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Pseudoscorpions (Arachnida) collected from the heaps with decomposing material in Slovakia

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Abstract: The first detailed survey of pseudoscorpions living in the heaps with decomposing material (compost heaps, manures) is presented. The research was performed on samples from 33 localities in Slovakia during the years 2012–2014. A total of 1118 pseudoscorpions of ten species in four families was examined during the study. The most abundant family was Chernetidae, whereas the lowest species and specimen numbers were recorded for the families Neobisiidae and Cheliferidae. Chernetid pseudoscorpions of the genus *Lamprochernes* Tömösváry, 1882 and of the species *Pselaphochernes scorpioides* (Hermann, 1804) were the most abundant. These are typical inhabitants of heaps with decomposing material, in which all their developmental stages, even females with eggs (in the case of *P. scorpioides*), can be found. Only one specimen each of *Dactylochelifer latreillii* (Leach, 1817) and *Dinocheirus panzeri* (C.L. Koch, 1831) was found. From a faunistic point of view, the first confirmed Slovakian record of the rare species *Chthonius ressli* Beier, 1956 is notable.

Key words: compost heaps, decomposing material, Central Europe

INTRODUCTION

Due to their microclimate and organic richness, compost heaps provide a favourable environment for the development of various organisms. A large number of decomposers, such as springtails and mites, inhabit compost, in which they play an important role in humification. They, in turn, serve as food for predators, including pseudoscorpions.

Despite this, pseudoscorpions living in compost or other decaying material have been studied sporadically in Slovakia. Verner (1971) mentioned, in general, that the species *Lamprochernes nodosus* (Schrank, 1803) lived in decaying plant material. Christophoryová (2009) found two males of *Lamprochernes chyzeri* (Tömösváry, 1882) in manure at Šurice in the Cerová vrchovina Highlands. The first record of *Chthonius hungaricus* Mahnert, 1981 in Slovakia referred to decaying plant material and manure at the same locality (Christophoryová 2009). Three specimens of *Atemnus politus* (Simon, 1878) and 26 of *L. nodosus* were collected in compost heaps and rotten hay in the Burda Mts (Christophoryová et al. 2014).

In other European countries, some authors provided general information about pseudoscorpion occurrence in compost or manure heaps. Beier (1963) mentioned in his identification key that compost heaps were a typical habitat for the species *L. nodosus* and *Pselaphochernes scorpioides* (Hermann, 1804). Ressl (1970) and Jędryczkowski (1985) mentioned, that among other habitats, *P. scorpioides* occurred in compost. Legg & Jones (1988) stated that compost was a typical habitat for the species *Lamprochernes savignyi* (Simon, 1881), *L. nodosus, L. chyzeri* and *P. scorpioides*. Other records of *P. scorpioides* in compost came from distant countries, including Spain (Beier 1955), the Azores (Beier 1961) and Crete (Beier 1966). Ressl & Beier (1958) recorded pseudoscorpion species in compost in Lower Austria. *Pselaphochernes scorpioides* was recorded in garden compost heaps located on field edges and containing mostly potato waste. The species *Chthonius fuscimanus* Simon, 1900, *Neobisium sylvaticum* (C.L. Koch, 1835), *N. carcinoides* (Hermann, 1804), *Allochernes*

wideri (C.L. Koch, 1843), *Dactylochelifer latreillii* (Leach, 1817) and *P. scorpioides* were found in compost heaps located near streams and forest edges. These contained mostly plant material, such as leaves, moss or hay. Also, *Chthonius tetrachelatus* (Preyssler, 1970), *C. fuscimanus*, *C. pusillus* Beier, 1947 and *N. carcinoides* were collected in compost containing mostly old plant waste, dry leaves, hay, moss and old wood (Ressl & Beier 1958). Drogla & Lippold (2004) recorded occasional occurrences of *C. tetrachelatus*, *N. sylvaticum*, *D. latreillii* and *L. chyzeri* in compost heaps of West Germany. However, *Allochernes powelli* (Kew, 1916), *D. panzeri* (C.L. Koch, 1837), *L. nodosus* and *P. scorpioides* were well represented (Drogla & Lippold 2004). Šťáhlavský (2006) found one female of *P. scorpioides* under a piece of wood in compost in Podyjí National Park in the Czech Republic. Šťáhlavský & Chytil (2013) reported finding of a male of *D. panzeri* in compost at Valtice, Czech Republic.

The aim of the present paper is to extend the knowledge on the pseudoscorpion fauna from the heaps with decomposing material in Slovakia.

