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# New data on pseudoscorpions (Arachnida: Pseudoscorpiones) in north-east Slovakia

**Alexandra Jászayová & Tomáš Jászay**

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**Abstract.** The paper presents new data on the diversity and distribution of pseudoscorpions from seven localities in the Stebnícka Magura massif in the Low Beskids, two localities in the East Carpathians Protected Landscape Area (PLA) and one locality in the Vihorlat PLA, Slovakia, collected by sieving methods. Altogether, 372 pseudoscorpion specimens belonging to 15 species and four families were sampled over three years (2007, 2010, 2015). The most abundant families were Neobisiidae (335 specimens, nine taxa) and Chthoniidae (33 specimens, four taxa); while the families Cheiridiidae and Chernetidae were represented by only one species each. *Neobisium sylvaticum* (C. L. Koch, 1835), *Neobisium erythrodactylum* (L. Koch, 1873), *Ephippiochthonius boldorii* (Beier, 1934), *Ephippiochthonius tetrachelatus* (Preyssler, 1790) and *Roncus* sp. were recorded only in the East Carpathians PLA within our study. The most abundant species was *Neobisium crassifemoratum* (Beier, 1928). The species *Ephippiochthonius boldorii* and *Ephippiochthonius fuscimanus* (Simon, 1900) were found in this area for the first time.

**Keywords:** Carpathians, distribution, faunistic, forest leaf litter

**Zusammenfassung. Neue Daten über Pseudoskorpione (Arachnida: Pseudoscorpiones) im Nordosten der Slowakei.** Die vorliegende Arbeit enthält neue Daten über die Diversität und Verbreitung von Pseudoskorpionen aus sieben Fundorten in Stebnícka Magura in den Niederen Beskiden, zwei Fundorten im Landschaftsschutzgebiet (LSG) Ostkarpaten und einem Fundort in Vihorlat LSG, Slowakei, gesammelte mit der Siebmethode. Insgesamt 372 Pseudoskorpion-Exemplare, die zu 15 Arten und vier Familien gehören, wurden in drei einjährigen Saisons (2007, 2010, 2015) identifiziert. Am häufigsten waren die Familien Neobisiidae (335 Exemplare, neun Taxa) und Chthoniidae (33 Exemplare, vier Taxa); die Familien Cheiridiidae und Chernetidae waren jeweils nur mit einer Art vertreten. *Neobisium sylvaticum* (C. L. Koch, 1835), *Neobisium erythrodactylum* (L. Koch, 1873), *Ephippiochthonius boldorii* (Beier, 1934), *Ephippiochthonius tetrachelatus* (Preyssler, 1790) und *Roncus* sp. wurden nur im Landschaftsschutzgebiet Ostkarpaten erfasst. Die zahlreichste Art in der gesamten Untersuchung war *Neobisium crassifemoratum* (Beier, 1928). Bemerkenswert sind die Nachweise von *Ephippiochthonius boldorii* und *Ephippiochthonius fuscimanus* (Simon, 1900), die erstmals in dieser Region gefunden wurden.

The north-eastern part of Slovakia is remarkable for its rich natural environment and received previous attention from zoologists, especially coleopterologists (e.g. Chyzer 1885a, 1885b, 1885c, 1885d, Bíró 1885). Here, we present new data on pseudoscorpions obtained during faunistic research into beetles in the East Carpathians Protected Landscape Area (PLA), the Vihorlat PLA and the Stebnícka Magura massif. Initial data on the occurrence of pseudoscorpions associated with the Vihorlat Mts. were published by Tömösváry (1884), Daday (1918), Szent-Iványi (1941) and Ducháč (1995). The most recent data from Stebnícka Magura were published by Jászayová et al. (2015). More intensive research into pseudoscorpions was carried out only in the territory of the Poloniny National Park, which is adjacent to the East Carpathians PLA (Krumpál & Krumpálová 2003). North-eastern Slovakia is interesting from a zoogeographical perspective, especially due to the occurrence of East Carpathian elements, because this represents the western border of their distribution in Slovakia (Jászay 2001). Along with the above-mentioned studies, which concern mainly epigeic and edaphic species, our research on pseudoscorpion diversity has focused on this little-known north-eastern area in Slovakia.

We offer faunistic data from north-eastern Slovakia, with a focus on the ecology and faunistics of individual pseudoscorpion species. Due to several uncertainties regarding unreliable characters for distinguishing species in the genera *Roncus* and *Neobisium*, we present such problematic records determined only to the genus level. These genera are subject to current intensive taxonomic study in the Central European context (Christophoryová pers. com.).

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## Material and methods

### Study area

Pseudoscorpion sampling was carried out at ten localities (Tab. 1). Seven localities in Stebnícka Magura were selected according to an elevation gradient from 400 m to 870 m a.s.l. Two localities (Udava and Lazky) are in the East Carpathians PLA and the remaining one (Jedlinka NR) in the Vihorlat PLA.

Stebnícka Magura is characterized by different types of plant associations of oak-beech, beech, and fir-beech forests, of which fir-beech occupies the largest area (Jászayová & Jászay 2017). The East Carpathians PLA represents the junction of two mountain systems: the Western and the Eastern Carpathians. The area is dominated by beech forest communities – beech forests in the foothills, and locally there are also natural communities of beech and fir flowery forests and beech-maple associations. The area of the East Carpathians PLA represents a juncture point of the Eastern and Western Carpathian and the Pontic-Mediterranean fauna and flora (Jászay 2001). The Vihorlat PLA, is one of the most forested montane areas in Slovakia, with a predominance of deciduous, especially beech and fir flowery forests, where beech (*Fagus sylvatica* L.) has the largest representation. Within the Vihorlat PLA the original forest community with white fir (*Abies alba* Mill.) and European spruce (*Picea abies* (L.) H. Karst) has been preserved, but only in the Jedlinka Nature Reserve.

