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Isopoda and Diplopoda of urban habitats: new data to the fauna of Budapest

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Abstract – We surveyed 25 urban and suburban habitats in Budapest and its surroundings under different human impact ranging from hothouses to rural forests. A total of 18 species of terrestrial isopods and 26 species of millipedes were encountered. This diversity is surprisingly high, representing 38% and 25% of the known Hungarian Oniscidea and Diplopoda fauna, respectively. One isopod (*Trichorhina tomentosa*) and three millipede species (*Amphitomeus attemsii*, *Cynedesmus formicola*, and *Poratia* aff. *digitata*) are recorded for the first time in Hungary. One of the latter (*Poratia* aff. *digitata*) may even prove to be new for science by future studies. With 4 figures and 3 tables.

Key words – Isopoda, Oniscidea, Diplopoda, urban and suburban habitats, Hungarian fauna.

INTRODUCTION

Urban habitats are dominated by a myriad of human influences, which can limit plant and animal distributions and alter ecosystem functions. Climate, soil development, land use history, disturbance regimes and stress are very different in cities than in the neighbouring rural areas. Species composition and diversity are expected to reflect these influences. As part of a large urban ecology project, the Baltimore Ecosystem Study, we surveyed soil invertebrates in different woody habitats of Budapest, Hungary. One objective of this research is to compare and zoogeographically analyse the soil communities in cities. Here we report the faunal list for two saprophagous arthropod groups: terrestrial isopods (Isopoda: Oniscidea) and millipedes (Diplopoda).

MATERIAL AND METHODS

Collectings were made by hand and using pitfall traps between March and June 2001. Altogether ca. 240 man-hours were spent in the field. Samples were preserved in 70% ethanol, and are deposited in the collections of the Department of Zoology, Hungarian Natural History Museum, and of the Department of Ecology, Zoological Institute, Szent István University, Budapest. Distribution of collecting localities in Budapest are shown in Fig. 1, whereas details of each locality are summarized in Table 1.

RESULTS

The lists of the collected and identified woodlice and millipedes are shown below. Altogether, we have found 18 species of terrestrial isopods, and 26 species of millipedes.

