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Pseudoscorpions (Arachnida: Pseudoscorpiones) collected in cemeteries in Slovakia

Šťúriky (Arachnida: Pseudoscorpiones) zbierané na cintorínoch na Slovensku

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Abstract. The present paper gives new records of pseudoscorpions from cemeteries in Slovakia, living in tree hollows, compost heaps and soil. The samples were collected in cemeteries at 13 localities during the years 2013 – 2015. Altogether 111 pseudoscorpions belonging to 10 species and three families were examined. The specimens of the genus *Lamprochernes* Tömösváry, 1882 were identified only to genus level. The families Chthoniidae and Chernetidae were the most abundant. The largest numbers of specimens were found in historic cemeteries, and the most species in rural cemeteries. Pseudoscorpions from the families Chthoniidae and Neobisiidae occurred mainly in soil samples and in compost heaps. Chernetids were found in tree hollows and in the soil samples. From a faunistic point of view, a rare species *Chthonius ressli* Beier, 1956 was recorded in soil samples and compost.

INTRODUCTION

The urban environment is constantly modified by human activities, especially housing construction and ongoing degradation of ecosystems. Cities or villages preserve some greenery, in the form of city parks, gardens, lanes and cemeteries.

Only marginal attention has been paid to pseudoscorpions living in the urban environment in Slovakia. Christophoryová (2010) identified the species *Chernes hahnii* (C. L. Koch, 1839), *Dinocheirus panzeri* (C. L. Koch, 1837) and *Allochernes wideri* (C. L. Koch, 1843) from tree hollows in parks and botanic gardens in the cities of Banská Štiavnica, Košice and Stupava. The species *C. hahnii* and *Neobisium sylvaticum* (C. L. Koch, 1835) were collected under tree bark and *Dactylochelifer latreillii* (Leach, 1817) in the nests of *Turdus merula* Linnaeus, 1778 in the cities of Bratislava and Stupava (Christophoryová 2010). Christophoryová (2013) recorded six species from the families Chthoniidae, Neobisiidae, Cheliferidae and Chernetidae in fragmented forest and parks in Bratislava. Krajčovičová & Christophoryová (2014) recorded seven species in tree hollows and under the tree bark in parks at seven localities in Slovakia. The discovery of the species *Mesochelifer ressli* Mahnert, 1981 under *Pinus* bark at two new localities for Slovakia, as well as in a new microhabitat type – in a *Salix* hollow (Krajčovičová & Christophoryová 2014), was of interest. Krajčovičová et al. (2015) found *D. latreillii*, *C. hahnii* and *A. wideri* in open nests of *T. merula* in urban habitats in Bratislava and Stupava. *Chernes hahnii*, *D. panzeri* and *A. wideri* were found in bat guano collected from boxes and tree hollows situated in parks in Nitra (Krajčovičová et al. 2015).

Cemeteries represent specialized greenery without extensive cutting and cultivation. That is why some species that cannot survive in urban build-up areas can often be found in cemeteries. Cemeteries have even yielded some rare or new invertebrate species for the fauna of Slovakia (Fenďa 2011, Holecová et al. 2015, Klesniaková & Holecová 2015).

The present paper gives new reports of pseudoscorpion species from cemeteries in Slovakia, living in tree hollows, compost heaps and soil.

MATERIALS AND METHODS

Different researchers collected the studied material in cemeteries situated at 13 localities in Slovakia during the years 2013 – 2015 (Figs 1, 2; Table 1). Three cemetery types were visited during the research – rural cemeteries (Čuňovo, Devín, Dúbravka, Ľubореč, Matúškovo, Príbelce, Sokoľ), historic cemeteries (Kozia brána, Mikulášsky cintorín, Ondrejský cintorín) and urban cemeteries (Martinský cintorín, Slávičie údolie, Košice). The rural cemeteries with active burials are situated at the edge of villages in contact with nature and their greenery is managed in a standard way. Historic cemeteries are a style of burial grounds that use landscaping in a park-like setting, and have no active burials. They are situated directly within the city territory and used as parks. The greenery is well developed and consists mainly of old trees. Urban cemeteries are burial grounds located in the city interior, with active burials and with a constantly increasing area. The graves are placed close together, and therefore surrounded with scarcely any vegetation.

