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Contribution to the Veigaiidae Oudemans, 1939 fauna of the Carpathian Basin and the Balkan Peninsula (Acari: Mesostigmata)

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Abstract. Altogether nine veigaiid mite species were listed from different countries of the Carpathian Basin and the Balkan Peninsula, eight of them belonging to the genus *Veigaia* Oudemans, 1905 and one to *Gamasolaelaps* Berlese, 1904. New species are added to the fauna of Albania (two), Austria (one), Kosovo (one), Macedonia (three), Serbia (four) and Slovakia (two).

Keywords. Acari, Mesostigmata, Veigaiidae, Balkan Peninsula, Carpathian Basin, first record.

INTRODUCTION

As belonging to the Mesostigmata order, the family *Veigaiidae* Oudemans, 1939 comprises free-living predator mite species. The classification of the family is generally accepted, it has four genera, namely *Cyrthydrolaelaps* Berlese, 1905, *Gamasolaelaps* Berlese, 1904, *Gorirossia* Farrier, 1957 and *Veigaia* Oudemans, 1905. Nevertheless, *Gorirossia* Farrier, 1957 has been considered as a junior synonym of *Gamasolaelaps* (Bregetova, 1977). The genus *Gamasolaelaps* Berlese, 1904 has the highest species number including about 60 species in the Holarctic region. Numerous data are available from different localities worldwide, *e.g.* from America (Farrier 1957), Africa (Hurlbutt 1979), Europe (Karg 1993; Willmann 1936; Evans 1955; Salmane & Kontschán 2005a; Bregetova 1961, Mašán *et al.* 2008), Australia and New Zealand (Womersley 1956), Caucasus (Petrova & Makarova 1989), China (Ma 1996).

These mites live in the upper soil surface, in the litter of forests, moss, decaying organic matter, often found in nests of ants, birds, and rodents. They prey mainly on eggs or larvae of small insects, smaller mite species, nematodes, and collembolans.

New occurrences for several countries from the Balkan Peninsula (Albania, Kosovo, Macedonia, Serbia) and the Carpathian Basin (Austria, Romania, Slovakia) are reported here, which expand our knowledge on the distribution of the family Veigaiidae Oudemans, 1939.

MATERIAL AND METHODS

Soil samples were taken in different countries during collecting trips and they were deposited in the Soil Zoology Collection of Hungarian Natural History Museum. Samples were extracted on Berlese-Tullgren type funnels. After examining under stereomicroscope the samples originated from the Balkan Peninsula and the Carpathian Basin, the veigaiid mites were sorted out and prepared by using lactic acid. The specimens examined are stored in ethanol and deposited in the Soil Zoology Collection of the Hungarian Natural History Museum. The classification of Veigaiidae Oudemans, 1939 follows Bregetova (1961). Dorsal and ventral chaetotaxy follows Lindquist & Evans (1965). The ecological characteristics added also on the basis of Bregetova (1961). The abbreviation of collectors are as follows: AD: Dorottya Angyal, AM: Andrej Mock, CSCS: Csaba Csuzdi, DL: László Dányi, EJ: Judit Erőss, FZ: Zoltán Fehér, HE: Edit

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Horváth, JZS:Zsuzsa Jely, KJ: Jenő Kontschán, KZ: Zoltán Korsós, LE: Endre Lazányi, MD: Dávid Murányi, MF: Ferenc Mészáros, MS: Sándor Mahunka, OA: András Orosz, OK: Kirill Márk Orci, PL: Peter L'uptáčik, SZGY: György Sziráki, SZT: Tamás Szűts, UC: unknown collector.

RESULTS

Family Veigaiidae Oudemans, 1939

Genus *Veigaia* Oudemans, 1905

Veigaia cerva (Kramer, 1876)

(Figure 1)

Gamasus cervus Kramer, 1876: 83.
Veigaia cervus: Salmane & Kontschán 2005b: 15.
Veigaia cerva: Kontschán & Ujvári 2008: 348, Fenďa & Mašán 2009: 191.

Material examined. Carpathian Basin: Romania, Jolotca from moss 05.VII.2001 HE. Romania, Râmetea, towards Piatra Secuiului from soil 07.VII.1998 HE. Romania, 2 km away from Pasul Vlăhiţa, from *Sphagnum* 01.VIII.1999 OA. Romania, Băile Balvanyos from *Sphagnum* 01.VIII. 1999 OA. Romania, Lacul Sfânta Ana, Tinovul Mohos from moss 01. VIII.1999 OA. Romania, Arieş vale, from moss 11.VII.1998 HE. Romania, Abrud from moss 25.XI.2003 CSCS. Romania, Tisa, from wet meadow soil 27.VI.2005.–01. VII.2005 OK, MD, KJ. Slovakia, Hrabusice-Podlesok, Suchá Belá from beech litter 02.VII.1991. MS. *Balkan Peninsula*: Kosovo, „Bjelushe (Belluka) W gorge along the road to Cakor-pass", from beech and pine litter 05.X.2005 MD. Serbia, Krajište Mts, Surdulica, brook in beech forest at the upper damn of the Vrla River 20.X.2006 DL, KJ, MD.