### Sampling and identification

The leaf litter and upper part of the soil of a cumulative area of about 1 $m^2$ were sampled at each locality. The exact date of sampling is given in the Results. The soil and leaf litter sam-

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**Tab. 1:** Sampled localities and habitats; NR – nature reserve, PLA – protected landscape area

| Code | Locality | N | E | a.s.l. (m) | Dominating tree species or plant associations |
|---|---|---|---|---|---|
| **1** | Stebnícka Magura – Mníchovský potok (stream) | 49.324167° | 21.235556° | 400–450 | oak-hornbeam (Querco-Carpinetum) |
| **2** | Stebnícka Magura – Čerešňa (mountain) | 49.335556° | 21.246389° | 520–530 | fir forest (*Abies alba*, *Fagus sylvatica*, *Quercus* sp.) |
| **3** | Stebnícka Magura – Tri studničky (mountain) | 49.345000° | 21.246667° | 580–610 | beech and fir flowery forest (*Fagus sylvatica*, *Abies alba*) |
| **4** | Stebnícka Magura – Kamenná hora (hill) | 49.343889° | 21.242778° | 665 | beech and fir flowery forest with the presence of *Acer* sp. |
| **5** | Stebnícka Magura – below the nature reserve border | 49.351944° | 21.248890° | 780–800 | beech and fir flowery forest with the presence of *Acer* sp. |
| **6** | Stebnícka Magura – penultimate resting place to Vykrývač | 49.356111° | 21.247222° | 850 | beech and fir flowery forest with the presence of *Acer* sp. |
| **7** | Stebnícka Magura – Vykrývač (mountain) | 49.359167° | 21.243333° | 850–870 | maple-beech mountain forest (*Fagus sylvatica*, *Acer pseudoplanatus* L.) |
| **8** | Lazky, East Carpathians PLA | 49.175323° | 22.060440° | 420–460 | beech and fir flowery forests (*Fagus sylvatica*) and birch (*Betula* sp.) |
| **9** | Udava, East Carpathians PLA | 49.025313° | 22.047383° | 340 | floodplain alder forest with beech (*Fagus sylvatica*) and grey alder (*Alnus incana* (L.) Moench) |
| **10** | Jedlinka NR, Vihorlat PLA | 48.915004° | 22.179703° | 820 | beech primeval forest with silver fir (*Abies alba*) and European spruce (*Picea abies*) |

