23.9"N 26°43'42.9"E. The spider was found and identified by Maksimienkaŭ. No data about exact date, distribution, density, sex and age were provided. If the record is valid it is the northernmost record of *D. plantarius* in Belarus. However, from the 09–20 September, 2013 we visited several other lakes and rivers in the territory of the National Park and found no trace of *D. plantarius*. Lake Ryčy was not investigated though so it is unclear whether the spider is really present there.

Another record was from the "Rare and protected species of invertebrates of National Park "Prypiacki" (Chizhevskaya 2009). The author indicated two specimens of *D. plantarius* that were present in the territory of the National Park. One of them was observed near the village of Simanickaja Rudnia near the river Svinavod in 01.05.2008 (Approximate coordinates 51°55'N 28°07'E). The second was found on 31.05.2008 in the Azeranskaje forestry, square 309, site 9 in birch forest with sedge and *Sphagnum* moss (51°59'14.4"N 27°58'43.8"E). The author did not provide data about the sex of the specimens or their age. In addition, we could not find the samples but the territory of the National Park "Prypiacki" seems to include many places with favourable conditions for *D. plantarius*. On the map issued in 2012 (available at http://www.npp.by/sertificat/map%20animals.php), there are four places in the park where *D. plantarius* is present including two sites mentioned by Chizhevskaya (2009). The data about other two records is unknown. Probably these are the first sites mentioned in the Red Data Book of 2006. Also, the sites mentioned in Moroz & Shavanova (2007) are not present in this scheme.

In one of the most protected National Parks of the Republic – Biełaviežskaja forest – the records are few but reliable. In 2007 one female was collected by J. Hihiniak on river Pravaja Lasnaja (52°27'"N 24°05'"E) and in 2011 one female was registered on the river Višnia near the village of Dziedaŭka, 52°28'57.9"N 24°01'23.8"E (Bajčoraŭ et al. 2011). The first specimen was examined and photos were taken (Fig. 1 b). Within the same collection of conference papers we found records of *D. plantarius* from the vicinity of Hrodna and Ščučyn by Ryžaja et al. (2011). No exact sites were mentioned, but we believe that the data presented are the same as that already published in 2006.

Savarin & Ostrovsky (2011) published data about several records from the south-east of Belarus. Their investigation was devoted to two spider species *D. plantarius* and *Argiope bruennichi* (Scopoli, 1772) in the Homel region. It was rather fruitful and the information presented was about three sites on different rivers. The first record was in June 2007 on the left bank of river Dniepr at the place where river Biarezina flows into it (between the villages Smyčok and Berahavaja Slabada, Rečycki district, 52°32'58.8"N 30°15'04.9"E) and on the right bank of river Biarezina several hundred meters above junction of these two rivers (52°32'58.8"N 30°15'04.9"E). The second site was on the right bank of river Vuza, in the Buda-Kašaloŭski district (August 2009). The third one was near the bay of the river Sož in the temporary water body of a gravel road, Homel city edge (August 2010). In the last two cases it was difficult to figure out even approximate coordinates. The authors also provided photos of general appearance of the spider (Savarin & Ostrovsky 2011).

One female was registered 22.05.2013 by Moroz and Laenko on the bank of river Słuč near the village of Pracevičy (52°56'37.4" N, 27°34'63.1"E) while conducting a survey of the invertebrate fauna of the rivers Słuč and Lakneja. The spider was collected with a hydrobiological net (Moroz & Laenko 2013). We could not examine the specimen.

Finally, Ostrovsky published his records of *D. plantarius* from south-east of Belarus in 2014. This work included records previously mentioned and one new site in south-west edge of Homel on the bank of river Sož (52°23'N 31°00'E) (Ostrovsky 2014).

Recent findings of *D. plantarius* in Belarus

Our own findings are presented in Tab. 1, some of which were already published (Ivanoŭ 2012). The genitalia of the available specimens are presented in Fig. 1. The only questionable record is a *D. plantarius* female from a pond near the biological faculty of the Belarusian state University. Therefore, the figures of the habitus and genitalia are presented separately for this case (Fig. 2). Also, the specimen collected by students from the Maksim Tank State Pedagogical University near Zialonaje village, Minsk region, approximately 30 km from Minsk, was an adult female but we could not track the precise

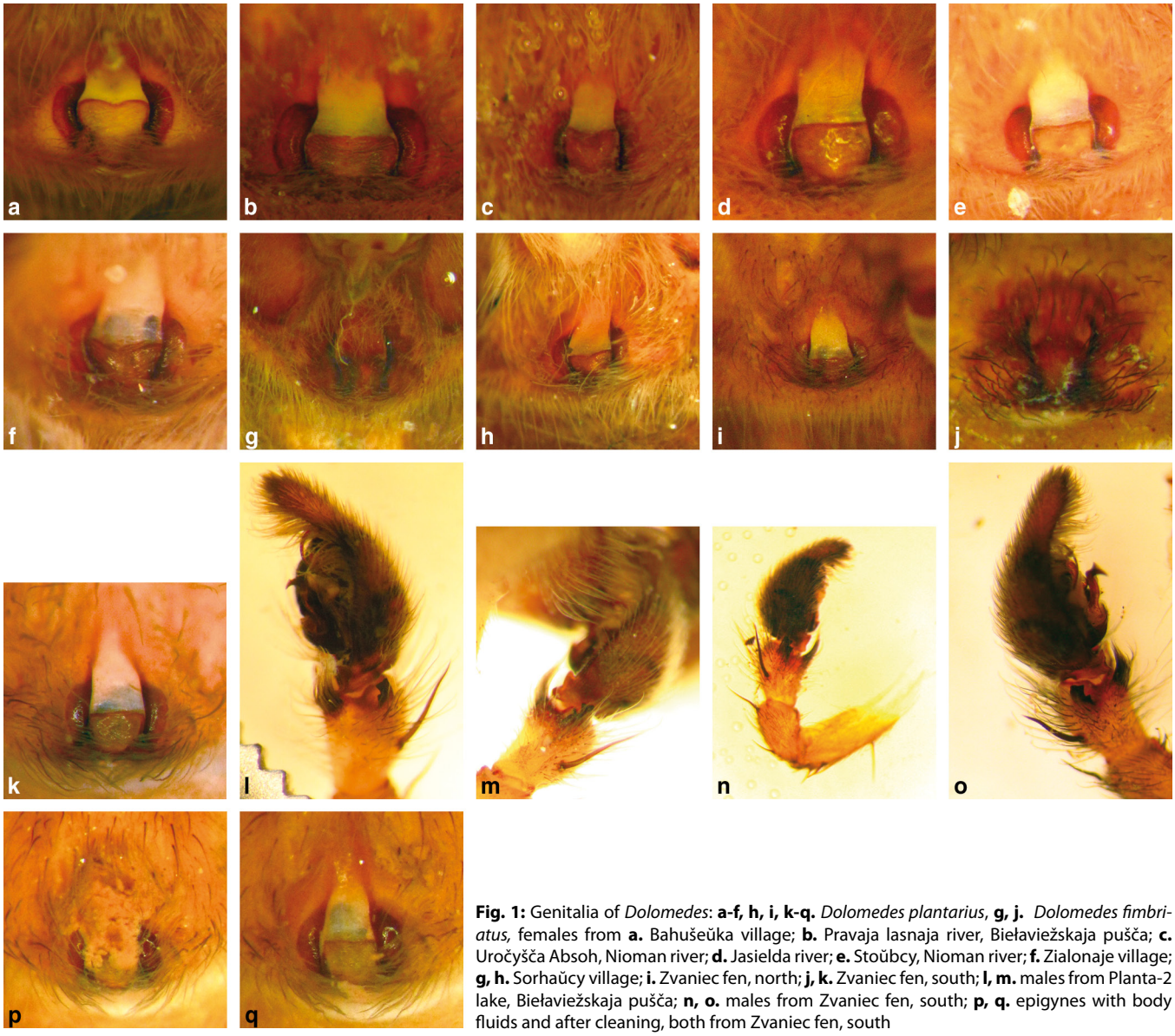

Fig. 1: Genitalia of *Dolomedes*: **a-f, h, i, k-q.** *Dolomedes plantarius*, **g, j.** *Dolomedes fimbriatus,* females from **a.** Bahušeŭka village; **b.** Pravaja lasnaja river, Biełaviežskaja pušča; **c.** Uročyšča Absoh, Nioman river; **d.** Jasielda river; **e.** Stoŭbcy, Nioman river; **f.** Zialonaje village; **g, h.** Sorhaŭcy village; **i.** Zvaniec fen, north; **j, k.** Zvaniec fen, south; **l, m.** males from Planta-2 lake, Biełaviežskaja pušča; **n, o.** males from Zvaniec fen, south; **p, q.** epigynes with body fluids and after cleaning, both from Zvaniec fen, south

site or conditions there. It is quite probable that the specimen was on the bank of river Čarnica, but we cannot be sure (epigyne, Fig. 1 f). We cannot provide exact coordinates, so the specimen is marked with "?" in the table.

The sites where *D. plantarius* was most abundant (though we did not collect many specimens due to conservation reasons) were the rivers Vilija (north-west), Rasta and Biesiedź (south-east) and Zvaniec fen (south). Within all of these sites both *D. plantarius* and *D. fimbriatus* occurred simultaneously. Near Planta-2 lake, which is situated in the National Park "Biełaviežskaja forest", only *D. plantarius* was found.

Interesting observation concerned the appearance of the epigyne in two cases of females from Zvaniec fen. The middle bright plate was covered with a pink-brown secretion which Harms et al. (2009) believe to be the remnants of some glandular activity while the female was laying eggs. Another possibility is that it was plain dirt. After removing the secretion there is no doubt about the characteristic features of the *D. plantarius* epigyne (Figs 1 p-q). However, such cases are mentioned rarely so unexperienced arachnologists might mistake examples with secretion as a *D. fimbriatus* epigyne without the bright white plate.

Distribution of *D. plantarius* in Belarus

According to the geography of our findings it seems that some groups of probable populations can be determined. Yet, it is impossible to set real boundaries between them now, as many records represent only the presence of a single specimen at a site, and distances between them are large. However, there might be one cluster of populations associated with the river Nioman and quite likely adjacent rivers and other water bodies. At least, *D. plantarius* was found practically along the whole length of the Nioman in Belarus. Another cluster seems to exist in the basin of the Dniepr river, including Sož, Biesiadź, and Biarezina of the large rivers that flow into it. Finally, there are populations within basin of the river Prypiać. The last two clusters are probably connected to each other. Population(s) on the river Vilija are quite likely to be isolated from other populations due to geographical barriers, as well as the northern ones if they really exist (Fig. 3). The majority of *D. plantarius* records in Belarus are associated with rivers or channels. At the same time the Zvaniec fen population of *D. plantarius* seems to be substantial and such biotopes may also be more favourable for this species. In Great Britain, all populations are associated with fens (Duffey 2012), similarly

Tab. 1: Summary of our records of *D. plantarius* in Belarus

Date	Water body	Coordinates	*D. plantarius* ♂/♀
09.07.2012	Nioman river	53°26'30.2"N 24°44'23.9"E	-/1
09.08.2012	Jaselda river	52°07'02.68"N 26°26'44.83"E	-/1
25.06.2013	Planta-2 lake	52°34'29.8"N 23°46'40.0"E	3/-
15.07.2013	Nioman river	53°29'57.0"N 26°39'03.8"E	-/1
09.2013	?, Minsk region	?	-/1
12.09.2013	Vilija river	54°46'30.7"N 26°12'36.1"E	-/1
05.06.-18.08.2014	Zvaniec fen	52°04'43.6"N 24°49'51.4"E and 52°05'42.0"N 24°52'55.2"E	3/6
14.06.2014	BSU, pond	53°50'10.7"N 27°28'01.4"E	-/1?
06.2015	Rasta river	53°45'93.41"N 30°42'43.61"E	1 specimen per transect 100 × 5 m along both river banks
06.2015	Biesiedź river	53°21'45.24"N 32°26'50.87"E	
06.2015	Biesiedź river	53°11'91,839"N 31°54'09,550"E	
06.2015	Biesiedź river	53°17'05,78"N 32°11'35,81"E	
06.2015	Biesiedź river	53°19'50,78"N 32°00'67,70"E	

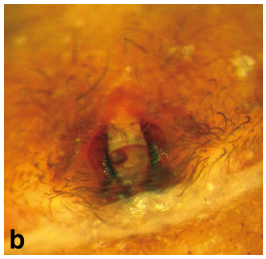

Fig. 2: *Dolomedes cf. plantarius* from vicinity of biological faculty of BSU. **a.** habitus; **b.** epigyne

in the Czech Republic, the few known populations live in the littoral zone of ponds and cut-off meanders (Buchar & Růžička 2002). It is known that practically no specialists in Belarus have ever tried to find *D. plantarius* intentionally and it was often collected occasionally while scientists were conducting other more general research. In fact, there was no specific work ever devoted to spiders of fens or bogs in Belarus.

Despite the fact that our, and previous, investigations have not yielded many specimens it is obvious that *D. plantarius* is widespread in Belarus. In short, it is present everywhere except for the north-east of the country. In 2013 we travelled through several districts of the Viciebsk region including the Western Dźvina and Dzisna rivers and did not find any specimens. However, our investigation was very short and we cannot be sure that *D. plantarius* is absent there. In addition, such large rivers as the Western Buh, Drysa, Uła, Ubarć, Druć, Pina, Łań, Ščara and many others have never been examined along with numerous fens and lakes in the territory of Belarus. Another important observation is that both species of *Dolomedes* may occur simultaneously within the same biotope. Such results were reported before (Holec 2000), but in this case the author was very careful in stating that the species coexist. We observed no differences in patterns of distribution of the two species and it seems that it is common for both of them to share the same biotope. At least within three of the most densely populated biotopes (the rivers Vilija, Biesiedź and Zvaniec fen) *D. plantarius* and *D. fimbriatus* were found together. The next step is to look at the dynamics of both species in order to evaluate competition rates and their actual preferences in terms of abiotic factors.