Published records. Austria (Ambros 1995), Belgium (Skubała *et al.* 2013), British Isles (Evans 1955), Finland (Huhta & Niemi 2003), Germany, Switzerland, England, France, United States, Canada (Farrier 1957), Hungary (Salmane & Kontschán 2005b), Latvia (Salmane & Brumelis 2008), Netherland (Gabryş *et al*. 2008), Norway (Slomian *et al.* 2005), Poland (Kaczmarek *et al*. 2011), Romania (Kontschán & Ujvári 2008), Russia (Makarova 2011), Slovakia (Fenďa & Mašán 2009), Sweden (Bengtsson *et al.* 1997).

Diagnosis. Dorsum with deeply incised schizodorsal shield. Tips of peritremes surpass base of setae j1, opisthonotal region of dorsal shield with 15 pairs of setae; at the base of coxa IV, metapodal punctiform organ with 6–8 pores. Tectum with median elongated projection, plumose apically.

Distribution. Holarctis (Salmane & Kontschán 2005b).

Remarks. Live in litter of forests, moss and decaying wood. Widespread in Europe, but this is the first record from Serbia and Kosovo.

Veigaia exigua (Berlese, 1917)

(Figure 1)

Cyrtolaelaps exiguus Berlese, 1916: 300.
Veigaia exigua: Salmane & Kontschán 2005a: 50, Manu 2013: 10, Fenďa & Mašán 2009: 192, Kaczmarek *et al.* 2009: 183.

Material examined. Carpathian Basin: Romania, Buru from moss 11.VII.1998 HE. Romania, Piatra Caprei from moss 20.VIII.1999 MF. Romania, Abrud from moss 25.XI.2003 CSCS. *Balkan Peninsula*: Serbia, Đerdap Planine, Moşna from oak forest litter 12.X.2006 DL, KJ, MD.

Published records. Austria (Wissuwa et al. 2012), Belgium (Skubała et al. 2013), British Isles (Skorupski & Luxton 1998), Canary Islands - Spain (Moraza & Peña 2005), Croatia (Kaczmarek *et al.* 2009), Finland (Huhta & Niemi 2003), Germany (Maraun *et al.* 2001), Hungary (Salmane & Kontschán 2005a), Italy (Farrier 1957), Latvia (Salmane 1999), Norway (Slomian *et al.* 2005), Poland (Skorupski 2009), Romania (Manu 2013), Russia (Makarova 2011), Slovakia (Fenďa & Mašán 2009), Sweden (Lundqvist 1974).

Diagnosis. Dorsum with slightly incised schizodorsal shield. Opisthonotal region of dor-

sum with 12 pairs of setae. All dorsal setae simple with subequal length. Central projection of tectum elongated, densely pilose. Metapodal punctiform organ at base of coxae IV absent.

Distribution. Europe (Karg 1993).

Remarks. Live in forest litter, moss and mostly in the upper layer of soils. This is the first record from Serbia.

Veigaia kochi (Trägårdh, 1901)

(Figure 1)

Cyrtolaelaps kochi Trägårdh, 1901: 61.
Veigaia kochi: Ambros 1987: 103, Kontschán & Ujvári 2008: 348, Fenďa & Mašán 2009: 192.

Material examined. Carpathian Basin: Romania, Munţii Rodnei from moss 27.VI.2005–01.VII.2005 OK, MD, KJ. Romania, Râmetea from detritus 20.IX.2000 SZT. Slovakia, Rakovec from litter 03.VII.1991 MS. Slovakia, Dobšiná from moss 03.VII.1991 UC. Slovakia, Rakovec from soil 03.VII.1991 MS.

Published records. Austria (Ambros 1995), British Isles (Evans 1955), Germany, Canada, United States (Farrier 1957), Hungary (Ambros 1987), Latvia (Salmane & Brumelis 2008), Norway (Slomian *et al.* 2005), Poland (Kamczyc & Gwiazdowicz 2009), Romania (Kontschán & Ujvári 2008), Russia (Klimov 1998), Slovakia (Fenďa & Mašán 2009), Sweden (Bengtsson *et al*. 1997).

Diagnosis. Dorsum with separate podonotal and opisthonotal shields. Podonotal shield with 21 pairs of setae. Posterior margin of ventral shield with two pairs of setae, punctiform organ with five or six distinct pits, sternal shield well sclerotized, central projection of tectum elongated and brush-like.

Distribution. Palearctis (Karg 1993).

Remarks. Live in litter, moss and in various microhabitats, like caves, nests of ants and birds, decaying wood.

Veigaia nemorensis (C. L. Koch, 1839)

(Figure 1)

Gamasus nemorensis Koch, 1839: 18.
Veigaia nemorensis: Salmane & Kontschán 2005b: 15, Fenďa & Mašán 2009: 192, Manu 2013: 10.