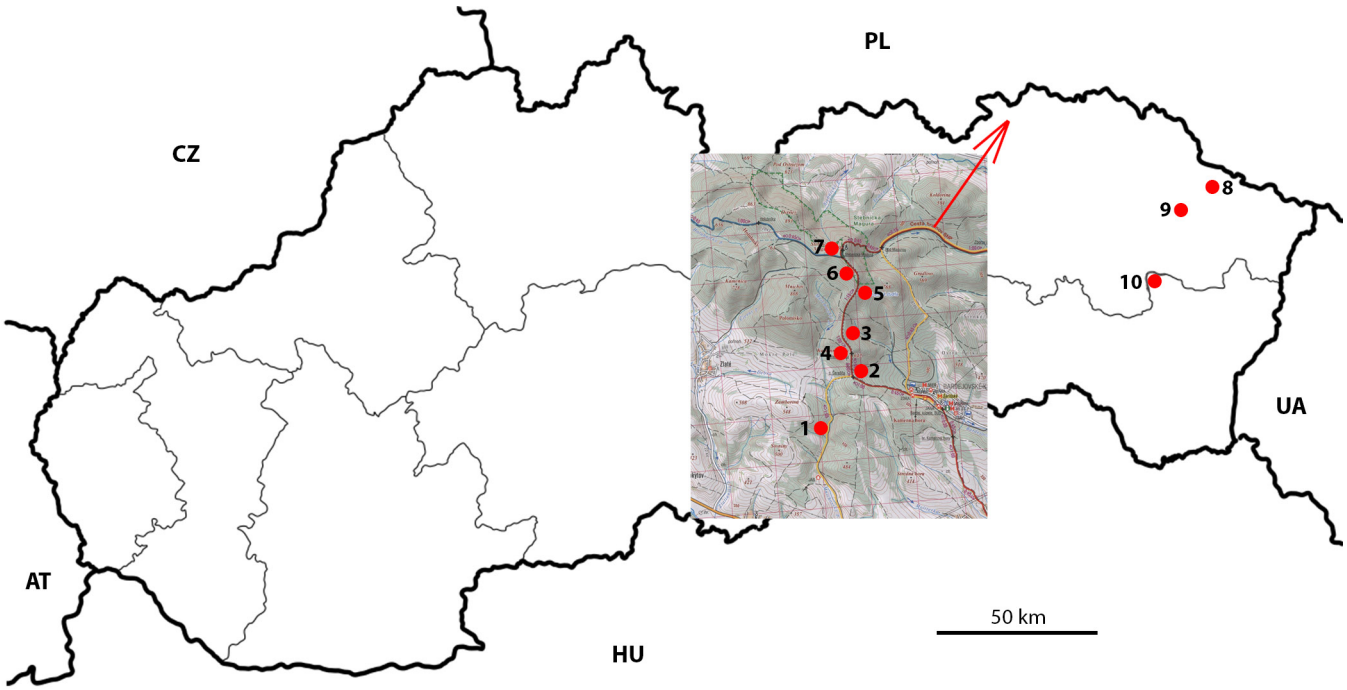



**Fig. 1:** Studied localities in Slovakia. For locality codes, see Tab. 1

ples were obtained by sieving. Samples were extracted using xereclectors of the Moczarski's type (Besuchet et al. 1987) for three weeks, and the material was separated every day. Specimens were preserved in 70% ethanol, and all samples were studied on temporary slides using lactic acid. The studied material was collected by both authors and identified by the first author. Pseudoscorpions were identified using the key of Christophoryová et al. (2011b). Unless otherwise indicated, nomenclature follows Zaragoza (2017), Červená et al. (2020a) and the World Pseudoscorpiones Catalog (2022). The year of description of the species *Chthonius heterodactylus* Tömösváry, 1883, was modified based on the work of Judson (2018). The material is deposited in the collection at the Natural History Department of Šariš Museum in Bardejov, Slovakia.

The following abbreviations for all developmental stages are used in the text: A – adult, Tn – tritonymph, Dn – deutonymph, Pn – protonymph, ∑ – total number of specimens per locality; structure of data in Results: locality Nº: number of specimens and sex, collecting date.

## Results

In total 372 specimens belonging to 15 species from four families were identified (Tab. 2). The most abundant family was Neobisiidae (335 specimens, nine taxa). Chthoniidae

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**Fig. 2:** Sampling sites at Stebnícka Magura. **a.** Mníchovský potok (stream) (locality № 1); **b.** Tri studničky (locality № 3); **c.** Below the border of a nature reserve (locality № 5); **d.** Vykrývač (locality № 7)

was less abundant (33 specimens, four taxa); Cheiridiidae and Chernetidae were represented by only one species each (and each species represented by two specimens). A total of 129 specimens were collected from seven localities at Stebnícka Magura. *Neobisium sylvaticum*, *N. erythrodactylum*, *Ephippiochthonius boldorii*, *E. tetrachelatus* and *Roncus* sp. were recorded only in the East Carpathians PLA. *Roncus* sp. and some species of *Neobisium* spp. were only identified to genus level.

## Faunistic data of the collected taxa

### Family Chthoniidae Daday, 1889

#### *Chthonius heterodactylus* Tömösváry, 1883

**Material examined. 5:** 1 ♀, 23. Apr. 2010; **7:** 1 ♂, 24. May 2010; **7:** 1 ♀, 25. May 2010; **8:** 2 ♀♀, 1 ♂, 6. Aug. 2015; 1 ♀, 10. Jun. 2015; **9:** 3 ♀♀, 8 ♂♂, 27. Jul. 2015; 6 ♀♀,4 ♂♂, 4. Aug. 2015.

**Distribution.** Czech Republic, Germany, Greece, Hungary, Poland, Romania, Slovakia, Ukraine (World Pseudoscorpiones Catalog 2022).

**Tab. 2:** Pseudoscorpion taxa and numbers of individuals collected from different localities: 1 – Stebnícka Magura, Mníchovský potok (stream), 2 – Stebnícka Magura, Čerešňa, 3 – Stebnícka Magura, Tri studničky, 4 – Stebnícka Magura, Kamenná hora 5 – Stebnícka Magura, below the nature reserve border, 6 – Stebnícka Magura – penultimate resting place to Vykrývač, 7 – Stebnícka Magura, Vykrývač, 8 – Lazky, 9 – Udava, 10 – NR Jedlinka

| Taxon/Locality | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | ∑ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Chthoniidae** | | | | | | | | | | | |
| *Chthonius heterodactylus* | . | . | . | . | 1 | . | 2 | 4 | 21 | . | **28** |
| *Ephippiochthonius boldorii* | . | . | . | . | . | . | . | . | 3 | . | **3** |
| *Ephippiochthonius fuscimanus* | . | 1 | . | . | . | . | . | . | . | . | **1** |
| *Ephippiochthonius tetrachelatus* | . | . | . | . | . | . | . | . | 1 | . | **1** |
| **Neobisiidae** | | | | | | | | | | | |
| *Neobisium* (*N.*) *brevidigitatum* | 3 | 14 | 3 | 6 | 10 | . | 8 | 16 | 13 | . | **73** |
| *Neobisium* (*N.*) *carcinoides* | . | 2 | . | 1 | . | . | . | 6 | . | . | **9** |
| *Neobisium* (*N.*) *carpaticum* | . | 2 | . | . | . | . | 3 | . | . | . | **5** |
| *Neobisium* (*N.*) *crassifemoratum* | 15 | 7 | 4 | . | 9 | . | 9 | 18 | 38 | . | **100** |
| *Neobisium* (*N.*) *erythrodactylum* | . | . | . | . | . | . | . | 22 | 4 | . | **26** |
| *Neobisium* (*N.*) *fuscimanum* | . | 4 | . | 1 | 3 | 1 | . | 1 | . | . | **10** |
| *Neobisium* (*N.*) *polonicum* | . | . | . | . | . | . | . | . | . | 4 | **4** |
| *Neobisium* (*N.*) *sylvaticum* | . | . | . | . | . | . | . | 3 | 8 | . | **11** |
| *Neobisium* spp. | . | . | . | . | . | 1 | 2 | 27 | 12 | . | **42** |
| *Neobisiidae* gen. sp. | 3 | 1 | . | 1 | 4 | 3 | 3 | 15 | 18 | . | **48** |
| *Roncus* sp. | . | . | . | . | . | . | . | 5 | 2 | . | **7** |
| **Cheliferidae** | | | | | | | | | | | |
| *Pselaphochernes scorpioides* | . | . | . | . | . | . | 1 | 1 | . | . | **2** |
| **Cheiridiidae** | | | | | | | | | | | |
| *Cheiridium museorum* | . | . | . | . | . | 1 | . | . | 1 | . | **2** |
| ∑ | **21** | **31** | **7** | **9** | **27** | **6** | **28** | **118** | **121** | **4** | **372** |

