Pseudoscorpions (Arachnida: Pseudoscorpiones) from leaf litter of the Slovak Karst National Park

Authors: Jászayová, Alexandra, and Jászay, Tomáš

Source: Arachnologische Mitteilungen: Arachnology Letters, 61(1) : 77-83

Published By: Arachnologische Gesellschaft e.V.

URL: https://doi.org/10.30963/aramit6113

Pseudoscorpions (Arachnida: Pseudoscorpiones) from leaf litter of the Slovak Karst National Park

Alexandra Jászayová & Tomáš Jászay

doi: 10.30963/aramit6113

Abstract. A total of 667 specimens of pseudoscorpions, belonging to 15 species and four families were collected during 2014. Samples were taken from leaf litter at five localities in the Western Carpathians in the Slovak Karst National Park, Slovakia. The most abundant families were Neobisiidae (381 specimens) and Chthoniidae (275 specimens). Furthermore ten chernetid specimens and a single cheliferid deutonymph were recorded. Four of the 15 pseudoscorpion species were recorded in the Slovak Karst for the first time.

Keywords: Carpathians, distribution, faunistics, Slovakia

Zusammenfassung. Pseudoskorpione (Arachnida: Pseudoscorpiones) aus Laubstreu im Nationalpark Slowakischer Karst. Im Jahr 2014 wurden insgesamt 667 Pseudoskorpione aus 15 Arten und vier Familien gesammelt. Die Proben wurden in fünf verschiedenen Gebieten im Nationalpark Slowakischer Karst (Westkarpaten, Slowakei) genommen. Am häufigsten waren die Familien Neobisiidae (381 Exemplare) und Chthoniidae (275 Exemplare) vertreten. Weiterhin wurden zehn Exemplaren der Chernetidae und nur eine Deutonymphe einer Cheliferidae erfasst. Vier der 15 Pseudoskorpionarten wurden erstmals im slowakischen Karst nachgewiesen.

The Slovak Karst National Park is one of the most valuable areas in Slovakia in terms of biodiversity (Tomaskinova & Tomaskin 2013). The territory of the National Park consists of the Koniarská, Plešivská, Silická, Zádielská and Jasovská plateaus, the Horný and Dolný hills, and is divided into gorges and valleys. It is one of the largest karst areas in Central Europe. The area of the National Park is about 346 km^2. In 1977, the territory of the Slovak Karst was included in the international network of biosphere reserves within the UNESCO Programme "Man and the Biosphere" (https://en.unesco.org/biosphere/wnbr). The karst phenomenon, together with other abiotic factors, was of great importance in the development of animal communities in this area. Pseudoscorpions from the Slovak Karst have not been systematically studied. The first data from the territory of the Slovak Karst were published by Daday (1888) and later by Krumpál & Kiefer (1981). More recently, additional data by Papáč et al. (2007), Christophoryová (2009, 2010), Christophoryová et al. (2011b) and Jászayová & Christophoryová (2019) have been published. The majority of faunistic data concern the species *Neobisium* (*Blothrus*) *slovacum* (Ducháč 1996, Ducháč & Mlejnek 2000a, 2000b, Christophoryová 2010, Červená et al. 2019). We know very little about the ecology of pseudoscorpions in Slovakia, as they are often only found in random collections. The aim of the present paper was to complement the current faunistic inventory of pseudoscorpions from five localities in the Sites of Community Importance (SCIs) of Slovak Karst in the Western Carpathians, obtained by the method of sifting the forest leaf litter.

Material and methods

Study area

Research on the pseudoscorpions was carried out at monthly intervals (May–September) during the year 2014 at five localities (Fig. 1): Brzotín Rocks (BR), Pod Fabiánkou (F), Drieňovec (D), Hrušovská lesostep forest-steppe (HL) and Jasovské dubiny (JD).

BR: Brzotín Rocks National Nature Reserve is situated at 290–679 m a.s.l. and located on the northwestern slopes of Silická plateau. The area with 433.78 ha is the largest natural reserve in the Slovak Karst. The geological substrate consists mainly of light Wetterstein limestones. Characteristic of this area are the natural forest associations of thermophilic oak-beech (Fago-Quercetum) and linden maples (Tilio-Aceretum). Sampling sites were located at 48.58801°N, 20.49075°E.

F: Pod Fabiánkou Nature Reserve is situated at 490–510 m a.s.l. and is characterized by the occurrence of species characteristic for meadows and pastures, into which thermophilic species from the surrounding xerothermic phytocoenoses penetrate. In the central part of the area forests grow, especially oak-hornbeam (Querco-Carpinetum) and thermophilic oak or beech forests (Fago-Quercetum). Sampling sites were located at 48.55890°N, 20.54735°E.

D: Drieňovec National Nature Reserve is situated at 430–804 m a.s.l., the substrate is built of karst limestones. Forest and rock plant associations on limestone and non-limestone type substrate are present. The vegetation cover consists of beech-oak (Fago-Quercetum) and linden-maple forests (Tilio-Aceretum) and in the southern part of the reserve, there are partially deforested rocky slopes of forest-steppe and xerothermophilic steppe. Sampling sites were located at 48.64085°N, 20.68926°E.

HL: Hrušovská lesostep forest-steppe National Nature Reserve – declared as a protected area in 1984 – is situated at 265–525 m a.s.l. and it has an area of 40.85 ha and represents a typical forest-steppe with xerothermic vegetation of downy oak (*Quercus pubescens* Willd.) and manna ash (*Fraxinus ornus* L.). Turkey oak (*Quercus cerris* L.) also occasionally occurs. Sampling sites are located at 48.59778°N, 20.63278°E.

JD: Jasovské dubiny National Nature Reserve, which is the oldest nature reserve in the Slovak Karst, is situated at 260–340 m a.s.l. The following types of forest are represented there: beech-hornbeam (Fago-Carpinetum), oak-beech (Fago-Quercetum) and oak-beech with a transition to the oak forest with a typical sessile oak (*Quercus petraea* (Matt.) Liebl.). Sampling sites are located at 48.67851°N, 20.96929°E.

