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Faunistic survey of pseudoscorpions (Arachnida: Pseudoscorpiones) collected from compost heaps in Slovakia

Faunistický prehľad šťúrikov (Arachnida: Pseudoscorpiones) zbieraných z kompostov na Slovensku

Jana CHRISTOPHORYOVÁ, Andrea KAŇUCHOVÁ & Katarína KRAJČOVIČOVÁ

Department of Zoology, Faculty of Natural Sciences, Comenius University, Mlynská dolina, Ilkovičova 6, SK–842 15 Bratislava, Slovakia; e-mail: christophoryova@gmail.com

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Abstract: The present paper gives new records of pseudoscorpions collected from compost heaps. Material from 31 localities in Slovakia was investigated during four years of research. A total of 1799 pseudoscorpions of 14 taxa from four families were examined. The most abundant were the families Chthoniidae and Chernetidae; only one cheliferid specimen was recorded during the study. The most abundant taxa were typical inhabitants of compost heaps, chernetid pseudoscorpions of the genus *Lamprochernes* Tömösváry, 1882 and the species *Pselaphochernes scorpioides* (Hermann, 1804). The taxa *Chthonius carinthiacus* Beier, 1951, *Chthonius boldorii* Beier, 1934, *Mundochthonius carpaticus* Rafalski, 1948, *Neobisium fuscimanum* (C. L. Koch, 1843), *Neobisium sylvaticum* (C. L. Koch, 1835) and *Roncus* sp. were recorded in decomposing material for the first time in Slovakia.

INTRODUCTION

The organic richness of compost heaps, and their decomposer inhabitants, provide a favourable environment and food source for pseudoscorpions. In the past, only marginal attention has been paid to pseudoscorpions living in decomposing material in Slovakia. Verner (1971) published only general information about the species *Lamprochernes nodosus* (Schrank, 1803) living in decaying plant material. Two males of *L. chyzeri* (Tömösváry, 1882) and one male of *Chthonius hungaricus* Mahnert, 1981 were found in manure and decaying plant material in the Cerová vrchovina Highlands (Christophoryová 2009). Christophoryová et al. (2014) identified the species *L. nodosus* and *Atemnus politus* (Simon, 1878) in compost heaps and rotten hay in the Burda Mts. The first detailed survey of pseudoscorpions living in heaps of decomposing material was presented only recently (Kaňuchová et al. 2015). The research was performed on samples from 33 localities and a total of 1118 specimens of ten species in four families were identified (Kaňuchová et al. 2015). The first confirmed Slovakian record of the rare species *Chthonius ressli* Beier, 1956, collected in this habitat type, was notable (Kaňuchová et al. 2015). Christophoryová et al. (2016) found 21 specimens of five taxa in compost heaps in cemeteries in Slovakia.

The aim of the present paper is to extend the knowledge of the pseudoscorpion fauna of compost heaps in Slovakia.

MATERIALS AND METHODS

Samples were collected from man-made compost heaps by different researchers at 31 localities in Slovakia during a four-year period of research (Figs 1, 2; Table 1). Samples of decomposing material 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 represented approximately 6 dm^3; from several localities, more than one sample was taken. Specimens were heat extracted using Tullgren funnels. Some of the specimens were prepared as permanent slide mounts, mounted using Liquido de Swann medium, and a varnish was applied to provide a vapour barrier. The majority of specimens were deposited in 70% ethanol and studied as temporary slide mounts using lactic acid. Pseudoscorpions were identified using the key in Christophoryová et al. (2011). Nomenclature for all taxa follows Harvey (2013). The material is deposited in the zoological collections of Comenius University, Bratislava.

RESULTS AND DISCUSSION

During the study, 1799 specimens of 14 taxa from four families were identified (Table 2). Specimens of the genera *Lamprochernes* and *Roncus* were identified only to genus level. The families Chernetidae and Chthoniidae were the most abundant. From the family Cheliferidae, only one specimen of *Dactylochelifer latreillii* was collected (Table 2). The species *Pselaphochernes scorpioides* was the most numerous. Several taxa were recorded from decomposing material for the first time in Slovakia. In this part of the study only the occurrence of the species in decomposing material in Slovakia is discussed.