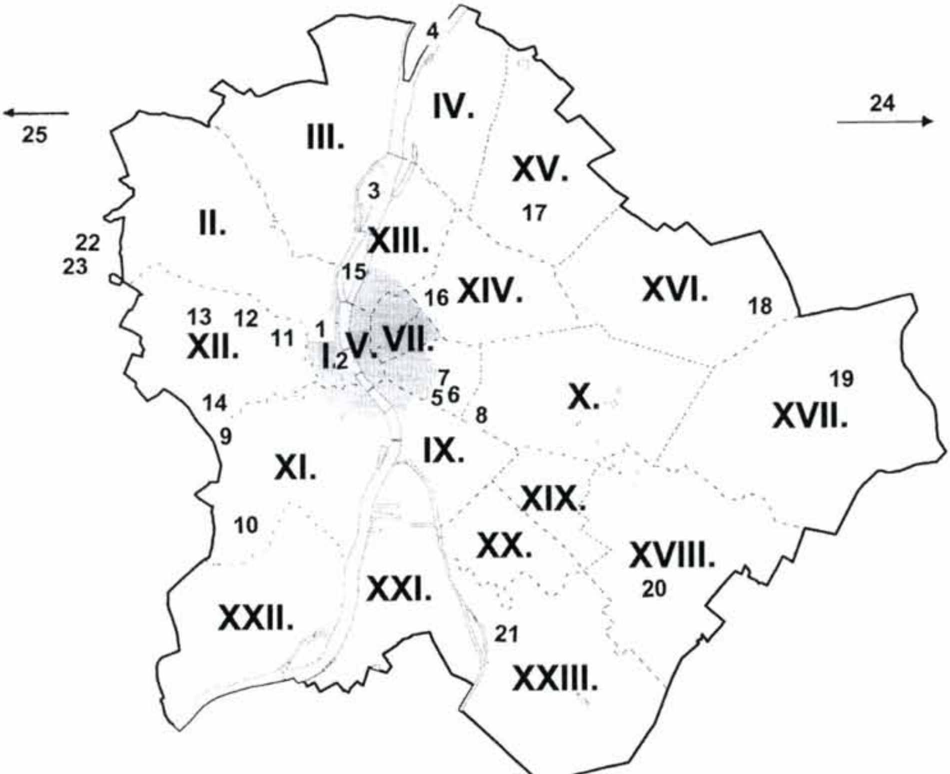


Fig. 1. Collecting localities in Budapest (see Table 1 for details on each locality)

Table 1. Collecting locality details

No.	City	District of Budapest	Locality	Date	Habitat
1.	Budapest	I.	Vérmező	6 June	City park
2.	Budapest	I.	Gellérthegy	12 June	City park
3.	Budapest	III.	Óbudai-sziget	7 June	Island, recreational area
4.	Budapest	IV.	Palotai-sziget	7 June	Island
5.	Budapest	VIII.	Ludovika-tér	5 June	City park
6.	Budapest	VIII.	Orczy-kert	9 March, 5 June	City park
7.	Budapest	VIII.	ELTE Füvészkert	9 March	Greenhouse, botanical garden
8.	Budapest	X.	Népliget	9 March, 8 June	City park
9.	Budapest	XI.	Rupp-hegy	27 April, 31 May, 14 June	Warm oak forest
10.	Budapest	XI.	Kamaraerdő	31 May, 5–6 June	Forest
11.	Budapest	XII.	Városmajor, Kútvölgyi hospital	2 June	Small forested patch in the city
12.	Budapest	XII.	Virányos	12 June	Oak forest at the edge of city
13.	Budapest	XII.	Normafa	13 June	Forest
14.	Budapest	XII.	Széchenyi-hegy Csillebérc	13 June	Forest
15.	Budapest	XIII.	Margitsziget	8 June	Island, recreational park
16.	Budapest	XIV.	Városliget	12 June	Recreational park
17.	Budapest	XV.	Újpalota, Páskomliget	15 June	Planted forest
18.	Budapest	XVI.	Cinkota, Naplás-tó	30 May, 6 June	Planted forest
19.	Budapest	XVII.	Rákoskeresztúr, Akadémia-erdő	6 June	Planted forest
20.	Budapest	XVIII.	Péterhalmi-erdő	15 June	Planted forest
21.	Budapest	XXIII.	Soroksár, Botanikuskert	9 March	Greenhouse, botanical garden
22.	Budakeszi		Vadaspark	31 May	Forest
23.	Budakeszi		Fekete-hegy	13 June	Forest
24.	Gödöllő		Erzsébet-park	30 May	Recreational park
25.	Piliscsaba		Széna-hegy	9 June	Forest

Species lists

Isopoda: Oniscidea
Trichoniscidae
1. *Hyloniscus riparius* (C. L. KOCH, 1838)
2. *Androniscus roseus* (C. L. KOCH, 1838)
3. *Haplophthalmus danicus* BUDDE-LUND, 1880
4. *Haplophthalmus mengii* (ZADDACH, 1844)
Buddelundiellidae
5. *Buddelundiella cataractae* VERHOEFF, 1930
Platyarthridae
6. *Trichorhina tomentosa* (BUDDE-LUND, 1893)
7. *Platyarthrus hoffmannseggii* BRANDT, 1833
Cylisticidae
8. *Cylisticus convexus* (DE GEER, 1778)
Porcellionidae
9. *Orthometopon planum* (BUDDE-LUND, 1879)
10. *Porcellionides pruinosus* (BRANDT, 1833)
11. *Porcellio scaber* LATREILLE, 1804
12. *Protracheoniscus politus* (C. L. KOCH, 1841)
13. *Trachelipus nodulosus* (C. L. KOCH, 1838)
14. *Trachelipus rathkei* (BRANDT, 1833)
15. *Trachelipus ratzeburgii* (BRANDT, 1833)
16. *Porcellium collicola* VERHOEFF, 1907
Armadillidiidae
17. *Armadillidium nasatum* BUDDE-LUND, 1885
18. *Armadillidium vulgare* (LATREILLE, 1804)