Alexandra JÁSZAYOVÁ, Institute of Parasitology, Slovak Academy of Sciences, Hlinkova 3, SK – 040 01 Košice, Slovakia; University of Veterinary Medicine and Pharmacy in Košice, Komenského 73, 041 81, Košice, Slovakia; E-mail: jaszayova@saske.sk
Tomáš JÁSZAY, Natural History Department, Museum of Šariš, Rhodyho 2, SK–085 01 Bardejov, Slovakia; E-mail: tomasjaszay@nextra.sk

Academic editor: Konrad Wiśniewski

submitted: 27.10.2020, accepted: 21.3.2021, online: 27.4.2021

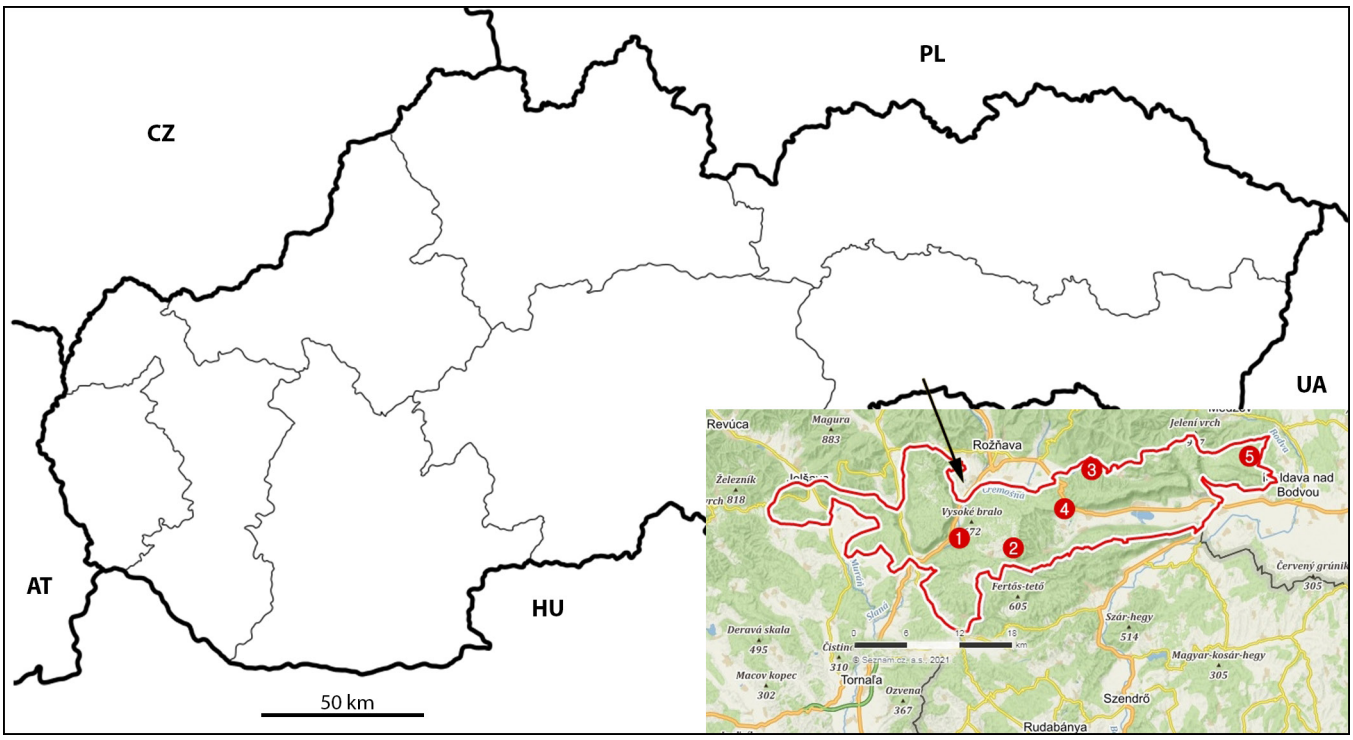

Fig. 1: Map of Slovakia and detail of Slovak Karst with locations of study sites. **1.** Brzotín Rocks (BR); **2.** Pod Fabiánkou (F); **3.** Drieňovec (D); **4.** Hrušovská lesostep forest-steppe (HL); **5.** Jasovské dubiny (JD)

Sampling design

From each locality a volume of about 5 litres of forest leaf litter was sieved. Per 10 m² five sieving samples were made. Samples were extracted using xereclectors of Moczarski´s type (Besuchet et al. 1987). All pseudoscorpions were studied on temporary slide mounts using lactic acid and then rinsed in the water and returned to 70 % alcohol. The studied material was collected by both authors and identified by the first author. Pseudoscorpion specimens were identified using the key of Christophoryová et al. (2011c). If not otherwise indicated, nomenclature follows the catalogue of Pseudoscorpions of the World (Harvey 2013), Zaragoza (2017) and the updated checklist of pseudoscorpions by Červená et al. (2020). The material is deposited in the collection at the Natural History Department of Šariš Museum in Bardejov, Slovakia.

Results

In total, 667 specimens belonging to 15 species from four families were identified. The most numerous family was Neobisiidae (381 specimens, six taxa) and the second most abundant family was Chthoniidae (275 specimens, six taxa); Chernetidae (10 specimens, three taxa) was less abundant and the family Cheliferidae was represented only by a single deutonymph. The list of taxa collected is given below with date and number of specimens of each sex or developmental stage (tritonymph: Tn, deutonymph: Dn, protonymph: Pn).

Family Chthoniidae Daday, 1888

***Chthonius carinthiacus* Beier, 1951**

Material examined. BR: 5 ♂♂, 5. May 2014; 14 ♂♂, 2 ♀♀, 23. Jun. 2014; 8 ♂♂, 13 ♀♀, 15. Jul. 2014; 8 ♂♂, 2 ♀♀, 5. Aug. 2014; 12 ♂♂, 5 ♀♀, 9. Sep. 2014; **F:** 7 ♀♀, 26. May 2014; 11 ♂♂, 14 ♀♀, 25. Jun. 2014; 1 ♂, 2 ♀♀, 5. Aug. 2014; 4 ♂♂, 2 ♀♀, 9. Sep. 2014; **D:** 1 ♂, 1 ♀, 27. May 2014; 5 ♂♂, 1 ♀, 24. Jun. 2014; **HL:** 3 ♂♂, 6. May 2014; 2 ♂♂, 25. Jun. 2014; **JD:** 2 ♀♀, 28. May 2014.

Distribution. Austria, Czech Republic, Hungary, Italy, Slovakia, Slovenia, Switzerland (Harvey 2013, Červená et al. 2020).