Samples of compost, wood mould from tree hollows and soil (containing soil, leaf litter and dead wood) were collected by hand, using polyethylene bags. The specimens were heat extracted from the samples in Tullgren funnels. Some specimens were collected using formalin pitfall traps or using the flagging method. The sampling flag consisted of 1 m^2 piece of white cotton flannel. Flag was dragging on vegetation on transects oriented in one direction on area 100 m^2. The majority of pseudoscorpions were studied as permanent slide mounts, mounted using 'Liquido de Swann' (Swann's medium). The remainder 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). The identification of some Chthoniidae species was checked and confirmed by Dr. Giulio Gardini (Italy). Nomenclature for all taxa follows Harvey (2013). The material is deposited in the zoological collections of Comenius University, Bratislava.

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	Bratislava, Čuňovo	48°01′57.80″	17°11′57.80″	130
2	Bratislava, Devín	48°10′43.99″	16°58′49.36″	140
3	Bratislava, Dúbravka	48°11′06.90″	17°01′20.29″	330
4	Bratislava, Kozia brána	48°08′50.09″	17°05′54.56″	174
5	Bratislava, Martinský cintorín	48°09′47.35″	17°09′40.61″	140
6	Bratislava, Mikulášsky cintorín	48°08′33.75″	17°05′24.12″	170
7	Bratislava, Ondrejský cintorín	48°08′53.18″	17°07′21.01″	140
8	Bratislava, Slávičie údolie	48°09′23.59″	17°04′07.00″	165
9	Košice	48°41′39.98″	21°15′13.58″	225
10	Ľubореč	48°18′48.03″	19°31′03.61″	274
11	Matúškovo	48°09′43.56″	17°43′39.80″	115
12	Príbelce	48°11′55.61″	19°15′40.33″	256
13	Sokoľ	48°48′53.64″	21°13′31.69″	252

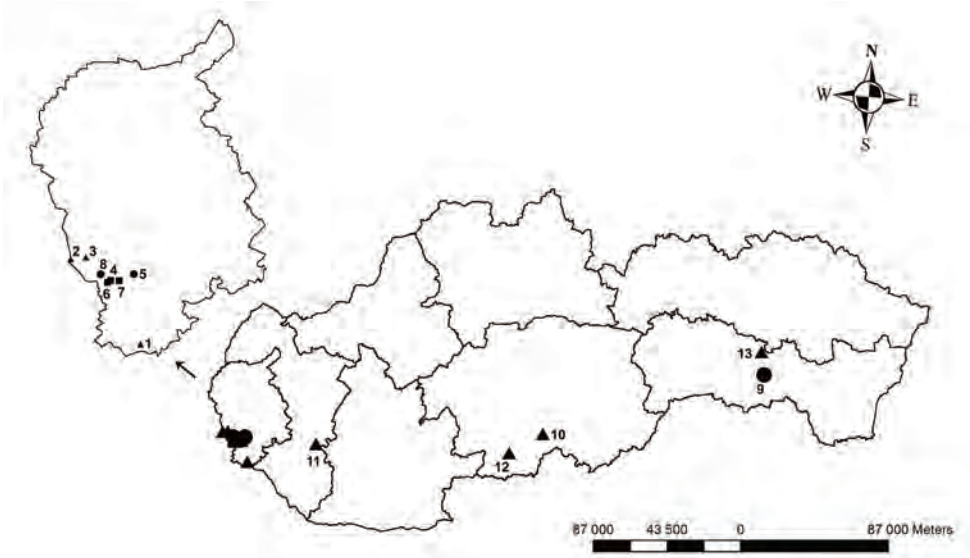

Fig. 1. Locations of the studied cemeteries in Slovakia with detail of the Bratislava Region – rural cemeteries (triangles), historic cemeteries (squares), urban cemeteries (circles). For the locality code see Table 1.
Obr. 1. Rozmiestnenie študovaných cintorínov na Slovensku s detailom Bratislavského kraja – dedinské (rurálne) cintoríny (trojuholníky), historické cintoríny (štvorce), mestské (urbánne) cintoríny (kruhy). Kódy lokalít sú uvedené v tabuľke 1.