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**Remarks.** Gardini (2014) synonymized *Chthonius diophthalmus* Daday, 1889, with *Chthonius heterodactylus*, which was already known from Slovakia. *Chthonius heterodactylus* is an epigeic species known to occur in tree hollows, moss, and leaf litter (Krumpál & Krumpálová 2003, Krajčovičová et al. 2016, Christophoryová et al. 2017b, Jászayová & Christophoryová 2019, Jászayová & Jászay 2021).

***Ephippiochthonius boldorii* (Beier, 1934)** (Fig. 3 a-c)
**Material examined. 9:** 1 ♂, 27. Jul. 2015; 2 ♂♂, 4. Aug. 2015.
**Distribution.** Austria, Croatia, Germany, Italy, Luxembourg, Slovakia, Slovenia, Switzerland (Gardini 2013, World Pseudoscorpiones Catalog 2022).
**Remarks.** The characteristic habitat for this species in Slovakia is oak-hornbeam forest (Christophoryová & Krumpál 2005, Christophoryová & Holecová 2012, Holecová et al. 2012). It was recorded at lower elevations from the Malé Karpaty Mts. (Christophoryová & Krumpál 2005, 2007, Christophoryová & Holecová 2012, Christophoryová 2013) and in compost heaps (Christophoryová et al. 2017c). *Ephippiochthonius boldorii* was found in leaf litter and upper parts of the soil as a eudominant species (Christophoryová & Krumpál 2007). Christophoryová et al. (2007) and Jászayová & Jászay (2021) also recorded this species in an oak-hornbeam forest. There were no records of the species over the following ten years until Christophoryová et al. (2017c) recorded one female in a compost heap at an elevation of 490 m a.s.l. The species had not previously been recorded in compost heaps or decaying material in Slovakia. During entomological research in the Slovak Karst NP in 2014, 22 individuals of *E. boldorii* were collected, mostly from oak-hornbeam forest (Jászayová & Jászay 2021). Our present results as well as data from the Slovak Karst NP suggest a preference by this species for the Fago-Quercetum forest association.

***Ephippiochthonius fuscimanus* (Simon, 1900)**
**Material examined. 2:** 1 ♂, 24. Jun. 2010.
**Distribution.** Austria, Czech Republic, Georgia, Germany, Hungary, Italy, Poland, Slovakia, Turkey (Červená et al. 2020a, World Pseudoscorpiones Catalog 2022).
**Remarks.** *Ephippiochthonius fuscimanus* is a typical epigeic species, already known from oak-hornbeam forests (Christophoryová & Krumpál 2007, Christophoryová et al. 2012, Christophoryová 2013, Jászayová & Christophoryová 2019, Červená et al. 2020b, Jászayová & Jászay 2021), compost heaps, deadwood, and tree hollows (Kaňuchová et al. 2015, Christophoryová et al. 2017b). The present study adds new locations to its already known distribution in Slovakia.

***Ephippiochthonius tetrachelatus* (Preyssler, 1790)**
**Material examined. 9:** 1 ♀, 23. Jun. 2015.
**Distribution.** Common European species, known from almost all countries bordering Slovakia (World Pseudoscorpiones Catalog 2022).
**Remarks.** *Ephippiochthonius tetrachelatus* is considered a eurytopic, mainly epigeic species and often represents the most commonly collected species from the family Chthoniidae (Holecová et al. 2012, Christophoryová 2013, Jászayová & Christophoryová 2019, Jászayová & Jászay 2021). *Ephippiochthonius tetrachelatus* often occurs in leaf litter along southern exposed forest edges or inside sparse forests; it is also frequently found under stones or logs, among stones in stone walls, usually in sunny or semi-shaded locations. Less often, it has been collected in decaying wood inside tree hollows, in bird nests, among washed-up items along coasts or in garden compost heaps and the litter of stables and barns (Lissner 2021). The species prefers relatively dry places, but also occurs in wetter habitats (Ducháč 1994); it is often associated with tree cavities (Christophoryová & Mock 2009). Only a single specimen was recorded, however we did not investigate the habitats and microhabitats typical for this species.