It is our strong belief that Belarus has many potential sites where *D. plantarius* might be present and that its populations are big and healthy. Previous lack of records is explained simply by lack of interest from the side of specialists and amateurs as well as a lack of specialists themselves. It is obvious that the importance of Belarus for conservation purposes is underestimated by specialists from Western Europe, while the country has plenty of water bodies suitable for the species. There are more than 20 000 rivers, 10 000 lakes and numerous swampy areas (more that 14 % of the territory of the country!). The territory of Belarus is practically equal to the territory of Great Britain but the human population is 6 times lower which ensures the safety of natural biotopes simply by the inability to destroy it. Also, 8 % of the territory is already protected and as soon as *D. plantarius* is included in The Red Book of Belarus every record is a legal reason to confer conservational status to a particular territory and increase the total amount of protected areas. Models that predict distribution and dynamics of *D. plantarius* in Europe (Leroy et al., 2013) underestimated the presence of the species in Belarus and probably the calculations were slightly wrong, however, the general trend is correct. If the populations will shift in time to the east and north of Europe due to climate change, newcomers will find the sites already occupi-

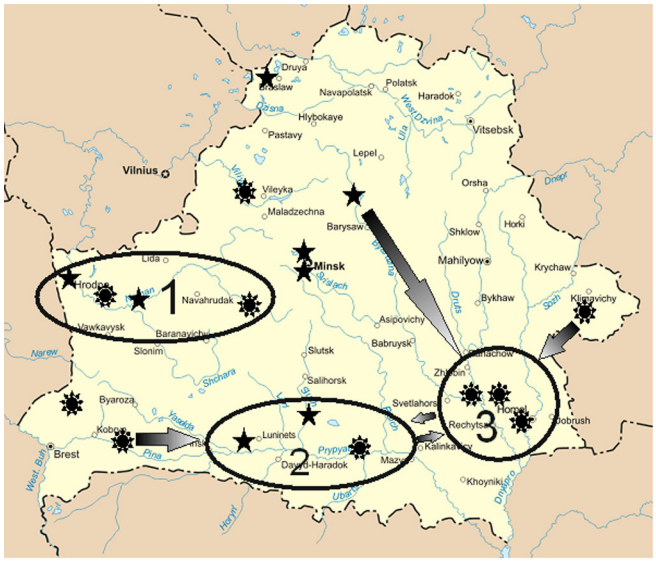

Fig. 3. The scheme of *Dolomedes plantarius* distribution in Belarus. Five-pointed stars – single specimen, multiple-pointed stars – several specimens. Areas marked with black lines – probable populations' clusters (**1** – Nioman cluster, **2** – Prypiać cluster, **3** – Dniapro cluster). Arrows – probable connections between clusters.

ed and we can expect admixture between them. However the consequences are hard to predict.

To sum up, if there is a strong intention to save *D. plantarius* in Europe it is essential that not only Belarusian specialists will be involved in investigation of this species within Belarus itself, but all interested legal bodies and scientists across the Europe.

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We sincerely thank Jury Hihiniak and Vital Łukin for providing specimens, Oleg Borodin for logistics help, Eric Duffey for providing literature, Marko Mutanen for advice and criticism of an early version of the manuscript and Mohamed bin Zayed Species Conservation Fund for financial support (Project number 13256173).

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Uloborus walckenaerius and *Oxyopes heterophthalmus* in Poland (Araneae: Uloboridae, Oxyopidae)

Konrad Wiśniewski & Angelika Dawidowicz

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Abstract. We report the presence of *Uloborus walckenaerius* Latreille, 1806 and *Oxyopes heterophthalmus* (Latreille, 1804) in Poland. Two females and a juvenile of *U. walckenaerius* and a male of *O. heterophthalmus* were recorded in a heathland in the western part of the country, in Lower Silesia. Both species are known from similar habitats in neighbouring regions in eastern Germany (Brandenburg and Saxony). Heathlands in Poland may have great importance in maintaining populations of these two species, and some other rare invertebrates. The habitat requires management activities.

Keywords: Central Europe, faunistics, former military area, heath, prescribed fire

Zusammenfassung. *Uloborus walckenaerius* und *Oxyopes heterophthalmus* in Polen (Araneae: Uloboridae, Oxyopidae). Wir weisen *Uloborus walckenaerius* Latreille, 1806 und *Oxyopes heterophthalmus* (Latreille, 1804) erstmals für Polen nach. Zwei Weibchen und ein Jungtier von *U. walckenaerius* sowie ein Männchen von *O. heterophthalmus* wurden in Heidegebieten Westpolens/Niederschlesiens gefunden. Beide Arten sind bereits aus ähnlichen Lebensräumen im benachbarten Osten Deutschlands (Brandenburg und Sachsen) bekannt. Die *Calluna*-Heiden Polens spielen für den Schutz beider Arten, wie auch für andere seltene Wirbellose, eine wichtige Rolle. Für den Erhalt des Lebensraumes sind Managementmaßnahmen notwendig.

Protection of heathlands in Europe has recently become an important topic. This issue has also been discussed in the context of spider populations (Krause et al. 2011), communities (Bell et al. 2001), or ecology of different arthropod groups, also taking different heathland types into account (Fartmann et al. 2015). Large-area heathlands in western Poland are situated mostly in former, and still actively used, military training areas and are anthropogenic. Nevertheless, these habitats are considered valuable and the need to prevent natural succession has been discussed. In 2015 a plot of heather in Lower Silesia (W Poland) was rejuvenated using prescribed burning and a subsequent inventory of the flora and fauna in the plot, and in some adjacent habitats, was carried out. In the course of this research we observed two spider species that had not been recorded from the territory of Poland before: *Uloborus walckenaerius* Latreille, 1806 from the family Uloboridae and *Oxyopes heterophthalmus* (Latreille, 1804) from Oxyopidae. The aim of this article is to document these records and to discuss them in the context of heathland protection issues.

Only two members of the family Uloboridae have been reported from Poland to date: *Hyptiotes paradoxus* (C. L. Koch, 1834) and *Uloborus plumipes* Lucas, 1846 (Nentwig et al. 2017). The previous species was sporadically recorded in different parts of the country (Kupryjanowicz 2008), the latter is a typical synanthropic spider in the Central Europe and it is regularly observed in greenhouses and plant markets (Stankiewicz & Kupryjanowicz 2002, Rozwałka 2007, Rozwałka et. al 2013). The newly found spider – *Uloborus walckenaerius* – is a Palaearctic species (World Spider Catalog 2017). It has been recorded from neighbouring countries – i.e. the Czech Republic, Germany, Slovakia and Ukraine (Nentwig et al. 2017). The only oxyopid species known in Poland to date was *Oxyopes ramosus* (Martini & Goeze, 1778). It is not a rare spider and – besides being spotted in diverse habitats – it is known to be very common in heathlands (Nentwig et al. 2017). *Oxyopes heterophthalmus* is a decidedly rare species near its northern range border. Its known localities – for example in Germany (Arachnologische Gesellschaft 2017) or in southern England (British Arachnological Society 2017) – are extremely scarce or scattered.

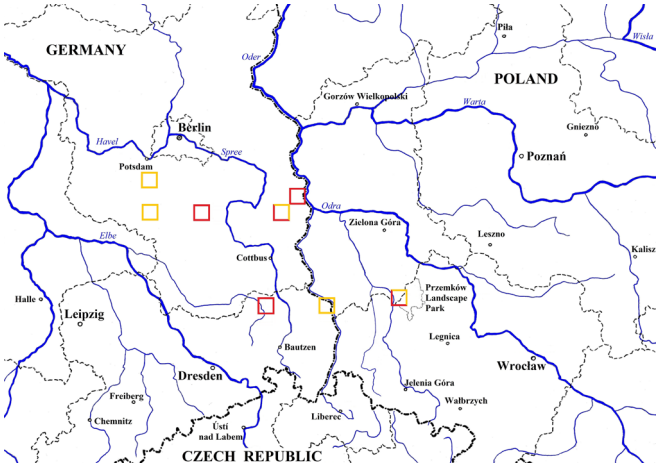

Fig. 1: Sites, where *Uloborus walckenaerius* (red frames) and *Oxyopes heterophthalmus* (yellow frames) were recorded in Brandenburg and Saxony (after the Arachnologische Gesellschaft 2017) and their new locality in Poland (UTM square: WT40). Main rivers and cities, country and voivodeship/Land borders are depicted. The area of the Landscape Park of Przemków is also shown (small dots).

Site and sampling methods

The heathland is situated in the middle part of a former military training area, which was used until the early 1990s (N51°28'04", E15°42'09", 150 m a.s.l.; western Poland, northern part of Lower Silesia Voivodeship; Fig. 1). These habitats are protected within the Przemków Landscape Park and are also the part of the Natura 2000 network ('Wrzosowisko Przemkowskie'; PLH020015). Many large-area heath patches, which have not undergone succession by Scots pine or birch yet, can still be found there. Prescribed burning was applied to rejuvenate one, ca. 4.5 ha large, old heather plot on 18 March 2015. We carried out a subsequent fauna survey of

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Figs 2-3: *Uloborus walckenaerius*, female habitus. **2.** Dorsal, **3.** Ventral

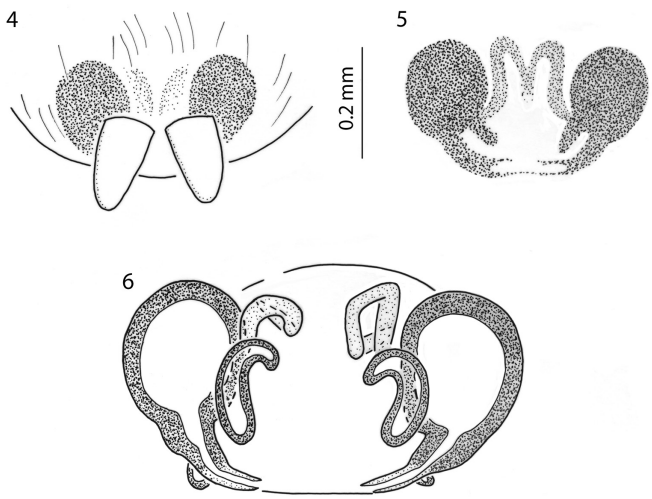
the area using pitfall traps (seven per plot) in the burned plot, in the neighbouring heather and a stand of the grass *Molinia caerulea* (L.) Moench. The traps were exposed all year round. Additionally, we sampled invertebrates form heather, *Molinia* and pine trees (burned and living) with a sweep net. A beating net was used to take samples from trees; we also sampled invertebrates by beating them from heather and grass onto a metal bowl. Some other neighbouring habitats were also investigated by sweep-netting.

The records

Two females and one juvenile of *Uloborus walckenaerius* were found. The species has a very characteristic habitus (Figs 2-3) and genitalia (Figs 4-6). We collected the specimens either with a sweep-net (on 29 May 2015, 28 May 2016 – females) or by sampling with a metal bowl from heather (on 16 September 2016 – juvenile). The three specimens were found in places dominated by heather *Calluna vulgaris* (L.) Hull: in one case this was a patch of compact, old *Calluna*-shrubs (Fig. 7); in the other – a dune fairly densely covered with heather; the juvenile was found in small *Calluna* upgrowth (Fig. 8), 18 months after prescribed fire was applied to rejuvenate heather in this plot.

Oxyopes heterophthalmus is easily distinguished from its congeners by the genital structure (Fig. 9-12). The single male of this species was found in a pit-fall trap in the plot where prescribed burning was applied (Fig. 8). The exposure time of the trap was 28 May – 21 June 2016, i.e. about 14 months after the fire.

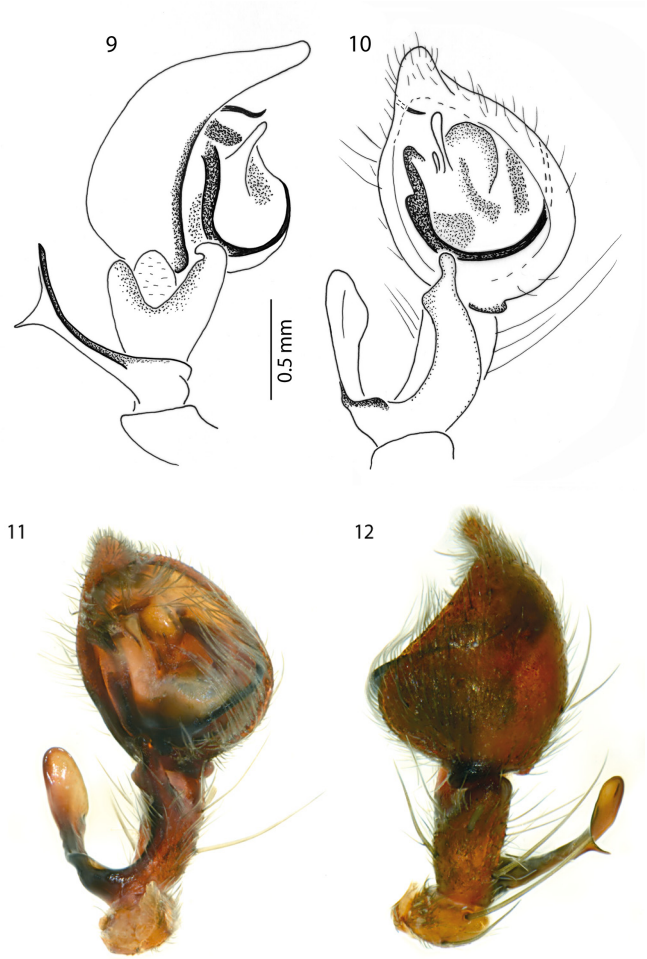
Figs 7-8: Heathland, habitat of *Uloborus walckenaerius*. **7.** Mature heathland with compact *Calluna*, **8.** Regenerating heathland, 17 months after applying prescribed burning (25 Aug 2016)



Figs 4-6: Epigyne of *Uloborus walckenaerius*. **4.** External view, **5, 6.** Internal structures (ventral view)

Discussion

Both species are known from neighbouring countries and their occurrence in Poland was to be expected. They were recorded in Saxony and Brandenburg (Platen et al. 1999, Balkenhol & Haase 2013, Kielhorn 2016, Arachnologische Gesellschaft 2017) fairly close to the country border. These two regions share similar habitats, there is also a plenty of former and contemporary military training areas where large heathland patches persist. *Uloborus walckenaerius* was also recorded at similar latitudes to the present location, for example in the southern part of England (Locket & Millidge 1951, Denton 1999a, British Arachnological Society 2017), in Belgium and the Netherlands (van Helsdingen 1999). It is rare in Central Europe – in Germany the species was reported from just few places (Arachnologische Gesellschaft 2017); in the Czech Republic it was only found in the southern part of Moravia (Czech Arachnological Society 2017). *Oxyopes heterophthalmus* has similar distribution to that of *U. walckenaerius* in this part of Europe, but it seems to be even rarer, as shown by the example of the British Isles – where it is present in only few



Figs 9-12: *Oxyopes heterophthalmus*, male palp. **9.** Retrolateral view, **10, 11.** Ventral, **12.** Dorsal

places in southern England (British Arachnological Society 2017) – and Germany (Arachnologische Gesellschaft 2017).