RESULTS AND DISCUSSION

Altogether 111 pseudoscorpion specimens of 10 species from three families were identified (Tables 2, 3). The families Chthoniidae and Chernetidae were the most abundant. The lowest species and specimen number were recorded from the family Neobisiidae (Table 2). The species *Chthonius tetrachelatus* and *Dinocheirus panzeri* were the most abundant. Only one specimen of *Chthonius fuscimanus* was collected. The largest numbers of specimens were found in soil samples and in tree hollows (Table 2). The largest numbers of specimens were collected on historic cemeteries and the most species in rural cemeteries (Table 3). From the faunistic point of view, a rare species *Chthonius ressli* was recorded, for which only a few records are known so far, from mole nests, leaf litter, under stones and from caves: Austria (Beier 1956), Italy (Inzaghi 1981), France (Judson 1990), Slovakia (Mock et al. 2004), the Czech Republic (Šťáhlavský 2006) and Hungary (Novák & Kutasi 2014).

A list of the taxa collected is given below with locality code, sample type, date and number of developmental stages (female: ♀, male: ♂, tritonymph: Tn, deutonymph: Dn, protonymph: Pn) and collector's name.

The list of the collected taxa

Chthoniidae Daday, 1888
Chthonius* (*Chthonius*) *ressli Beier, 1956
2: soil sample, 10.vi.2014, 1 ♀, lgt. P. Fenďa, M. Kocáková, checked by G. Gardini;

Table 2. Pseudoscorpions collected from different microhabitat types in cemeteries in Slovakia. Abbreviations: CO – compost heaps, FM – flagging method, FT – formalin pitfall traps, SS – soil samples, TH – tree hollows.
Tabuľka 2. Šťúriky zbierané z rôznych typov mikrohabitatov na cintorínoch Slovenska. Skratky: KO – komposty, V – vlajkovanie, FP – formalínové zemné pasce, PV – pôdne vzorky, DU – dutiny.

Taxon/ Microhabitat	**CO**	**FM**	**FT**	**SS**	**TH**	**Total**
Taxón/ Mikrohabitat	**KO**	**V**	**FP**	**PV**	**DU**	**Spolu**
Chthonius ressli	1			6		7
Chthonius fuscimanus				1		1
Chthonius tetrachelatus	12		1	29	2	44
Neobisium carcinoides	2		1	4		7
Neobisium sylvaticum		2				2
Chernes hahnii				5		5
Dinocheirus panzeri				1	21	22
Allochernes wideri				8	4	12
Lamprochernes sp.	2					2
Pselaphochernes scorpioides	4			4	1	9
Total/ Spolu	**21**	**2**	**2**	**58**	**28**	**111**

6: soil sample, 22.vi.2013, 1 ♀, lgt. M. Holecová; 10.vi.2014, 2 ♀♀, lgt. P. Fenďa, M. Kocáková; 9.x.2014, 2 ♀♀, lgt. M. Kocáková;
6: compost heap, 10.vi.2014, 1 ♂, lgt. M. Holecová, checked by G. Gardini.

The species had not previously been recorded in urban environments in Slovakia. During the present study, seven specimens were found, mainly in soil samples (Table 2).

Chthonius* (*Ephippiochthonius*) *fuscimanus Simon, 1900
3: soil sample, 3.vii.2013, 1 ♂, lgt. M. Holecová.

The species was collected in the fragmented forest at Mlynská dolina, Bratislava surrounded by roads and urban agglomeration, intensively affected by humans. The specimens were collected there by the quadrat method combined with sifting (Christophoryová 2013).

Chthonius* (*Ephippiochthonius*) *tetrachelatus (Preyssler, 1790)
1: soil sample, 2.vii.2013, 1 ♀, 1 ♂, lgt. M. Holecová;
2: soil sample, 10.vi.2014, 2 Dn, lgt. P. Fenďa, M. Kocáková;
3: soil sample, 3.vii.2013, 2 ♂♂, lgt. M. Holecová;
4: soil sample, 21.vi.2013, 2 ♀♀, 2 ♂♂, lgt. M. Holecová; 11.vi.2014, 1 Dn, lgt. M. Kocáková;
4: pitfall trap, 17.vii.2013, 1 ♂, lgt. M. Holecová;
4: tree stump hollow, 11.vi.2014, 2 Tn, lgt. J. Christophoryová;
5: soil sample, 11.vi.2014, 2 Tn, lgt. M. Kocáková;
6: soil sample, 22.vi.2013, 1 ♀, 2 ♂♂, 1 Tn, lgt. M. Holecová;
8: soil sample, 1.vii.2013, 1 ♀, 5 ♂♂, 2 Tn, lgt. M. Holecová; 25.iv.2014, 1 ♀, lgt. M. Holecová; 10.vi.2014, 1 Dn, lgt. M. Kocáková; 9.x.2014, 1 ♀, 1 ♂, lgt. M. Kocáková;
11: compost heap, 21.ix.2013, 2 ♀♀, 6 ♂♂, 2 Tn, lgt. D. Gruľa, K. Krajčovičová, vid. Gardini (two females);
13: compost heap, 28.x.2013, 1 ♂, 1 Dn, lgt. J. Rudy, vid. Gardini (one male).