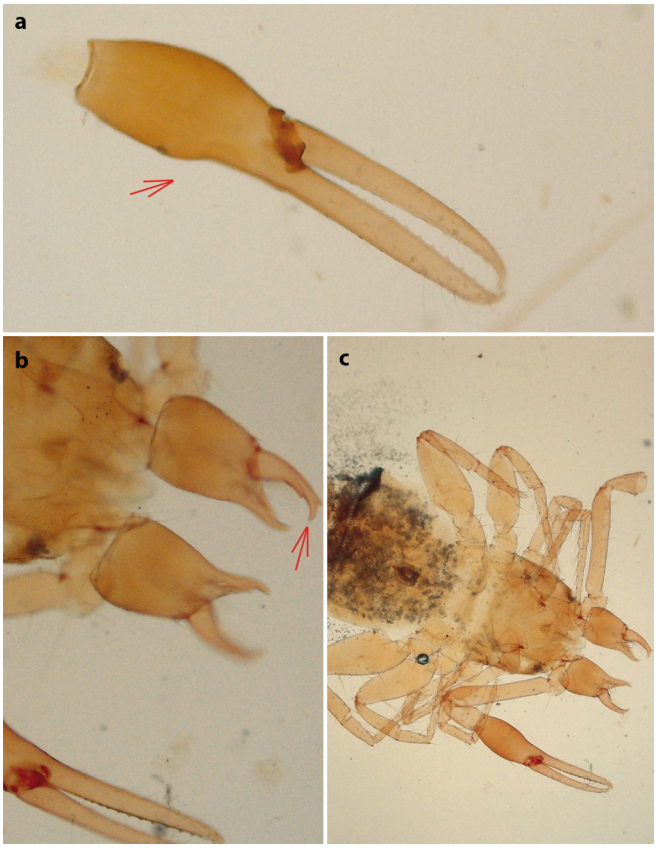



**Fig. 3:** *Ephippiochthonius boldorii*, specimen originates from Udava. **a.** hand of a pedipalpus (arrow = chelal hand with a distinct dorsal depression); **b.** claws (arrow = cheliceral movable finger without isolated subdistal tooth) on left chelicera; **c.** body (prosoma), ventral view of *E. boldorii*

**Family Neobisiidae Chamberlin, 1930**
***Neobisium* (*Neobisium*) *brevidigitatum* (Beier, 1928)**
**Material examined. 1:** 3 ♂♂, 25. Jun. 2010; **2:** 13 ♀♀, 1 ♂, 24. Jun. 2010; **3:** 3 ♀♀, 25. Jun. 2010; **4:** 4 ♀♀, 2 ♂♂, 4. May 2010; **5:** 7 ♀♀, 3 ♂♂, 25. Apr. 2010; **7:** 1 ♂, 24. May 2010; 3 ♀♀, 4 ♂♂, 25. May 2010; **8:** 2 ♀♀, 1 ♂, 27 Jul. 2015; 3 ♀♀, 6 ♂♂, 6. Aug. 2015; 1 ♀, 3 ♂♂, 10. Jun. 2015; **9:** 5 ♀♀, 1 ♂, 23. Jun. 2015; 4 ♀♀, 3 ♂♂, 27. Jul. 2015.
**Distribution.** Georgia, Hungary, Poland, Romania, Slovakia (Novák 2015, Červená et al. 2020a, World Pseudoscorpiones Catalog 2022), Ukraine (Novák 2017).
**Remarks.** In Slovakia *Neobisium brevidigitatum* was previously recorded from the High Tatra Mts., Great Fatra Mts., Pieniny Mts. and the Slovak Karst NP (Krumpál 1980, Rafalski 1967, Šťáhlavský & Dolejš 2019, Jászayová & Jászay 2021). No records of this species have previously been published from the area we investigated.

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***Neobisium* (*Neobisium*) *carcinoides* (Hermann, 1804)**
**Material examined. 2:** 2 ♂♂, 24. Jun. 2010; **4:** 1 ♀, 4. May 2010; **8:** 1 ♀, 10. Jun. 2015; 5 ♀♀, 6. Aug. 2015.
**Distribution.** A wide distribution across Europe and from different countries in Africa, Central and South Asia (World Pseudoscorpiones Catalog 2022).
**Remarks.** *Neobisium carcinoides* is eurytopic and often the most sampled species from the family Neobisiidae in Central Europe. It occurs in different habitats, from dry to heavily waterlogged; in tree hollows and deadwood (Christophoryová 2010, 2013, 2014); in bird nests, which it most probably entered accidentally (Christophoryová et al. 2017a); in compost heaps (Kaňuchová et al. 2015, Christophoryová et al. 2016, 2017c); and from cave entrances (Christophoryová 2009, 2013, Christophoryová & Krumpál 2010, Christophoryová et al. 2016, Jászayová & Jászay 2021). It was also collected using Malaise traps (Krajčovičová & Christophoryová 2014). The species was recorded in high numbers in the Poloniny Mts. (Krumpál & Krumpálová 2003) and was found in eastern Slovakia in the Slovak Karst (Jászayová & Christophoryová 2019, Jászayová & Jászay 2021). Based on a recent molecular analysis (Muster et al. 2021), this species was shown to exhibit high levels of cryptic diversity, which suggests that may consist of several, as yet undescribed, species. Future research with molecular methods appears to be necessary.

***Neobisium* (*Neobisium*) *carpaticum* Beier, 1935**
**Material examined. 2:** 2 ♀♀, 24. Jun. 2010; **7:** 2 ♀♀, 1 ♂, 25. May 2010.
**Distribution.** Poland, Romania, Serbia, Slovakia (World Pseudoscorpiones Catalog 2022).
**Remarks.** This species is a Carpathian element with a typical occurrence in oak-hornbeam forests (Krumpál & Krumpálová 2003, Christophoryová & Krumpál 2007, Christophoryová et al. 2012) and in leaf litter (Jászayová & Jászay 2021).