Remarks. *Chthonius carinthiacus* is an epigean species. It was previously reported from Austria (Beier 1951) and later from several further countries. In Slovakia *C. carinthiacus* was reported for the first time from Slovenské rudohorie and from the Slovak Karst by Christophoryová et al. (2011b). Additional records from the Slovak Karst were also published recently by Jászayová & Christophoryová (2019).

***Chthonius heterodactylus* Tömösváry, 1882**

Material examined. BR: 2 ♂♂, 5. May 2014; 3 ♀♀, 9. Sep. 2014; **F:** 2 ♀♀, 25. Jun. 2014; **D:** 1 ♂, 6. May 2014; 4 ♀♀, 10. Sep. 2014; **HL:** 2 ♂♂, 16. Jul. 2014; **JD:** 1 ♂, 6. May 2014; 1 ♂, 11. Sep. 2014.

Distribution. Czech Republic, Hungary, Poland, Romania, Slovakia (Červená et al. 2020), Ukraine (Gardini 2014).

Remarks. This is an epigeic species distributed across the whole Carpathians (Ducháč et al. 2007, Gardini 2014). It has previously been recorded in the Slovak Karst (Mock et al. 2009, Papáč et al. 2009, Jászayová & Christophoryová 2019).

***Ephippiochthonius boldorii* (Beier, 1934)**

Material examined. BR: 1 ♀, 5. Aug. 2014; **D:** 3 ♀♀, 5. Aug. 2014; **HL:** 5 ♀♀, 16. Jul. 2014; 4 ♂♂, 3 ♀♀, 6. Aug. 2014; **JD:** 2 ♂♂, 4 ♀♀, 6. Aug. 2014 (rev. J. Christophoryová).

Distribution. Austria, Croatia, Germany, Italy, Slovakia, Slovenia and Switzerland (Muster et al. 2004, Zaragoza 2017, Červená et al. 2020).

Remarks. In Slovakia, this species was recorded in oak-hornbeam forest at lower altitudes from the Malé Karpaty Mts. and in the Trnavská pahorkatina Highland. These localities have habitats and conditions suitable for the occurrence of stable and relatively numerous populations of this species

(Christophoryová & Krumpál 2005, 2007, Christophoryová 2013). *Ephippiochtonius boldorii* is an epigeic species occurring in oak-hornbeam forests (Muster et al. 2004, Christophoryová & Krumpál 2007). The highest localities in the Alps exceed 1500 m a.s.l., but on the other hand, this species was also recorded at sea-level in Venice. The species occurs predominantly in leaf litter in mesophilic habitats (Muster et al. 2004). One female was recorded from compost heaps (Christophoryová et al. 2017b). We found *E. boldorii* in all studied localities except Pod Fabiánkou.

***Ephippiochthonius fuscimanus* (Simon, 1900)**
Material examined. BR: 1 ♂, 1 ♀, 5. May 2014; **HL:** 3 ♂♂, 2 ♀♀, 28. May 2014; 2 ♂♂, 6. Aug. 2014; 5 ♂♂, 1 ♀, 10. Sep. 2014.
Distribution. Austria, Czech Republic, Georgia, Germany, Hungary, Italy, Poland, Slovakia and Turkey (Harvey 2013, Červená et al. 2020).
Remarks. *Ephippiochthonius fuscimanus* was recorded in Slovakia from the oak-hornbeam forest of the Malé Karpaty Mts (Christophoryová & Krumpál 2007, Christophoryová et al. 2012, Christophoryová 2013), from the Slovak Karst in front of cave entrances (Jászayová & Christophoryová 2019) and from bird nests in different parts of Slovakia (Christophoryová et al. 2011a). One deutonymph and one female of the species were recorded in tree hollows and dead wood in western Slovakia (Christophoryová et al. 2017a).

***Ephippiochthonius tetrachelatus* (Preyssler, 1790)**
Material examined. D: 1 ♀, 10. Sep. 2014; **HL:** 14 ♂♂, 5 ♀♀, 25. Jun. 2014; **JD:** 2 ♀♀, 6. Aug. 2014.
Distribution. *Ephippiochthonius tetrachelatus* is widely distributed, known from the Palaearctic region, Argentina, Cuba, Seychelles and the USA (Harvey 2013); in Europe it occurs in Austria, Czech Republic, Germany, Hungary, Poland, Slovakia, Slovenia and Switzerland (Červená et al. 2020).
Remarks. In Slovakia, *Ephippiochthonius tetrachelatus* is one of the most common species, inhabiting different types of habitat and preferring dry or slightly moist conditions (Christophoryová 2013, Christophoryová et al. 2017b). This species was previously confirmed from a cave entrance in the Slovak Karst National Park, from Ardovská cave (Jászayová & Christophoryová 2019).

***Mundochthonius carpaticus* Rafalski, 1948**
Material examined. BR: 2 ♀♀, 5. Aug. 2014; 2 ♀♀, 9. Sep. 2014; **F:** 5 ♀♀, 5. Aug. 2014; 1 ♂, 5 ♀♀, 9. Sep. 2014; **D:** 1 ♀, 6. May 2014; 2 ♀♀, 5. Aug. 2014; **JD:** 1 ♂, 6. May 2014.
Distribution. Czech Republic, Hungary**,** Poland, Slovakia, Ukraine (Harvey 2013, Červená et al. 2020).
Remarks. This species is a Carpathian faunal element known from the whole of Slovakia. It occurs in leaf litter of mixed forests, in humus, under stones, pieces of wood (Christophoryová et al. 2017a, Christophoryová & Krajčovičová 2019), and in the Slovak Karst it was recorded in front of cave entrances (Mock et al. 2009, Papáč et al. 2009, Jászayová & Christophoryová 2019).

Undetermined material from the family Chthoniidae Daday, 1888
BR: 5 Tn, 9. Sep. 2014; 12 Tn, 5. Aug. 2014; **F:** 2 Dn, 25. June 2014; 1 Dn, 3 Tn, 9. Sep. 2014; 9 Tn, 5. Aug. 2014; **D:** 1 Pn, 24. June 2014; 2 Tn, 5. Aug. 2014; 1 Dn, 10. Sep. 2014; **HL:** 1 Pn, 1 Tn, 28. May 2014; 3 Dn, 5 Tn, 6. Aug. 2014; 2 Tn, 10. Sep. 2014; **JD:** 1 Tn, 6. May 2014; 4 Tn, 6. Aug. 2014.