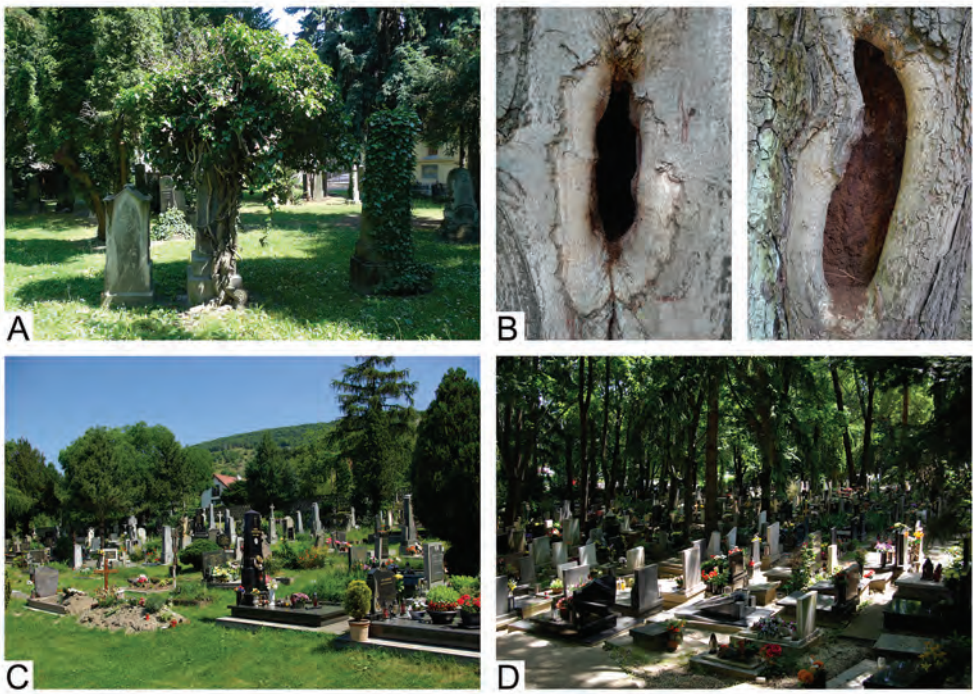

Fig. 2. Studied cemeteries with examples of their microhabitats. A: Kozia brána cemetery, B: Tree hollows in Kozia brána cemetery, C: Devín cemetery, D: Slávičie údolie cemetery. Photos A, B by J. Christophoryová, photos C, D by P. Fenďa.
Obr. 2. Študované cintoríny a príklad ich mikrohabitatov. A: Cintorín Kozia brána, B: Dutiny na cintoríne Kozia brána, C: Cintorín Devín, D: Cintorín Slávičie údolie. Fotky A, B fotografovala J. Christophoryová, fotky C, D fotografoval P. Fenďa.

Until now, the species has not been recorded in urban environments in Slovakia. In the present study, 44 specimens were found, mainly in soil samples (Table 2).

Neobisiidae Chamberlin, 1930
Neobisium* (*Neobisium*) *carcinoides (Hermann, 1804)
2: soil sample, 3.vii.2013, 1 Dn, lgt. M. Holecová; 10.vi.2014, 1 Pn, lgt. P. Fenďa, M. Kocáková;
6: soil sample, 22.vi.2013, 1 Dn, lgt. M. Holecová;
6: pitfall trap, 3.i.2015, 1 ♀, lgt. O. Majzlan;
8: soil sample, 25.iv.2014, 1 ♂, lgt. M. Holecová;
13: compost heap, 28.x.2013, 1 ♀, 1 Dn, lgt. J. Rudy.