***Neobisium* (*Neobisium*) *crassifemoratum* (Beier, 1928)**
**Material examined. 1:** 5 ♀♀, 10 ♂♂, 25. Jun. 2010; **2:** 7 ♂♂, 24. Jun. 2010; **3:** 4 ♀♀, 25. Jun. 2010; **5:** 6 ♀♀, 3 ♂♂, 23. Apr. 2010; **7:** 2 ♀♀, 5 ♂♂, 24. May 2010; 1 ♀, 1 ♂, 25. May 2010; **8:** 4 ♀♀, 2 ♂♂, 27. Jul. 2015; 4 ♀♀, 8 ♂♂, 6. Aug. 2015; **9:** 14 ♀♀, 3 ♂♂, 23. Jun. 2015; 10 ♀♀, 27. Jul. 2015; 9 ♀♀, 2 ♂♂, 4. Aug. 2015.
**Distribution.** Azerbaijan, Bulgaria, Czech Republic, Georgia, Germany, Greece, Hungary, North Macedonia, Poland, Romania, Serbia, Slovakia, Turkey, Ukraine (World Pseudoscorpiones Catalog 2022), Lithuania (Krajčovičová et al. 2018).
**Remarks.** This species prefers moist habitats and occurs mostly in the soil (Krumpál & Krumpálová 2003). In Slovakia, *N. crassifemoratum* was recorded in the Great Fatra Mts. (Krumpál 1980), the Poloniny NP (Krumpál & Krumpálová 2003) and the Slovak Karst NP (Jászayová & Christophoryová 2019). Most faunistic data come from the Poloniny Mts., where the species lives in different habitats, from beech forests or shrubby slopes to montane meadows (Krumpál and Krumpálová 2003).

***Neobisium* (*Neobisium*) *erythrodactylum* (L. Koch, 1873)**
**Material examined. 8:** 6 ♀♀, 10. Jun. 2015; 12 ♀♀, 4 ♂♂, 6. Aug. 2015; **9:** 3 ♀♀, 1 ♂, 27. Jul. 2015.
**Distribution.** Armenia, Austria, Azerbaijan, Bosnia, Croatia, Czech Republic, Georgia, Germany, Greece, Hungary, Iran, Italy, Poland, Romania, Serbia, Slovakia, Slovenia, Turkey, Ukraine (World Pseudoscorpiones Catalog 2022).
**Remarks.** In Slovakia, this typical epigeic species lives in forest leaf litter (Krumpál & Krumpálová 2003, Christophoryová et al. 2012, Krajčovičová & Christophoryová 2014, Červená et al. 2020b, Jászayová & Jászay 2021) and in tree hollows (Christophoryová et al. 2017b). *Neobisium erythrodactylum* is known mainly from the Poloniny NP, where it occurred most frequently in leaf litter (Krumpálová & Krumpál 2003). It is also a common species in the East Carpathians PLA.

***Neobisium* (*Neobisium*) *fuscimanum* (C. L. Koch, 1843)**
**Material examined. 2:** 4 ♂♂, 24. Jun. 2010; **4:** 1 ♀, 4. May 2010; **5:** 3 ♀♀, 23. Apr. 2010; **6:** 1 ♂, 24. May 2010; **8:** 1 ♂, 6. Aug. 2010.
**Distribution.** Albania, Austria, Bosnia, Bulgaria, Croatia, Czech Republic, Georgia, Germany, Greece, Hungary, Iran, Italy, Montenegro, Poland, Romania, Serbia, Slovakia, Slovenia, Turkey (World Pseudoscorpiones Catalog 2022).
**Remarks.** *Neobisium fuscimanum* prefers mainly moist soil, leaf litter or moss and grass tussocks (Krumpál & Krumpálová 2003, Mock et al. 2009, Červená et al. 2021, Krajčovičová et al. 2016). It is also known to occur in anthills (Beier 1948, Jászayová et al. 2015), compost heaps and decaying organic material (Christophoryová et al. 2017c).

***Neobisium* (*Neobisium*) *polonicum* Rafalski, 1936**
**Material examined. 10:** 4 ♀♀, 24. May 2007.
**Distribution.** Poland, Romania, Slovakia, Ukraine (World Pseudoscorpiones Catalog 2022), Hungary (Červená et al. 2020a).
**Remarks**. From Hungary, the presence of *Neobisium polonicum* was reported for the first time under the name *Neobisium biharicum* Beier, 1939, based on a single female from the Macskabarlang Cave, located in the Pilis Mts. (Novák 2013). Later, Novák & Hörweg (2017) synonymized *N. biharicum* with *N. polonicum.* It is remarkable that during intensive faunistic research into cave habitats in Slovakia, which has been carried out for almost two decades, this species has not been found in this habitat type, more so given that the studied cave habitats in Slovakia are very similar to the original Macskabarlang Cave locality in the Pilis Mts. in Hungary (Novák 2013). Besides the cave habitats, the species inhabits beech-fir stands. In Slovakia, it is known from several localities from the Poloniny NP and in adjacent areas, and from the Vihorlat PLA (Krumpál 1979). *Neobisium polonicum* was accidentally sampled during entomological research in the Jedlinka NR. The species was recorded for the first time from the localities Nová Sedlica and Stužica at a range of elevations from 500–650 m a.s.l. (Krumpál 1979). It was also recorded in the Poloniny NP (Krumpál & Krumpálová 2003). The only record from the Vihorlat mountain range is near the source of the Prechodovec stream (48.940048°N, 22.219125°E) with an incorrectly estimated elevation of 800 m a.s.l. (Ducháč 1995). This spring is located at an elevation of about 665 m a.s.l. The species is interesting for its exceptionally large body size (typical size of a female is 5.10–5.80 mm (Krumpál 1979)).