The list of the taxa collected is given below with locality code (see Table 1), biotope and sample type, date and number of developmental stages (female: ♀, male: ♂, nymph without knowing the concrete stage because of the damage: N, tritonymph: Tn, deutonymph: Dn, protonymph: Pn) and collector name.

The list of the collected taxa

Chthoniidae

Chthonius* (*Chthonius*) *carinthiacus Beier, 1951
16: house garden, 13.x.2013, 12 ♀♀, 4 ♂♂, lgt. K. Hrúzová.

The species has not previously been recorded in decaying material in Slovakia.

Chthonius* (*Chthonius*) *ressli Beier, 1956
3: house garden, 4.ix.2013, 5 ♀♀, lgt. M. Holecová;
13: field near the stream, 21.ix.2013, 15 ♀♀, 6 ♂♂, 4 Tn, lgt. D. Gruľa, K. Krajčovičová;
28: house garden, 1.ix.2013, 2 ♀♀, 4 ♂♂, 1 Tn, 1 Dn, lgt. A. Krajča.

Kaňuchová et al. (2015) found 49 specimens in one compost heap situated near the road at the edge of a village. Christophoryová et al. (2016) recorded one male in a compost heap in cemetery in an urban area. The majority of our specimens were collected in an agricultural area. The latest findings suggest that the species might not be as rare in Slovakia as we previously suggested. The occurrence of the species and its habitat preference is summarized by Šestáková et al. (2017).

Chthonius* (*Ephippiochthonius*) *boldorii Beier, 1934
27: allotment garden, 3.xi.2013, 1 ♀, lgt. P. Fenďa.

The species has not previously been recorded in compost heaps or decaying material in Slovakia.