Diplopoda
Polyxenida
19. *Polyxenus lagurus* (LINNAEUS, 1758)
Glomerida
20. *Glomeris hexasticha* BRANDT, 1833
Julida
21. *Nemasoma varicorne* C. L. KOCH, 1847
22. *Proteroiulus fuscus* (AM STEIN, 1857)
23. *Blaniulus guttulatus* (FABRICIUS, 1798)
24. *Cibiniulus phlepsii* (VERHOEFF, 1897)
25. *Choneiulus palmatus* (NEMEC, 1895)
26. *Cylindroiulus boleti* (C. L. KOCH, 1847)
27. *Cylindroiulus latestriatus* (CURTIS, 1845)

28. *Kryphioiulus occultus* (C. L. KOCH, 1847)
29. *Ommatoiulus sabulosus* (LINNAEUS, 1758)
30. *Ophyiulus pilosus* (NEWPORT, 1842)
31. *Xestoiulus laeticollis* (PORAT, 1889)
32. *Brachyiulus bagnalli* (CURTIS, 1845)
33. *Megaphyllum unilineatum* (C. L. KOCH, 1838)
34. *Megaphyllum projectum* (VERHOEFF, 1894)
35. *Mesoiulus paradoxus* BERLESE, 1886

Polydesmida

36. *Brachydesmus superus* LATZEL, 1884
37. *Brachydesmus dadayi* VERHOEFF, 1895
38. *Polydesmus complanatus* (LINNAEUS, 1761)
39. *Polydesmus denticulatus* C. L. KOCH, 1847
40. *Strongylosoma stigmatosum* (EICHWALD, 1830)
41. *Oxidus gracilis* (C. L. KOCH, 1847)
42. *Amphitomeus attemsii* (SCHUBART, 1934)
43. *Poratia* aff. *digitata* (PORAT, 1889)
44. *Cynedesmus formicola* COOK, 1896

The distribution of species according to the 25 different localities are summarized in Table 2. Two localities, Nos 7 and 21, clearly stand out with the highest species numbers. Both are greenhouses that provide favourable conditions for both exotic and local species.

One isopod species (*Trichorhina tomentosa*) and three millipede species (*Amphitomeus attemsii*, *Poratia* aff. *digitata*, and *Cynedesmus formicola*) are recorded for the first time in Hungary. (*Trichorhina tomentosa* was preliminarily mentioned already by KONTSCHÁN & HORNUNG 2001.) All of them were found in the hothouse of the Eötvös Loránd University (Füvészkert), which is located in the center of Budapest. It is a rather old hothouse, and has a well-established network to regularly import new plant material from exotic places, which enables the easy introduction of the soil fauna as well.

A phenetic classification using Euclidean distances and average linkage (UPGMA, Systat 8.0) were carried out for 21 localities. Localities 1, 2, 5, and 16 were omitted from the analysis because neither isopods, nor diplopods were found at these sites. Table 3 shows the presence-absence data matrix. The dendrogram (Fig. 2) shows that Füvészkert (No. 7) and Soroksár (No. 21) are separated from the rest of the localities. In the next locality cluster, first Népliget (No. 8), then Rupp-hegy (No. 9), Palotai-sziget (No. 4), and Óbudai-sziget (No. 3) are separated, all representing different semi-natural biotopes and human influences. The remaining localities are combined in two large clusters.

Table 2. List of terrestrial isopods and diplopods according to the 25 localities (see Table 1). Localities 1, 2, 5, and 16 were omitted from the analysis because neither isopods, nor diplopods were found at these sites.