The two species have quite clear habitat preferences in the northern part of their range, as they prefer warm and dry habitats. *Uloborus walckenaerius* is generally recognized as a xerothermic and thermophilous species (Platen et al. 1999, Buchar & Růžička 2002). The majority of records from the British Isles (Locket & Millidge 1951, Denton 1999a, British Arachnological Society 2017) and Germany (Platen et al. 1999, Kielhorn 2016, Nentwig et al. 2017) come from heather. In the Czech Republic it was found predominately in different sandy habitats (Růžička 1998, Buchar & Růžička 2002, Hula et al. 2014). In Ukraine it was most numerous in sandy steppes (Polchaninova 2012). It is worth remembering that some of the habitats where *U. walckenaerius* was found have been created by human activity (Weber 1999, Hula et al. 2014); the majority of heathlands in Poland are also anthropogenic. *Oxyopes heterophthalmus* was also recorded in heathlands both in England (Denton 1999b, British Arachnological Society 2017) and in Germany (von Broen 1995, Balkenhol & Haase 2013, Kielhorn 2016), which confirms its affinity to these habitats in this part of Europe.

Due to their rarity and preference for particular habitats the two species have been included into several Red Lists. *Uloborus walckenaerius* has high ranks in some European countries (EN in the Czech Republic – Řezáč et. al. 2015; seriously endangered in Germany – Blick et al. 2016) or regions, e.g. Brandenburg (endangered from extinction; Platen et al. 1999). However in comparison to previous versions of these list, it has been given lower categories, because of an increase in its abundance (Řezáč et. al. 2015), better availability of information on its distribution or changes in the methodology of preparing such lists (Blick et al. 2016). *Oxyopes heterophthalmus* was also included in some lists as extremely rare (Blick et al. 2016) or endangered from extinction (Platen et al. 1999).

The presence of the two species in this part of Poland is important with respect to nature protection. In the neighbouring countries the species are rare, endangered and regarded as valuable. They might be considered as characteristic for heathlands. These habitats require management activities as they quickly undergo succession by pine and birch forest, and there is also the need for rejuvenation of heather. The other concern is the expansion of *Molinia caerulea* grasslands – a problem on the European scale (Chambers et. al. 1999, Brys et al. 2005). In the heathlands of Przemków pine and birch overgrowth is regularly cut down. Lately, prescribed fire and choppering were experimentally applied to rejuvenate the heath (the part of our study). In other studies these methods were found to be appropriate to protect habitats of another endangered species – also present in our study – *Eresus kollari* Rossi, 1846 (Krause et al. 2011). Burning the heather may create suitable habitats for a high number of valuable spider species (Krause & Assmann 2016). Another example of a rare species present in the area is a salticid protected under Polish law – *Philaeus chrysops* (Poda, 1761), which lives both in the former and the presently used military training areas (Wiśniewski et. al 2015).

Former and actively used military training areas thus often serve as refugia for disturbance dependent species (Warren & Büttner 2008) and valuable invertebrate assemblages (Čížek et al. 2013), including spiders (Buchholz & Hartmann 2008, Lemke 2017). The protection of anthropogenic habitats present in these areas may raise some ambiguities in terms of its scope and methods. However, the results may be important not only for biological diversity but also to local human communities, as the example of heather honey production in Poland shows. The presence of *U. walckenaerius*, *O. heterophthalmus*, the above mentioned *P. chrysops*, and many other rare species are important reasons to undertake management activities of heathlands in this region.

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The Emperor is back! Rediscovery and redescription of the holotype of *Pandinus imperator* (Scorpiones: Scorpionidae)

Joachim Holstein, Ingo Wendt & Andrea Rossi

doi: 10.5431/aramit5410

Abstract. The holotype of the Emperor Scorpion *Pandinus imperator* (C.L. Koch, 1841) was long believed to have been lost. In 2015, as scientists at the State Museum of Natural History in Stuttgart were digitizing its entomological collections, they rediscovered the specimen on which Koch had based his description of the scorpion in 1841.

Keywords: *Buthus imperator*, Emperor Scorpion, lost type, State Museum of Natural History Stuttgart

Zusammenfassung. Der Kaiser ist zurück! Entdeckung und Wiederbeschreibung des Holotyps von *Pandinus imperator* (Scorpiones: Scorpionidae). Der Holotypus des Kaiserskorpions *Pandinus imperator* (C.L. Koch, 1841) galt lange Zeit als verschollen. Im Zuge der Sammlungsdigitalisierung am Staatlichen Museum für Naturkunde in Stuttgart wurde das Exemplar 2015 wiederentdeckt, das Koch für seine Beschreibung 1841 zur Verfügung stand.

The Emperor Scorpion is one of the world's most famous scorpions mainly due to its large size. Its impressive size, together with the large chelate pedipalps, harmless sting and its easy breeding in captivity, led this species to become a popular pet for arachnid keepers. Therefore, the ever increasing demand of this species for breeding has led to it being added to the list of animals protected by the Washington Convention (Lourenço & Cloudsley-Thompson 1996, Rossi 2015b, 2015d).

In the wild, the species is distributed in the moist and wet tropical forests of West and Central Africa, approximately from Liberia to Cameroon (Prendini 2004, Rossi 2015b). However, its precise distribution has by no means yet been conclusively determined.

The type specimen of *Pandinus imperator* was considered lost (Moritz & Fischer 1980, Lourenço 2014). During the digitalization of the collections at the State Museum of Natural History in Stuttgart, a drawer labelled "Holotypus: Buthus imperator KOCH 1842" containing several scorpions turned up. One of these scorpion specimens bore great resemblance to Koch's description (Koch 1841) and coloured drawing (Figs 1-2).

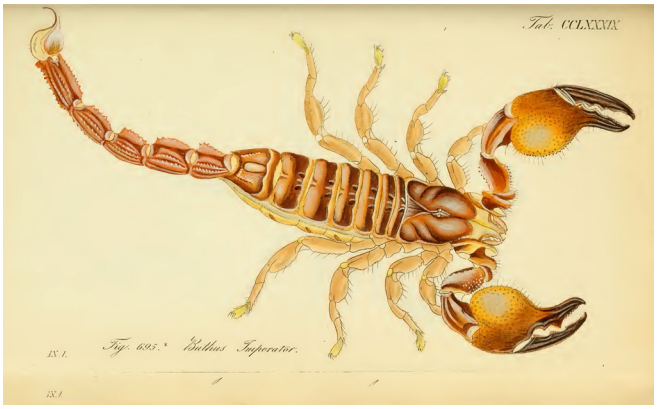

Fig. 1: *Pandinus imperator*, hand-coloured plate of the holotype specimen from Koch (1841: Plate 289)

Fig. 2: *Pandinus imperator*, photograph of the holotype (SMNS-Scor-002031) and the label attached

Material and methods

The type specimen is inventoried at the SMNS as SMNS-Scor-002031. Measurements are callipered according to the plate (Fig. 3). Morphological terminology mainly follows Hjelle (1990). The classifications of family, subfamily and tribe follow Rossi (2016). High quality images of type specimen details are available at http://ent.smns-bw.org/drawer/Entomologie-drawers_Arachnida.htm. Abbreviation: SMNS = Staatliches Museum für Naturkunde, Stuttgart, Germany.

Results

Having considered all the available evidence, we conclude that the specimen in question is the holotype of *Pandinus imperator*. It agrees well with both the original description and the original illustration (colour, total length, 16 pectinal teeth, etc., see Figs. 2-4) (Koch 1841). The colour of the specimen agrees with the hand-coloured figure on Koch's plate and ranges from brown to ochre. In our opinion, this could be due to bleaching. Koch described the specimen from the Erlangen University collection, where it had possibly been presented in an earlier exhibition. Unfortunately, no locality is indicated on the label nor in the original description.

In the original description, the length is given in units, possibly lignes or Pariser Linien "' (Paris lines = 1/12 pouce) and French Zoll " (inches or pouce) that were in use in various sciences after the 18th century: 1 Linie (line) = 2.2558 mm and 1 Zoll (pouce) = 2.7069949 cm.

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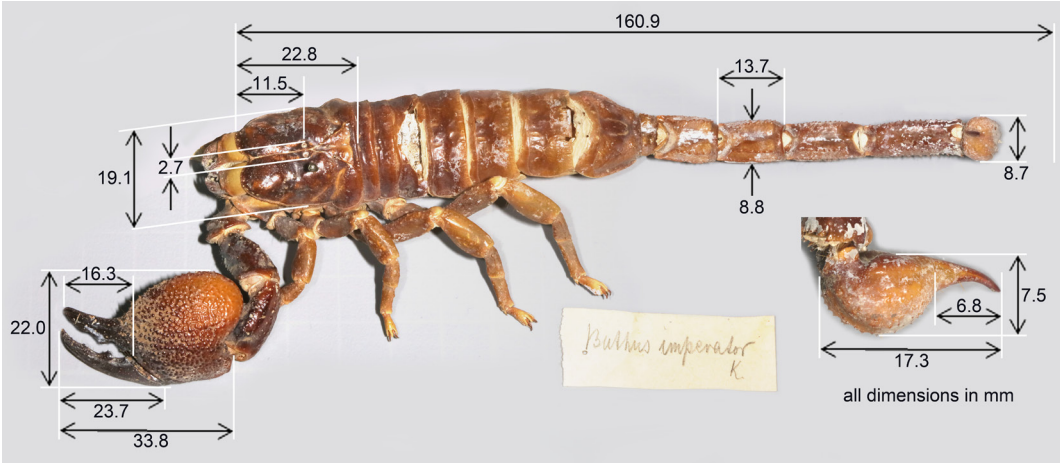

Fig. 3: *Pandinus imperator*, photograph of the holotype with measurements

Fig. 4: *Pandinus imperator*, photograph of the pectines

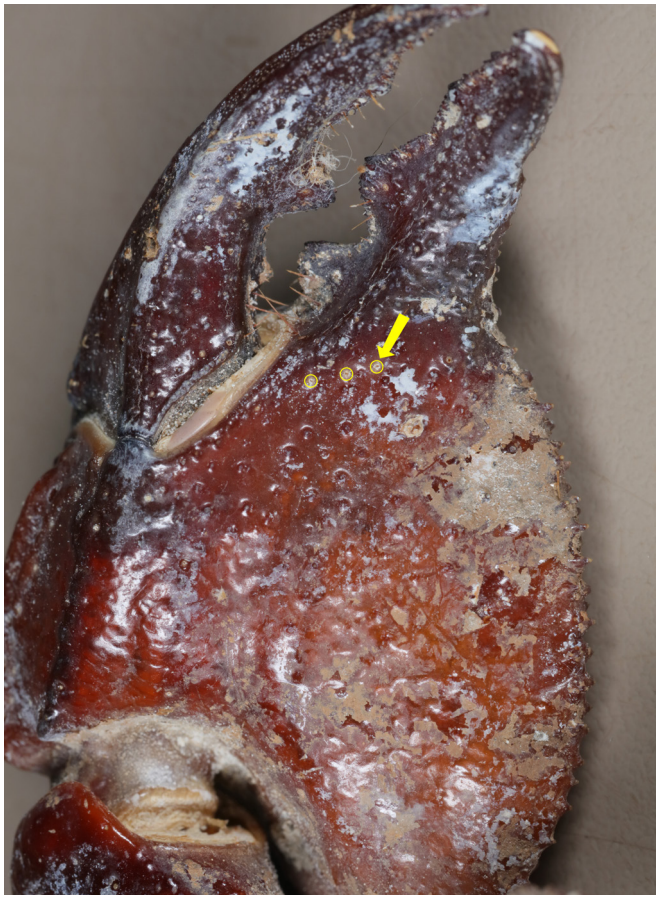

Fig. 5: *Pandinus imperator*, internal surface of right chela, trichobothria marked with yellow rings (yellow arrow)

Fig. 6: *Pandinus imperator*, ventral surface of right chela, trichobothria marked with yellow rings

The dimensions specified by Koch (1841) are as follows: head: 10 ½ ‴ = 23.69 mm, body: 24 ‴ = 54.14 mm, tail: 36 ‴ = 81.21 mm, rendering a total length of 159.04 mm; Koch also reported the total length to be almost 6 ″ = <162.4 mm (or 175.12 mm when using the Bavarian decimal Zoll).

Recent measurements: prosoma: 22.8 mm, mesosoma: 56.4 mm, metasoma and telson: 81.7 mm (i.e., including vesicle and aculeus, with the length of the first segment interpolated); total length: 160.9 mm (measured by a vernier calliper, in view of the fact that the telson is coiled up; see Fig. 3).

Fig. 7: *Pandinus imperator*, ventral surface of right patella, trichobothria marked with yellow rings. High quality images of these details are available at http://ent.smns-bw.org/drawer/Entomologie-drawers_Arachnida.htm

Most of the first metasomal segment of the specimen is missing. The metasoma has been torn from the mesosoma and is now connected by a straw. This was probably as a result of later handling since there is no reference to any damage in Koch's (1841) description. A comparison with the plate figure makes it clear that the tip of the stinger also suffered subsequent damage (Fig. 3).

As Koch's method of measurement for the carapace, mesosoma, metasoma and telson is not clear, the measurements do not agree completely with the specimen. It is also feasible that Koch used a different measuring unit than that assumed (e.g., 'Bavarian lines', 'Rheinland Zoll'). The total length nevertheless appears to be consistent with the value measured in the rediscovered specimen. If we take into account the missing part of the first metasomal segment and the broken aculeus, the possible total length of the specimen is approximately 170 mm, similar to that reported by Koch using the Bavarian decimal Zoll. On the other hand, if Koch used the French Zoll, the total length adheres to the values which can now be measured in the damaged specimen. This being the case, the original drawing was possibly manipulated to represent a complete specimen despite the missing parts.