Family Neobisiidae Chamberlin, 1930
***Neobisium* (*Neobisium*) *brevidigitatum* (Beier, 1928)**
Material examined. BR: 2 ♂♂, 6 ♀♀, 23. Jun. 2014; 1 ♀, 15. Jul. 2014; 1 ♀, 5. Aug. 2014; 4 ♂♂, 7 ♀♀, 9. Sep. 2014; **F:** 5 ♀♀, 15. Jul. 2014; 2 ♂♂, 3 ♀♀, 5. Aug. 2014; **D:** 1 ♂, 2 ♀♀, 24. Jun. 2014; 2 ♀, 15. Jul. 2014; 2 ♂♂, 16 ♀♀, 10. Sep. 2014; **HL:** 1 ♀, Sep. 2014.
Distribution. Georgia, Poland, Romania, Slovakia (Harvey 2013), Hungary (Novák 2015), Ukraine (Novák 2017).
Remarks. This species was first described from Romania (Beier 1928). The presence of *Neobisium* (*N.*) *brevidigitatum* was confirmed in the High Tatra Mts, Great Fatra Mts and National Park of Pieniny (Krumpál 1980, Šťáhlavský & Dolejš 2019).

***Neobisium* (*Neobisium*) *carcinoides* (Hermann, 1804)**
Material examined. BR: 1 ♀, 23. Jun. 2014; **F:** 1 ♀, 9. Sep. 2014.
Distribution. This species is distributed in West, Central, North (except Lithuania), East (except Belarus and Moldovia) and South (except Albania) Europe, in Africa (Algeria, Morocco, Tunisia and Kenya) and Asia (India and Kazakhstan) (Harvey 2013, Červená et al. 2020).
Remarks. *Neobisium* (*N.*) *carcinoides* is a eurytopic, mainly epigeic species and is by far the most frequently recorded *Neobisium* species in Central Europe (Drogla & Lippold 2004, Christophoryová 2013). In our study, we found only two females. The occurrence of this species in the Slovak Karst was also reported by Jászayová & Christophoryová (2019).

***Neobisium* (*Neobisium*) *carpaticum* Beier, 1935**
Material examined. BR: 1 ♀, 15. Jul. 2014; **D:** 1 ♀, 5. Aug. 2014.
Distribution. Poland, Slovakia (Červená et al. 2020).
Remarks. The species is regarded as a Carpathian element (Beier 1963, Christophoryová et al. 2012). The typical habitat of this species is oak-hornbeam forest (Krumpál & Krumpálová 2003, Christophoryová & Krumpál 2007) and cave entrances (Krumpál 2000). From the Slovak Karst, *N.* (*N.*) *carpaticum* was recorded for the first time in front of the entrance to Silická ľadnica cave (Jászayová & Christophoryová 2019).

***Neobisium* (*Neobisium*) *crassifemoratum* (Beier, 1928)**
Material examined. BR: 1 ♀, 5. May 2014; 12 ♀♀, 23. Jun. 2014; 2 ♂♂, 15. Jul. 2014; 3 ♀♀, 5. Aug. 2014; 9 ♂♂, 7 ♀♀, 9. Sep. 2014; **F:** 3 ♂♂, 3 ♀♀, 25. Jun. 2014; 1 ♀, 15. Jul. 2014; 1 ♂, 4 ♀♀, 5. Aug. 2014; 10 ♂♂, 20 ♀♀, 9. Sep. 2014; **D:** 1 ♂, 6. May 2014; 2 ♀♀, 24. Jun. 2014; 8 ♂♂, 5 ♀♀, 10. Sep. 2014; **HL:** 1 ♂, 6. May 2014; 2 ♂♂, 3 ♀♀, 16. Jul. 2014; 1 ♂, 10. Sep. 2014; **JD:** 2 ♀♀, 28. May 2014; 1 ♂, 1 ♀, 25. Jun. 2014; 1 ♀, 6. Aug. 2014.
Distribution. Central and Eastern Europe, also Turkey, Georgia, Azerbaijan (Harvey 2013), Lithuania (Krajčovičová et al. 2018).
Remarks. This species occurs mostly in the leaf litter (Krumpál & Krumpálová 2003). In Slovakia *N.* (*N.*) *crassifemoratum* was recorded in the Great Fatra Mts (Krumpál 1980) and Na-

tional Park of Poloniny (Krumpál & Krumpálová 2003). A few specimens were also recorded from bird nests (Fenďa et al. 1998, Christophoryová et al. 2011a). From the Slovak Karst, *N.* (*N.*) *crassifemoratum* was recently recorded just outside the entrance to a cave (Jászayová & Christophoryová 2019).

***Neobisium* (*Neobisium*) *erythrodactylum* (L. Koch, 1873)**
Material examined. BR: 2 ♀♀, 23. Jun. 2014; **F:** 4 ♀♀, 5. Aug. 2014; **D:** 1 ♂, 10. Sep. 2014; **JD:** 2 ♂♂, 1 ♀, 16. Jul. 2014; 1 ♂, 11. Sep. 2014.
Distribution. This species is widespread in Central Europe. It occurs also in Armenia, Azerbaijan, Bosnia and Herzegovina, Croatia, Georgia, Greece, Iran, Italy, Romania, Serbia, Turkey and Ukraine (Harvey 2013, Červená et al. 2020).
Remarks. *Neobisium* (*N.*) *erythrodactylum* is a typical epigeic species living in forest leaf litter and in the upper part of the soil (Krajčovičová & Christophoryová 2014). The species was reported from numerous faunistic surveys in Slovakia (Christophoryová et al. 2012).

***Neobisium* (*Neobisium*) *sylvaticum* (C. L. Koch, 1835)**
Material examined. F: 1 ♀, 5. Aug. 2014; **HL:** 1 ♀, 6. May 2014.
Distribution. This species is widespread throughout Europe except for the United Kingdom, North Europe and European Russia. It occurs also in Armenia, Georgia and Turkey (Harvey 2013).
Remarks. *Neobisium* (*N.*) *sylvaticum* occurs in forest habitats in the leaf litter and moss, but is also known from the entrances of caves and was found under trees or in bird nests (Krumpál & Krumpálová 2003, Drogla & Lippold 2004, Christophoryová 2010, Christophoryová et al. 2017a). Some data from the Slovak Karst were already published by Papáč et al. (2009) and Jászayová & Christophoryová (2019).