Material and Methods

The studied material was collected by following collectors: Jana Christophoryová, Peter Fenďa, Daniel Gruľa, Milada Holecová, Kamila Hrúzová, Andrea Kaňuchová, Andrej Krajča, Katarína Krajčovičová, Jasna Kraljik, Barbora Mangová, Andrej Mock, Ján Rudy, Eduard Stloukal, Viera Stloukalová, Anna Šestáková and Lucia Štasselová. The material from 33 localities in Slovakia was investigated during the years 2012–2014 (Fig. 1, Table 1). Each sample was collected from heap formed by humans. The samples of heaps with decomposing material (Figs 3 & 5) were collected by hand and transported in polyethylene bags. The samples were taken from the deeper parts of the heaps with decomposing material. Each sample volume was approximately 6 dm^3. The number of samples was from 1 to 8 per each locality (Table 1).

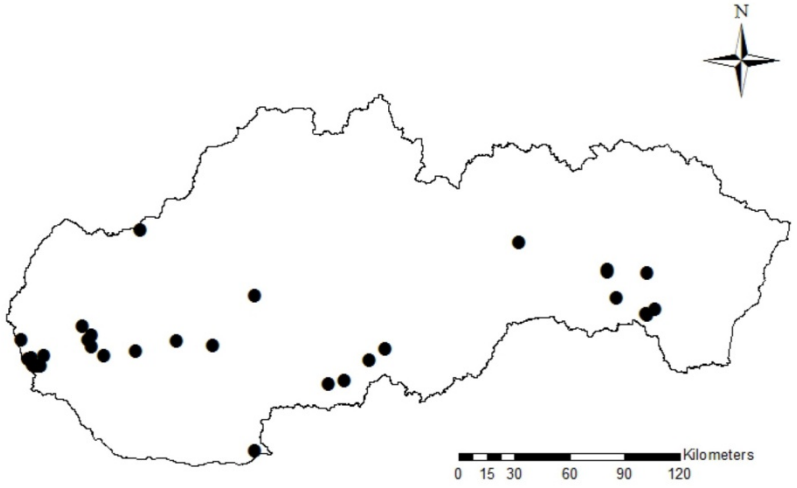


Fig. 1. Location of sampling areas in Slovakia.

Heaps with decomposing material were divided into six categories according to environmental type and their composition (Table 1). Category A included compost heaps in gardens situated close to houses in rural landscapes. These heaps consisted of grass, kitchen and plant waste, and animal waste (excrement, feathers, eggshells). Category B included heaps with decomposing material in allotment gardens situated mainly in villages and community gardens. These consisted mainly of plant material, such as grass, leaves, vegetables waste and

pieces of bark. Category C included heaps with decomposing material containing silage material and situated in agricultural areas. Category D included compost heaps situated in botanical gardens or an arboretum, which were made up of typical garden waste, such as lops, woody parts and decaying leaves. Category E covered heaps with decomposing material situated in forest environment and park, containing mainly leaves, leaf litter and grass. Category F included manure heaps and cow dung from a cow shed.

Table 1. List of localities. N – North latitude, E – East longitude, NS – number of samples. For categories A–F see Material and Methods.

No	Locality	N	E	m a.s.l	Environment (Category)	NS
1	Bratislava, Botanical Garden	48.14544444	17.07254167	143	botanical garden (D)	2
2	Bratislava, Botanical Garden	48.14745	17.07405	152	botanical garden (D)	4
3	Bratislava, Dúbravka	48.183921	17.048366	236	allotment garden (B)	1
4	Bratislava, Fialkové údolie	48.14344444	17.09113889	202	house garden (A)	3
5	Bratislava, Jezuitské lesy	48.176225	17.02437778	315	allotment garden (B)	1
6	Bratislava, Prírodovedecká fakulta	48.14902222	17.06854722	159	forest (E)	1
7	Bratislava, Rača – Krasňany	48.196612	17.142575	144	community garden (B)	1
8	Bratislava, Sasinková	48.149673	17.122279	142	community garden (B)	1
9	Budmerice	48.36219444	17.39618056	210	park around manor house (E)	1
10	Čataj	48.26537222	17.48060278	132	house garden (A)	1
11	Čebovce	48.17873611	19.22808889	227	house garden (A)	1
12	Devínske jazero	48.26222222	16.96444444	140	house garden (A)	8
13	Jarná	48.32151111	17.46876667	148	agricultural area (C)	1
14	Kalša	48.61152778	21.53631111	196	former agricultural cooperative (C)	1
15	Kalša	48.61152778	21.5363111	196	house garden (A)	1
16	Kalša	48.61368	21.52284	203	garden in village (B)	1
17	Kamenica nad Hronom	47.82870278	18.73423611	108	house garden (A)	1
18	Kaplna	48.29765278	17.45408611	152	house garden (A)	2
19	Kľak	48.58316944	18.64434722	609	house garden (A)	2
20	Košice	48.68464444	21.298183	210	allotment garden (B)	1
21	Ľuboreč	48.312675	19.51868333	276	house garden (A)	1
22	Nitra, Zobor	48.33425278	18.09750278	259	house garden (A)	1
23	Plevovec, Kopanice u Zlatých	48.85801667	17.75992778	380	house garden (A)	2
24	Pusté Uľany	48.22500556	17.57988611	120	grove (E)	1
25	Sokoľ	48.81233	21.22676	250	garden in village (B)	1
26	Sokoľ	48.81575	21.52284	290	allotment garden (B)	1
27	Sokoľ-Uhrinč	48.82027	21.22114	247	allotment garden (B)	1
28	Spišská Nová Ves	48.93335556	20.55928889	469	forest (E)	1
29	Šoporňa	48.26457222	17.80788611	129	house garden (A)	1
30	Tesárske Mlyňany	48.32259167	18.36371389	170	arboretum (D)	1
31	Tomášovce	48.373825	19.62281111	199	garden in village (B)	1
32	Veľký Krtíš	48.20629444	19.34442778	192	restaurant garden (A)	1
33	Zemplínska Teplica	48.63672	21.58542	204	cow shed (F)	1