Material examined. Carpathian Basin: Croatia, Drenovac stream-side 21.IV.2004 KJ. Croatia, Novo Zvecevo 22.IV.2004 KJ. Croatia, Štrmac from forest litter 21.IV.2004 KJ. Hungary, Aggtelek, Baradla cave, leaf litter and humus 21.III.2013 AM, PL. Hungary, Csákberény, Szappanos valley from decaying wood 29.V.2013 HE, SZGY. Hungary, Kiskunhalas from poplar tree litter 27.V.2012 LE. Hungary, Pilisszentkereszt from oak litter 07.VI.2012 HE, SZGY. Hungary, Nagykovácsi, Vöröspocsolya from hornbeam litter 18.IX.2012 HE, SZGY. Hungary, Salgótarján from oak litter 04.IV.2013 AD, KZ, HE, SZGY. Hungary, Salgótarján from decaying wood and moss 04.IV.2013 AD, KZ, HE, SZGY. Hungary, Salgótarján, Kercsegtető from beech litter 04.IV.2013 AD, KZ, HE, SZGY. Romania, Lunca de Sus from moss from altitude 1250 m a.s.l. 19.IX.2002 JZS, HE. Romania, Lunca de Sus from pine litter 19.VII. 2002 JZS, HE. Romania, Băile Balvanyos from beech litter and soil 21.IX.2002 JZS, HE. Romania, Băile Tuşnad 21.IX.2002 JZS, HE. Romania, Munţii Retezat, near La Beci from altitude 1200–1300 m a.s.l. from moss 07.IX.2003 OA. Romania, Munţii Bihorului, Nof Canda 25.VII.2003 PT. Romania, Harghita-Băi from moss on a pine tree 29.VII. 2004 HE. Romania, Harghita-Băi, near Pokat Resort from moss 30.VII.2004 HE. Romania, Borsa from litter and soil 27.VI.2005-01.VII.2005 OK, KJ, MD. Romania, Rona de Sus, Hera, Zalom valley from decaying tree 27.VI.2005–01.VII.2005 OK, KJ, MD. Romania, Transylvania from *Sphagnum*, without exact date, PT. Romania, County Harghita, Orotva, „Lengő kő" from moss 05.VII.2001 HE. Romania, County Harghita, Orotva, bank of the pârâu Török, from pine litter 05.VII.2001 HE. Romania, County Harghita, Orotva, bank of the pârâu Ászok, from moss 05.VII.2001 HE. Romania, County Harghita, Orotva, „Lengő kő", from moss on decay-

ing wood 05.VII.2001 HE. Romania, „Nagymokos" from moss 10.VII.1998 MF. Romania, Judeţul Alba, Râmetea, towards Piatra Secuiului, from altitude 1128 m a.s.l., from soil 07.VII.1998 HE. Romania, County Harghita, 2 km away from Pasul Vlăhiţa from *Sphagnum* 01.VIII.1999 OA. Romania, County Alba, Buru, valley of brook Râmetea from moss 11.VII.1998 HE. Romania, County Alba, Râmetea, towards Piatra Secuiului, from altitude 700 m a.s.l. from moss 07.VII.1998 HE. Romania, County Alba, 5 km away from Corneşti, Arieş vale from moss 11.VII.1998 HE. Romania, Băile Balvanyos, north side of the mountain, from altitude 400 m a. s. l. from moss 01.VIII.1999 OA. Romania, Lacul Sfânta Ana, north side of the mountain, from altitude 600 m a.s.l. 01.VIII.1999 OA. Romania, County Alba, Runc, "Runki-szoros" from moss 10.VII.1998 HE. Romania, County Harghita, 2 km away from Pasul Vlăhiţa from moss 01. VIII.1999 OA. Romania, near Lacul Sfânta Ana, from *Sphagnum* 01.VIII.1999 OA. Romania, Piatra Caprei from moss 20.VIII.1999 MF. Romania, Abrud from moss, 25.XI.2003 CSCS. Romania, Maramureş Mts, Borşa-Băile Borşa, stream over the village from moss 26.IX.2006 DL, KJ, MD. Romania, Kolozs Cluj county Negreni, left side-stream of the Crisul Repede River, beech litter and moss 06.X.2006 MD. Romania, County Maramureş, Maramureş Mts, Borşa-Băile Borşa, Stanchii spring from moss 22.V.2007 CsCs, DL, KJ, MD. Romania, County Maramureş, Maramureş Mts, Borşa-Băile Borşa, Vinişor valley from mixed forest 22.V.2007 CSCS, DL, KJ, MD. Romania, County Maramureş, Rodna Mts, Săcel, Iza spring in pine forest from decaying wood and forest litter 23.V.2007 CSCS, DL, KJ, MD. Romania, County Maramureş, Maramureş Mts, Poienile de Sub Munte, Socolău valley from mixed forest litter 25.V.2007 CSCS, DL, KJ, MD. Romania, Paştera Urşilor, near Vislo village from dry forest 24.X 2003 PT. Romania, Turda, Cheile Turzii from moss 20.VIII.1999 MF. Romania, Râmetea, Piatra Secuiului from moss 20.IX.2000 SZT. Slovakia, Dobsina from moss 03.VII.1991 UC. Slovakia, Rakovec from moss 03.VII.1991 MS. Slovakia „Klastromka fent" 02.VII.1991 MS. Slovakia, Hrabusice-Podlesok, Suchá Belá from litter 02.VII.1991 MS. Slovakia, Hrabusice-Podlesok, Suchá Belá from decaying wood 02.VII. 1991 MS. *Balkan Peninsula*: Albania, Periferi Malesia from littoral bush, limestone rocks, gallery forest 04.X.2005 MD. Albania, Okol, near a brook, mixed forest 06.VII.2003 EJ, KJ, MD, FZ. Macedonia, Šar Planina, Gorno Jelovce from beech forest, moss of soil 15.X.2006 DL, KJ, MD. Macedonia, Belasica Planinite Kolešino platan-beech forest litter 18.X.2006 DL, KJ, MD. Macedonia, Maleševski Planina, Berovo beech forest litter 18.X.2006 DL, KJ, MD. Macedonia, Osogovski Planina, Sasa, valley of a sidebrook of the Kamenica Stream, from moss of soil 19.X. 2006 DL, KJ, MD. Macedonia, Valandovsko Basin, Furka, temporary puddle from moss 18.X.2006 DL, KJ, MD. Serbia, Đerdap Mts, Majdanpek, mixed beech forest litter 13.X.2006 DL, KJ, MD. Serbia, Krajište Mts, Vučedelce, brooks in beech forest above the village from moss 20.X.2006 DL, KJ, MD. *Alps:* Austria, Altenmarkt an der Triesting, moss from soil 11.X.2003 SZGY.