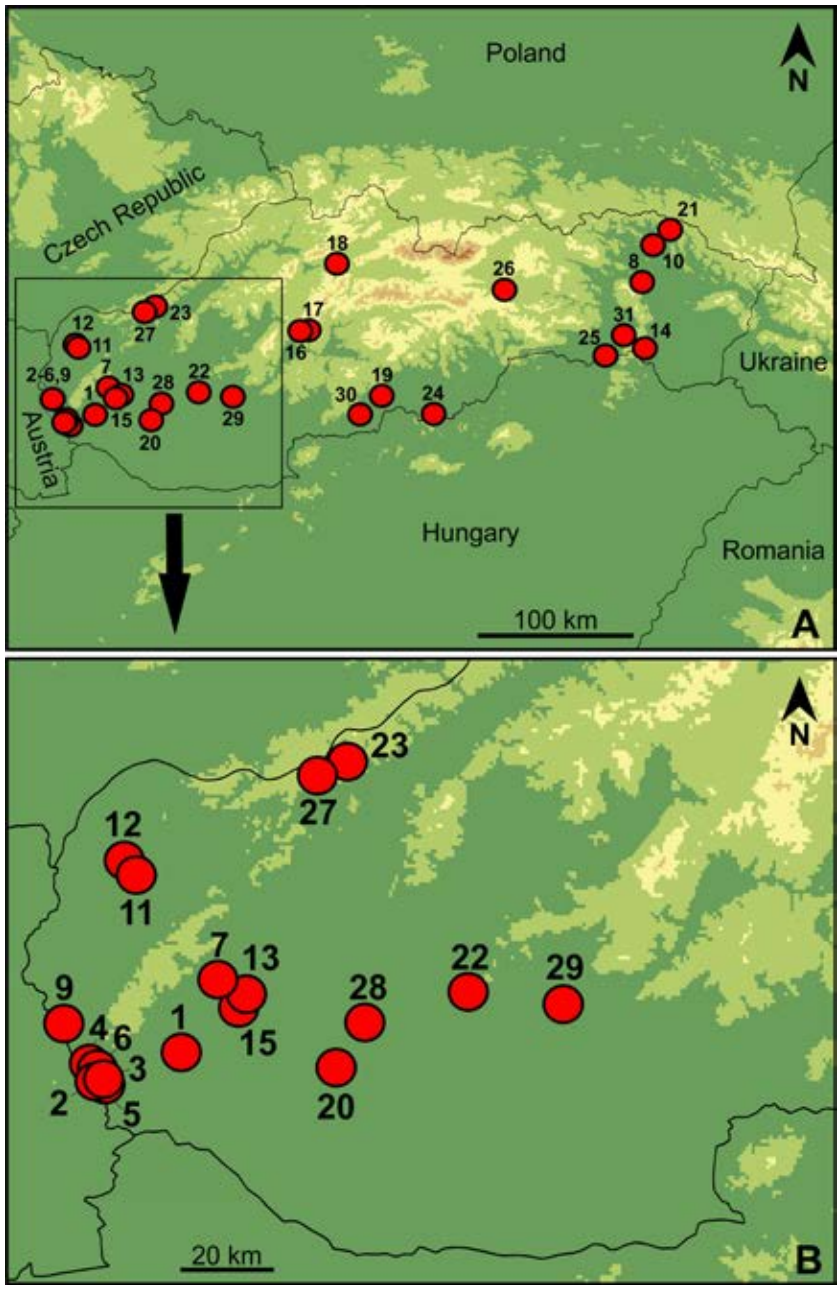

Fig. 1. Location of the studied localities in Slovakia (A) with a detail of Western Slovakia (B). For locality code see Table 1.

Obr. 1. Rozmiestnenie študovaných lokalít na Slovensku (A) s detailom na západné Slovensko (B). Pre kód lokality viď Tabuľku 1.

Table 1. List of localities.
Tabuľka 1. Zoznam lokalít.

Code Kód	Locality Lokalita	N S	E V	a.s.l. (m) m n.m.
1	Bernolákovo	48°11′47.87″	17°17′37.31″	129
2	Bratislava, Botanical Garden	48°08′50.82″	17°04′26.58″	152
3	Bratislava, Fialkové údolie	48°08′36.4″	17°05′28.1″	202
4	Bratislava, Jezuitské lesy	48°10′34.41″	17°01′27.76″	315
5	Bratislava, Nábrežie arm. gen. L. Svobodu	48°08′38.41″	17°04′55.22″	151
6	Bratislava, Prírodovedecká fakulta	48°08′56.48″	17°04′06.77″	159
7	Budmerice	48°21′43.90″	17°23′46.25″	210
8	Bystré	49°00′33″	21°32′32″	200
9	Devínske jazero	48°15′44″	16°57′52″	140
10	Duplín	49°14′06″	21°37′35″	200
11	Gazarka	48°37′24.76″	17°08'34.85″	185
12	Gazarka	48°37′27.34″	17°08'24.90″	185
13	Jarná	48°19′17.44″	17°28′07.56″	148
14	Kalša	48°36′41.50″	21°32′10.72″	196
15	Kaplna	48°17′51.55″	17°27′14.71″	152
16	Kremnica	48°42′22.71″	18°54′56.8″	560
17	Kremnica	48°42′33.78″	18°55′26.29″	660
18	Ľubochňa	49°07′19.11″	19°10′11.92″	581
19	Ľuboreč	48°18′45.63″	19°31′07.26″	276
20	Matúškovo	48°09′43.56″	17°43′39.80″	115
21	Miroľa	49°19′45″	21°45′33″	370
22	Nitra, Zobor	48°20′03.31″	18°05′51.01″	259
23	Plevovec, Kopanice u Zlatých	48°51′28.86″	17°45′35.74″	380
24	Pohanský hrad	48°12′00.34″	19°55′24.85″	572
25	Seňa	48°33′32″	21°15′26″	180
26	Spišské Tomášovce	48°57′44″	20°28′20″	520
27	Súš	48°49′	17°40′	490
28	Šoporňa	48°15′52.46″	17°48′28.39″	129
29	Tesárske Mlyňany	48°18′21.30″	18°21′49.37″	170
30	Veľký Krtíš	48°12′22.66″	19°20′39.94″	192
31	Vyšný Čaj	48°41′02″	21°23′58″	240

Chthonius* (*Ephippiochthonius*) *tetrachelatus (Preyssler, 1790)
3: house garden, 4.ix.2013, 4 ♀♀, 1 ♂, 3 Tn, 1 Dn, lgt. M. Holecová;
5: garden near block of flats, 4.ix.2013, 1 ♂; 10.x.2013, 1 ♂, lgt. D. Gruľa;
6: forest, 25.x.2013, 1 ♀, lgt. J. Christophoryová, A. Kaňuchová;
7: park around manor house, 21.ix.2013, 1 ♀, lgt. D. Gruľa, K. Krajčovičová;
9: house garden, 15.viii.2012, 2 ♂♂, lgt. E. Stloukal, V. Stloukalová;
13: field near the stream, 21.ix.2013, 21 ♀♀, 9 ♂♂, 7 Tn, 7 Dn, lgt. D. Gruľa, K. Krajčovičová;
18: house garden, 12.x.2012, 5 ♀♀, 11 ♂♂, 9 Tn, 12 Dn, lgt. M. Krumpál;
19: house garden, 22.ix.2013, 1 ♂, 1 Tn, lgt. D. Gruľa, K. Krajčovičová;
20: cemetery, 21.ix.2013, 1 ♀, lgt. D. Gruľa, K. Krajčovičová;