Taxonomy
Family Scorpionidae Latreille, 1802
Subfamily Pandininae Thorell, 1876
Tribe Pandinini Thorell, 1876
Genus *Pandinus* Thorell, 1876
Pandinus imperator (C.L. Koch, 1841)
(for the historical references until 1998, see Fet et al. 2000)

Redescription of the holotype
Type material: ♂ holotype (dry, SMNS-Scor-002031), unknown locality.
Description: Measurements in Fig. 2. Total length 160.9 mm. [Possible total length including the missing broken parts about 170 mm.] Base colour brown to reddish brown; pedipalp brown to reddish brown with chela palm yellowish to orange-brown and fingers brown; carapace brown; tergites brown; sternites yellowish brown; pectines and genital operculum pale yellow; legs from brown (femur) to yellowish (tarsomere); chelicerae yellowish with fingers brown; metasoma brown and telson yellowish to brown. Carapace with many fine granules mainly on anterior and lateral sides. Carapace with a V furrow on its anterior border and a low triangular median depression on the posterior side. Median eyes grey and closer to posterior border of carapace. Lateral eyes three in number and grey. Tergites generally smooth with some fine granules on VII tergite. Sternites smooth. Stigmata very long and narrow. Genital operculum is damaged. Pectines with 16/16 teeth form an angle of approximately 120°. Sternum pentagonal almost identical in length and width. Coxoapophysis of reddish yellow and longer than wide. Chelicerae with two denticles on the fixed finger and four denticles on the movable finger (Vachon 1963). Pedipalps with very few and short setae, on chela fingers only. Trochanter and femur tuberculated on anterior and superior side. Patella generally smooth. Chela very wide and round, dorsally with rounded granules, rarely conical or pointed; ventral surface with several granules. Chela with 3 internal trichobothria (Fig. 5) and 9 ventral trichobothria (Fig. 6). Patella with 32 ventral trichobothria (Fig. 7). These numbers correlate on left and right pedipalp. Fixed and movable fingers all have six/seven subrows of granules which forms a single line. Type C trichobothrial pattern (Vachon 1974). Tarsomere II with 2 spines on the inclined antero-ventral surface. Spine formula of tarsomere II: 4/3: 4/3: 4-5/3: 4-5/3. Metasomal segments with 8-8-8-8-7 carinae; latero-ventral carinae almost completely absent on segments I, II, and III. Ventral carinae smooth on segments I, II, and III, with some granules on segment IV and moderately pointed on segment V. Dorsal carinae on metasomal segments pointed. All segments longer than wide but metasomal segment I badly damaged and cannot be studied. Telson with only a few short setae. Vesicle piriform; its ventral surface showing several granules. Aculeus long, but broken at the tip.

Discussion
The specimen undoubtedly belongs to what is presently known as the species *P. imperator*. In fact, it clearly differs from the two most closely related species, *Pandinus ulderigoi* Rossi, 2014 from the Central African Republic and *Pandinus gambiensis* Pocock, 1900 from Senegal, Mali, Guinea-Bissau and Gambia (Vachon 1967, Rossi 2014, 2015a, 2015b, 2015c, 2015d).

There has been some confusion as to the correct year of description for *Buthus imperator*; a matter already discussed by Brignoli (1985). Although Koch's 9th Volume of "Die Arachniden" was published in 1842, the first 56 pages, containing the description of *Buthus imperator,* had already been published in 1841. Due to article 21.5 of ICZN (2017) the year 1841 is therefore correct.

The newly discovered insect drawer containing the holotype of *Buthus imperator* contains 18 other scorpion specimens, only some of which are labelled (see http://ent.smns-bw.org/drawer/Entomologie-drawers_Arachnida.htm). While further examinations revealed that the labelled specimens and their descriptions did not tally particularly well, the specimen of *Androctonus margarelon* C.L. Koch, 1838 corresponds well to Koch's (1838) description. In particular, its damaged pectines are explicitly mentioned by Koch. The type of *A. margarelon* had also been considered lost (Fet et al. 2000) and the species was treated as a junior synonym of *Hottentotta hottentotta* (Fabricius, 1787) by Kraepelin (1891). Furthermore, two specimens labelled as *Buthus reticulatus* and *Tityus hottentotta* fit Koch's descriptions (Koch 1837, 1845), while others (*Opistopthalmus* [sic] *capensis* (Herbst, 1800) in Koch (1837), *Tityus mucronatus* (Fabricius, 1798) in Koch (1845), *Androctonus paris* C.L. Koch, 1838 in Koch (1838), and *Ischnurus australasiae* (Fabricius, 1775) in Koch (1837), do not seem to resemble the specimens on which his descriptions are based. The unlabeled specimens have not yet been examined.

It remains a mystery as to how these specimens found their way into the collection at the National History Museum in Stuttgart in the first place. The SMNS is starting a project to digitize its archives of printed and handwritten historical documents. We hope, these efforts will also result in hints to clarify the accession of these scorpion specimens.

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First record of the jumping spider *Icius subinermis* (Araneae, Salticidae) in Hungary

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Abstract. We report the first record of *Icius subinermis* Simon, 1937, one female, from Budapest, Hungary. We provide photographs of the habitus and of the copulatory organ. The possible reasons for the new record and the current jumping spider fauna (Salticidae) of Hungary are discussed. So far 77 salticid species (including *I. subinermis*) are known from Hungary.

Keywords: distribution, faunistics, introduced species, urban environment

Zusammenfassung. Erstnachweis der Springspinne *Icius subinermis* (Araneae, Salticidae) aus Ungarn. Wir berichten über den ersten Nachweis von *Icius subinermis* Simon, 1937, eines Weibchens, aus Budapest, Ungarn. Fotos des weiblichen Habitus und des Kopulationsorgans werden präsentiert. Mögliche Ursachen für diesen Neunachweis und die Zusammensetzung der Springspinnenfauna Ungarns werden diskutiert. Bisher sind 77 Springspinnenarten (einschließlich *I. subinermis*) aus Ungarn bekannt.

The spider fauna of Hungary is well studied (Samu & Szinetár 1999). Due to intensive research and more specialized collecting methods, new records frequently emerge. Some of these new species are indigenous, others are newcomers. International trade is one of the most important factors that contribute to the spread of invasive arthropod species, including spiders (Nedvěd et al. 2011). In addition, climate change may also facilitate the establishment of exotic species originating from warmer areas (Nentwig 2015). Due to a warmer climate, Mediterranean spider species have extended their range northwards (e.g. Kumschick et al. 2011, Nedvěd et al. 2011). Among 87 introduced alien spiders, 44 expanded their range from the Mediterranean or the Eastern Palaearctic to western and northern Europe (Kobelt & Nentwig 2008).

Jumping spiders (Salticidae) are one of the most common spider families (after Theridiidae and Pholcidae) in which species are indicated as alien (Nentwig 2015). Salticidae is the richest family worldwide with over 620 genera and more than 5900 described species (WSC 2017). Within Salticidae, the genus *Icius* comprises 34 described species (WSC 2017) and five *Icius* species are confined to the Mediterranean region of Europe (Nentwig et al. 2017). Two of them, *I. hamatus* (C.L. Koch, 1846) (Tomasiewicz & Wesołowska 2006, Schäfer & Deepen-Wieczorek 2014) and *I. subinermis* Simon, 1937 (Jäger 1995, Helsdingen 2006) have also been reported from Central and Western Europe in recent years. No representatives of *Icius* have been found in Hungary until now (Szűts et al. 2003, Helsdingen 2017).

Material and methods

The arthropod community of *Acer campestre* was surveyed in a green area of Budapest (Mátyás tér, 47°29'32"N, 19°4'48"E, 110 m a.s.l.), Hungary, in the growing season of 2016. This area is covered by trees (e.g. *Acer* spp., *Fraxinus* spp., *Robinia* spp.), small bushes (e.g. *Berberis* spp., *Juniperus* spp., *Rosa* spp.), grassy patches and concrete surfaces, and surrounded by multi-storey buildings and traffic roads.

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The specimen was collected on June 22nd 2016 using the beating method. The study was carried out at the Department of Entomology of Szent István University. The specimen was examined with Leica MZ6 and photographed with a Sony XCD-SX90CR camera attached to a Zeiss Stemi stereomicroscope. We used the key available in Alicata & Cantarella (1994) for identification. The female vulva was prepared and macerated with 20 % KOH and photographed with a Zeiss Imager A2 light microscope equipped with AxioCam MRc5. Measurement are given in millimetres. The specimen was deposited in the second author's private collection.

Results

The adult female jumping spider specimen was identified as *Icius subinermis* Simon, 1937 (leg. D. Korányi, det. L. Mezőfi). The specimen's general appearance is shown in Fig 1. The

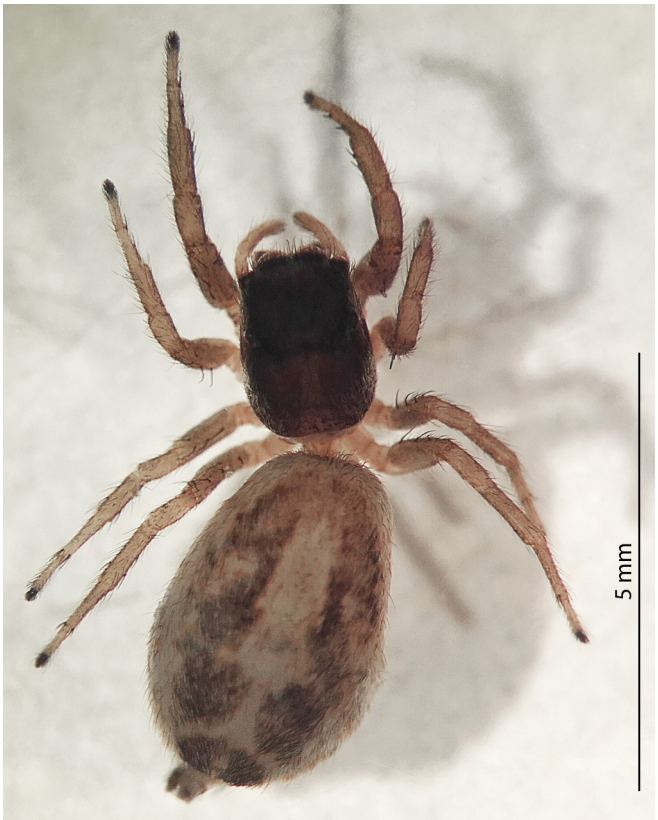

Fig. 1: *Icius subinermis* female general appearance, dorsal view

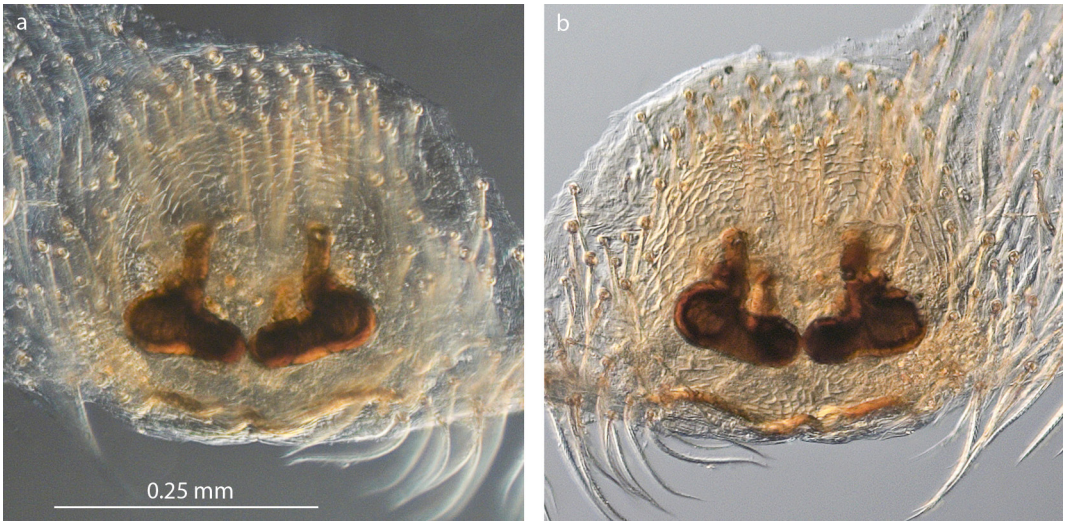

Fig. 2: Cleared, dissected epigyne/vulva of *Icius subinermis* female from Hungary; **a.** epigyne, ventral view; **b.** vulva, dorsal view

specimen's opisthosoma has a light brown or off-white tincture and reddish-brown spots which form a horseshoe-shaped pattern. The epigyne and vulva are shown in Fig. 2.

Discussion

Icius subinermis is known from Spain, France (including Corsica), Italy (including Sicily and Sardinia), Portugal, Macedonia, Slovenia, Switzerland (Helsdingen 2017), Germany (Blick et al. 2016) and Serbia (Stanković 2012). *I. subinermis* was also reported from the Netherlands (Helsdingen 2006) and recently from the Czech Republic (Šich 2015) although its establishment has not been confirmed in these two countries.

This species generally occurs in moist habitats, for example near streams or on moist meadows. It builds a silken retreat on rush plants or under rocks near rivers or creeks (Stanković 2012). It may also occur on trees, especially in the vegetation bordering aquatic environments, but is usually present at the waterside at the time of its reproduction. Females are often seen guarding their eggs (Ledoux 2007).

Although *I. subinermis* has a Mediterranean origin (Alicata & Cantarella 1994), it has also been reported from Central and Western Europe (e.g. from Germany and the Netherlands) (Jäger 1995, Helsdingen 2006). *Icius subinermis* probably lives in moist habitats under natural conditions (Stanković 2012, Leroy et al. 2014). However, it was also observed in urban environments or near residential areas (Jäger 1995, Komnenov 2005, Kostanjšek & Fišer 2005, Helsdingen 2006, Stanković 2012). Furthermore, in most cases the specimens were found in buildings (e.g. in a house, greenhouse or apartment) (Jäger 1995, 1996, Komnenov 2005, Helsdingen 2006). This supports the findings of Nedvěd et al. (2011) that occurrence in buildings is a prerequisite for range expansion in many arachnid species. Moreover, these observations suggest that an urban environment and its microclimate may provide suitable conditions for this species, particularly northwards from the Mediterranean region.

How this specimen of *I. subinermis* got to Hungary is unclear and hard to speculate about. The warming climate and/or human mediation could be suspected. Since the specimen was found in a semi-natural habitat in Budapest, it may have an established population here. To confirm this, further surveys are needed, mainly in residential areas and semi-natural habitats nearby.

In Hungary, the most comprehensive checklist of the Salticidae family was published by Szűts et al. (2003), with 70 salticid species from Hungary. Since then several jumping spider species have been reported: *Chalcoscirtus nigritus* (Thorell, 1875), *Saitis tauricus* Kulczyński, 1904 (Szita et al. 2004), *Sitticus inexpectus* Logunov & Kronestedt, 1997 (Déri et al. 2007), *Euophrys herbigrada* (Simon, 1871), *Talavera parvistyla* Logunov & Kronestedt, 2003 (Kis 2007, cited in Kovács et al. 2012) and *Talavera aperta* (Miller, 1971) (Batáry et al. 2008). The Fauna Europaea Database lists 78 valid salticid species for Hungary (Helsdingen 2017). However *E. herbigrada* and *Talavera monticola* (Kulczyński, 1884) (for the latter see Szűts et al. 2003) is missing from the list, whereas *Pellenes campylophorus* (Thorell, 1875), *Aelurillus simplex* (Herman, 1879), *Myrmarachne simonis* (Herman, 1879) and *Synageles dalmaticus* (Keyserling, 1863) are erroneously listed. *Pellenes campylophorus* was recognized as a nomen dubium by Logunov et al. (1999), while *A. simplex, M. simonis* and *S. dalmaticus* have no records from the present territory of Hungary. Although the latter three species were on the spider faunal list of Hungary made by Chyzer & Kulczyński (1918), these records originated from regions that are not part of Hungary today. Chyzer & Kulczyński (1918) reported *A. simplex* from Doroszló (Doroslovo, now in Serbia), *M. simonis* (as *Salticus simonis*) from Körösfeketető (Negreni, now in Romania) and *S. dalmaticus* from Buccari (Bakar, now in Croatia, also erroneously noted as being in Hungary by Logunov 2004) and Crkvenica (Crikvenica, now in Croatia).