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***Neobisium* (*Neobisium*) *sylvaticum* (C. L. Koch, 1835)**
**Material examined. 8:** 1 ♂, 10. Jun. 2015; 2 ♀♀, 6. Aug. 2015; **9:** 6 ♀♀, 27. Jul. 2015; 2 ♀♀, 4. Aug. 2015.
**Distribution.** Albania, Armenia, Austria, Bosnia, Bulgaria, Croatia, Czech Republic, France, Georgia, Germany, Greece, Hungary, Italy, Moldova, Montenegro, Poland, Portugal, Romania, Serbia, Slovakia, Spain, Switzerland, Turkey, Ukraine (World Pseudoscorpiones Catalog 2022).
**Remarks.** *Neobisium sylvaticum* mainly inhabits leaf litter and grass tussocks; it lives under tree bark and in bird and mammal nests (Christophoryová 2014, Christophoryová et al. 2016, 2017a, Jászayová & Christophoryová 2019, Červená et al. 2020b, Jászayová & Jászay 2021). The species was also recorded from Malaise traps (Červená et al. 2020b). It is a common species in the East Carpathians PLA (World Pseudoscorpiones Catalog 2022).

***Neobisium* spp.**
**Material examined. 6:** 1 ♂, 24. May 2010; **7:** 2 ♀♀, 25. May 2010; **8:** 4 ♀♀, 4 ♂♂, 10. Jun. 2015; 2 ♀♀, 27. Jul. 2015; 17 ♀♀, 6. Aug. 2015; **9:** 7 ♀♀, 5 ♂♂, 27. Jul. 2015.
**Remarks**. Due to several uncertainties regarding the unreliable characters used to distinguish some species within the genus *Neobisium*, we present such problematic specimens determined only to genus level. These are the subject of a current intensive taxonomic study of *Lamprochernes* and *Neobisium* species in a Central European context (Christophoryová pers. comm.).

***Roncus* sp.**
**Material examined. 8:** 3 A, 10. Jun. 2015; 2 A, 27. Jul. 2015; **9:** 1 A, 23. Jun. 2015; 1 A, 4. Aug. 2015.
**Remarks.** The genus *Roncus* includes several species complexes lacking morphological or morphometric characters that could be used for their unequivocal identification. Based on the identification key of Christophoryová et al. (2011b) we would classify the species as *Roncus lubricus*. According to (World Pseudoscorpiones Catalog 2022), two species of the genus *Roncus* occur in Slovakia, namely *Roncus lubricus* L. Koch, 1873 and *Roncus transsilvanicus* Beier, 1928. However, ongoing molecular research suggests that other species might also be present. Due to this fact, we list our findings only as *Roncus* sp. Specimens are stored in the collection of the Šariš Museum in Bardejov and could be made available for future research.

**Undetermined material from the family Neobisiidae Chamberlin, 1930**
**1:** 3 Tn, 25. Jun. 2010; **2:** 1 Tn, 24. Jun. 2010; **4:** 1 Tn, 4. May 2010; **5:** 4 Tn, 23. Apr. 2010; **6:** 3 Tn, 24. May 2010; **7:** 3 Tn, 25. May 2010; **8:** 1 Pn, 2 Dn, 6 Tn, 10. Jun. 2015; 4 Dn, 2 Tn, 6. Aug. 2015; **9:** 2 Dn, 23. Jun. 2015; 3 Pn, 5 Dn, 4 Tn, 27. Jul. 2015; 1 Pn, 2 Dn, 1 Tn, 4. Aug. 2015.

**Family Chernetidae Menge, 1855**
***Pselaphochernes scorpioides* (Hermann, 1804)**
**Material examined. 7:** 1 ♀, 25. May 2010; **8:** 1 ♂, 10. Jun. 2015.
**Distribution.** This species occurs throughout Europe and in western Asia and northern Africa. It was also introduced to the eastern USA (World Pseudoscorpiones Catalog 2022, Christophoryová & Jablonski 2017).
**Remarks.** *Pselaphochernes scorpioides* is a common species in Slovakia, a typical inhabitant of leaf litter, compost heaps, tree hollows and decaying wood. It also occurs under tree bark (Christophoryová 2013, Christophoryová et al. 2016, Jászayová & Jászay 2021) and in bird nests and anthills (Jászayová et al. 2015, Krajčovičová et al. 2015, Christophoryová et al. 2017b, 2017c). Two studies (Kaňuchová et al. 2015, Christophoryová et al. 2017c) reported some species inhabiting decomposing material in Slovakia, and *P. scorpioides* was indeed most abundant there.

**Family Cheiridiidae Hansen, 1894**
***Cheiridium museorum* (Leach, 1817)**
**Material examined**. **6:** 1 ♀ 24. May 2010; **9:** 1 ♀, 27. Jul. 2015.
**Distribution.** Widespread in Europe and recorded from several countries in Africa (introduced at least south of the Sahara) and Asia and also introduced into the USA (Massachusetts, Michigan) (World Pseudoscorpiones Catalog 2022, Červená et al. 2021).
**Remarks.** This species is considered to be the smallest European pseudoscorpion (Jędrzejowska et al. 2021). *Cheiridium museorum* is a synanthropic and cosmopolitan species commonly inhabiting synanthropic habitats (Christophoryová 2010, Christophoryová & Červená 2020, Christophoryová et al. 2011a, 2017a). In Slovakia, the species was found in bird nests and in wood-mould in a tree hollow (Červená et al. 2020b).