Pseudoscorpions were heat-extracted using Tullgren funnels. Some of the specimens obtained were studied as temporary slide mounts using lactic acid and then returned to 70% ethanol, but most were studied as permanent slide mounts, made using Swann's fluid. All specimens were identified using the key in Christophoryová et al. (2011c). The identification of *Chthonius ressli* Beier, 1956 was made by comparison with the descriptions of Beier (1956, 1963) and Judson (1990). The identifications of *C. ressli* and *Chthonius tetrachelatus* (Preyssler, 1790) were checked and confirmed by Dr Giulio Gardini. Nomenclature for all taxa follows Harvey (2013). The micrograph of *P. scorpioides* (Fig. 4) was made using EOS Utility software and a digital camera (Canon EOS 1100D) connected to a Zeiss Stemi 2000-C stereomicroscope. The material is deposited in the zoological collections of Comenius University, Bratislava.

RESULTS

During the study, 1118 specimens of 10 taxa from four families were identified from the studied localities (Table 2). The specimens of the genus *Lamprochernes* Tömösváry, 1882 were not identified to species level, due to an ongoing taxonomic revision. The family Chernetidae was the most abundant, with almost 1000 collected specimens in five taxa. The lowest number of species and specimens was recorded for Neobisiidae and Cheliferidae (Table 2). Pseudoscorpions of the genus *Lamprochernes* and the species *P. scorpioides* were the most abundant. These two taxa also occurred at the most localities (Table 2). Only one specimen each of the species *D. latreillii* and *D. panzeri* was found. The occurrence of the rare species *Chthonius ressli* Beier, 1956 in Slovakia was confirmed. The list of the collected taxa is given below with locality code, date and number of each developmental stage (♀: female, ♂: male, Tn: tritonymph, Dn: deutonymph, Pn: protonymph, A: adult of undetermined sex).

Table 2. Number of specimens of pseudoscorpions in heaps with decomposing material in Slovakia. *Cr – Chthonius ressli*, *Cf – C. fuscimanus*, *Ct – C. tetrachelatus*, *Nc – Neobisium carcinoides*, *Dl – Dactylochelifer latreillii*, *Ch – Chernes hahnii*, *Dp – Dinocheirus panzeri*, *Aw – Allochernes wideri*, *L*sp – *Lamprochernes* spp., *Ps – Pselaphochernes scorpioides*.

No	Locality	*Cr*	*Cf*	*Ct*	*Nc*	*Dl*	*Ch*	*Dp*	*Aw*	*L*sp	*Ps*	∑
1	Bratislava, Botanical Garden							1		34	6	41
2	Bratislava, Botanical Garden									22	14	36
3	Bratislava, Dúbravka			1							17	18
4	Bratislava, Fialkové údolie			5						10	96	111
5	Bratislava, Jezuitské lesy		2							4	4	10
6	Bratislava, Prírodovedecká fakulta									1		1
7	Bratislava, Rača – Krasňany						1			1		2
8	Bratislava, Sasinková			9								9
9	Budmerice			3						1	8	12
10	Čataj									13		13
11	Čebovce									1		1
12	Devínske jazero			1			4			275	4	284
13	Jarná			4						10		14
14	Kalša			4						28		32
15	Kalša										6	6
16	Kalša										26	26
17	Kamenica nad Hronom									54		54
18	Kaplna									30	29	59
19	Kľak									1	6	7
20	Košice									8	15	23
21	Ľuboreč								1		2	3
22	Nitra, Zobor									65		65
23	Plevovec, Kopanice u Zlatých			20	6				5	6	57	94
24	Pusté Uľany	49		19					6	1		75
25	Sokoľ										1	1
26	Sokoľ				2							2
27	Sokoľ-Uhrinč										1	1
28	Spišská Nová Ves									10	5	15
29	Šoporňa								2			2
30	Tesárske Mlyňany									1		1
31	Tomášovce			1		1				1	1	4
32	Veľký Krtíš									94		94
33	Zemplínska Teplica									2		2
	∑	49	2	67	8	1	5	1	14	673	298	1118

Family Chthoniidae Daday, 1888

***Chthonius* (*Chthonius*) *ressli* Beier, 1956**

24: 22 Sep 2013, 10 ♀♀, 10 ♂♂, 2 Dn, 27 Tn.