Undetermined material from family Neobisiidae Chamberlin, 1930
BR: 3 Tn, 5. May 2014; 12 Pn, 10 Dn, 6 Tn, 23. Jun. 2014; 2 Pn, 2 Dn, 5 Tn, 15. Jul. 2014; 1 Pn, 3 Dn, 8 Tn, 5. Aug. 2014; **F:** 4 Tn, 26. May 2014; 2 Dn, 6 Tn, 25. Jun. 2014; 3 Pn, 3 Tn, 15. Jul. 2014; 1 Pn, 16 Dn, 6 Tn, 5. Aug. 2014; 1 Pn, 24 Dn, 3 Tn, 9.Sep. 2014; **D:** 1 Tn, 6. May 2014; 3 Pn, 5 Tn, 24. Jun. 2014; 1 Dn, 2 Tn, 15. Jul. 2014; 1 Pn, 6 Dn, 9 Tn, 5. Aug. 2014; 1 Pn, 4 Dn, 3 Tn, 10. Sep. 2014; **HL:** 3 Tn, 6.May 2014; 1 Tn, 6. Aug. 2014; **JD:** 3 Tn, 28. May 2014; 1 Tn, 16. Jul. 2014; 2 Dn, 2 Tn, 6. Aug. 2014; 3 Tn, 11.Sep. 2014.

Family Chernetidae Menge, 1855
***Chernes cimicoides* (Fabricius, 1793)**
Material examined. BR: 1 ♂, 23. Jun. 2014; 2 ♀♀, 9. Sep. 2014.
Distribution. Central Europe (Červená et al. 2020), Eurasia (Harvey 2013).
Remarks. In Slovakia, this species is common in tree hollows and under tree bark (Krajčovičová & Christophoryová 2014) and can also be found in anthills (Drogla & Lippold 2004) or bird nests (Krištofík et al. 2002). We found three specimens of *C. cimicoides* at the Brzotín Rocks.

***Chernes similis* (Beier, 1932)**
Material examined. D: 4 ♂♂, 10. Sep. 2014.
Distribution. Austria, Bulgaria, Czech Republic, Hungary, Macedonia, Montenegro, Poland, Romania, Slovakia, Turkey (Novák 2012, Harvey 2013, Christophoryová 2013, Červená et al. 2020), Lithuania (Krajčovičová et al. 2020).
Remarks. A few records of this species are known from Slovakia (Krumpálová & Krumpál 1993). *Chernes similis* was found by Šťáhlavský & Dolejš (2019) in Domica in the Slovak Karst. In our study, we only found four male specimens at the Drieňovec site.

***Pselaphochernes scorpioides* (Hermann, 1804)**
Material examined. F: 1 ♀, 5. Aug. 2014; **HL:** 1 ♂, 10. Sep. 2014.
Distribution. This species is widespread across Europe (Červená et al. 2020) and in some countries in Asia and Africa (Harvey 2013).
Remarks. *Pselaphochernes scorpioides* occurs in Slovakia mainly in leaf litter, decomposing material, tree hollows, bird nests, decaying wood and under tree bark (Beier 1963, Krumpál & Cyprich 1988, Krištofík et al. 2009, Christophoryová 2013, Krajčovičová & Christophoryová 2014, Kaňuchová et al. 2015, Christophoryová et al. 2016, Christophoryová et al. 2017b) or in ant nests (Jászayová et al. 2015).

Undetermined material from family Chernetidae Menge, 1855
F: 1 Tn, 25. June 2014.

Undetermined material from family Cheliferidae Risso, 1827
F: 1 Dn, 9. Sep. 2014.

Discussion

The present paper reports faunistic data on the occurrence of 15 species of pseudoscorpions from the Slovak Karst National Park. We present four new species for the study area. A total of 20 pseudoscorpion species are presently known from the Slovak Karst, which is almost 39 % of the fauna of Slovakia (Tab. 1). The area shows a high species richness in the leaf litter – 15 species at six localities in our study as compared to 12 species at 26 localities in southwestern Slovakia (Christophoryová 2013). The results were obtained by similar methods in similar habitats, mainly in oak and oak-hornbeam. The published results originate from intensive research of cave habitats, the area around cave entrances and warm oak-beech forests. Further research should focus on different habitats and microhabitats prevalent in the territory of the Slovak Karst, such as decayed wood, tree hollows, compost, ant, bird and mammalian nests, or different wetlands, including peat bogs and fens. Generally, the Slovak Karst represents one of the most valuable areas in terms of biodiversity for the whole of Slovakia. For example, in beetle research several new species for the fauna of Slovakia were found in this area (Jászay 1998, Jászay & Hlaváč 2016, Jászay & Jászayová 2018).

Acknowledgements
The authors express their gratitude to Jana Christophoryová (Bratislava) for revising the species difficult to identify, especially *Ephippiochthonius boldorii*. We are also grateful Katherine R. Day (Tallahassee) for the correction of English language and Patricia Antlová (Vienna) for the German correction and two anonymous reviewers for their constructive comments.

Tab. 1: List of known pseudoscorpions from the Slovak Karst (original name of locality in square brackets)