No.	Isopoda	Diplopoda	Total
3.	–	*Nemasoma varicorne* *Cylindroiulus boleti* *Ophyiulus pilosus* *Polydesmus complanatus* *Polydesmus denticulatus*	0+5
4.	*Hyloniscus riparius* *Cylisticus convexus* *Trachelipus rathkei* *Porcellium collicola* *Armadillidium vulgare*	*Cibiniulus phlepsii* *Cylindroiulus boleti* *Xestoiulus laeticollis* *Polydesmus complanatus* *Polydesmus denticulatus*	5+5
6.	*Platyarthrus hoffmannseggii* *Cylisticus convexus* *Porcellio scaber* *Porcellium collicola* *Armadillidium vulgare*	*Brachyiulus bagnalli*	5+1
7.	*Hyloniscus riparius* *Androniscus roseus* *Haplophthalmus danicus* *Buddelundiella cataractae* *Trichorhina tomentosa* *Cylisticus convexus* *Porcellio scaber* *Trachelipus rathkei* *Armadillidium nasatum* *Armadillidium vulgare*	*Choneiulus palmatus* *Cylindroiulus latestriatus* *Oxidus gracilis* *Amphitomeus attemsii* *Poratia* aff. *digitata* *Cynedesmus formicola*	10+6
8.	*Cylisticus convexus* *Porcellio scaber* *Trachelipus nodulosus* *Trachelipus rathkei* *Porcellium collicola* *Armadillidium vulgare*	*Proteroiulus fuscus* *Blaniulus guttulatus* *Brachyiulus bagnalli* *Ophyiulus pilosus* *Brachydesmus superus*	6+5
9.	*Hyloniscus riparius* *Platyarthrus hoffmannseggii* *Orthometopon planum* *Protracheoniscus politus* *Porcellium collicola*	*Polyxenus lagurus* *Cylindroiulus boleti* *Kryphioiulus occultus* *Megaphyllum projectum* *Ophyiulus pilosus* *Brachydesmus dadayi*	5+6
10.	*Cylisticus convexus* *Porcellionides pruinosus* *Porcellium collicola* *Armadillidium vulgare*	*Polyxenus lagurus* *Cylindroiulus boleti* *Megaphyllum unilineatum*	4+3

Table 2 (continued)

No.	Isopoda	Diplopoda	Total
11.	*Armadillidium vulgare*	*Cylindroiulus boleti*	1+1
12.	*Protracheoniscus politus* *Armadillidium vulgare*	*Cylindroiulus boleti* *Ophyiulus pilosus*	2+2
13.	*Haplophthalmus mengii* *Orthometopon planum* *Protracheoniscus politus*	–	3+0
14.	*Armadillidium vulgare*	–	1+0
15.	*Hyloniscus riparius* *Porcellio scaber* *Trachelipus ratzeburgii*	–	3+0
17.	*Porcellium collicola* *Armadillidium vulgare*	*Cylindroiulus boleti* *Megaphyllum unilineatum* *Ommatoiulus sabulosus*	2+3
18.	*Porcellium collicola* *Armadillidium vulgare*	*Polydesmus complanatus*	2+1
19.	*Porcellium collicola* *Armadillidium vulgare*	*Brachyiulus bagnalli* *Megaphyllum unilineatum*	2+2
20.	*Porcellium collicola* *Armadillidium vulgare*	*Cylindroiulus latestriatus* *Brachyiulus bagnalli* *Megaphyllum unilineatum*	2+3
21.	*Hyloniscus riparius* *Androniscus roseus* *Haplophthalmus danicus* *Cylisticus convexus* *Porcellio scaber* *Protracheoniscus politus* *Armadillidium nasatum* *Armadillidium vulgare*	*Choneiulus palmatus* *Cylindroiulus latestriatus* *Cylindroiulus boleti* *Megaphyllum unilineatum* *Ophyiulus pilosus* *Mesoiulus paradoxus* *Polydesmus complanatus* *Oxidus gracilis*	8+8
22.	*Orthomethopon planum* *Protracheoniscus politus*	–	2+0
23.	*Hyloniscus riparius* *Trachelipus rathkei* *Porcellium collicola* *Armadillidium vulgare*	*Cylindroiulus boleti* *Megaphyllum projectum* *Ophyiulus pilosus*	4+3
24.	*Hyloniscus riparius* *Trachelipus rathkei* *Porcellium collicola* *Armadillidium vulgare*	*Cylindroiulus boleti* *Megaphyllum projectum*	4+2