Published records. Austria (Čoja & Bruckner 2006), Belgium (Skubała *et al.* 2013), British Isles (Evans 1955), Franconia, New Hampshire, Germany, Norway, Sweden, France, Netherlands (Farrier 1957). Finland (Huhta & Niemi 2003), Hungary (Salmane & Kontschán 2005b), Italy (Sabbatini Peverieri 2011), Iran (Moradian *et al.* 2011), Ireland (Arroyo *et al.* 2010), Latvia (Salmane 1999), Poland (Kamczyc & Gwiazdowicz 2009), Romania (Manu 2013), Russia (Makarova 2011), Slovakia (Fenďa & Mašán 2009), Spain (Moraza & Peña 2005, Moraza 2007), Sweden (Lundqvist *et al.* 2000), Turkey (Çobanoğlu 2001).

Diagnosis. Dorsal shield separated, opisthonotal shield with 19 pairs of setae. Tectum with two small spines at median projection and apex terminates in two or three short pilose appendages. Two pairs of presternal plates present, anal shield wider than long.

Distribution. Palearctis (Karg 1993).

Remarks. Live in decaying wood, litter. and moss, nest of ants and rodents. This is widely distributed species with first records for Albania, Macedonia and Serbia.

Veigaia planicola (Berlese, 1892)

(Figure 1)

Cyrtolaelaps nemorensis var. *planicola* Berlese, 1892: fasc. 63.
Veigaia planicola: Fenďa & Mašán 2009: 193, Kaczmarek *et al.* 2009: 183, Szabó et al. 2009: 149, Manu *et al.* 2013: 35.

Material examined. Carpathian Basin: Croatia, Novo Zvecevo streamside 22.IV.2004 KJ. *Balkan Peninsula:* Macedonia, Šar Planina, Tetovo, Popova Šapka, brook in alpine grassland from moss 15.X.2006 DL, KJ, MD. Macedonia, Sveti Naum, near springs and spring lake above the Ohrid Lake, from litter 16.X.2006 DL, KJ, MD.

Published records. Austria (Wissuwa *et al.* 2012), Belgium (Skubała *et al.* 2013), British Isles (Skorupski & Luxton 1998), Croatia (Kaczmarek *et al.* 2009), Germany (Koehler 2000), Hungary (Szabó *et al.* 2009), Italy, Sicily (Farrier 1957), Poland (Kaczmarek *et al.* 2011), Romania (Manu *et al.* 2013), Slovakia (Fenďa & Mašán 2009), Spain (Moraza & Peña 2005, Moraza 2007), Sweden (Lundqvist 1974), Turkey (Bayram & Çobanoğlu 2005).

Diagnosis. Dorsal shield separated, genital and ventral shields not fused, punctiform organ pores on soft membranous cuticule, median elongated part of tectum brush-like, at base with a large spine.

Distribution. Europe and Asia (Karg 1993).

Remarks. Live in moss, forest litter and upper layer of soils. This is the first record from Macedonia.

Veigaia propinqua Willmann, 1936

(Figure 1)

Veigaia propinqua Willmann, 1936: 251.
Veigaia propinqua: Fenďa & Mašán 2003: 188, Pavlova 2009: 113, Minodora 2012: 394.

Material examined. Carpathian Basin: Slovakia, Rakovec from moss 03.VII.1991 MS. *Balkan Peninsula*: Serbia, Krajište Planine, Surdulica beech forest litter 20.X.2006 DL, KJ, MD.

Published records. Austria (Farrier 1957), British Isles (Evans 1955), Bulgaria (Pavlova 2009), Poland (Gabryş et al. 2008), Romania (Minodora 2012), Slovakia (Fenďa & Mašán 2003).

Diagnosis. Dorsal shield separated, podonotum with 22 pairs of setae. Median part of tectum with elongated projection, terminates apically slightly pilose. Anterolateral corners of ventral shield fused with peritremal shields.

Distribution. Europe (Karg 1993).

Remarks. Previous records are from caves and litter of forests. This is the first record from Slovakia.

Veigaia transisalae (Oudemans, 1902)

(Figure 1)

Cyrtolaelaps transisalae Oudemans, 1902: 28.
Veigaia transisalae: Szalay 1931: 27, Fenďa & Mašán 2009: 193, Minodora 2012: 394.