***Chthonius* (*Ephippiochthonius*) *fuscimanus* Simon, 1900**

5: 5 Oct 2013, 1 ♀, 1 ♂

***Chthonius* (*Ephippiochthonius*) *tetrachelatus* (Preyssler, 1790)**

3: 5 Mar 2014, 1 ♀; **4:** 4 Sep 2013, 5 ♂♂; **8:** 3 Oct 2014, 2 ♀♀, 2 ♂♂, 2 Dn, 3 Tn; **9:** 21 Sep 2013, 2 ♀♀, 1 ♂; **12:** 15 Aug 2012, 1 ♂; **13:** 21 Sep 2013, 2 ♂♂, 1 Dn, 1Tn; **14:** 9 Nov 2012, 1 ♀, 2 ♂♂, 1 Tn; **23:** 10 Aug 2013, 1 ♀, 5 ♂♂, 6 Dn, 8 Tn; **24:** 22 Sep 2013, 2 ♀♀, 5 ♂♂, 9 Dn, 3 Tn; **31:** 22 Sep 2013, 1 ♀.

Family Neobisiidae Chamberlin, 1930

***Neobisium* (*Neobisium*) *carcinoides* (Hermann, 1804)**

23: 10 Aug 2013, 4 Pn, 2 Dn; **26:** 25 Oct 2013, 1 ♀, 1 ♂.

Family Cheliferidae Risso, 1827

***Dactylochelifer latreillii* (Leach, 1817)**

31: 22 Sep 2013, 1 ♂.

Family Chernetidae Menge, 1855

***Chernes hahnii* (C.L. Koch, 1839)**

7: 9 Sep 2014, 1 Tn; **12**: 15 Aug 2012, 1 ♀; 8 Oct 2012, 1 ♀, 1 ♂; 18 Oct 2013, 1 Dn.

***Dinocheirus panzeri* (C.L. Koch, 1837)**

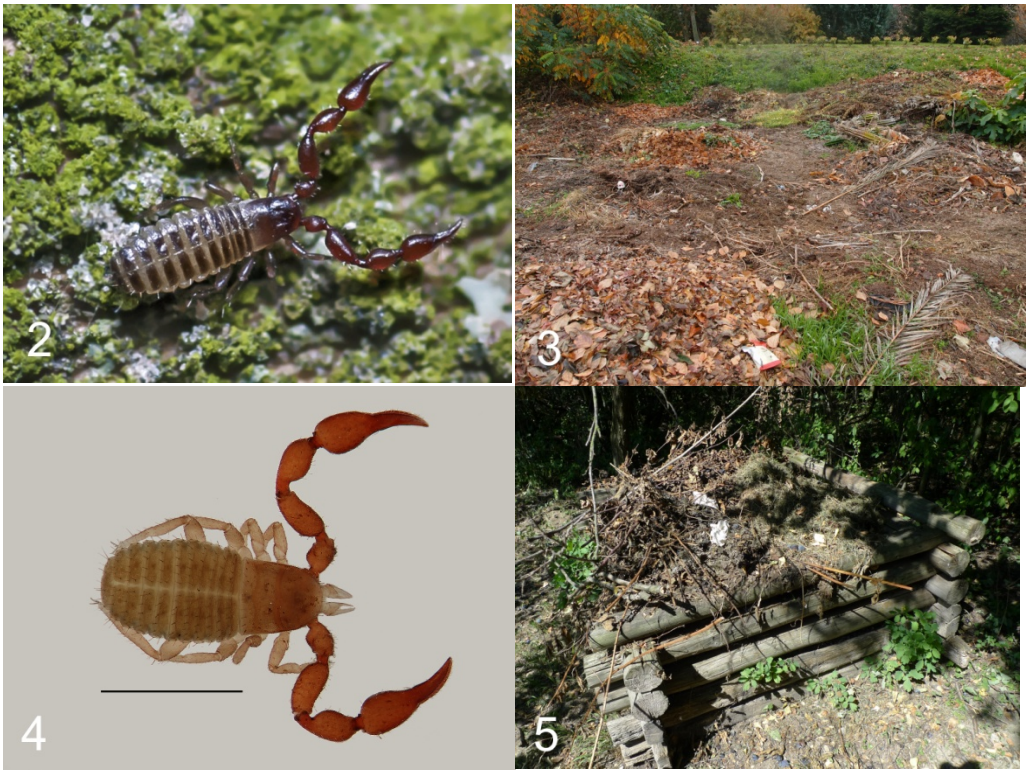
1: 25 Oct 2013, 1 ♀.