27: allotment garden, 9.xi.2012, 4 ♀♀, 8 ♂♂, 5 Tn, 3 Dn, lgt. P. Fenďa;
28: house garden, 1.ix.2013, 1 ♀, 2 ♂♂, 1 Dn, lgt. A. Krajča.

This species was the most abundant of the family Chthoniidae, which corresponds to previous records from decomposing material in Slovakia. It was extracted from compost in higher numbers mainly in forest environments and domestic gardens (Kaňuchová et al. 2015). Several specimens were identified from compost samples obtained from rural cemeteries (Christophoryová et al. 2016).

Mundochthonius carpaticus Rafalski, 1948
16: house garden, 13.x.2013, 4 ♀♀, 1 Dn, lgt. K. Hrúzová.

The species has not previously been recorded in compost heaps or decaying material in Slovakia.

Neobisiidae

Neobisium* (*Neobisium*) *carcinoides (Hermann, 1804)
4: allotment garden, 5.x.2013, 1 Pn, lgt. D. Gruľa, K. Krajčovičová;
17: house garden, 13.x.2013, 1 ♀, lgt. K. Hrúzová;
24: pasture, 21.ix.2012, 1 ♀, lgt. K. Krajčovičová.

Several specimens had previously been found in compost in house and allotment gardens and in rural cemeteries in Slovakia (Kaňuchová et al. 2015, Christophoryová et al. 2016).

Neobisium* (*Neobisium*) *fuscimanum (C. L. Koch, 1843)
16: house garden, 13.x.2013, 1 ♀, 1 Tn, lgt. K. Hrúzová.

The species has not previously been recorded in compost heaps or decaying material in Slovakia.

Neobisium* (*Neobisium*) *sylvaticum (C. L. Koch, 1835)
14: house garden, 31.vii.2010, 1 ♀, lgt. A. Mock;
17: house garden, 13.x.2013, 1 Tn, 1 Dn, lgt. K. Hrúzová.

The species has not previously been recorded in compost heaps or decaying material in Slovakia.

***Roncus* sp.**
24: pasture, 21.ix.2012, 2 ♀♀, 2 ♂♂, lgt. K. Krajčovičová.

This genus includes several species complexes without known morphological or morphometric characters. That is why the specimens were identified only to the genus level. The genus has not previously been recorded in compost heaps or decaying material in Slovakia.

Cheliferidae

Dactylochelifer latreillii (Leach, 1817)
31: house garden, 18.x.2015, 1 Tn, lgt. R. Olajoš.

One *D. latreillii* female was previously recorded in compost heap situated in village garden in Slovakia (Kaňuchová et al. 2015).

Chernetidae

Chernes hahnii (C. L. Koch, 1839)
9: house garden, 15.viii.2012, 1 ♀, lgt. E. Stloukal, V. Stloukalová.

Kaňuchová et al. (2015) recorded specimens of *C. hahnii* in compost heaps situated in house and community gardens in Slovakia.

Allochernes wideri (C. L. Koch, 1843)
27: allotment garden, 9.xi.2012, 4 Tn, 4 Dn, 1 Pn, lgt. P. Fenďa.

Several specimens of *A. wideri* were extracted from compost heaps situated near family houses in Slovakia (Kaňuchová et al. 2015).