Material examined. Carpathian Basin: Romania, Transylvania from *Sphagnum*, without exact date, PT. Romania, Harghita-Băi, near Pokat Resort from moss 30.VII.2004 HE. Romania, Munţii Retezat, near La Beci from altitude 1200-1300 m a.s.l. from moss 07.IX.2003 OA. Romania, Băile Tuşnad 21.IX.2002 JZs, HE. Romania, „Nagymokos" from peat moss 10.VII. 1998 MF. Romania, 2 km away from Pasul Vlăhiţa, from *Sphagnum* 01.VIII.1999 OA. Romania, Băile Bálványos, north side of the mountain, from altitude 400 m a. s. l. from moss 01.VIII.1999 OA. Romania, Lacul Sfânta Ana, north side of the mountain, from altitude 600 m a.s.l. 01.VIII.1999 OA. Romania, Borsa from litter and soil 27.VI.2005-01.VII.2005 OK, KJ, MD. Romania, Abrud from moss 25.XI.2003 CSCS. Slovakia, Rakovec from moss 03.VII.1991 MS. Slovakia „Klastromka fent" 02.VII.1991 MS. *Balkan Peninsula*: Albania, Akol rodonines, from

altitude 1300 m a.s.l., from moss 22.VII.1996 HE. Macedonia, Šar Planina, Tetovo, Popova Šapka, brook in alpine grassland, from moss 15.X.2006 DL, KJ, MD. Serbia, Đerdap Planine, Moşna from oak forest litter 12.X.2006 DL, KJ, MD. Serbia, Krajište Mts, Vučedelce, brooks in beech forest above the village from moss 20.X.2006 DL, KJ, MD. *Alps:* Austria, Altenmarkt an der Triesting, moss from soil 11.X.2003 SZGY.

Published records. Belgium (Skubała *et al.* 2013), British Isles (Evans 1955), Latvia (Salmane 2007), Poland (Kamczyc & Gwiazdowicz 2009), Romania (Minodora 2012), Russia (Makarova 2011), Slovakia (Fenďa & Mašán 2009), Netherland, France, Germany, Hungary, Madeira Island, Austria, Switzerland (Farrier 1957).

Diagnosis. Dorsal shield with slightly bent incision laterally, opisthonotal region with 19 pairs of setae. Dorsal setae j1, j4, z5 and r3 two or three times longer than other setae. Tectum median elongated projection Y-shaped and serrate apically, at the base a triangular spine emerges.

Distribution. Europe (Karg 1993).

Remarks. Live in decaying wood, coniferous and deciduous litter and moss. This is the first record from Austria, Albania, Serbia and Macedonia.

Veigaia uncata Farrier, 1957

(Figure 1)

Veigaia uncata Farrier, 1957: 82.

Material examined. Carpathian Basin: Romania, 2 km away from Pasul Vlăhiţa, from *Sphagnum* 01.VIII.1999 OA.

Published records. Australia, Papua New Guinea (Halliday 1990), East Africa (Hurlbutt 1979), North Carolina (Farrier 1957), Russia (Bregetova 1961).

Diagnosis. Dorsal shield deeply straight incised laterally, opisthonotal shield with 21 pairs of setae; j1, j4, z5 and r3 at least two times longer than other setae. Tectum with Y-shaped median projection, serrate apically. Punctiform organs at base of coxae IV consisting of three rows of pits.

Distribution. Cosmopolitan.

Remarks. This species has a wide distribution from America to Europe and East Africa. Live in litter and moss. This is the first record from Romania.

Genus *Gamasolaelaps* Berlese, 1904

Gamasolaelaps tuberculatus Bregetova, 1961

(Figure 1)

Gamasolaelaps tuberculatus Bregetova, 1961: 95.
Gamasolaelaps tuberculatus: Didyk 2013: 14.

Material examined. Carpathian Basin: Romania, Abrud from moss 25.XI.2003 CSCS. Slovakia, Rakovec from soil 03.VII.1991 MS.

Published records. Latvia (Salmane 2001), Russia (Bregetova 1961), Ukraine (Didyk 2013).

Diagnosis. Dorsum with separate podonotal and opisthonotal shields. Opisthonotal region with 11 pairs of setae. Femur of the legs IV with small tuberculum. Dorsal shield with smooth edges. Ventral shield with 7 pairs of setae. Tectum has 3 apex with each almost the same size.

Distribution. East Europe.

Remarks. Little information is available about its distribution and ecology. Previous records are from forest litter, decaying matter and bird nests. This is the first data from Romania and Slovakia.