In total, including the new record of *I. subinermis*, 77 jumping spider species are recorded from Hungary so far.

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First record of the alien spider species *Mermessus trilobatus* (Araneae: Linyphiidae) in Ukraine

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Abstract. *Mermessus trilobatus* (Emerton, 1882) is recorded for the first time in Ukraine. Its presence represents the easternmost boundary of this species in Europe. One male was found in the glacial cirque of the mountain massif Svydivets' in the Ukrainian Carpathians at an altitude of 1495 m. The locality is a mountain stream, the banks of which have been moderately grazed by sheep. Information on the distribution of this species in Central and Eastern Europe is given.

Keywords: non-native species, Ukrainian Carpathians

Zusammenfassung. Erstnachweis der neozoischen Spinnenart *Mermessus trilobatus* (Araneae: Linyphiidae) in der Ukraine. *Mermessus trilobatus* (Emerton, 1882) wird erstmals für die Ukraine nachgewiesen. Es ist der östlichste Verbreitungspunkt der Art in Europa. Ein Männchen wurde in einem Kartal des Bergmassifs Svydivets in den Ukrainischen Karpaten in 1495 m Höhe gefangen. Der Fundort ist an einem Bergbach, dessen Uferbereiche extensiv mit Schafen beweidet wurden. Die Verbreitung der Art in Mittel- und Osteuropa wird diskutiert.

The European spider fauna comprises almost 4600 species, of which 184 (4 %) are allochthonous in Europe (Nentwig 2015, Helsdingen 2016). Among them, *Mermessus trilobatus* was introduced from North America relatively recently (in the 1980s) into south-western Germany (Karlsruhe; Dumpert & Platen 1985).

Since 1990, new records of this species have gradually appeared from other areas of Europe, namely Switzerland (Hänggi 1990), Italy (1995: cited by Helsdingen & IJland 2007), Austria (Breuss 1999), Belgium (Aminal 2000), France (Blick 2000), the Netherlands (Helsdingen & IJland 2007), Great Britain (Harvey 2008), the Czech Republic (Dolanský et al. 2009), Poland (Rozwałka 2010, Rozwałka et al. 2013, 2017), Slovenia (Čandek et al. 2013), Hungary (Szinetár et al. 2014), Croatia (Republic of Croatia 2014) and Slovakia (Šestáková et al. 2017). This expansion into the east started within Germany (Arachnologische Gesellschaft 2016), and has already reached the Czech Republic, Slovakia, Hungary, Poland and now Ukraine. The Ukrainian Carpathians represent the eastern boundary for the spread of *Mermessus trilobatus* on the Eurasian continent.

Material and methods

The collection locality of *Mermessus trilobatus* is Ukraine, Zakarpats'ka oblast', Rakhiv rayon (district), the Svydivets' mountain massif, f.n. Vorozheska (48°16'32"N, 24°11'32"E; 1495 m a.s.l.); at the bottom of the glacial cirque covered with subalpine green alder scrubs, *Juniper* thickets, *Vaccinium* heaths and meadows; a mountain stream (soft water bryophyte springs; after 200 m it flows into Lake Vorozheska), between stones and in moss, collected by hand, 9.VIII.2016, 1♂ (Fig. 1, 2). There is moderate grazing of sheep within the area and it is generally hard to reach by tourists because of the steep slopes of the glacial cirque.

Besides *Mermessus trilobatus*, a small number of other native species typical for this habitat were found: *Agyneta rurestris* (C.L. Koch, 1836) 1♀, *Diplocephalus helleri* (L. Koch, 1869) 1♀, *Kaestneria torrentum* (Kulczyński, 1882) 2♂♂, *Micrargus* sp. 2♀♀, *Oedothorax retusus* (Westring, 1851) 1♀, *Porrhomma convexum* (Westring, 1851) 1♀ and *Sittiflor rupicola* (C. L. Koch, 1837) 2♀♀, 6 juv.

Fragmentary data about the fauna of the Svydivets' mountain massif has been known since the middle of the twentieth century (Baum 1934, Balogh 1940, Balogh & Loksa 1947a, 1947b). The present study was conducted in glacial cirques of the Svydivets' massif (once per month from V to VIII.2016) on the basis of standard collecting methods, such as Barber

Fig. 1: Locality of *Mermessus trilobatus*

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pitfall traps, entomological sweep-netting, hand-collecting, and with the aid of pooter. The specimen of *Mermessus trilobatus* was found at only one locality.

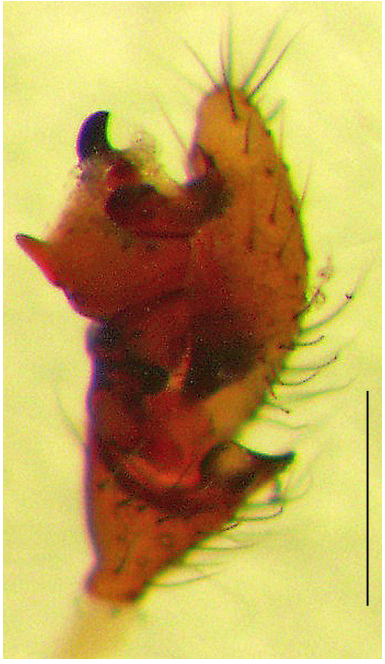

Fig. 2: *Mermessus trilobatus*, male palp, retrolateral view (from the Svydivets' mountain massif, Ukraine; Scale 0.1 mm)

The photograph of *Mermessus trilobatus* was taken using an Olympus DP72 camera connected to an Olympus SZX10 stereoscope (Center for collective use of the scientific equipment, National Museum of Natural History, NAS of Ukraine, Lviv).

Discussion

The range of *Mermessus trilobatus* is continually spreading out from Germany, where the species was introduced in the late twentieth century. However, this species has now been found not only in Western Europe, but also in most of Central Europe (Poland, the Czech Republic, Slovakia, Hungary, Slovenia, Croatia) (Fig. 3; Dolanský et al. 2009, Kůrka et al. 2010, Rozwałka 2010, Košulič & Hula 2011, Holec et al. 2012, Čandek et al. 2013, Košulič et al. 2013, Rozwałka et al. 2013, 2017, Hula et al. 2014, Niedobová & Hula 2014, Republic of Croatia 2014, Dudić, 2015, Kovács & Szinetár 2015, Kovács et al. 2015, Szinetár et al. 2015; Šestáková et al. 2017; CAS 2017). There is a higher concentration in Western Europe (France, INPN 2017) and in Central Europe: i.e. Switzerland (CSCF 2017), Germany (Arachnologische Gesellschaft 2016), the Czech Republic and western Poland (Rozwałka et al. 2017).

Fig. 3: Map of known records of *Mermessus trilobatus* in eastern Central and Eastern Europe (see text for references). In the shaded area, the species is widely distributed and found at many localities.

In the Carpathian Mountains *Mermessus trilobatus* is known within Poland (Gajdoš et al. 2014) and Slovakia (Šestáková et al. 2017: heated greenhouses in the Botanical Garden in Košice). In Poland (Tatra National Park) one female has been found in the glacial cirque of the Gąsienicowa Valley around the lake Litworowe Staw (ca 1700 m a.s.l.; Rozwałka et al. 2017). In other words, under conditions similar to the presently documented locality of this species in the Svydivets' mountain massif in Ukraine.

Mermessus trilobatus belongs to the smaller linyphiids, with an average body length of 1.6-2.1 mm. It is a eurytopic species, capable of successfully spreading in the air by ballooning (Dolanský et al. 2009, Rozwałka 2010, Blandenier et al. 2013). In North America the species inhabits both diverse natural habitats and heterogeneous habitats changed by human activities (Millidge 1987). The ability to live in a wide variety of ecosystems and to tolerate a wide range of environmental conditions, together with a strategy of aerial dispersal, allows *Mermessus trilobatus* not only to survive in the temperate climatic belt of Europe, but also to spread quickly and easily. Currently the species is found in nearly all types of more or less open habitats.

Our knowledge of the overall impact of an alien species on European spiders is low, in particular on the small number of alien species that can exist in natural habitats (Nentwig 2015). The influence of an invasion of *Mermessus trilobatus* on the structure of spider communities and the functioning of associated ecosystems remains an open question. It is not known whether it replaces native species, becoming part of the regional fauna. Therefore, at this time we can only accumulate data based on the initial country records of *Mermessus trilobatus*, and conduct long-term monitoring of spider communities at these localities.

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Revised checklist of Nordic harvestmen (Opiliones) with five species new to Norway

Pavel Bezděčka, Klára Bezděčková & Torstein Kvamme

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Abstract. We present a revised checklist of harvestmen (Opiliones) covering all the Nordic countries, including Iceland and the Faroe Islands. Altogether 31 species from 18 genera and four families are currently known, of which 23 are from Norway, 21 from Sweden, 17 from Finland, 25 from Denmark, five from the Faroe Islands and four from Iceland. Five species are documented for the first time in Norway: *Lacinius dentiger* (C. L. Koch, 1847), *Lacinius horridus* (Panzer, 1794), *Opilio saxatilis* C. L. Koch, 1839, *Leiobunum blackwalli* Meade, 1861 and *Leiobunum limbatum* L. Koch, 1861.

Keywords: first records, Nordic countries, Phalangiidae, Scandinavia, Sclerosomatidae

Zusammenfassung: Überarbeitete Checkliste der Nordischen Weberknechte (Opiliones) mit fünf Neunachweisen für Norwegen. Wir stellen eine aktualisierte Checkliste der Weberknechte (Opiliones) der nordischen Länder vor. Aktuell sind 31 Arten aus 18 Gattungen und vier Familien, darunter 23 aus Norwegen, 21 aus Schweden, 17 aus Finnland, 25 aus Dänemark, fünf von den Färöer Inseln und vier aus Island, bekannt. Fünf Arten werden erstmals für Norwegen nachgewiesen: *Lacinius dentiger* (C. L. Koch, 1847), *Lacinius horridus* (Panzer, 1794), *Opilio saxatilis* C. L. Koch, 1839, *Leiobunum blackwalli* Meade, 1861 und *Leiobunum limbatum* L. Koch, 1861.

The last checklist of harvestmen including all the Nordic countries was published by Stol (2007). He listed 17 species from Norway, 20 species from Sweden, 12 species from Finland, 19 species from Denmark, four species from Iceland and five from the Faroe Islands. Since 2007 the knowledge of the Opiliones fauna in the Nordic countries has increased. The number of species currently reported from each country is: 23 species known from Norway, 21 from Sweden (Jonsson 2013, pers. comm. 2017), 17 from Finland (Uddström et al. 2013, Uddström & Rinne 2016a, 2016b), 25 from Denmark (Enghoff et al. 2014). The species numbers of the Faroe Islands and Iceland have remained, to our knowledge, unchanged compared to Stol (2007).

Material and methods

In total 20 localities in South Norway were visited during the period from 11th to 22nd August 2015. Our priority was a study of ant communities (Hymenoptera: Formicidae) and the survey of the Opiliones fauna was an additional activity. The collected specimens have all been sampled manually. The nomenclature used in this paper, as well as the identification of material, is based on Martens (1978), Martens & Schönhofer (2016) and Wijnhoven (2009).

The EIS numbers and the Norwegian county part abbreviations follow the system as presented in Norwegian Journal of Entomology (NJE 2015).

Norway national biogeography regions:
AAY = Aust-Agder, outer or coast parts
AAI = Aust-Agder, inner parts
AK = Akershus
Ø = Østfold
TEY = Telemark, outer or coast parts
VAY = Vest-Agder, outer or coast parts
VE = Vestfold

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Localities (sorted by date of visit)

L–01. AK, Ås: Kaja (EIS 28), 59°39‘54.4“N, 10°46‘59.9“E, 11.8.2015
L–02. AK, Ås: University campus (EIS 28), 59°40‘01.2“N 10°46‘31.5“E, 12.8.2015
L–03. VE, Larvik: Geiterøya, Arøybukta (EIS 11), 59°00‘06.8“N 9°46‘38.9“E, 12.8.2015
L–04. TEY, Bamble: Langøya north part (EIS 11), 59°00’35.9”N 9°45’19.8”E, 12.8.2015
L–05. AAI, Valle: Rygnestadtunet (EIS 16), 59°15‘45.3“N 7°29‘23.5“E, 13.8.2015
L–06. AAI, Valle: south of Skagen Bro – East side (EIS 16), 59°06’27.8”N 7°30’39.6”E, 13.8.2015
L–07. AAI, Bygland: Fånefjell south side (EIS 9), 58°46’35.2”N 7°50’13.2”E, 13.8.2015
L–08. VAY, Kristiansand City: Kvadraturen (EIS 2), 58°08’56.1”N 8°00’01.5”E, 14.8.2015
L–09. VAY, Kristiansand: Nedre Timenes, close to Ytre Drangsvannet (EIS 2), 58°09’42.4”N 8°06’02.0”E, 14.8.2015
L–10. AA, Gjerstad: close to Sundebru (EIS 11), 58°50’13.6”N 9°04’52.7”E, 15.8.2015
L–11. VE, Larvik: Mølen Nature Reserve (EIS 11), 58°58‘19.9“N 9°49‘42.5“E, 15.8.2015
L–12. AK, Frogn: Håøya (EIS 28), 59°42‘59.5“N 10°33‘17.1“E, 17.8.2015
L–13. Ø, Hvaler: Søndre Sandøy (EIS 12), 59°00‘16.8“N 11°04‘51.0“E, 18.8.2015
L–14. AK, Ås: Åsmåsan (EIS 28), 59°40‘08.8“N 10°47‘34.0“E, 18.8.2015
L–15. VE, Horten: Løvøya, Vestre Veggbukt (EIS 19), 59°27‘02.1“N 10°26‘26.4“E, 19.8.2015
L–16. VE, Horten: Borrehaugene (EIS 19), 59°23‘03.2“N 10°28‘14.0“E, 19.8.2015
L–17. AK, Oslo: Tøyen Botanisk Hage (EIS 28), 59°55‘8.870“N, 10°46‘18.630“E, 21.8.2015
L–18. AK, Oslo: Aker Brygge (EIS 28), 59°54‘36.449“N, 10°43‘29.940“E, 21.8.2015
L–19. AK, Oslo: Bygdøy – close to Kontiki Museum (EIS 28), 59°54‘12.754“N, 10°41‘53.979“E, 22.8.2015
L–20. AK, Oslo: Kvadraturen (EIS 28), 59°54‘44.978“N, 10°44‘48.791“E, 22.8.2015

Results and discussion

Newly collected in Norway

We collected altogether 163 specimens of harvestmen from 21 species, 12 genera and three families in the studied sites. Five species are newly reported from Norway.