Species	Locality in the Slovak Karst
Chthonius carinthiacus Beier, 1951	Snežná diera cave, Silická ľadnica cave (Christophoryová 2010), Silická ľadnica cave (Christophoryová et al. 2011b), Ardovská cave, Silická ľadnica cave (Jászayová & Christophoryová 2019) and the present study
Chthonius heterodactylus Tömösváry, 1883	Silická plateau – Silická ľadnica cave (Krumpál & Kiefer 1981, Jászayová & Christophoryová 2019) and the present study
Chthonius hungaricus Mahnert, 1980	Hrušovská lesostep forest-steppe (Krumpál & Kiefer 1981), Ardovská cave (Jászayová & Christophoryová 2019)
Ephippiochthonius boldorii (Beier, 1934)	the present study
Ephippiochthonius fuscimanus (Simon, 1900)	Hrušovská lesostep forest-steppe (Krumpál & Kiefer 1981), Ardovská cave, Silická ľadnica cave (Jászayová & Christophoryová 2019) and the present study
Ephippiochthonius tetrachelatus (Preyssler, 1790)	Ardovská cave (Jászayová & Christophoryová 2019) and the present study
Mundochthonius carpaticus Rafalski, 1948	Majkova cave (Christophoryová 2009), Domica, Majkova cave, Silická ľadnica cave, Pod Fabiánkou NR (Christophoryová 2010), Silická ľadnica cave (Jászayová & Christophoryová 2019) and the present study
Neobisium (*Neobisium*) *brevidigitatum* (Beier, 1928)	the present study
Neobisium (*Neobisium*) *carcinoides* (Hermann, 1804)	Turňa nad Bodvou [= Torna] (Daday 1888), Snežná diera cave (Papáč et al. 2007), Majkova cave (Christophoryová 2009), Ardovská cave, Čertova diera cave, Majkova cave, Silická ľadnica cave (Christophoryová 2010), Ardovská cave, Silická ľadnica cave (Jászayová & Christophoryová 2019) and the present study
Neobisium (*Neobisium*) *carpaticum* Beier, 1935	Silická ľadnica cave (Jászayová & Christophoryová 2019) and the present study
Neobisium (*Neobisium*) *crassifemoratum* (Beier, 1928)	Silická ľadnica cave (Jászayová & Christophoryová 2019) and the present study
Neobisium (*Neobisium*) *erythrodactylum* (L. Koch, 1873)	Ardovská cave, Silická ľadnica cave (Jászayová & Christophoryová 2019) and the present study
Neobisium (*Neobisium*) *fuscimanum* (C. L. Koch, 1843)	Silická ľadnica cave (Jászayová & Christophoryová 2019)
Neobisium (*Neobisium*) *sylvaticum* (C.L. Koch, 1835)	Zádielská dolina Valley [= Szádellö] (Daday 1888), Ardovská cave, Silická ľadnica cave (Jászayová & Christophoryová 2019) and the present study
Neobisium (*Blothrus*) *slovacum* Gulička, 1977	Brzotínska cave (Ducháč 1996), Šingliarova priepasť chasm, Zvonivá chasm, Zombor priapasť chasm, Stará Brzotínska cave, Diviačia cave, Csík Lyuk cave, Fialová cave, Obrovská priapasť chasm, Márnica cave, Erňa cave (Ducháč & Mlejnek 2000a, 2000b), Šingliarova priepasť chasm (Christophoryová 2010), Stará brzotínska cave, Zvonivá jama chasm, Zombor priepasť chasm, Diviačia cave, Čikova diera cave, Fialová cave, Šingliarova priepasť chasm, Obrovská priapasť chasm, Pri salaši 2 priepasť chasm, Natrhnutá priepasť chasm, Erňa cave, Slnečná priepasť chasm, Vlčia priepasť chasm, Veľká Peňažnica priepasť, Hačavská cave (Červená et al. 2019)
Chernes cimicoides (Fabricius, 1793)	the present study
Chernes similis (Beier, 1932)	Domica (Šťáhlavský & Dolejš 2019) and the present study
Lamprochernes chyzeri (Tömösváry, 1882)	Turňa nad Bodvou [= Torna] (Daday 1918)
Pselaphochernes scorpioides (Hermann, 1804)	the present study
Dactylochelifer latreillii (Leach, 1817)	Ardovská cave (Jászayová & Christophoryová 2019), Domica (Šťáhlavský & Dolejš 2019)

References

Beier M 1928 Die Pseudoskorpione des Wiener Naturhistorischen Museums. I. Hemictenodactyli. – Annalen des Naturhistorischen Museums in Wien 42: 285-314

Beier M 1951 Zur Kenntnis der ostalpinen Chthoniiden (Pseudoscorp.). – Entomologisches Nachrichtenblatt 3: 163-166

Beier M 1963 Ordnung Pseudoscorpionidea (Afterskorpione). Bestimmungsbücher zur Bodenfauna Europas. Lieferung 1. Akademie-Verlag, Berlin. 313 pp.

Besuchet C, Burckhardt DH & Löbl I 1987 The "Winkler/Moczarski" eclector as an efficient extractor for fungus and litter Coleoptera. – The Coleopterists Bulletin 41: 392-394

Červená M, Šťáhlavský M, Papáč V, Kováč Ľ & Christophoryová J 2019 Morphological and cytogenetic characteristics of *Neobisium* (*Blothrus*) *slovacum* Gulička, 1977 (Pseudoscorpiones, Neobisiidae), the northernmost troglobitic species of the subgenus *Blothrus* in Europe. – ZooKeys 817: 113-130 – doi: 10.3897/zookeys.817.27189

Červená M, Krajčovičová K, Christophoryová J 2020 Updated checklist of pseudoscorpions (Arachnida: Pseudoscorpiones) of Central Europe. – Arthropoda Selecta 29: 219-228 – doi: 10.15298/arthsel.29.2.06

Christophoryová J 2009 Šťúriky (Pseudoscorpiones) čeľadí Chthoniidae a Neobisiidae jaskýň a ich vchodov na Slovensku. [Pseu-

doscorpiones from the family Chthoniidae and Neobisiidae from the caves and their entrances in Slovakia]. In: Galamboš M (ed.) Študentská vedecká konferencia [Student conference], 22. Apr. 2009, Bratislava. Univerzita Komenského v Bratislave Prírodovedecká fakulta. Zborník recenzovaných príspevkov [Collection of peer-reviewed papers]. pp. 254-260 [in Slovak]

Christophoryová J 2010 Šťúriky (Pseudoscorpiones) Slovenska [Pseudoscorpions (Pseudoscorpiones) of Slovakia]. Dissertation, Comenius University in Bratislava, Faculty of Natural Sciences. Department of Zoology. Bratislava. 174 pp. [In Slovak]

Christophoryová J 2013 A faunistic study on the pseudoscorpions (Arachnida: Pseudoscorpiones) of oak-hornbeam forests in SW Slovakia. – Munis Entomology & Zoology 8: 634-645

Christophoryová J & Krajčovičová K 2019 Faunistic records of pseudoscorpions (Arachnida: Pseudoscorpiones) from South East Poland. – Klapalekiana 55: 193-198

Christophoryová J & Krumpál M 2005 Communities of pseudoscorpions (Pseudoscorpiones, Arachnida) in epigeon of oak-hornbeam forest in the Malé Karpaty Mts. and Trnavská pahorkatina hills (SW Slovakia). – Ekológia 24: 76-86

Christophoryová J & Krumpál M 2007 Pseudoscorpions (Pseudoscorpiones) from the leaf litter of Malé Karpaty Mts. and Trnavská pahorkatina hills. – Entomofauna Carpathica 19: 27-31 [in Slovak, with English abstract]

Christophoryová J, Krumpálová Z, Krištofík J & Országhová Z 2011a Association of pseudoscorpions with different types of bird nests. – Biologia 66: 669-677 – doi: 10.2478/s11756-011-0072-8