Table 2 (continued)

No.	Isopoda	Diplopoda	Total
25.	*Orthometopon planum* *Protracheoniscus politus*	*Glomeris hexasticha* *Cylindroiulus boleti* *Megaphyllum projectum* *Ophyiulus pilosus*	2+4

DISCUSSION

Isopoda

The majority of species encountered in our survey are well known from Hungary, and are more or less widely distributed (FORRÓ & FARKAS 1998). Three species (*Buddelundiella cataractae, Trichorhina tomentosa*, and *Armadillidium nasatum*) were found only in greenhouses and/or botanical gardens. These special habitats are "hotspots" of isopod species diversity. The fourth greenhouse species, *Androniscus roseus,* was also found in a cave in Hungary (LOKSA 1960) as well as in flood forests of the Bakony Mts (KONTSCHÁN 2001).

Buddelundiella cataractae is not included in the checklist compiled by FORRÓ & FARKAS (1998). However, both GRUNER (1966) and FLASAROVA (1995) mentioned that this species had been found in a Budapest hothouse, although neither author gave specific references. Our record may well be the same hothouse. Interestingly, *B. cataractae* is considered to be an expansive species (FLASAROVA 1995), and has been recorded in many localities in Europe from Corsica to Finland. This small isopod is very sensitive to moisture, which may explain many records in greenhouses and garden centers. In Britain it was even found in coastal areas of Wales (OLIVER 1983). Humans undoubtedly play and active role in spreading *B. cataractae* further.

Another species with only one earlier record from Hungary is *Armadillidium nasatum.* FARKAS and FORRÓ (1998) also reported this species for the first time in Pécs. KONTSCHÁN and HORNUNG (2001) also collected regularly in the hothouses of Szeged, Eger, Felsőtárkány, and Debrecen, everywhere it was very abundant. *Armadillidium nasatum* is widespread in the Atlantic region, but in Scandinavia and Central Europe it is clearly introduced and usually restricted to greenhouses and gardens (STROUHAL 1951, FLASAROVA 1995, BERG & WINJHOVEN 1997). Our records fit to this pattern. *Armadillidium nasatum* was also introduced to North

America, where it became one of the most common oniscid species especially in the Northeastern United States (SCHULTZ 1961, 1982).

Trichorhina tomentosa is reported here for the first time in Hungary (Fig. 3). It is known from Central and South America (Ecuador, Venezuela, Nicaragua, Jamaica, Haiti). This tropical species survives only in greenhouses in Europe (GRUNER 1966: p. 217, Fig. 164, OLSEN 1995). Only females are known, thus reproduction is most likely parthenogenetic. The completely white, max. 5 mm long body is flattened, each eye consists of one black ocellus. Dorsal surface with hairs and small scales.

Protracheoniscus politus was caught in five localities. Until recent years *P. politus* and *P. amoenus* were considered to be two separate species, the latter being