**Discussion and conclusion**
Fifty-eight species of pseudoscorpions are known from Slovakia (Červená et al. 2020a, Christophoryová & Krajčovičová 2021). In the present paper, we publish records of 15 species belonging to four families. In the literature, 19 species are listed from the Poloniny NP (Krumpál & Krumpálová 2003).

We recorded *Neobisium brevidigitatum* (73 ex.) and *N. crassifemoratum* (100 ex.) at almost every site (Tab. 2). These two species were the most numerous, and overall, the family Neobisiidae was the best represented in terms of the number of species and individuals in our entire study. It is the most diverse family of Pseudoscorpiones in Slovakia. Other species were found in small numbers individually at the studied sites. Concerning the less common species, we recorded four females of *Neobisium polonicum*. This was a coincidental finding in a course of some coleopterological research. However, the species may commonly occur in this area, as confirmed by previously published findings (see Results).

We confirmed an interesting record of *Ephippiochthonius boldorii* in Slovakia from Udava in the East Carpathians PLA. This species is mostly present in the leaf litter of mesophilic habitats in oak-hornbeam forests (Muster et al. 2004, Christophoryová & Krumpál 2007). Mahnert (1980) distinguished *E. boldorii* and *E. fuscimanus* based on the absence (*boldorii*) or presence (*fuscimanus*) of an isolated subdistal tooth on the movable finger of the chelicerae. Muster et al. (2004) revised extensive European material based on this character. They concluded that *E. boldorii* was a western species, mostly confined to localities west of 14°E. Thus the records from Slovakia represent the easternmost outposts of its known range. Further studies are required to determine whether *E. boldorii* is more widespread in Central Europe than assumed by Muster et al. (2004), or whether another

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cryptic species could be involved (cf. Muster et al. 2021). Also, other aspects of the distribution need to be reconsidered. For instance, *E. boldorii* is known from southern Switzerland (Cotti 1989) and Austria (Schmarda 1995). *Ephippiochthonius boldorii* was confirmed at higher elevations in the northern Alps (1500 m a.s.l.), but surprisingly it was also recorded at sea level in Venice. Its northern distribution boundaries coincide with the end of the Hercynian highlands. *Ephippiochthonius boldorii* seems to extend more into the montane belt than *E. fuscimanus*. Apparently, the species is sensitive to temperature, which is reflected in its distribution. At the end of spring and during the summer it is abundant in leaf litter, and with decreasing temperatures it migrates into deeper layers of the soil (Christophoryová & Krumpál 2007). It can be assumed that this species is widespread throughout Slovakia. It would be interesting to pay more attention to this species due to the large differences in its abundances between present and previous studies from this country. In our research, we were able to compare morphological features characteristic for *E. fuscimanus* and *E. boldorii* from Slovakia; we also provided a comparison with material from the Slovak Karst NP and in each case the subdistal tooth was absent (Fig. 3).

In localities at Stebnícka Magura, *Neobisium carpaticum* and *N. fuscimanum* were previously collected from *Formica polyctena* nests (Jászayová et al. 2015). Surprisingly, we recorded only one specimen of *Pselaphochernes scorpioides* at the sites in Stebnícka Magura. Comparing the data in Tab. 2 with the data in Jászayová et al. (2015), in which the authors listed 252 specimens, we expected a much higher specimen number for this species in our research. Thus, it could be stated that in this area, *P. scorpioides* is associated with ant nests, which is also confirmed by numerous records in Červená et al. (2020c). The species *N. carpaticum* was found at the same elevation (520–530 m a.s.l.) as the ants' nests occurred (Jászayová et al. 2015). However, this species also occurred at a higher elevation (870 m a.s.l.) in Stebnícka Magura – Vykrývač, represented by three specimens. Both habitats were in a slightly colder environment on a north-facing slope and may provide suitable conditions for the occurrence of this pseudoscorpion species. This is also supported by the findings of this species from caves (Krumpál 2000).

No records of *Neobisium brevidigitatum* have been previously published from the area we investigated. Our results show that the species occurs in higher numbers, as seen by our discovery of 73 specimens. We found two specimens of *Cheiridium museorum* in leaf litter. The species was probably overlooked due to its small size, thus, its distribution appears insufficiently investigated. This species was recorded at Stebnícka Magura and Lazky for the first time.

Currently, we are unable to assign the *Roncus* specimens to any particular species. Cytogenetic studies have revealed the presence of cryptic species of the genus in Slovakia (Šťáhlavský et al. 2013). A molecular and morphological revision of the genus is in progress. Some specimens listed as *Neobisium* spp. could not be identified by use of morphological features from the available determination keys. It is possible that they belong to undescribed species, but molecular analyses are required in such taxa with high cryptic diversity.

Finally, the list of recorded species is biased by the sampling methods used, which mostly consisted of sifting leaf litter. Therefore, many sampled specimens belong to epigeic species. In terms of faunistic knowledge, our work offers new information on the distribution of pseudoscorpions from poorly explored areas of north-eastern Slovakia, especially from mountainous, forested habitats. We recorded some common species in great numbers (*N. erythrodactylum, N. sylvaticum*), which are typical for the oak-hornbeam-association. Some other common species were less numerous (e.g. *C. museorum*). For *E. fuscimanus* our findings expand the known range of the species. More intensive research on pseudoscorpion faunistics is still necessary and may reveal an even greater diversity of species in Slovakia.

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