***Allochernes wideri* (C.L. Koch, 1843)**

21: 22 Sep 2013, 1 ♀; **23:** 10 Aug 2013, 2 ♀♀, 1 ♂, 2 Pn; **24:** 22 Sep 2013, 2 ♀♀, 1 Pn, 1 Dn, 2 Tn; **29:** 1 Sep 2013, 2 ♂♂.

***Lamprochernes* spp.**
(Figs 2 & 3)

1: 25 Oct 2013, 17 ♀♀, 5 ♂♂, 2 Dn, 10 Tn; **2:** 9 May 2012, 7 ♀♀, 7 ♂♂, 3 Tn; 25 Oct 2013, 3 ♀♀, 2 ♂♂; **4:** 4 Sep 2013, 6 ♀♀, 4 ♂♂; **5:** 5 Oct 2013, 1 ♂, 1 Dn, 2 Tn; **6:** 25 Oct 2013, 1 ♂; **7:** 9 Sep 2014, 1 ♀; **9:** 21 Sep 2013, 1 ♀; **10:** 21 Sep 2013, 1 ♀, 2 ♂♂, 4 Dn, 6 Tn; **11:** 10 Oct 2013, 1 ♂; **12:** 15 Aug 2012, 24 ♀♀, 22 ♂♂, 2 Pn, 24 Dn, 40 Tn; 8 Oct 2012, 8 ♀♀, 1 ♂, 41 Pn, 40 Dn, 12 Tn; 18 Oct 2013, 2 ♀♀, 29 Dn, 30 Tn; **13:** 21 Sep 2013, 2 ♀♀, 3 Dn, 5 Tn; **14:** 21 Aug 2013, 12 ♀♀, 11 ♂♂, 5 Tn; **17:** 2 Nov 2012, 5 ♀♀, 24 ♂♂, 10 Dn, 15 Tn; **18:** 19 Sep 2012, 1 ♀, 1 ♂, 1 Tn; 1 Sep 2013, 2 ♂♂, 5 Pn, 13 Dn, 7 Tn; **19:** 12 May 2013, 1 ♂; **20:** 11 Sep 2013, 1 ♀, 3 Dn, 4 Tn; **22:** 19 Sep 2012, 2 ♀♀, 33 Pn, 23 Dn, 7 Tn; **23:** 10 Aug 2013, 4 Pn, 2 Dn; **24:** 22 Sep 2013, 1 Pn; **28:** 26 Oct 2013, 6 ♀♀, 4 ♂♂; **30:** 10 Oct 2013, 1 Tn; **31:** 22 Sep 2013, 1 Pn; **32:** 22 Sep 2013, 10 ♀♀, 12 ♂♂, 3 Pn, 22 Dn, 47 Tn; **33:** 7 Nov 2013, 1 ♀, 1 ♂.



Figs 2–5. Pseudoscorpions and their habitat in heaps with decomposing material in Slovakia; 2 – *Lamprochernes* spp.; 3 – Compost heap in Botanical Garden, Bratislava; 4 – *Pselaphochernes scorpioides*, scale: 1 mm; 5 – Compost at Plevovec, Kopanice u Zlatých. Photo 2 by A. Šestáková, photos 3–5 by J. Christophoryová.

***Pselaphochernes scorpioides* (Hermann, 1804)**
(Figs 4 & 5)

1: 9 May 2012, 1 ♀, 1 ♂; 25 Oct 2013, 4 ♀♀; **2:** 25 Apr 2013, 1 ♂; 13 Jun 2013, 1 ♀, 25 Oct 2013, 2 ♀♀, 10 ♂♂; **3:** 5 Mar 2014, 8 ♀♀, 6 ♂♂, 1 Dn, 2 Tn; **4:** 4 Sep 2013, 21 ♀♀, 23 ♂♂, 1 A, 15 Pn, 24 Dn, 12 Tn; **5:** 5 Oct 2013, 3 ♀♀, 1 ♂; **9:** 21 Sep 2013, 4 ♀♀, 3 ♂♂, 1 Tn; **12:** 15 Aug 2012, 1 ♀, 2 ♂♂; 8 Oct 2012, 1 ♀; **15:** 9 Nov 2012, 2 ♀♀, 2 ♂♂, 2 Dn; **16:** 4 Nov 2013, 15 ♀♀, 6 ♂♂, 5 Tn; **18:** 1 Sep 2013, 16 ♀♀, 10 ♂♂, 1 A, 1 Dn, 1 Tn; **19:** 12 May 2013, 4 ♀♀, 2 ♂♂; **20:** 11 Sep 2013, 6 ♀♀, 2 ♂♂, 5 Dn, 2 Tn; **21:** 22 Sep 2013, 2 ♂♂; **23:** 10 Aug 2013, 14 ♀♀, 27 ♂♂, 1 A, 2 Pn, 1 Dn, 12 Tn; **25:** 26 Oct 2013, 1 ♀; **27:** 27 Oct 2013, 1 ♂; **28:** 26 Oct 2013, 3 ♀♀, 2 ♂♂; **31:** 22 Sep 2013, 1 ♂.