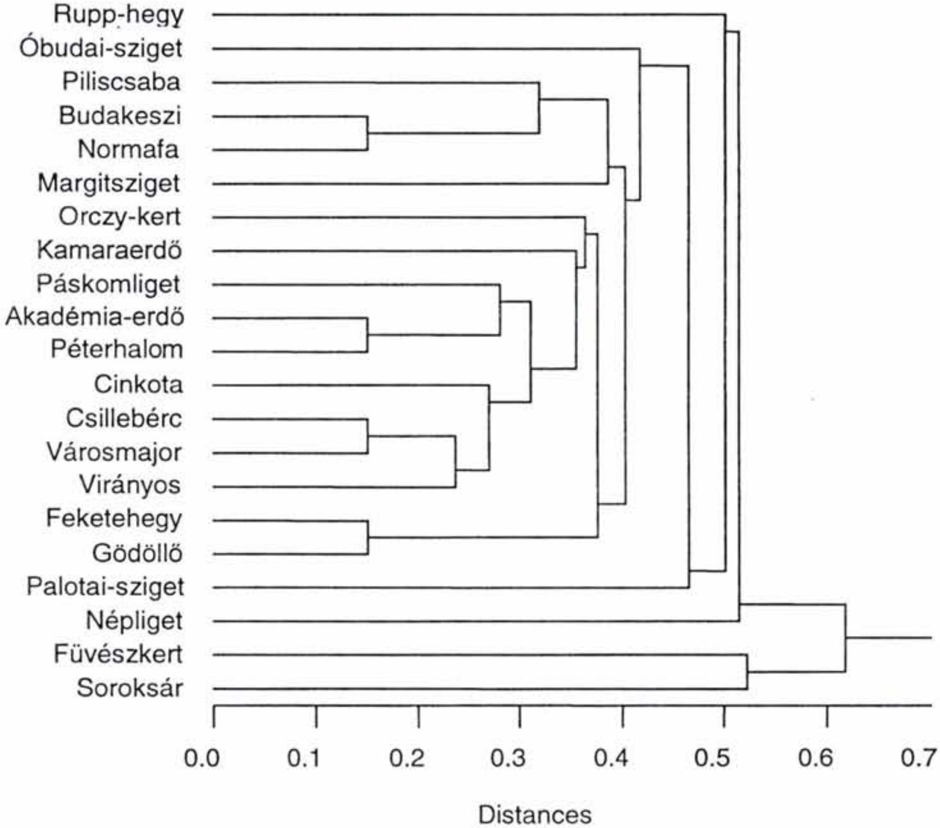
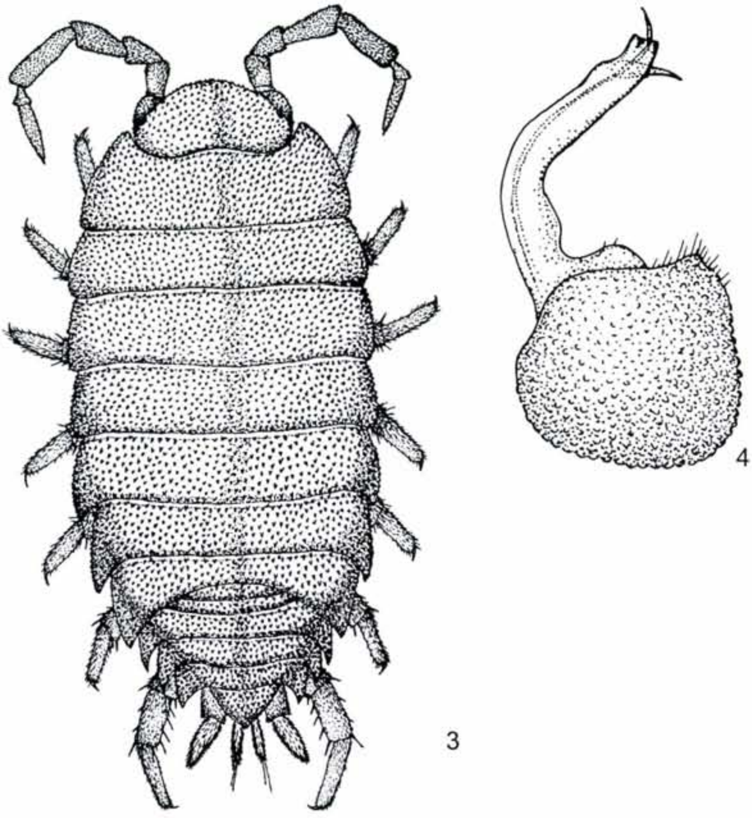


Fig. 2. Dendrogram of the 21 localities classified according to their isopod and diplopod fauna together

more widely distributed in Hungary (e.g. LOKSA 1966, FORRÓ & FARKAS 1998). *Protracheoniscus politus* was thought to be restricted to the northern and western parts of Hungary (ALLSPACH & SZLÁVECZ 1990, SZLÁVECZ 1995). VERHOEFF (1927) described *P. amoenus* as *P. politus*, creating a confusion of the two species names in later records. Although STROUHAL (1947) attempted to clarify the situation, today the two are considered to be one species, *Protracheoniscus politus* (SCHMALFUSS, pers. comm). The species name given in this paper reflects this situation.