***Lamprochernes* spp.**
1: house garden, 11.viii.2013, 1 Dn, lgt. J. Christophoryová;
2: botanical garden, 22.xi.2013, 33 ♀♀, 22 ♂♂, 7 Tn, 4 Dn, 1 Pn, lgt. P. Fenďa;
4: allotment garden, 5.x.2013, 1 ♀, 1 Tn, 1 Dn, lgt. D. Gruľa, K. Krajčovičová;
8: fruit grove, 4.x.2015, 1 Dn, 2 Pn, lgt. A. Kmecová;
9: house garden, 15.viii.2012, 47 ♀♀, 40 ♂♂, 81 Tn, 64 Dn, 43 Pn; 8.x.2012, 4 Dn, 2 Pn, lgt. E. Stloukal, V. Stloukalová;
10: house garden, 3.xi.2015, 1 ♂, lgt. A. Čanády;
15: house garden, 19.ix.2012, 1 Tn, 3 Dn, 2 Pn; 1.ix.2013, 26 Tn, 5 Dn, lgt. K. Krajčovičová;
21: house garden, 30.x.2015, 1 ♂, lgt. A. Čanády;
22: house garden, 19.ix.2012, 1 N, 6 Tn, 6 Dn, 20 Pn, lgt. L. Stasselová;
25: house garden, 27.x.2015, 2 ♀♀, 3 Dn, 2 Pn, lgt. A. Čanády;
29: arboretum, 10.x.2013, 11 ♀♀, 1 ♂, 5 Tn, 1 Dn, lgt. J. Christophoryová, K. Krajčovičová;
30: restaurant garden, 22.ix.2013, 7 ♀♀, 18 ♂♂, 5 Tn, lgt. J. Christophoryová, K. Krajčovičová.

Two *Lamprochernes* species, *L. chyzeri* and *L. nodosus*, are known from Slovakia (Christophoryová et al. 2012). The identification of these species is based on questionable morphological characters and overlapping morphometric data (Christophoryová et al. 2011). The specimens collected in the present study have been subjected to detailed molecular and taxonomic analysis. The preliminary results confirm the occurrence of both species in compost heaps in Slovakia. Other specimens will be analysed and many continuous and discrete morphological characters will be measured and scored. Until then, the specimens are identified only to genus level.

The genus includes typical inhabitants of decomposing material. Kaňuchová et al. (2015) found hundreds of specimens in decomposing material in different environments, including all developmental stages. Christophoryová et al. (2016) reported two specimens in compost heaps in cemeteries in Slovakia.

Pselaphochernes scorpioides (Hermann, 1804)
1: house garden, 11.viii.2013, 7 ♀♀, lgt. J. Christophoryová;
2: botanical garden, 13.vi.2013, 1 ♀; 22.xi.2013, 1 ♀, 1 ♂, lgt. P. Fenďa;
3: house garden, 4.ix.2013, 2 ♂♂, 5 Tn, 3 Dn, lgt. M. Holecová;
5: garden near block of flats, 20.viii.2013, 3 ♀♀, 1 Dn; 30.ix.2013, 7 ♀♀, 11 ♂♂; 10.x.2013, 2 ♂♂, lgt. D. Gruľa;

Fig. 2. Examples of sampled compost heaps in Slovakia. A. Tesárske Mlyňany. B. Veľký Krtíš. C. Bratislava, Botanical Garden. D. Ľubореč. Photos by J. Christophoryová.
Obr. 2. Príklady vzorkovaných kompostov na Slovensku. A. Tesárske Mlyňany. B. Veľký Krtíš. C. Bratislava, Botanická záhrada. D. Ľubореč. Fotografovala J. Christophoryová.

Table 2. Number of recorded pseudoscorpion taxa.
Tabuľka 2. Počet zaznamenaných taxónov šťúrikov.

Taxa **Taxón**		**Specimen number/ Locality records** **Počet jedincov/ Počet lokalít**
Chthoniidae	*Chthonius carinthiacus*	16/ 1
	Chthonius ressli	38/ 3
	Chthonius boldorii	1/ 1
	Chthonius tetrachelatus	123/ 11
	Mundochthonius carpaticus	5/ 1
Neobisiidae	*Neobisium carcinoides*	3/ 3
	Neobisium fuscimanum	2/ 1
	Neobisium sylvaticum	3/ 2
	Roncus sp.	4/ 1
Cheliferidae	*Dactylochelifer latreillii*	1/ 1
Chernetidae	*Chernes hahnii*	1/ 1
	Allochernes wideri	9/ 1
	Lamprochernes ssp.	482/ 12
	Pselaphochernes scorpioides	1111/ 16
Total/ Spolu		**1799**