Nymphs were found for the majority of the species (Table 3). The presence of all nymphal stages was recorded mainly for *Lamprochernes* spp. and *P. scorpioides* (Table 3). Deutonymphs and tritonymphs were collected in chthoniid species (Table 3). Six females of *P. scorpioides* with eggs were found in compost heaps – one in May, one in June and four in September. Females of most species construct a brood nest, which explains why the females with eggs and, in some cases, protonymphs could not be extracted by Tullgren funnels.

Table 3. Number of recorded nymphal stages of some pseudoscorpion taxa in compost heaps.

No	Taxa /	Nymphal stages			∑
		Protonymphs	Deutonymphs	Tritonymphs	
1	*C. ressli*		2	27	29
2	*C. tetrachelatus*		18	16	34
3	*N. carcinoides*	4	2		6
4	*C. hahnii*		1	1	2
5	*A. wideri*	3	1	2	6
6	*Lamprochernes* spp.	90	176	195	461
7	*P. scorpioides*	17	34	35	86
	∑	114	234	276	624

Pseudoscorpions of the genus *Lamprochernes* were present in all distinguished categories (see Material and Methods). The other chernetid, *P. scorpioides*, was found in all categories except C and F (Table 4). *Lamprochernes* and *P. scorpioides* occurred simultaneously in one third of the collected samples (Table 2). The family Chthoniidae was most numerous in the forest environment. However, *C. tetrachelatus* was present almost in all environmental categories, except cow sheds and botanical gardens. Other species recorded during the study were present accidentally in the collected material (Table 4).

Table 4. Specimen number of pseudoscorpions in compost heaps according to environmental type listed in Table 1. For categories A – F see Material and Methods.

No	Taxa	Environmental category					
		A	B	C	D	E	F
1	*C. ressli*					49	
2	*C. fuscimanus*		2				
3	*C. tetrachelatus*	26	11	8		22	
4	*N. carcinoides*	6	2				
5	*D. latreillii*		1				
6	*C. hahnii*	4	1				
7	*D. panzeri*				1		
8	*A. wideri*	8				6	
9	*Lamprochernes* spp.	549	14	38	57	13	2
10	*P. scorpioides*	200	65		20	13	
	∑	793	96	46	78	103	2

DISCUSSION

During the study, 10 pseudoscorpion taxa were identified from heaps with decomposing material. Four species were recorded for the first time from compost heaps in Slovakia previously (Christophoryová 2009, Christophoryová et al. 2014), of which *C. hungaricus* and *A. politus* were not found during the present study.

Members of Chthoniidae and Neobisiidae usually live in leaf litter and the upper part of the soil. Three chthoniid species and one species of Neobisiidae were recorded from heaps with decomposing material during our study. The species *C. ressli* and *C. tetrachelatus* were collected in higher numbers mainly in the forest environment or in domestic gardens. *Chthonius tetrachelatus*, from the family Chthoniidae, was found in the highest number of samples. In Slovakia, it is the most common species of Chthoniidae (Christophoryová 2013). Mock et al. (2005) identified as *Chthonius* cf. *ressli* (earlier reported as *C.* aff. *ressli* by Mock et al. 2004) a single specimen collected from Klenbová Cave in Čierna hora Mts, Slovakia. Mock et al. (2004, 2005) noticed that this was probably the first record of this pseudoscorpion in Slovakia, but that it should be confirmed by more detailed study. Here we confirm the presence of *C. ressli* in Slovakia. This is a rare species, previously recorded only from a few

localities in France, Italy, Austria, Hungary and the Czech Republic (Harvey 2013, Novák & Kutasi 2014). The majority of findings in Italy were from mole nests (Inzaghi 1981), but elsewhere most records are from under stones or in caves (Beier 1956, 1963; Judson 1990; Mock et al. 2004, 2005; Šťáhlavský 2006; Novák & Kutasi 2014). Previously, *C. fuscimanus* was recorded from Slovakia only in leaf litter and soil (Christophoryová 2013). *Neobisium carcinoides* is considered to be a eurytopic species (Beier 1963). In Slovakia, it is generally epigeic, but it was also collected from tree hollows, bird nests, dead wood, using Malaise traps and cardboard strips (Christophoryová 2010, 2013; Christophoryová et al. 2011a, 2014; Krajčovičová & Christophoryová 2014). Ressl & Beier (1958) recorded *C. fuscimanus*, *C. tetrachelatus* and *N. carcinoides* from compost heaps containing plant material and located near streams and forest edges in Austria.