Although this time we did not find isopods on Vérmező (No. 1), earlier collectings resulted in three species, *Armadillidium vulgare, Porcellium collicola,* and *Protracheoniscus politus* (SZLÁVECZ, unpubl.).



Figs 3–4. 3 = *Trichorhina tomentosa* (courtesy of DÁVID MURÁNYI); 4 = *Poratia* aff. *digitata*, left male gonopod, lateral view (courtesy of DÁVID MURÁNYI)

Another isopod previously unknown from Budapest is *Platyarthrus schoeblii* BUDDE-LUND, 1885. This time only its more common relative, *P. hoffmannseggii* was collected, but earlier HORNUNG and TARTALLY (unpubl.) found *P. schoeblii* at several localities in Budapest. It occurs in the nests of the ant *Lasius neglectus* VAN LOON, BOOMSMA et ANDRÁSFALVY, 1990 (KONTSCHÁN & HORNUNG 2001). This introduced ant is agressively spreading in urban habitats all over Europe. To our present knowledge the isopod is associated only with *L. neglectus* in Hungary.

The species composition of isopods of the different localities reflects the degree of anthropogenic impact. For instance, *Orthometopon planum, Trachelipus ratzeburgii* and *Protracheoniscus politus* were collected only in semi-natural habitats with less disturbance, such as the forests of Rupp-hegy, Normafa, Budakeszi, Piliscsaba, and Virányos, or as remnants of a former natural fauna as in Margitsziget. Although the forest stands are often fragmented, isolated and surrounded by suburban residential areas, they still sustain populations of these more sensitive isopods. *Armadillidium vulgare* and *Porcellium collicola* are more ubiquitous, expansive species that also tolerate a wide range of moisture conditions. They dominate the planted, more disturbed forests in Pest (Páskomliget, Akadémia-erdő, Péterhalom, Cinkota). Other species, such as *Cylisticus convexus* and *Porcellionides pruinosus* always indicate strong human influence.

Diplopoda

Millipedes from urban and other anthropogenic habitats in Hungary were studied previously by KORSÓS (1992). Comparing the present findings with those results reveals several interesting facts. For instance, *Dorypetalum degenerans*, a callipodid millipede, was not found on the Gellérthegy this time perhaps due to lack of specific search. Similarly, *Cylindroiulus latestriatus* did not turn out in Városliget. Previously it was found for the first time in Hungary together with *Mesoiulus paradoxus*, a blind julid species (KORSÓS 1992). This time the latter species was found only in the greenhouse at Soroksár. The members of the *Cylindroiulus truncorum*-group (see KORSÓS & ENGHOFF 1990) are usually present in European hothouses, yet the present collectings did not yield any specimen.

The eastern julid species, *Xestoiulus laeticollis*, was found in the semi-natural flooded forest of Palotai-sziget. This is an interesting record considering that formerly it was known only from the Bátorliget Nature Reserve (KORSÓS 1991) and along the Dráva river (KORSÓS 1997).