The species occurred in leaf litter and soil in the fragmented forest of Horský Park and the fragmented forest Mlynská dolina in Bratislava; both localities are intensely used by humans (Christophoryová 2013).

Neobisium* (*Neobisium*) *sylvaticum (C. L. Koch, 1835)
9: flagging method, 22.vii.2013, 1 Dn, lgt. J. Kraljik; 23.x.2013, 1 ♀, lgt. J. Kraljik.

One female was individually collected under *Platanus hispanica* bark in the park in the city of Stupava (Christophoryová 2010). Five specimens of *N. sylvaticum* were found in leaf litter and soil in the fragmented forest of Horský Park in Bratislava (Christophoryová 2013).

Chernetidae Menge, 1855
Chernes hahnii (C. L. Koch, 1839)
2: soil sample, 3.vii.2013, 1 ♂, lgt. M. Holecová;
5: soil sample, 6.vii.2013, 1 ♀, 3 ♂♂, lgt. M. Holecová.

The species was found under *Platanus orientalis* bark near a bus stop in Karlova Ves, Bratislava and in tree hollows in parks and in a hospital surrounding in Košice (Christophoryová 2010). Later, the species was recorded under tree bark, in open nests of *T. merula* and in guano from bat boxes in urban environments in other cities in Slovakia (Krajčovičová & Christophoryová 2014, Krajčovičová et al. 2015).

Dinocheirus panzeri (C. L. Koch, 1837)
4: hollow of *Aesculus hippocastanum* (100 cm above the ground), 11.vi.2014, 3 ♀♀, 1 ♂, 2 Tn, 1 Dn, lgt. J. Christophoryová; hollow of *A. hippocastanum* (77 cm above the ground), 11.vi.2014, 1 ♀, 2 Tn, lgt. J. Christophoryová;
4: hollow of *Robinia pseudoacacia* (140 cm above the ground), 11.vi.2014, 2 ♀♀, 2 ♂♂, 4 Tn, 2 Dn, lgt. J. Christophoryová;
6: soil sample, 10.vi.2014, 1 Dn, lgt. P. Fenďa, M. Kocáková;
7: hollow of *Acer pseudoplatanus* (situated on the ground), 11.vi.2014, 1 ♀, lgt. J. Christophoryová.

The species occurred in tree hollows in a park and in a hospital surrounding in Košice (Christophoryová 2010) and one female occurred in bat guano from alder hollow in a park in Nitra (Krajčovičová et al. 2015).

Table 3. Pseudoscorpions collected in different cemetery types in Slovakia.
Tabuľka 3. Šťúriky zbierané na rôznych typoch cintorínov na Slovensku.

Taxon/ Cemetery type **Taxón/ Typ cintorínu**	**Historic** **Historický**	**Rural** **Dedinský**	**Urban** **Mestský**
Chthonius ressli	6	1	
Chthonius fuscimanus		1	
Chthonius tetrachelatus	12	18	14
Neobisium carcinoides	2	4	1
Neobisium sylvaticum			2
Chernes hahnii		1	4
Dinocheirus panzeri	22		
Allochernes wideri	5		7
Lamprochernes sp.		2	
Pselaphochernes scorpioides	1	8	
Total/ Spolu	**48**	**35**	**28**

Allochernes wideri (C. L. Koch, 1843)
4: hollow of *A. hippocastanum* (100 cm above the ground), 11.vi.2014, 1 Tn, lgt. J. Christophoryová;
5: soil sample, 6.vii.2013, 4 Tn, 3 Pn, lgt. M. Holecová;
6: soil sample, 10.vi.2014, 1 Tn, lgt. P. Fenďa, M. Kocáková;
7: hollow of *Tilia cordata* (30 cm above the ground), 11.vi.2014, 2 ♂♂, 1 Dn, lgt. J. Christophoryová.

The species was collected in tree hollows in parks and in a hospital surrounding in Košice (Christophoryová 2010) and in tree hollows in two village parks (Krajčovičová & Christophoryová 2014). One female was found in open nest of *T. merula* in Bratislava and several specimens in bat guano in two parks in Nitra (Krajčovičová et al. 2015).

***Lamprochernes* sp.**
10: compost heap, 22.ix.2013, 1 ♀, lgt. D. Gruľa, K. Krajčovičová;
12: compost heap, 22.ix.2013, 1 Tn, lgt. D. Gruľa, K. Krajčovičová.