During this study, only one specimen of each species *Dactylochelifer latreillii* and *Dinocheirus panzeri* was found. Ressl & Beier (1958) recorded *D. latreillii* from forest compost containing plant material in Austria, and Drogla & Lippold (2004) found it sporadically in compost in West Germany. One male of *D. panzeri* was collected in compost in the Czech Republic (Šťáhlavský & Chytil 2013). Also in West Germany, this species was reported as frequently occurring in compost (Drogla & Lippold 2004). The chernetids *C. hahnii* and *A. wideri* are commonly found under tree bark, in tree hollows, bird nests and in decaying wood, or collected using Malaise traps (Krumpál & Christophoryová 2007; Christophoryová 2010; Christophoryová & Krumpál 2010; Christophoryová et al. 2011a, 2014; Krajčovičová & Christophoryová 2014). During this study, only a few specimens of both these species were recorded in heaps with decomposing material, containing mainly grass, plant and animal waste.

Most of the specimens collected from heaps with decomposing material belong to species of the genus *Lamprochernes*. They were present in heaps of all environmental categories and at almost all sampled localities. Besides, the *Lamprochernes* species were found in all developmental stages. At present, two *Lamprochernes* species (*L. chyzeri* and *L. nodosus*) are known from Slovakia (Christophoryová et al. 2012). The species *L. chyzeri* was described from localities in Slovakia by Tömösváry (1882). It was recorded mainly in Europe, but also in Georgia, Kazakhstan and Turkey (Harvey 2013). It was frequently recorded from natural habitats, particularly from under tree bark, bird nests and rarely from compost heaps (Beier 1963; Legg & Jones 1988; Drogla & Lippold 2004; Krumpál & Christophoryová 2007; Christophoryová 2009, 2010; Christophoryová et al. 2012). Harvey (2013) noticed that *L. nodosus* was distributed in whole Europe, in Asia and Africa. It was more often associated with humans, lives in compost heaps and manure or, more rarely, in bird nests, under tree bark or sparophytic fungi (Beier 1963; Mašán & Krištofík 1992; Krištofík et al. 1995, 1996; Drogla & Lippold 2004; Christophoryová & Krumpál 2010; Krajčovičová & Christophoryová 2014). The identification of both species is based on questionable characters. According to the identification key in Legg & Jones (1988) the female anterior genital operculum bears more than 20 setae in *L. nodosus* and 9–11 setae in *L. chyzeri*, but Christophoryová et al. (2011c) did not observe any specimens either of these species with less than 20 setae. The morphometric data on palps are overlapping (Christophoryová et al. 2011c). The main diagnostic character that differentiates both species from each other is the shape of protuberance on palpal trochanter, but this character is very subjective. Because of these facts we were unable to distinguish these two species by the morphological characters. The collected material is used in detailed molecular and taxonomic analysis. DNA extraction and sequencing fragments of the mitochondrial protein-encoding cytochrome c oxidase subunit gene (COI) of 20 adult specimens was conducted. The preliminary results confirm the occurrence of both species in Slovakia. At some localities (Bratislava, Botanical garden, Čataj and Nitra), both of the species

were present simultaneously. The main diagnostic characters were checked and 30% of the sequenced specimens were incorrectly identified based on the shape of protuberance on palpal trochanter. None of the collected females bears less than 20 setae on anterior genital operculum and the measurements of palpal femur overlapped. Other specimens will be analysed and many continuous and discrete morphological characters will be measured and scored.

Pselaphochernes scorpioides occurred in heaps with decomposing material in almost all environmental categories and localities and was represented by all developmental stages, including females with eggs. This habitat type is favoured by *P. scorpioides*, as confirmed by findings in other European countries (Beier 1955, 1961, 1963, 1966; Ressl & Beier 1958; Ressl 1970; Jędryczkowski 1985; Drogla & Lippold 2004; Šťáhlavský 2006). In Slovakia, it was collected in leaf litter, bird and ant nests, dead wood, tree hollows, decaying wood and under tree bark, as well as by using Malaise traps (Krumpál & Christophoryová 2007; Christophoryová 2010, 2013; Christophoryová & Krumpál 2010; Christophoryová et al. 2011a, 2014; Krajčovičová & Christophoryová 2014; Jászayová et al. 2015).