DISCUSSION

Numerous works are published on the family *Veigaiidae* Oudemans, 1939, mainly from Europe, but the Balkan Peninsula remained less explored. Altogether nine species were collected in ten countries from the Carpathian Basin and the Balkan Peninsula. Most of the records are from

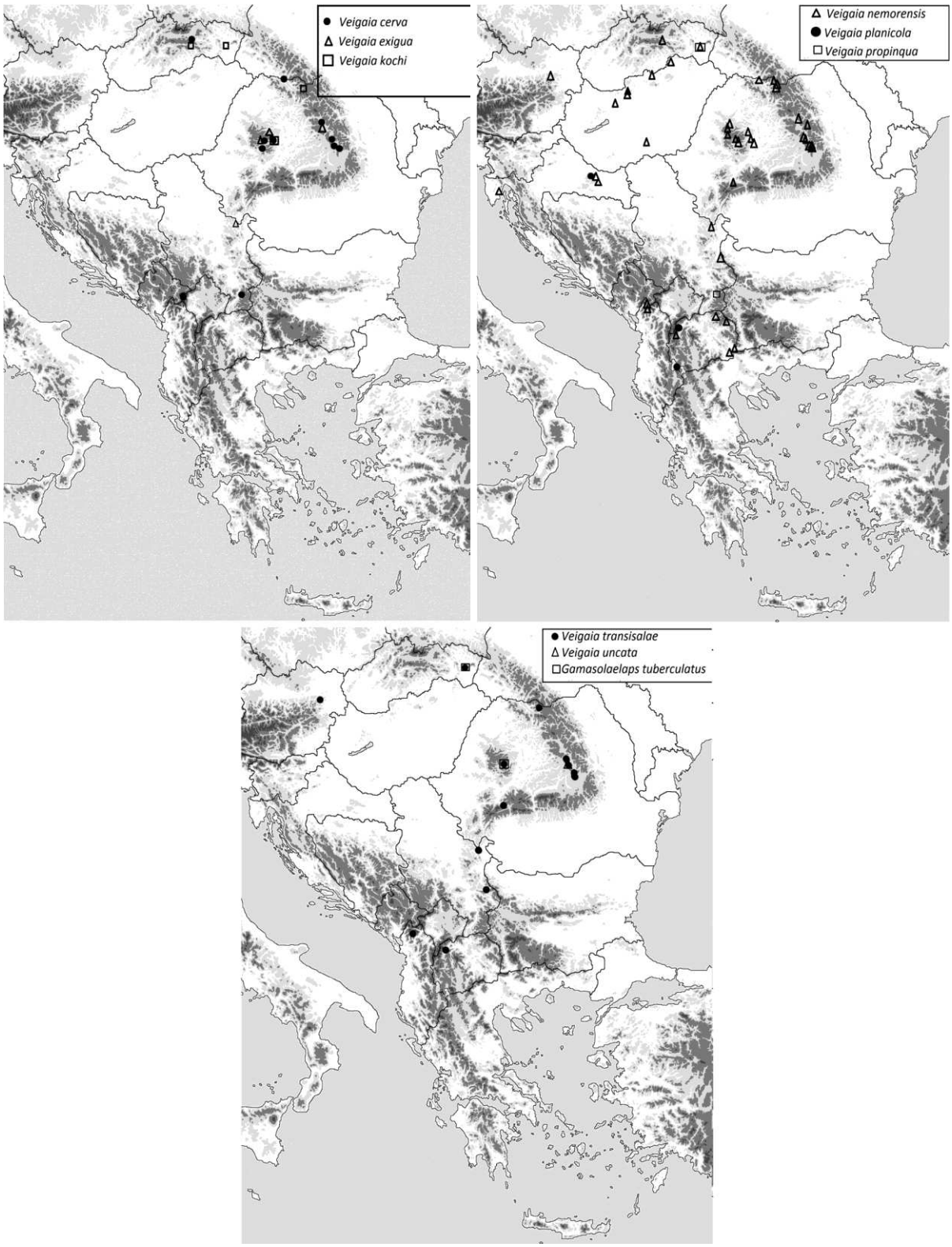

Figure 1. Occurrences of veigaiid species in the Carpathian Basin and in the Balkan Peninsula

Romania. The majority of the species are distributed in the Palaearctic region. The most frequent species, with 70 records was *Veigaia nemorensis*, a common species with wide distribution. *Veigaia transisalae* was also frequent in the soil samples and on the basis of previous data it is distributed in Europe and now we have reported here new occurrences for the Balkan Peninsula; this species is new for the fauna of Albania, Macedonia and Serbia. *Veigaia cerva* was also reported mainly from the European region, and we have provided here the first records for Serbia and Kosovo in the Balkan Peninsula. *Veigaia planicola* was known from Europe and Asia. In the present study it has been reported for the first time from the Balkans, from Macedonia. Interestingly, *Veigaia uncata* hasn't been reported from Europe until now, previous data are from very different regions, like Australia, East-Africa, North-Carolina and Russia. *Gamasolaelaps tuberculatus* seemed to be an Eastern European species, but for the first time, it has been collected from the Carpathian Basin.

Summarizing, we reported new species occurrences for seven countries and with these records the number of known species is increased in Albania from zero to two, in Austria from nine to ten, in Kosovo from zero to one, in Macedonia from zero to three, in Romania from nine to eleven, in Serbia from zero to four and in Slovakia from thirteen to fifteen species.