The specimens of *Lamprochernes* were identified only to genus level. Until now, the species *L. chyzeri* (Tömösváry, 1882) and *L. nodosus* (Schrank, 1803) were recorded in Slovakia, but the majority of characters used to distinguish them overlap (Christophoryová et al. 2011, 2012). The adult specimen collected is currently the subject of detailed molecular and taxonomic analysis.

Pselaphochernes scorpioides (Hermann, 1804)
3: soil sample, 3.vii.2013, 1 ♀, 1 ♂, 1 Tn, 1 Dn, lgt. M. Holecová;
4: hollow of *R. pseudoacacia* (140 cm above the ground), 11.vi.2014, 1 Dn, lgt. J. Christophoryová;
10: compost heap, 22.ix.2013, 1 ♀, 1 Dn, lgt. D. Gruľa, K. Krajčovičová;
13: compost heap, 28.x.2013, 1 ♀, 1 ♂, lgt. J. Rudy.

One male of *P. scorpioides* was found in soil and leaf litter in the fragmented forest of Horský Park, Bratislava (Christophoryová 2013). Several specimens were collected in *Quercus* and *Salix* hollows in city and village parks (Krajčovičová & Christophoryová 2014).

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SÚHRN

Mestské prostredie je špecifické tým, že je trvalo pozmenené ľudskou činnosťou. Mestá si čiastočne zachovávajú zeleň v podobe parkov, stromoradí alebo cintorínov. Cintoríny predstavujú špecifickú mestskú zeleň, ktorá nie je extenzívne udržiavaná, preto sa tu môžu nachádzať aj druhy, ktoré by v mestskej zástavbe nemali šancu prežiť. Predložená práca sa zaoberá výskumom šťúrikov žijúcich na cintorínoch Slovenska. Šťúriky zbierali viacerí zberatelia na 13 lokalitách počas rokov 2013 – 2015. Zbery pochádzajú z troch typov cintorínov. Dedinské (rurálne) cintoríny sú situované na dedinách a aktívne sa na nich pochováva (Čuňovo, Devín, Dúbravka, Ľuboreč, Matúškovo, Príbelce, Sokoľ). Historické cintoríny prechádzajú často parkovou úpravou a aktívne sa na nich nepochováva (Kozia brána, Mikulášsky cintorín, Ondrejský cintorín). Mestské (urbánne) cintoríny sa aktívne využívajú na pochovávanie, ich rozloha sa neustále zväčšuje (Martinský cintorín, Slávičie údolie, Košice).

Na cintorínoch boli odoberané vzorky pôdy (vrátane hrabanky a mŕtveho dreva), kompostov a práchna z dutín stromov. Šťúriky boli následne extrahované pomocou Tullgrenových aparátov a spracované na trvalé alebo dočasné preparáty.

Celkovo bolo získaných 111 jedincov patriacich ku 10 druhom a do troch čeľadí. V súčasnej dobe prebieha morfologická a molekulárna analýza druhov z rodu *Lamprochernes* Tömösváry, 1882, preto neboli jedince identifikované na úroveň druhu. Najpočetnejšie boli zastúpené šťúriky z čeľadí Chthoniidae a Chernetidae. Najnižší počet druhov aj jedincov bol zaznamenaný u čeľade Neobisiidae. Najviac jedincov bolo nazbieraných u druhov *Chthonius tetrachelatus* (Preyssler, 1790) a *Dinocheirus panzeri* (C. L. Koch, 1837). Druh *C. tetrachelatus* nebol doteraz na Slovensku zaznamenaný v mestskom prostredí, druh *D. panzeri* už bol v tomto type prostredia zbieraný, a to najmä z dutín stromov. Počas výskumu bol nájdený len jeden jedinec druhu *Chthonius fuscimanus* Simon, 1900 na cintoríne v Bratislave.

Šťúriky sledovaných cintorínov boli najpočetnejšie zastúpené v pôdnych vzorkách a v práchne dutín stromov. Najviac jedincov bolo získaných v areáloch historických cintorínov a najviac druhov vo vzorkách z dedinských cintorínov. Zaujímavý bol nález vzácneho druhu *Chthonius ressli* Beier, 1956 v pôdnych vzorkách a komposte z historických a dedinských cintorínov.