Family Nemastomatidae

Mitostoma chrysomelas (Hermann, 1804) L–09: 2♀♀; L–12: 2♂♂, 1♀ (all under stones).

Nemastoma bimaculatum (Fabricius, 1775) L–03: 2♀♀; L–12: 2♂♂ (all under stones).

Nemastoma lugubre (O. F. Müller, 1776) L–13: 2♀♀ (under a stone).

Family Phalangiidae

Lacinius dentiger (C. L. Koch, 1847) L–12: 1♂, 1♂ (on a tree), a new record for Norway.

Lacinius ephippiatus (C. L. Koch, 1835) L–03: 2♂♂ (under a stone).

Lacinius horridus (Panzer, 1794) L–13: 4♂♂, 1♀ (on a rock and on soil), a new record for Norway.

Lophopilio palpinalis (Herbst, 1799) L–12: 2♂♂, 2♀♀ (under vegetation); L–13: 3♂♂ (under a stone).

Mitopus morio (Fabricius, 1779) L–12: 2♂♂ (on vegetation); L–13: 2♂♂, 3♀♀ (on soil).

Oligolophus hanseni (Kraepelin, 1896) L–3: 1♂, 1♀; L–04: 1♂; L–12: 1♂, 1♀ (all under stones); L–20: 1♂ (on a wall).

Oligolophus tridens (C. L. Koch, 1836) L–12: 3♂♂, 3♀♀; L–15: 3♂♂ (all under stones), L–20: 1♂ (on a tree).

Opilio canestrinii (Thorell, 1876) L–02: 2♂♂; L–08: 2♂♂; L–18: 1♂; L–20: 2♂♂, 1♀ (all on walls).

Opilio parietinus (De Geer, 1778) L–17: 2♂♂ (on tree); L–20: 1♂ (on a wall).

Opilio saxatilis C. L. Koch, 1839 L–20: 2♂♂ (on a wall), a new record for Norway.

Paroligolophus agrestis (Meade, 1855) L–02: 4♀♀ (under wood); L–03: 2♀♀; L–04: 2♂♂, 4♀♀; L–12: 5♂♂, 2♀♀; L–13: 1♂, 4♀♀; L–15: 2♂♂, 2♀♀ (all under stones); L–20: 3♀♀ (on a tree).

Phalangium opilio Linnaeus, 1758 L–01: 2♂♂ (on vegetation in a garden); L–02: 1♀ (on a wall); L–03: 1♂, 1♀ (on a tree); L–04: 2♀♀ (on a rock); L–05: 1♂; L–06: 2♀♀ (on vegetation); L–09: 2♀♀ (on a wall); L–12: 3♀♀; L–13: 2♀♀; L–15: 1♂, 1♀; L–16: 2♂♂ (all on vegetation); L–20: 1♂, 1♀ (on a wall).

Rilaena triangularis (Herbst, 1799) L–16: 2 juv. (under vegetation).

Family Sclerosomatidae

Leiobunum blackwalli Meade, 1861 L–01: 1♂, 2♀♀ (on a wall), a new record for Norway.

Leiobunum gracile Thorell, 1876 L–07: 2♂♂ (on a rock); L–09: 1♂, 1♀; L–10: 1♂, 1♀; L–11: 1♂; L–13: 1♀; L–15: 1♂, 1♀; L–20: 2♀♀ (all on trees).

Leiobunum limbatum L. Koch, 1861 L–08: 2 juv.; L–19: 2♀♀; L–20: 1♂ (all on walls), a new record for Norway.

Leiobunum rotundum (Latreille, 1798) L–01: 1♂, 1♀; L–02: 2♀♀; L–08: 1♂, 1♀ (all on walls); L–09: 2♂♂, 2♀♀; L–10: 2♀♀; L–13: 2♂♂, 2♀♀; L–14: 1♂, 1♀; L–15: 1♂, 2♀♀; L–20: 1♀ (all on trees).

Nelima gothica Lohmander, 1945 L–10: 1♂, 1♀ (on a tree).

In total 21 species were recorded, out of which five species were reported from Norway for the first time. The species *L. horridus* and *O. saxatilis* had already been found in all Nordic mainland countries. *L. dentiger* had been recorded in Finland, *L. blackwalli* in Sweden and Denmark. The presence of *L. limbatum* is presently known only from Norway. We found this species in the cities of Kristiansand and Oslo, in the vicinity of harbours. This might suggest an introduction of this species to Norway by ship or other types of transportation.

Additionally, we assume that several other harvestmen species may be reported from Norway in the near future, e.g. *Dicranopalpus ramosus* (Simon, 1909), *Odiellus spinosus* (Bosc, 1792), the still unnamed species *Leiobunum* sp. "A" (sensu Wijnhoven et al. 2007) or *Nelima semproni* Szalay, 1951.

The revised harvestmen checklist of the Nordic countries

In the past ten years, the list of harvestmen from Nordic countries has undergone a number of changes. The species currently known from the individual countries are summarized in Tab. 1.

New records and changing distribution patterns of Opiliones species have been reported in Northern Europe (e.g. Gederaas et al. 2012, Uddström et al. 2013, 2016b, Enghoff et al. 2014, Fritzén et al. 2015). The list presented here is certainly not definitive. Future research will undoubtedly bring a number of new faunistic records and may also reveal the occurrence of additional species in Nordic countries.

Two years of first description differ from those given by Stol (2007): *Trogulus tricarinatus* Linnaeus, 1767 (instead of 1758 – it was formerly wrongly assigned to the 10th instead of the 12th edition of Linnaeus' 'Systema naturae') and *Paroligolophus meadii* (O. Pickard-Cambridge, 1891) (corrected from 1890, according to Sykes 1941).

According to the revision of Martens & Schönhofer (2016) all specimens of the formerly recorded *Leiobunum rupestre* (Herbst, 1799) from Scandinavia belong to *L. gracile*, a senior synonym of *Leiobunum tisciae* Avram, 1968.

Leiobunum limbatum was reported for Sweden by Stol (2007) based on Martens (1978). However, according to Jonsson (2017 pers. comm.), there is neither older voucher material nor new findings supporting the presence of this species in Sweden.

Specimens of *Platybunus bucephalus* (C. L. Koch, 1835) recorded from Finland were questioned by Stol (2007). Later the species was deleted from the Finish list – all revised specimens were juvenile specimens of *Rilaena triangularis* (cf. Uddström et al. 2013, Fritzén et al. 2015). Information concerning the presence of *Opilio dinaricus* and *Mitostoma chrysomelas* in Finland is based on Uddström & Rinne (2016b). The authors stated that it is quite probable that these species were imported into Finland with raw wood and it is not certain whether they could actually establish in Finland.

Acknowledgements

We are very grateful to Professor Henrik Enghoff, University of Copenhagen (Denmark), Dr. Lars J. Jonsson, Kristianstad University, Kristianstad (Sweden) and Dr. Annika Uddström, Finnish Environment Institute, Helsinki (Finland) for providing valuable information.

Tab. 1: Checklist of the harvestmen (Opiliones) known from the Nordic countries
Abbreviations and symbols: NO – Norway, SE – Sweden, FI – Finland, DK – Denmark, FO –Faroe Islands, IS – Iceland; "+" presence, without index published by Stol (2007), [0] new record by the authors published in this paper, [1] Gederaas et al. (2012), [2] Fritzén et al. (2015), [3] Jonsson (2013), [4] Uddström et al. (2013), [5] Uddström & Rinne (2016b), [6] Enghoff & Pedersen (2007), [7] Enghoff et al. (2014)

Family/Species	NO	SE	FI	DK	FO	IS
Family Nemastomatidae						
Mitostoma chrysomelas (Hermann, 1804)	+	+	+[5]	+		
Nemastoma bimaculatum (Fabricius, 1775)	+				+	+
Nemastoma lugubre (Müller, 1776)	+	+	+	+		
Paranemastoma quadripunctatum (Perty, 1833)				+[7]		
Family Trogulidae						
Trogulus tricarinatus (Linnaeus, 1767)	+	+		+		
Family Phalangiidae						
Dicranopalpus ramosus (Simon, 1909)		+[3]		+[7]		
Lacinius dentiger (C. L. Koch, 1847)	+[0]		+[4]			
Lacinius ephippiatus (C. L. Koch, 1835)	+	+	+	+	+	
Lacinius horridus (Panzer, 1794)	+[0]	+	+	+		
Lophopilio palpinalis (Herbst, 1799)	+	+	+	+		
Megabunus diadema (Fabricius, 1779)	+				+	+
Mitopus morio (Fabricius, 1779)	+	+	+	+	+	+
Odiellus spinosus (Bosc, 1792)				+[6]		
Oligolophus tridens (C. L. Koch, 1836)	+	+	+	+		+
Oligolophus hanseni (Kraepelin, 1896)	+	+	+[4]	+		
Opilio canestrinii (Thorell, 1876)	+[1]	+	+[4]	+		
Opilio dinaricus Šilhavý, 1938			+[5]			
Opilio parietinus (De Geer, 1778)	+	+	+	+		
Opilio saxatilis C. L. Koch, 1839	+[0]	+	+[4]	+		
Paroligolophus agrestis (Meade, 1855)	+	+		+		
Paroligolophus meadii (O. Pickard-Cambridge, 1891)					+	
Phalangium opilio Linnaeus, 1758	+	+	+	+		
Platybunus pinetorum (C. L. Koch, 1839)		+[2]		+[7]		
Rilaena triangularis (Herbst, 1799)	+	+	+	+		
Family Sclerosomatidae						
Leiobunum blackwalli Meade, 1861	+[0]	+		+		
Leiobunum gracile Thorell, 1876	+	+	+	+		
Leiobunum limbatum L. Koch, 1861	+[0]	?				
Leiobunum rotundum (Latreille, 1798)	+	+		+		
Leiobunum sp. "A" sensu Wijnhoven et al. (2007)				+[7]		
Nelima gothica Lohmander, 1945	+	+	+	+		
Nelima sempronii Szalay, 1951				+[7]		
Number of species	**23**	**21**	**17**	**25**	**5**	**4**

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New records of spiders (Araneae) from Portugal

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Abstract. Data about spiders collected in Portugal are presented. Two new species are described, *Scotophaeus dolanskyi* **spec. nov.** (Gnaphosidae) and *Apostenus crespoi* **spec. nov.** (Liocranidae). Three species are recorded for the first time in Portugal: *Dysdera lata* Wider, 1834 (Dysderidae), *Scotophaeus validus* (Lucas, 1846) and *Euophrys nigripalpis* Simon, 1937 (Salticidae). Illustrations of two rarely illustrated species are also presented: *Nigma hortensis* (Simon, 1870) (Dictynidae) and *Canariphantes zonatus* (Simon, 1884) (Linyphiidae).

Keywords: *Apostenus*, *Euophrys*, Gnaphosidae, Liocranidae, new species, *Nigma*, *Scotophaeus*, taxonomy

Zusammenfassung. **Neue Spinnennachweise (Araneae) aus Portugal.** Es werden Daten von Spinnenaufsammlungen aus Portugal vorgestellt. Zwei neue Arten werden beschrieben, *Scotophaeus dolanskyi* **spec. nov.** (Gnaphosidae) und *Apostenus crespoi* **spec. nov.** (Liocranidae). Drei Arten werden erstmals für Portugal nachgewiesen, *Dysdera lata* Wider, 1834 (Dysderidae), *Scotophaeus validus* (Lucas, 1846) und *Euophrys nigripalpis* Simon, 1937 (Salticidae). Abbildungen zweier weiterer seltenen Arten werden präsentiert, *Nigma hortensis* (Simon, 1870) (Dictynidae) und *Canariphantes zonatus* (Simon, 1884) (Linyphiidae).

The spider fauna of Portugal currently includes 812 species (Nentwig et al. 2017) and is still incompletely known. This study deals with a small sample of spiders from mainland Portugal collected by the author, additional small samples were made available by Jan Dolanský from the East Bohemian Museum in Pardubice, Czech Republic and Jorge Alexandre Mota de Almeida from the University of Coimbra, Portugal. Among the combined material (133 species, 239 specimens – see Supplementary File 1) two species are new to science and three others new to Portugal. The aim of this study is to describe the new species, to present details of species recorded in Portugal for the first time and to provide illustrations of two rarely illustrated species.

Material and methods

Spiders were collected by hand, by shaking vegetation or by brushing stones above a tray. Illustrations were created from photos of selected features using a Leica Wild M10 stereomicroscope fitted with a Leica DFC425 digital camera or a Leica 205 stereomicroscope fitted with a Leica DFC450 digital camera. The microscopes were connected to computers with Leica Application Suite software, Zerene Stacker software and the vector graphics editor Inkscape.

The following abbreviations are used in the text:

AER = anterior eye row
ALE = anterior lateral eyes
AME = anterior median eyes
CJL = collection Jørgen Lissner
NHMD = Natural History Museum of Denmark
PER = posterior eye row
PLE = posterior lateral eyes
PME = posterior median eyes.

Taxonomy

***Nigma hortensis* (Simon, 1870)** (Dictynidae) (Figs 1-2)
Dictyna hortensis Simon 1870: 296 (without figures)
Previous records from Portugal were compiled by Morano et al. (2014)

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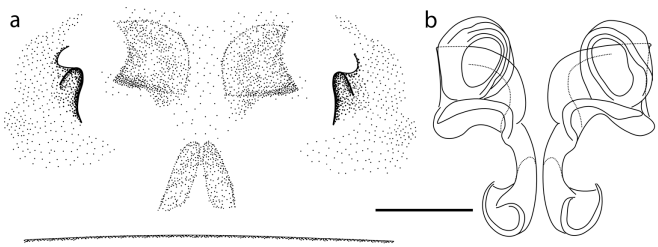

Fig. 1: *Nigma hortensis* (Simon, 1870): **a.** epigyne in ventral view (hairs removed); **b.** vulva in ventral view. Scale bar 0.1 mm

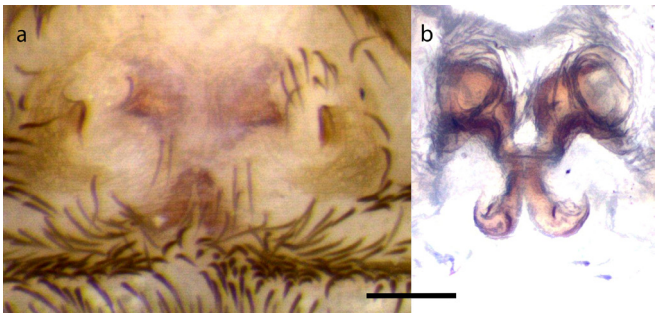

Fig. 2: *Nigma hortensis* (Simon, 1870), photos: **a.** epigyne in ventral view (hairs removed); **b.** vulva in ventral view. Scale bar 0.1 mm

Material examined. PORTUGAL, Viseu, Silgueiros, Póvoa Dão (N40°32'56", W7°56'37"), mixed forest with clearings (230 m), 29.IV.2007, 1 ♀ leg. Jorge Mota Almeida (CJL-4241).