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Zur Regenwurmfauna (Oligochaeta: Lumbricidae), insbesondere zur *Proctodrilus*-Verteilung, in den Auen der Tschernosem- und Parabraunerde-Gebiete beiderseits des Erzgebirges

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Abstract. ***On the earthworm fauna (Oligochaeta: Lumbricidae), in particular the distribution of Proctodrilus, in the floodplains of the chernozem and gray-brown podzolic soil areas on both sides of the Ore Mts.*** In a study of mineral soils in floodplains, shallow depressions, and dry valley heads of the Saale-Elster plateau in eastern Germany and along the lower Eger/Ohře river in Czechia, sixteen earthworm species were found. On the basis of these findings, areas of gray-brown podzolic soils can be differentiated from chernozem areas mainly by the occurrence in the former of the two species *Proctodrilus antipai* and *P. tuberculatus*. In a section of one floodplain in the gray-brown podzolic soil area, the distribution of these two earthworm species shows a vicariance situation, such that *P. antipai* is restricted to the outer edges of the floodplain while *P. tuberculatus* inhabits the parts close to the river. In the chernozem areas, on the other hand, *P. antipai* is the only one of the two species to occur, and is also found in those areas close to the river. *P. tuberculatus* disappears in the transitional zone between a floodplain where it occurs and a chernozem floodplain. The distribution of *P. antipai* ends where a floodplain inhabited by it graduates into one belonging to a large river with a high rate of flow. On the stretch of the Elbe near Mlékojedy, where the position of the confluence with the Ohře has migrated over time, the vicariant distribution of the two species within the soil profile was noted. Here *P. antipai* is found in the uppermost soil layer, while *P. tuberculatus* lives in the lower-lying mineral soil at the same location. This ecological vicariance appears to represent different stages of clay translocation in flood loam. The results show that *P. tuberculatus* is dependent on such clay translocation or lessivage, and where this soil-profile-influencing process cannot take place the species does not occur. Examples would be oligotrophic acid montane brown forest soils, eutrophic brown forest soils, and chernozems, as well as the floodplain soils derived from all three.

Keywords. Earthworms, ecological vicariants, floodplain soils, lessivage, Central Bohemian table, Leipzig lowland.

EINLEITUNG

Viele Studien versuchten, die Regenwurmverbreitung mit physikalischen und chemischen Parametern des Bodens in Beziehung zu setzen, oft mit Ergebnissen von mangelhafter Beweiskraft (Curry 1998). Eine einfache Direktbindung der Arten an einzelne abiotische Bodenfaktoren lässt sich nicht sichern und ist auch nicht zu erwarten (Dunger 1998). Auch gibt es der Erfahrung nach keine selektive Anpassung an Bodentypen. Möglicherweise sind für Regenwürmer wie andere Bodenorganismen primär Bodenprozesse wichtig, für die sie eine Reaktionsbreite als Anpassung an Bodensituationen während der Warm- und Kaltzeiten des Eiszeitalters erworben haben (Dunger 1998). Zu diesen Bodenprozessen gehören wahrscheinlich die durch Erosion, Sedimentation, Umlagerung und Perkolation bedingten, so u.a. die texturelle Bodenschichtung, die Tonverlagerung und das mit ihr verbundene Einwaschen kolloidaler Humusstoffe (Höser 1986, 2011). Weitere Hinweise dazu, ermittelt aus der Verbreitung der Regenwürmer über die Grenzen zwischen Parabraunerde- und Tschernosem-Gebieten hinweg, werden im Folgenden aus Auen beiderseits des Erzgebirges vorgestellt.

UNTERSUCHUNGSGEBIETE

Die Untersuchungen fanden in einigen Fluss- und Bach-Auen beiderseits des Erzgebirges statt,

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so im Sandlössgebiet der Saale-Elster-Platte Mitteldeutschlands (Lembke *et al.* 1970) und im Tafelland an der Unteren Eger (Dolnooharská tabule), das im nördlichen Teil von Löss, im südlichen auch von Sandlöss und Flugsanden bedeckt ist (Breburda 1958). In den hydrologischen Einzugsgebieten dieser Auen kommen in unterschiedlichem Ausmaße Parabraunerden und Tschernoseme vor (Ganssen & Hädrich 1965, Ganssen 1972). Auf der Saale-Elster-Platte wurden Standorte südwestlich von Leipzig untersucht, die beiderseits der Verbreitungsgrenze zwischen Tschernosem und Parabraunerde liegen (Haase 1978, Sächsisches Landesamt für Umwelt und Geologie 1995), von denen aber die meisten mit Parabraunerde-Vorkommen in Kontakt stehen. Im Tafelland an der Unteren Eger/Ohře herrschen Tschernoseme vor, im südlichen Teil dieses Gebietes treten auch tschernosemähnliche Böden (Kalkrendzinen), nährstoffreiche Braunerde und große Flecken von Parabraunerde auf (Janovský 1941, Breburda 1958, Pelíšek 1961, Ganssen & Hädrich 1965). Dementsprechend sind im Eger-Tafelland überwiegend Auenstandorte des Tschernosem-Gebietes und wenige im Kontaktbereich von Parabraunerde-Vorkommen untersucht worden. Viele Auenstandorte im Bereich der Unteren Eger zeichnen sich durch ihre besonders stark zu Gleyen geprägten Böden aus (Pelíšek 1961).

175 Standorte in Auen und zugehörigen Dellen außerhalb menschlicher Siedlungen wurden untersucht, fast ausschließlich auf Grünland, nur einzelne auf aufgelassenem Acker oder in einer Sukzession mit Gehölzen. Die meisten dieser Bodenstandorte liegen im Bach-Wiesengraben-System der Saale-Elster-Platte, die übrigen mehrheitlich im Bereich von Ohře und Čepel.