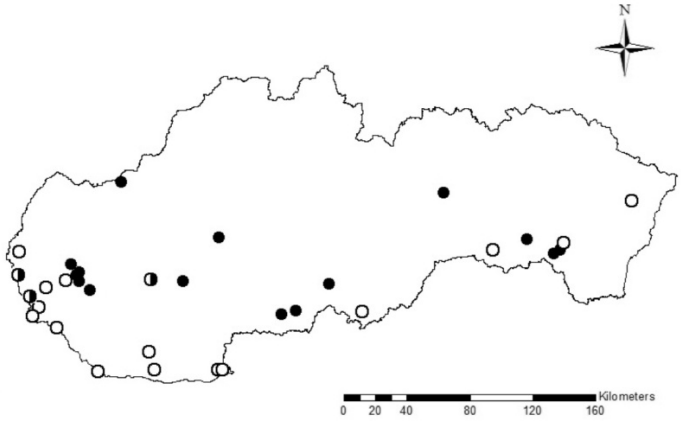


Fig. 6. Distribution of the genus *Lamprochernes* in Slovakia; white dots represent published data from different habitat types (Tömösváry 1882, Mašán & Krištofík 1992, Krištofík et al. 1994, 1995, 1996, Krumpál et al. 1997, Krumpál & Christophoryová 2007, Christophoryová 2009, 2010, Christophoryová & Krumpál 2010, Christophoryová et al. 2011a, 2011b, 2014, Krajčovičová & Christophoryová 2014); black dots represent current data from heaps with decomposing material; black-and-white dots represent intersections of the previously published locations with new data.

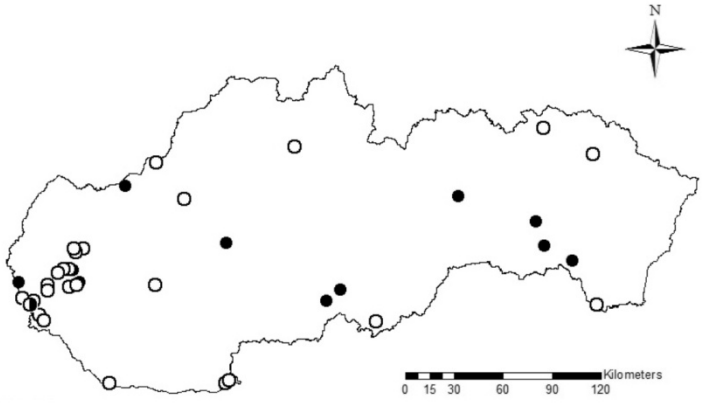


Fig. 7. Distribution of *Pselaphochernes scorpioides* in Slovakia; white dots represent published data from different habitat types (Krumpál & Christophoryová 2007, Christophoryová & Krumpál 2010, Christophoryová et al. 2011a, 2014, Christophoryová 2013, Krajčovičová & Christophoryová 2014, Jászayová et al. 2015); other dots as in Figure 6.

Lamprochernes spp. and *P. scorpioides* are typical inhabitants of heaps with decomposing material. Many new localities of these taxa we recorded in Slovakia during this study (Figs 6 & 7). Future research of the compost heaps and other accumulations of waste could lead to more records of pseudoscorpion that are rare or unknown in this country.

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STRESZCZENIE

[**Zaleszczotki (Arachnida: Pseudoscorpiones) pryzm kompostowych na Słowacji**]

Celem badań było uzyskanie szerszych danych na temat zaleszczotków w pryzmach kompostowych. Materiał zbierano w latach 2012–2014 na 33 stanowiskach na Słowacji. Łącznie przeanalizowano 1118 osobników z 10 gatunków i 4 rodzin. Gatunki z rodzaju *Lamprochernes* były oznaczone tylko do rodzaju, ze względu na trudności w ich rozróżnieniu w oparciu o cechy morfologiczne. Najliczniej występujące zaleszczotki reprezentowały rodzinę Chernetidae, zaś najmniej gatunków należało do rodzin Neobisiidae i Cheliferidae – ich przedstawiciele występowali tylko sporadycznie. Najliczniej stwierdzone gatunki z rodziny Chernetidae to: *Lamprochernes* sp. oraz *Pselaphochernes scorpioides*. Z gatunków *Dactylochelifer latreillii* i *Dinocheirus panzeri* odnotowano tylko pojedyncze osobniki. W badanich potwierdzono występowanie na Słowacji rzadkiego gatunku *Chthonius ressli*. Ponadto wykazano, że *Lamprochernes* spp. i *P. scorpioides* są typowymi

mieszkańcami pryzm kompostowych, gdzie przebiega ich cały cykl życiowy; tam znajdowano ich wszystkie stadia rozwojowe, a nawet samice z jajami (*P. scorpioides*). Pryzmy kompostowe reprezentowały różne kategorie siedliska z uwagi na typ środowiska oraz etap rozkładu gnijącego materiału. Zaleszczotki z rodzaju *Lamprochernes* znaleziono w pryzmach należących do każdej z sześciu wyróżnionych kategorii. W pryzmach z czterech kategorii stwierdzono *P. scorpioides*. Rodzina Chthoniidae była odnotowywana najczęściej w kompoście leśnym. Gatunki spoza tej rodziny były znajdywane znacznie rzadziej, co wskazuje na ich zaledwie sporadyczną obecność w materiale kompostowym.

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