7: park around manor house, 21.ix.2013, 10 ♀♀, 3 ♂♂, lgt. D. Gruľa, K. Krajčovičová;
9: house garden, 15.viii.2012, 6 ♀♀, 3 ♂♂, 1Tn, lgt. E. Stloukal, V. Stloukalová;
11: pine-forest, 24.vi.2015, 70 ♀♀, 61 ♂♂, 22 Tn, 111 Dn, 46 Pn, lgt. J. Christophoryová, A. Kaňuchová, K. Krajčovičová;
12: allotment garden, 24.vi.2015, 10 ♀♀, lgt. J. Christophoryová, A. Kaňuchová, K. Krajčovičová;
13: field near the stream, 21.ix.2013, 33 ♀♀, 24 ♂♂, 102 Tn, 45 Dn, 12 Pn, lgt. D. Gruľa, K. Krajčovičová;
15: house garden, 19.ix.2012, 54 ♀♀, 70 ♂♂, 1 Tn, 12 Dn, 1 Pn; 10.viii.2013, 1 ♀, 1 ♂; 1.ix.2013, 1 ♀, 4 Tn, lgt. K. Krajčovičová;
19: house garden, 22.ix.2013, 4 ♀♀, 8 ♂♂, 2 Tn, 4 Dn, lgt. D. Gruľa, K. Krajčovičová;
23: cottage garden, 10.viii.2013, 11 ♀♀, 20 ♂♂, 11 Tn, 1 Dn, 1 Pn, lgt. J. Christophoryová;
25: house garden, 27.x.2015, 4 ♀♀, 1 ♂, lgt. A. Čanády;
26: meadow, rotten hay, 13.xi.2015, 1 ♀, lgt. Z. Gurinová;
27: allotment garden, 9.xi.2012, 106 ♀♀, 102 ♂♂, 37 Tn, 21 Dn, 5 Pn; 3.xi.2013, 4 ♂♂, lgt. P. Fenďa;
28: house garden, 1.ix.2013, 1 ♀, 14 ♂♂, 1 Tn, 3 Dn, 1 Pn, lgt. A. Krajča.

Pselaphochernes scorpioides is a typical inhabitant of heaps of decomposing material, in which all its developmental stages, even females with eggs, can be found (Kaňuchová et al. 2015). Four specimens of this species were recorded in compost heaps in rural cemeteries in Slovakia (Christophoryová et al. 2016).

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SÚHRN

Komposty predstavujú vhodný typ habitatu pre život šťúrikov, najmä vďaka bohatstvu organickej hmoty a potravnej ponuky. V minulosti sa šťúrikom v kompostoch venovala len okrajová pozornosť. Cieľom našej práce bolo rozšíriť poznanie fauny šťúrikov vyskytujúcich sa v kopách rozkladajúceho sa organického materiálu, ktoré boli vytvorené človekom. Vzorky boli odoberané rôznymi zberateľmi na 31 lokalitách Slovenska počas štyroch rokov. Šťúriky boli spracované na dočasné aj trvalé preparáty.

Celkovo bolo identifikovaných 1799 jedincov, patriacich ku 14 taxónom a do štyroch čeľadí. Jedince z rodov *Lamprochernes* a *Roncus* boli identifikované len na úroveň rodu, pre ich nejednoznačnú determináciu a prebiehajúcu molekulárnu a morfologickú analýzu. Najpočetnejšie boli zaznamenané šťúriky z čeľadí Chthoniidae a Chernetidae, z čeľade Cheliferidae bola naopak nájdená len jedna tritonymfa druhu *Dactylochelifer latreillii* (Leach, 1817). Najviac jedincov patrilo druhu *Pselaphochernes scorpioides* (Hermann, 1804), druhý najpočetnejší bol rod *Lamprochernes*. Oba taxóny predstavujú typických obyvateľov kompostov, v ktorých sa pravidelne vyskytujú a bývajú zastúpení všetkými vývinovými štádiami. Taxóny *Chthonius carinthiacus* Beier, 1951, *Ch. boldorii* Beier, 1934, *Mundochthonius carpaticus* Rafalski, 1948, *Neobisium fuscimanum* (C. L. Koch, 1843), *N. sylvaticum* (C. L. Koch, 1835) a *Roncus* sp. boli zaznamenané v kompostoch na Slovensku po prvýkrát.