Christophoryová J, Mock A & Ľuptáčik P 2011b *Chthonius* (*Chthonius*) *carinthiacus* and *Chthonius* (*Ephippiochthonius*) *tuberculatus* new to fauna of Slovakia (Pseudoscorpiones: Chthoniidae). – Arachnologische Mitteilungen 42: 23-28 – doi: 10.5431/aramit4206

Christophoryová J, Šťáhlavský F & Fedor P 2011c An updated identification key to the pseudoscorpions (Arachnida: Pseudscorpiones) of the Czech Republic and Slovakia. – Zootaxa 2876: 35-48 – doi: 10.11646/zootaxa.2876.1.4

Christophoryová J, Šťáhlavský F, Krumpál K & Fedor P 2012 Pseudoscorpions of the Czech Republic and Slovakia: An annotated and revised checklist (Arachnida: Pseudoscorpiones). – North-Western Journal of Zoology 8: 1-21

Christophoryová J, Krajčovičová K & Kaňuchová A 2016 Pseudoscorpions (Arachnida: Pseudoscorpiones) collected in cemeteries in Slovakia. – Klapalekiana 52: 33-41

Christophoryová J, Jajcayová D & Krajčovičová K 2017a Pseudoscorpions (Arachnida: Pseudoscorpiones) living in tree microhabitats in Slovakia. – Klapalekiana 53: 283-297

Christophoryová J, Kaňuchová A & Krajčovičová K 2017b Faunistic survey of pseudoscorpions (Arachnida: Pseudoscorpiones) collected from compost in Slovakia. – Klapalekiana 53: 11-19

Daday E 1888 Übersicht der Chernetiden des Ungarischen Nationalmuseums in Budapest. – Természetrajzi Füzetek 11: 165-192

Daday E 1918 Ordo Pseudoscorpiones. In: A Magyar Birodalom Állatvilága. Fauna Regni Hungariae. Regia Societas Scientiarum Naturalium Hungarica, Budapest. pp. 1-2

Drogla R & Lippold K 2004 Zur Kenntnis der Pseudoskorpion-Fauna von Ostdeutschland (Arachnida, Pseudoscorpiones). – Arachnologische Mitteilungen 27/28: 1-54 – doi: 10.5431/aramit2701

Ducháč V 1996 Über *Neobisium* (*Blothrus*) *slovacum* (Pseudoscorpiones: Neobisidae) aus der Brzotín – Höhle in der Slowakischen Republik. – Klapalekiana 32: 153-157

Ducháč V & Mlejnek R 2000a Records of the Pseudoscorpion *Neobisium* (*Blothrus*) *slovacum* (Neobisidae) in caves and chasms of the Slovak Karst. In: Mock A, Kováč Ľ & Fulín M (eds) Fauna jaskýň. [Cave fauna]. Zborník referátov zo seminára [The volume of papers from the meeting] 20.–21. Oct. 1999, Východoslovenské múzeum v Košiciach. pp. 15-20

Ducháč V & Mlejnek R 2000b *Neobisium slovacum* – nejsevernější eutroglobiontní štírek Evropy. [*Neobisium slovacum* – the northernmost eutroglobite pseudoscorpion of Europe]. – Speleofórum, Česká speleologická společnost 19: 48-49 [in Czech, with English summary]

Ducháč V, Mlejnek R & Šťáhlavský F 2007 *Chthonius* (*Chthonius*) *heterodactylus* (Pseudoscorpiones: Chthoniidae), eine neue Art für die Tschechische Republik. – Arachnologische Mitteilungen 33: 31-33 – doi: 10.5431/aramit3307

Fenďa P, Krumpál M & Cyprich D 1998 The soil fauna in the birds' nests in Slovakia. In: Pižl V & Tajovský K (eds) Soil Zoological Problems in Central Europe. České Budějovice. pp. 23-30

Gardini G 2014 The species of the *Chthonius heterodactylus* group (Arachnida, Pseudoscorpiones, Chthoniidae) from eastern Alps and the Carpathians. – Zootaxa 3887: 101-137 – doi: 10.11646/zootaxa.3887.2.1

Harvey MS 2013 Pseudoscorpions of the World, version 3.0. Western Australian Museum, Perth. – Internet: http://museum.wa.gov.au/catalogues-beta/pseudoscorpions/ (7. Sep. 2020)

Jászay T 1998 Faunistic records from Slovakia. Coleoptera: Staphylinidae. – Entomological Problems 29: 138

Jászay T & Hlaváč P 2016 Zoznam drobčíkovitých chrobákov Slovenska (Insecta: Coleoptera: Staphylinidae). [Checklist of rove beetles of Slovakia (Insecta: Coleoptera: Staphylinidae)]. – Folia faunistica Slovaca 21: 131-216 [in Slovak, with English abstract]

Jászay T & Jászayová A 2018 Nové zaujímavé nálezy chrobákov (Coleoptera: Bothrideridae, Carabidae, Derodontidae, Leiodidae, Melasidae, Staphylinidae, Tenebrionidae) na Slovensku. [New interesting findings of beetles (Coleoptera: Bothrideridae, Carabidae, Derodontidae, Leiodidae, Melasidae, Staphylinidae, Tenebrionidae) in Slovakia]. – Biodiversity & Environment 10: 25-37

Jászayová A, Christophoryová J & Jászay T 2015 Šťúriky (Pseudoscorpiones) v hniezdach *Formica polyctena* v doline Mníchovského potoka v masíve Stebníckej Magury. [Pseudoscorpions (Pseudoscorpiones) in nests of *Formica polyctena* in the valley of Mníchovský potok stream in the Stebnícka Magura massive]. – Folia faunistica Slovaca 20: 27-30 [in Slovak, with English abstract]

Jászayová A & Christophoryová J 2019 Šťúriky (Arachnida, Pseudoscorpiones) okolia Ardovskej jaskyne a Silickej ľadnice. [Pseudoscorpions (Arachnida, Pseudoscorpiones) of Ardovská cave and Silická ľadnica cave surroundings]. – Biodiversity & Environment 11: 64-71 [in Slovak, with English abstract]

Kaňuchová A, Christophoryová J & Krajčovičová K 2015 Pseudoscorpions (Arachnida) collected from the heaps with decomposing material in Slovakia. – Fragmenta Faunistica 58: 111-122 – doi: 10.3161/00159301FF2015.58.2.111

Krajčovičová K & Christophoryová J 2014 Faunistic survey of pseudoscorpions (Arachnida: Pseudoscorpiones) collected from trees and using Malaise traps in Slovakia and the Czech Republic. – Klapalekiana 50: 167-180