Comments. The species is known from Portugal, Spain, France, Italy and Algeria (Nentwig et al. 2017). The male palp has been depicted by Barrientos & Ferrández (1982), Simon (1914) and Wunderlich (2011), but apparently the epigyne was never illustrated. The female here is matched with *N. hortensis* as it is similar to photos of the epigyne made available by Oger (2017). This site presents photos of the male palp, female epigyne and vulva from a male and a female collected together. The lateral plates are much reduced compared to those of *Nigma puella* (Simon, 1870), notched and widely separated (Figs 1a, 2a). They are practically invisible unless the dense clothing of hairs in the epigynal area is scraped off. In the illustrated specimen parts of the vulva is visible through the integument (Fig. 2a). The vulva is illustrated in Fig. 1b

based on the photo in Fig. 2b. The copulatory openings are only clearly visible in a detached epigyne/vulva.

***Dysdera lata* Reuss, 1834** (Dysderidae)
Dysdera lata Reuss 1834: 196 (without figures)
Material examined. PORTUGAL, Lisbon, Santa Maria Maior, near Castelo de São Jorge (N38°42'53", W9°8'3.4"), lot with weeds and bushes (60 m), 12.III.2014, 1 juvenile ♂ (matured in captivity around Oct. 10, 2014), leg. Jørgen Lissner (CJL-9913).
Comments. New to Portugal. A juvenile male was found in a vacant lot adjacent to Castelo de São Jorge in the centre of Lisbon. It matured in captivity. According to Kovblyuk et al. (2008) *D. lata* differs from the closely related *D. westringi* O. Pickard-Cambridge, 1872 by having the flattened bulbus furnished with 3-7 teeth (*D. westringi* has no teeth on it). The hitherto westernmost locality for *D. lata* was Majorca (Bosmans et al. in press) but the new record from the present study extends the known range about 1000 km to the west. The identification was confirmed by Miquel Arnedo, University of Barcelona, Spain.

***Scotophaeus dolanskyi* Lissner spec. nov.**
(Gnaphosidae) (Figs 3-5)
Etymology. The species is dedicated to the collector of the species, the outstanding arachnologist, Jan Dolanský, with whom I am very honoured to collaborate with.
Type material. PORTUGAL: Beja, Moura, Sobral da Adiça (N37°58'40", W7°17'39"), holotype ♂, forest steppe/maquis (350 m), 27.III.2013 (specimen matured in captivity Aug. 22, 2013), Jan Dolanský leg., CJL-9049, deposited at NHMD.
Diagnosis. The three-pointed tibial apophysis readily separates the new species from other European *Scotophaeus* species for which males are known. It is possible that the new species is the unknown male of either *S. retusus* (Simon, 1878), *S. aculeatus* Simon, 1914, *S. brolemanni* Simon, 1914 or *S. fabrisae* Caporiacco, 1950. Only the former species has been recorded in Portugal while the three latter are known from France or Italy. Since this a poorly known genus the differences of the new species to other European and Macaronesian species are elaborated in the comments section.

Description of male
Measurements (n=1), body length 5.9, carapace length 2.7, width 2.1.

Fig. 3: *Scotophaeus dolanskyi* Lissner **spec. nov.** Habitus of male. *Inset*: close-up of eye configuration

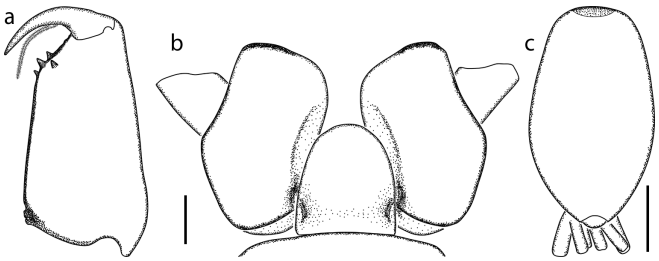

Fig. 4: *Scotophaeus dolanskyi* Lissner **spec. nov.**: **a.** right chelicera in posterior view showing positions of teeth on pro- and retromargin; **b.** mouthparts; **c.** opisthosoma in dorsal view showing extent of the scutum. Scale bars **a.**, **b.** 0.2 mm; **c.** 1 mm

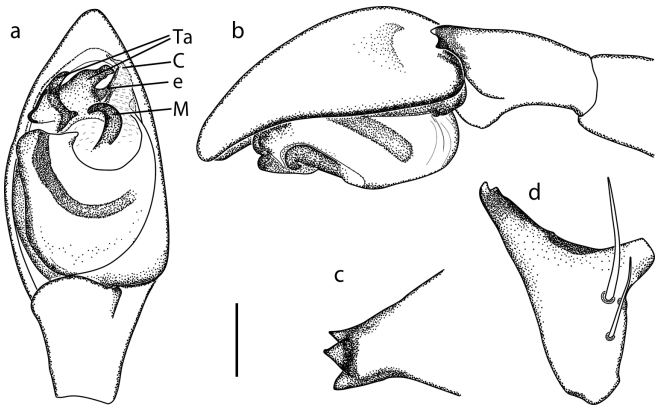

Fig. 5: *Scotophaeus dolanskyi* Lissner spec. nov. **a.** left male palp in ventral view; **b.** same in retrolateral view; **c.** apex of male palp tibial apophysis in retrolateral (viewed slightly from above); **d.** same in dorsal view. Scale bars **a.**, **b.** 0.25 mm; **c.** 0.2 mm; **d.** 0.1 mm. Ta = Terminal apophysis with two hook-like projections, C = conductor, e = embolus, M = median apophysis

Colour. General appearance as in Fig. 3. Carapace yellow brown, not darkened at margins, densely covered with simple hairs appearing whitish in flash photography of live specimen (Fig. 3), but greyish-brown in alcohol preserved specimen.
Prosoma. Fovea distinct. Eye group relatively compact for a *Scotophaeus* (Fig. 3, inset). Median eyes larger than laterals, AME largest (0.17) and distinctly ringed with black. PME (0.14) slightly oblique, PLE (0.14), ALE (0.15). PER strongly procurved as seen in dorsal view, AER slightly recurved and not as wide as PER. Height of clypeus equal to half the diameter of an anterior median eye. Edge of clypeus with a row of strong setae. Maxillae narrowed at middle, converging in front of labium, lateral sides concave in anterior half (Fig. 4b). Labium spatulate, slightly longer than wide. Chelicerae with three discrete teeth on promargin and one on retromargin (Fig. 4a). A modified plumose seta, slightly swollen corresponding to type (b) in Murphy (2007, p. 30), emerges from near the base of the fang (Fig. 4a). Leg formula IV-I-II-III. Legs spinose. Scopulae rather weakly developed, very similar to those of *S. blackwalli*.
Opisthosoma. Elliptical, covered with mousy grey pubescence. Scutum short, hardly reaching dorsum of opisthosoma (Fig. 4c). Brachiate setae appear completely absent, including on the rim of the anterior lateral spinnerets, but here with a slightly swollen plumose seta corresponding to type (b) in Murphy (2007).
Male palp. With a short tibial apophysis, the tip has three pointed processes when seen in retrolateral view and slightly from above (Figs. 5b-d). Only basal part of the retrolateral tibial apophysis is visible in ventral view (Fig. 5a). Palpal bulb

with a hooked median apophysis. Terminal apophysis consists of a large sclerite with two hook-like outgrowths. Embolus appears to arise from a broadened base, becoming thin and straight toward apex. The embolus is nearly hidden by a membranous conductor in ventral view, in retrolateral view it is invisible.

Comments. The new species belongs to the *Echemus* group of gnaphosid genera due to a plain-coloured opisthosoma and presence of a scutum in the male. Among the *Echemus* group genera it fits best within *Scotophaeus* Simon, 1893. This genus is characterized by a procurved PER, a palp with a hook-like median apophysis and without a broadened embolar base, endites narrowed in the middle and concave retrolaterally, a sternum with short sclerotized extensions to and between the coxae and absence of brachiate setae (Almquist 2006, Murphy 2007, Platnick & Shadab 1977). The new species meets these requirements except for the embolar base which appears broadened and for the reduced sclerotized extensions to the middle of the coxa, only the ones between the coxae are distinct. The species may need transfer to another genus, but this should await description of the female. The broadened embolar base, the indistinct sclerotized extensions to the coxae, the compact eye group and the presence of a long seta originating near base of the fang may prevent this species from being encompassed by *Scotophaeus*.

Conspecificity with the following species can be excluded based solely on the shape of the tibial apophysis and extent of scutum. *Scotophaeus blackwalli* (Thorell, 1871), *S. blackwalli isabellinus* (Simon, 1873), *S. scutulatus* (L. Koch, 1866) and *S. nanoides* Wunderlich, 2011 possess a single pointed tibial apophysis, as opposed to the three-pointed one in the new species. Regarding other European species, the tibial apophysis also differs from that of *S. musculus* (Simon, 1878) the latter having parallel sides and terminating in a small, sharp point curved at the apex like a crochet hook (Simon 1914: fig. 269, Schenkel 1938: fig. 1). *Scotophaeus musculus* is known from Madeira and France (World Spider Catalog 2017), but also mainland Portugal (Silva 2017) and the Selvagens Islands (= Savage Islands) (Crespo et al. 2009). *Scotophaeus validus* (Lucas, 1846) is widely distributed in the Mediterranean region. This species has a single pointed tibial apophysis and quite different palp structures according to illustrations in Simon (1914). Also the scutum of the male covers nearly the anterior half of the opisthosoma in this species (Simon 1914), much longer than in the male described here. *Scotophaeus westringi* Simon, 1914 is known from France only (World Spider Catalog 2017), the male has a different, single pointed tibial apophysis (Simon 1914). The new species also differs from the four species known to occur in the Macaronesian archipelagos by the shape of the tibial apophysis or the extent of the abdominal scutum. *Scotophaeus bifidus* Schmidt & Krause, 1994 is known from the Cape Verde Island of Sal has a distinct Y-shaped bifurcate tibial apophysis (Schmidt & Krause 1994), *S. insularis* Berland, 1936 and *S. jacksoni* Berland, 1936 are also known from the Cape Verde Islands, males of both species with a single-pointed tibial apophysis (Berland 1936). *Scotophaeus hierro* Schmidt, 1977 known from the Canary Islands has a very long scutum (Schmidt 1977), while that of the new species described here is very short. The genus holds several additional but poorly described species some of which only known from females (World Spider Catalog 2017).

***Scotophaeus validus* (Lucas, 1846) (Gnaphosidae)** (Figs 6-8)

Drassus validus Lucas 1846: 213, pl. 12, f. 10.

Material examined. PORTUGAL: Beja, Moura, Sobral da Adiça (N37°58'40", W7°17'39"), 1♀, forest steppe/maquis (350 m), 27.III.2013, Jan Dolanský leg., CJL-8794; SPAIN: Majorca, La Palma, Castillo de San Carlos (N39°32'47", W2°37'17"), 1 ♀, pine grove, 16 m a.s.l., 29.IV.2014, J. Lissner leg., CJL-9872.

Comments. *Scotophaeus validus* is known from Southern Europe, Morocco and Algeria (World Spider Catalog 2017), but is new to Portugal. Illustrations and photographs of the epigyne and vulva are presented in Figs. 6-8 and are compared to a specimen from Majorca. The epigyne of the Portuguese specimen is larger and more strongly sclerotized than that of the Majorcan specimen. The vulva has spermathecae bearing terminal bulbs (Fig. 8) characteristic of *Scotophaeus* females (Platnick & Shadab 1977). The build of the vulva and epi-

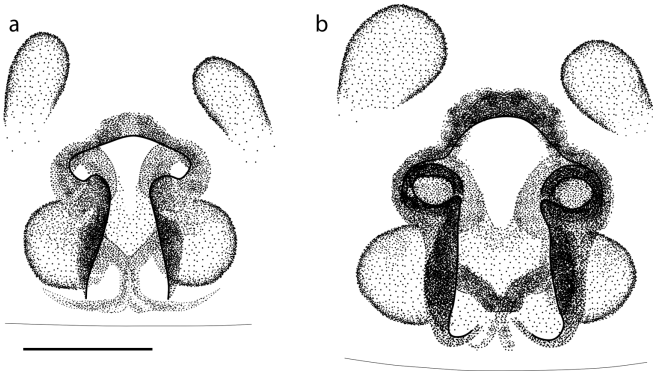

Fig. 6: *Scotophaeus validus* (Lucas, 1846). **a.** epigyne in ventral view (specimen from Majorca); **b.** specimen from Portugal. Scale bar 0.2 mm

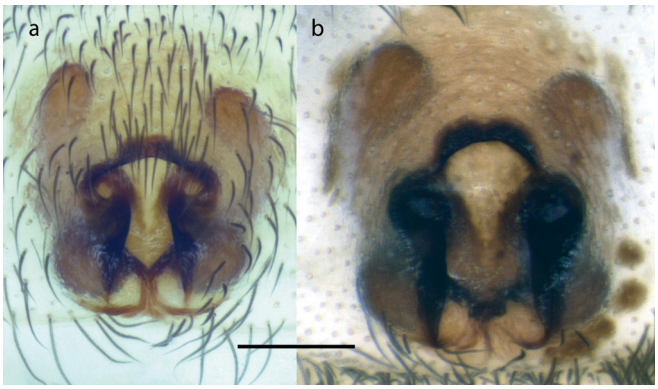

Fig. 7: *Scotophaeus validus* (Lucas, 1846). **a.** epigyne in ventral view (specimen from Majorca); **b.** specimen from Portugal. Scale bar 0.2 mm

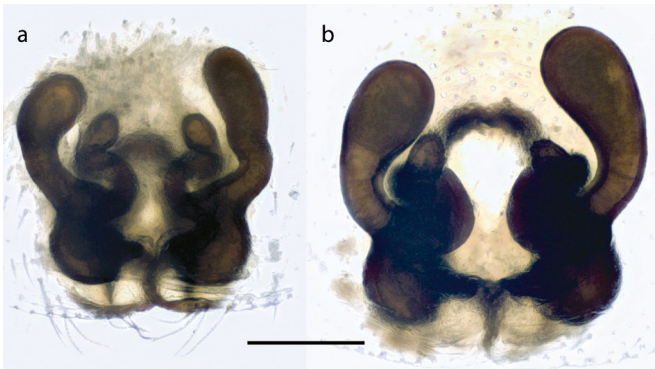

Fig. 8: *Scotophaeus validus* (Lucas, 1846), vulva in dorsal view. **a.** specimen from Majorca; **b.** specimen from Portugal. Scale bar 0.2 mm

gyne are nearly the same for the Portuguese and Majorcan specimens with the proportion of the structures showing only minor variation, also in dark parts of the vulva with dense sclerotizations not well presented in Fig. 8. Further images of *S. validus* epigynes are available from Oger (2017), also showing variation in the depth of sclerotization and minor variation in proportions. As a female belonging to this species was found at the same locality as the male of *S. dolanskyi* sp. n. described above, potential conspecificity was carefully considered and the two specimens were compared side by side. They differ in the configuration of eyes, being more compact in *S. dolanskyi* sp. n. Relative to *S. validus, S. dolanskyi* sp. n. has a distinctly less elongate sternum, distinctly shorter maxillae compared to their width (in *S. validus* they are nearly twice as long as wide, compare to fig. 4b), cheliceral dentation (only two, relatively smaller promarginal teeth are present in *S. validus*, none on the retromargin), indistinct extensions to the coxae, and more spinose legs. Also, two species with similar epigynes would not be expected to possess very different male palps.