Three polydesmid species are reported for the first time in Hungary. *Amphitomeus attemsii*, a member of the family Oniscodesmidae (new millipede family

Table 3. Presence–absence data matrix used for the phenetic classification. Columns 1–25 : localities in Table 1. Rows 1–44: species in Table 2 and list of species in Results, respectively

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
1	0	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	1	1	0
2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
3	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	1	0	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
9	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1
10	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
12	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	1
13	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
16	0	0	0	1	0	1	0	1	1	1	0	0	0	0	0	0	1	1	1	1	0	0	1	1	0
17	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
18	0	0	0	1	0	1	1	1	0	1	1	1	0	1	0	0	1	1	1	1	1	0	1	1	0
19	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
21	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
26	0	0	1	1	0	0	0	0	1	1	1	1	0	0	0	0	1	0	0	0	1	0	1	1	1
27	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
28	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
30	0	0	1	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	1	0	1	0	1
31	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	1	1	1	0	0	0	0
34	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
36	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0
39	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
42	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
43	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
44	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

for Hungary) originates most probably from South America (NW Andes, GOLOVATCH *et al.* 2001). In Europe it inhabits exclusively hothouses. It was found in the Copenhagen greenhouse for the first time in 1986 by ZK and HENRIK ENGHOFF (ENGHOFF 1987).

Cynedesmus formicola (family Pyrgodesmidae, also new to the fauna of Hungary) was originally described from the Canary Islands (VICENTE & ENGHOFF 1999), and, until now, was considered to be a Macaronesian endemic. Taxonomists still debate whether the species belongs to the genus *Cynedesmus*, since all other species of the genus are distributed in Central America. A good gonopod drawing, and scanning electron microscopic photographs were published by SILVESTRI (1947) and VICENTE & ENGHOFF (1999), respectively.

The other pyrgodesmid genus, *Poratia*, was recently revised by GOLOVATCH & SIERWALD (2000). Among the seven known species, two are regularly reported from European hothouses (*P. digitata* and *P. obliterata*), both being parthenogenetic here, whereas males are normally present in their region of origin (South America). Interestingly, the specimen found in the ELTE Füvészkert is a male. Its gonopod (Fig. 4) differs from all known males of the species in the genus, being closest, however, to *digitata*. More specimens have to be collected in order to decide whether we encountered an aberrant male from a parthenogenetic population, or indeed a new species for science.

Phenetic classification

The close relationship on the dendrogram (Fig. 2) between the Füvészkert (No. 7) and Soroksár (No. 21) localities is due to the fact that they are both permanently heated greenhouses, with many introduced exotic plants, and hence soil material. Their soil fauna is different from the other localities, because species not occurring outside hothouses are represented only here. The subsequent four localities (Népliget, No. 8; Rupp-hegy, No. 9; Palotai-sziget, No. 4; and Óbudai-sziget, No. 3) are well separated from each other. They all represent different semi-natural biotopes and human influences. Rupp-hegy is a protected, almost natural woodland in the Buda hills, Palotai-sziget and Óbudai-sziget are flooded forests at the bank of the Danube river, and Népliget is the largest city park in Budapest. This latter locality is perhaps also separated because millipedes were collected here from rotten logs and under bark.

Three localities, Piliscsaba, Budakeszi and Normafa form one cluster. All of them are large, predominatly oak forests on the Buda Hills or Pilis Mountains. They represent semi-natural habitats used only for recreation. Páskomliget, Akadémia and Péterhalom also harbor similar fauna. These planted forests are on the Pest side, drier, and surrounded by residential areas. The isopod and diplopod fauna obviously reflects various degrees of human disturbance and urban influences. However, further surveys are necessary to reveal more clear patterns.

CONCLUSIONS

Altogether a remarkably high species richness was found in Budapest and its surroundings. Based upon the known Hungarian fauna of these two arthropod groups (FORRÓ & FARKAS 1998, KORSÓS 1994, 1997, [1998]), our species lists represents 38% and 25% of the Oniscidea and Diplopoda, respectively. One explanation for this high species richness is the extreme heterogeneity of the urban landscape. On the one hand, urban development results in destruction of natural habitats. Depending on their size, and degree of human impact, fragmented semi-natural habitats may still support populations of native soil invertebrates. On the other hand, cities create special environments, such as greenhouses. where exotic species can survive. Species introductions as well as habitat destruction are likely to continue in the future. Urbanization is a dynamic process, which undoubtedly will lead to the modification of the species list presented here. Monitoring is one tool to assess the long term changes in soil fauna composition.

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