Krajčovičová K, Tamutis V, Ivinskis P, Machač O & Christophoryová J 2018 First records of pseudoscorpions (Arachnida: Pseudoscorpions) from Lithuania. – Entomologica Fennica 29: 49-53 – doi: 10.33338/ef.71011

Krajčovičová K, Ivinskis P, Rimšaité J & Christophoryová J 2020 *Chernes similis* (Beier, 1932) (Pseudoscorpiones, Chernetidae) new to the fauna of Lithuania. – Check List 16: 707-710 – doi: 10.15560/16.3.707

Krištofík J, Šustek Z & Mašán P 2002 Arthropods (Pseudoscorpionida, Acari, Coleoptera, Siphonaptera) in the nests of red-backed shrike (*Lanius collurio*) and lesser grey shrike (*Lanius minor*). – Biología 57: 603-613

Krištofík J, Mašán P, Šustek Z & Karaska D 2009 Arthropods in the nests of lesser spotted eagle (*Aquila pomarina*). – Biologia 64: 974-980 – doi: 10.2478/s11756-009-0148-x

Krumpál M 1980 Šťúriky (Pseudoscorpionidae) Gaderskej doliny (Veľká Fatra) [Pseudoscorpions (Pseudoscorpionidea) of the Gader Valley (Veľká Fatra)]. – Entomologické problémy 16: 23-29 [in Slovak, with Russian and German summaries]

Krumpál M 2000 Šťúriky (Pseudoscorpiones) jaskýň Čiernej hory (Slovensko) [Pseudoscorpions (Pseudoscorpiones) from the caves

of Čierna hora Mts. (Slovakia)]. In: Mock A, Kováč Ľ & Fulín M (eds) Fauna jaskýň. [Cave fauna]. Východoslovenské múzeum, Košice. pp. 95–98 [in Slovak]

Krumpál M & Cyprich D 1988 O výskyte šťúrikov (Pseudoscorpiones) v hniezdach vtákov (Aves) v podmienkach Slovenska. [On the distribution of pseudoscorpions (Pseudoscorpiones) in bird nests in the natural conditions of Slovakia]. – Zborník Slovenského národného Múzea, Prírodné Vedy 34: 41-48 [in Slovak, with German summary]

Krumpál M & Kiefer M 1981 Príspevok k poznaniu šťúrikov čeľade Chthoniidae v ČSSR (Pseudoscorpionidae). [Contributions to the knowledge of pseudoscorpions from the family Chthoniidae in the USSR]. – Zprávy Československé Společnosti Entomologické při ČSAV 17: 127-130 [in Slovak, with German summary]

Krumpál M & Krumpálová Z 2003 Šťúriky – Pseudoscorpiones. In: Mašán P & Svatoň J (eds) Pavúkovce Národného parku Poloniny (Arachnida: Araneae, Pseudoscorpiones, Opiliones, Acari – Parasitiformes). [Arachnids of the National Park Poloniny (Arachnida: Araneae, Pseudoscorpiones, Opiliones, Acari – Parasitiformes)]. Štátna ochrana prírody SR Banská Bystrica a Správa Národného parku Poloniny, Snina. pp. 115-126 [In Slovak]

Krumpálová Z & Krumpál M 1993 Funde von für die Slowakei neuen und seltenen Spinnentierarten (Arachnoidea). – Arachnologische Mitteilungen 6: 36–41 – doi: 10.5431/aramit0606

Mock A, Jászay T, Svatoň J, Christophoryová J & Stašiov S 2009 Suchozemské článkonožce (Arthropoda) jaskýň Čiernej hory (Západné Karpaty). [Terrestrial macrofauna of the caves in the Čierna hora Mts. (Western Carpathians, Slovakia)]. – Slovenský kras 47: 259-274 [in Slovak, with English abstract]

Muster C, Schmarda T & Blick T 2004 Vicariance in a cryptic species pair of European Pseudoscorpions (Arachnida, Pseudoscorpiones, Chthoniidae). – Zoologischer Anzeiger 242: 299-311 – doi: 10.1078/0044-5231-00106

Novák J 2012 New records of pseudoscorpions for the fauna of the Bükk Mts., Northeast Hungary (Arachnida: Pseudoscorpiones). – Opuscula Zoologica, Budapest 43: 57-65

Novák J 2015 New records for the pseudoscorpion-fauna of the Bakony Mts, Hungary (Arachnida: Pseudoscorpiones). – Opuscula Zoologica, Budapest 46: 153-158 – doi: 10.18348/opzool.2015.2.153

Novák J 2017 Contribution to the knowledge of the pseudoscorpion fauna of the North-Eastern Carpathians, Ukraine (Arachnida: Pseudoscorpiones). – Opuscula Zoologica, Budapest 48: 35-40 – doi: 10.18348/opzool.2017.35

Papáč V, Ľuptáčik P, Fenďa P, Košel V & Christophoryová J 2007 Spoločenstvá terestrických článkonožcov NPP Snežná diera (Slovenský kras, Horný vrch). [Communities of the terrestrial arthropods in the National Natural Monument Snežná diera (Snow Hole) Cave (Slovak Karst, Horný vrch plateau)]. – Slovenský kras 45: 151-157 [in Slovak, with English abstract]

Papáč V, Fenďa P, Ľuptáčik P, Mock A, Svatoň J & Christophoryová J 2009 Terestrické bezstavovce (Evertebrata) jaskýň vo vulkanitoch Cerovej vrchoviny. [Terrestrial invertebrates (Evertebrata) of caves in volcanic rocks of the Cerová vrchovina Highlands]. – Aragonit 14: 32-42 [in Slovak, with English abstract]

Šťáhlavský F & Dolejš P 2019 Catalogue of the pseudoscorpions (Pseudoscorpiones) in František Miller's collection (Department of Zoology, National Museum, Prague). – Arachnologische Mitteilungen 58: 18-22 – doi: 10.30963/aramit5807

Tomaskinova J & Tomaskin J 2013 Integrated management of the National Park Slovak Karst. – Journal of Environmental Protection and Ecology 14: 664-674

Zaragoza JA 2017 Revision of the *Ephippiochthonius* complex in the Iberian Peninsula, Balearic Islands and Macaronesia, with proposed changes to the status of the *Chthonius* subgenera (Pseudoscorpiones, Chthoniidae). – Zootaxa 4246: 001-221 – doi: 10.11646/zootaxa.4246.1.1