***Apostenus crespoi* Lissner spec. nov. (Liocranidae)**
(Figs 9–11)

Etymology. The species is named in honour of Luís Carlos da Fonseca Crespo in recognition of his work with Iberian and Macaronesian spiders.

Type material. PORTUGAL: Setúbal, Arrábida near Azeitão (N38°30'53", W8°59'42"), holotype ♀, rocky limestone steppe/maquis (195 m), 8.III.2014, Jørgen Lissner leg., CJL-9645, deposited at NHMD.

DNA Barcoding. The specimen was barcoded with a sequence of 658 bp obtained from the cytochrome *c* oxidase region (Barcode of Life Data System, Process ID: GREAR057-17; Sample ID: NHMD-JL-9645). Public barcode data for comparison are at present only available from one congener, *A. fuscus* Westring, 1851, which is not a particularly close relative with similarity % ranging from 93.5 % to 94.0 % (The Barcode of Life Data Systems 2017).

Diagnosis. The new species most closely resembles *Apostenus humilis* Simon 1932 and *A. maroccanus* Bosmans, 1999 based on build of the epigyne/vulva. Both species possess a median septum according to illustrations in Bosmans (1999) and Bosselaers (2009); such a septum was not observable for *A. crespoi* sp. n. *Apostenus algericus* Bosmans, 1999 is only known from the male, but is closely related to its other north African congener as judged by their fairly similar male palps, thus it could be expected that the female of this species also possesses a septum.

Fig. 9: *Apostenus crespoi* Lissner **spec. nov.** Habitus of female

Description of female

Measurements (n=1), body length 3.32, carapace length 1.19, width 0.95.

Colour. When alive this is a bright reddish-orange species with distinct abdominal chevrons and with indistinct leg annulations (Fig 9). Margin of carapace not darkened. Carapace with transparent hairs, in posterior half also some blackish ones. Dorsum of opisthosoma with scattered whitish hairs (Fig. 9), the whiteness augmented by flash photography and they may just be transparent hairs positioned at an angle reflecting flashlight. Dorsum, sides and venter with transparent hairs of various lengths and thicknesses, the thicker ones slightly swollen and plumose similar to hairs depicted in Ubick & Vetter (2005, f. 17). Colours of carapace and legs fade to yellow-brown in alcohol except for the dark-brown fovea, the very faint brown reticulations and the annulations of the legs becoming indiscernible. The darker parts of the opisthosoma including the chevrons remain brown, but the transverse orange bands lose their orange colour and become pale. Remaining description of colours refer to alcohol preserved specimen. Chelicerae and sternum yellow-brown. All eyes ringed with black. Tibiae, metatarsi and tarsi slightly darker than coxae, trochanter and femora. Venter of opisthosoma with a pale median band.

Prosoma. Carapace smooth with a narrow, protruding head. Eyes in a compact group and of normal size. PME separated by a little more than half a diameter, the sockets of the remaining eyes touching. Eyes of PER equal in size, larger than the AME but smaller than ALE. Eye sizes (lenses): AME 0.047, ALE 0.077, PME 0.064, PLE 0.061; interdistances: AME-AME 0.028, AME-ALE 0.016, PME-PME 0.069, PME-PLE 0.053, ALE-PLE 0.060, width of eye rows: AER 0.284, PER 0.353. Clypeus low about 0.5 the diameter of an AME. Labium shaped like a triangle with rounded corners, more than 1.5 times wider than long, slightly less than half the length of the endites. The latter are rectangular with rounded corners, about 1.5 times longer than wide. Cheliceral promargin with three minute, discrete teeth, retromargin with two small discrete teeth. Sternum scutiform, projecting between coxae IV.

Opisthosoma. Elongate oval, with four chevrons, densely covered with hairs, however those of the dorsum all fallen off in alcohol-preserved specimen, the hairs clearly visible in photo of live specimen (Fig. 9). Spinnerets are obscured by dense hairs, but seem similar to those of *A. californicus* which are well described and complemented with SEM images in Ubick & Vetter (2005).

Legs. Femur I-II with two macrosetae in dorsal midline, III-IV with three. Femur I with additional strong prolateral mac-

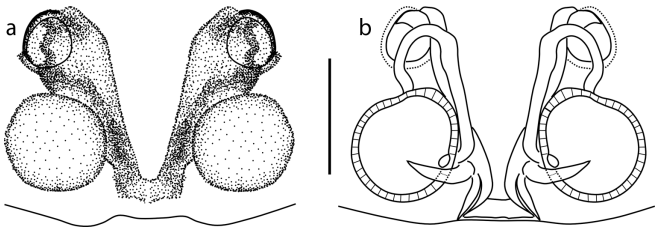

Fig. 10: *Apostenus crespoi* Lissner **spec. nov. a.** Epigyne in ventral view; **b.** vulva in dorsal view. Scale bar 0.1 mm

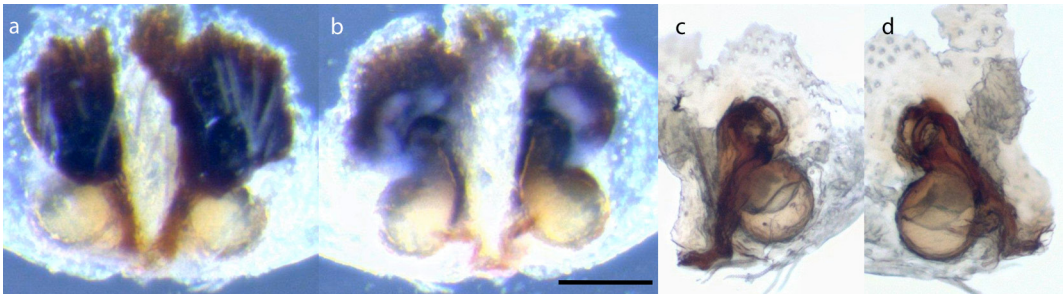

Fig. 11: *Apostenus crespoi* Lissner **spec. nov. a.**, **c.** epigyne in ventral view; **b.**, **d.** vulva in dorsal view. **a.**, **b.** with copulatory openings clogged by exudates obscuring anterior parts; **c.** one half-side of cleaned epigyne; **d.** one half-side of cleaned vulva. Scale bar 0.1 mm

rosetae and two ventral macrosetae one of which is strong and light brown, second is thinner and black. Femur III and IV also with an additional prolateral macroseta in distal position and two ventral-prolateral macrosetae, also in distal positions. Patella I and II without macrosetae, III and IV each with a dorsal macroseta in distal position. Tibia I and II with five pairs of ventral macrosetae, Mt I and II with three pairs. Leg measurements (coxa, femur, patella, tibia, metatarsus, tarsus): Leg I: 3.6 (0.32 + 0.92 + 0.49 + 0.73 + 0.62 + 0.48), Leg II: 3.4 (0.30 + 0.84 + 0.47 + 0.74 + 0.62 + 0.51), Leg III: 3.5 (0.39 + 0.83 + 0.41 + 0.66 + 0.68 + 0.54), Leg IV: 4.9 (0.29 + 1.10 + 0.52 + 0.99 + 0.99 + 0.97). Leg formula 4132, legs I-III subequal in length.

Epigyne/vulva. Epigyne without a septum, essentially an endogyne (Figs 10-11). The only external sclerotizations are the rather weakly sclerotized linings of the small copulatory openings which are circular- semicircular, and set apart anteriorly (cleaned epigyne of Fig. 10, in Fig. 11a the anterior part of the epigyne is obscured by exudates and the copulatory openings are not discernible). Remaining parts of the genitalia are below the integument. Thus the epigynal lobe found in most *Apostenus* species is absent. The median area is covered only by transparent cuticle not different from the cuticle outside the epigynal area, thus there is no epigynal plate (Fig. 11a, b, grey areas of detached epigyne/vulva in fig. 11c, d are artefacts caused by folded cuticle and loose hairs). The two halves of the vulva form a 'V' and are only bridged posteriorly by a thin bar which is interpreted not to be a part of the vulva. As a result of this weak structure, the two halves of the vulva broke apart during digestion in KOH and handling. As is typical for *Apostenus* the copulatory openings were clogged by hard secretions concealing much of the structures (Figs. 11a, b) however, these plugs became detached during digestion so that the details of the anterior parts became visible (Figs. 11c, d).

Ecology. The specimen was found under a stone on limestone grassland with bush encroachment interpreted as abandoned pasture.

Comments. The species is assigned to *Apostenus* Westring, 1851 due to the recurved PER and leg spination with tibiae I and II having five pairs of ventral macrosetae and metatarsi I and II having three pairs. There are 12 extant, primarily Palaearctic, *Apostenus* species described according to the World Spider Catalog (2017), three of which are known from mainland Europe (Nentwig et al. 2017), four from the Canary Islands, and two from northern Africa (Bosmans 1999). The four Canarian *Apostenus* species (*A. gomerensis* Wunderlich, 1992, *A. grancanariensis* Wunderlich, 1992, *A. annulipedes* Wunderlich, 1987 and *A. palmensis* Wunderlich, 1992) and the European mainland species (*A. fuscus* and *A. ochraceus* Hadjissarantos, 1940) all possess a more or less distinct sclerotized median epigynal lobe. Two further Nearctic species, *A. ducati* Bennett, Copley & Copley, 2013 and *A. californicus* Ubick & Vetter, 2005 likewise differ from *A. crespoi* sp. n. by possessing a distinct median epigynal lobe (Bennett et al. 2013, Ubick & Vetter 2005). The twelfth species of the genus, *A. annulipes* Caporiacco, 1935, is known from Karakorum, Central Mongolia and possesses an epigyne with a parallel-sided median septum according to the sketch in Caporiacco (1935), absent in the species described here. Thus the epigyne of *A. crespoi* n. sp. is rather unusual for *Apostenus* by lacking both a septum and a sclerotized epigynal lobe. The epigyne and vulva were examined carefully under both a stereomicroscope and compound microscope at various magnifications and light intensities but no slits or depressions in the integument or sclerotizations of a median plate/lobe were observable.

Canariphantes zonatus (Simon, 1884) (Linyphiidae)

(Fig. 14)

Lepthyphantes zonatus Simon 1884: 322, f. 91

Records from Portugal are listed at the Iberian Spider Catalogue (Morano et al. 2014).

Fig. 12: *Euophrys nigripalpis* Simon, 1937, male

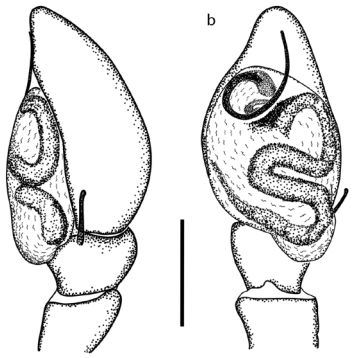

Fig. 13: *Euophrys nigripalpis* Simon, 1937. **a.** male palp in retrolateral view; **b.** same in ventral view. Scale bar 0.2 mm

Fig. 14: *Canariphanthes zonatus* (Simon, 1884). **a.** drawing of epigyne in ventral view; **b.** photo of detached epigyne with vulva partly visible; **c.** photo of epigyne in ventral view

Material examined. PORTUGAL: Évora, North of the town Évora along Roman aqueduct (N38°37'6", W7°57'36"), 1♀, among grass and weeds in pastures, 320 m a.s.l., 4.III.2015, Jørgen Lissner leg., CJL-11766.
Comments. This species is widespread in the Western Mediterranean (World Spider Catalog 2017). An illustration and photo of the epigyne in ventral view is presented here as well as a photo of a detached epigyne with some parts of the underlying vulva visible (Fig. 14).

***Euophrys nigripalpis* Simon, 1937 (Salticidae)** (Figs 12–13)
Euophrys nigripalpis Simon 1937: 1181, 1253
(without figures)
Material examined. PORTUGAL: Beja, Moura, Sobral da Adiça (N37°58'40", W7°17'39"), 2♂, forest steppe/maquis, 350 m a.s.l., 27.III.2013, Jan Dolanský leg., CJL-8789; Faro, Loulé, Fonte da Taipa (Querença) (N37°12'25", W7°56'14"), 2♂, habitat not recorded, 220 m a.s.l., 31.III.2013, Jan Dolanský leg., CJL-8758.
Comments. This species has been recorded in France and Corsica and is new to Portugal. The clypeus of the male is pumpkin orange (Fig. 12). Illustrations and photos of the male palp are presented here (Fig. 13). The retrolateral tibial apophysis is rather thin, not much thicker than the hairs covering the cymbium and is visible also in ventral view (Fig. 13b). The tip of the apophysis is slightly swollen, bent inwards and upwards. Photographs of both the epigyne and palps are only available on the internet (Oger 2017, Prószyński 2017) and are not published yet.

Discussion

The new records presented above represent five species recorded from Portugal for the first time, two of which are also new to science. This increases the total number of species cited from Portugal to 817.

Acknowledgements

I wish to thank Miquel Arnedo, University of Barcelona, Spain for assisting with identification of *Dysdera lata*. Torbjørn Ekrem, Department of Natural History, NTNU University Museum, Norway is thanked for including the *Apostenus* specimen in the Norwegian Barcode of Life (NorBOL) project. Gratitude is also extended to Pedro Cardoso, Finnish Museum of Natural History and an unknown reviewer for useful comments on an earlier version of the manuscript.

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Supplementary File 1: Supplement_Lissner_Portugal_spiders.xls, Excel spreadsheet with all spider records from Portugal in the collection of the author.

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