METHODIK

Die Regenwurmfauna der Auen wurde sowohl auf einzelnen, zufällig verteilten, als auch auf Untersuchungsflächen entlang mehrerer Transsekte erfasst, die quer zur Flussrichtung durch die Aue laufen. Auf jeder Untersuchungsfläche von 0,5 x 0,5 m wurden bis in 0,5 m Tiefe alle Regenwürmer ausgegraben und in zweimaliger Durchsicht des ausgegrabenen Bodens von Hand ausgelesen. Für die Auswertung wurden ausschließlich die adulten Tiere herangezogen. Die taxonomische und zoogeographische Nomenklatur folgt Csuzdi & Zicsi (2003), Csuzdi *et al.* (2011) und Pop *et al.* (2012). Konserviertes Material befindet sich in der Sammlung des Autors.

Die beim Ausgraben hergestellte Schürfgrube diente der Bodenansprache. Korngradierungen und Feuchtestufen des Bodens wurden nach feldmethodischen Kriterien (Fiedler & Schmiedel 1973, Ad-hoc-AG Boden, 2005) eingeschätzt.

Die Begriffe der Auen- und Talmorphologie sind definiert bei Schirmer (1983) und Ahnert (1999).

ERGEBNISSE

Gesamtübersicht

Von 16 Regenwurmarten, die in den Mineralböden der Dellen, Bach- und Kleinflussauen außerhalb menschlicher Siedlungen gefunden wurden, sind zehn sowohl auf der Saale-Elster-Platte als auch im Tafelland der Unteren Eger nachgewiesen, davon *Aporrectodea caliginosa* und *Ap. rosea* in größter Stetigkeit (Tabelle 1). Relativ hohe Stetigkeit erreichen auch *Allolobophora chlorotica* und *Octolasion lacteum*, so zumindest auf der Saale-Elster-Platte. Diese vier Arten und *Proctodrilus tuberculatus* konnten auch im ufernahen Auenboden eines jeden der großen Flüsse Saale, Weiße Elster und Elbe angetroffen werden (Tabelle 2). *Ap. longa*, die auf der Saale-Elster-Platte relativ stetig vorkommt, und *O. cyaneum* wurden im Tafelland der Unteren Eger nicht gefunden. Im Auenboden des gesamten Einzugsgebietes der Eger gelang nur ein Fund von *O. cyaneum*, so im Uferwall dieses Flusses bei Postelberg/Postoloprty, also außerhalb des in Tabelle 1 betrachteten Tschernosem-Kerngebiets und näher an den Parabraunerde-Decken, die neben anderen Böden im hydrologischen Einzugsgebiet dieses Auenstandorts vorhanden sind.

Tabelle 1. Die Regenwurmarten und ihre Verteilung in den Auen und zugehörigen Dellen der Parabraunerde- und Tschernosem-Gebiete der Saale-Elster-Platte und des Tafellandes der Unteren Eger (Dolnooharská tabule). Anzahl der Standorte mit Vorkommen der Arten und maximale Individuendichte (Adulti/0,25 m²) der Arten.

Untersuchtes Gebiet	Saale-Elster-Platte				Tafelland Untere Eger			
	Para-braunerde-Gebiet		Tscherno-sem- Gebiet		Para-braunerde-Gebiet		Tscherno-sem-Gebiet	
Untersuchte Standorte	81		50		4		27	
	A = Anzahl der Standorte mit Vorkommen adulter Tiere B = maximale Anzahl adulter Tiere pro 0,25 m²							
	A	B	A	B	A	B	A	B
Allolobophora chlorotica (Savigny, 1826)	51	24	27	15	-	-	7	2
Aporrectodea caliginosa (Savigny, 1826)	66	40	38	14	4	12	24	25
Aporrectodea longa (Ude, 1885)	29	9	21	10	-	-	-	-
Aporrectodea rosea (Savigny, 1826)	71	30	34	16	3	4	12	12
Dendrobaena auriculata (Rosa, 1897)	-	-	-	-	-	-	5	17
Dendrobaena octaedra (Savigny, 1826)	-	-	-	-	-	-	3	6
Dendrodrilus rubidus (Savigny, 1826)	1	1	1	3	-	-	1	1
Eiseniella tetraedra (Savigny, 1826)	-	-	3	2	-	-	-	-
Helodrilus oculatus Hoffmeister, 1845	-	-	6	5	-	-	-	-
Lumbricus castaneus (Savigny, 1826)	7	11	10	5	3	5	6	7
Lumbricus rubellus Hoffmeister, 1843	6	7	13	4	1	1	2	4
Lumbricus terrestris Linneaus, 1758	12	2	6	2	2	2	8	2
Octolasion cyaneum (Savigny, 1826)	15	5	-	-	-	-	-	-
Octolasion lacteum (Örley, 1881)	38	15	21	15	-	-	12	5
Proctodrilus antipai (Michaelsen, 1891)	2	6	7	8	-	-	9	10
Proctodrilus tuberculatus (Černosvitov, 1935)	10	12	-	-	1	4	-	-

Tabelle 2. Die Regenwurmarten der Bodenstandorte auf flussbegleitendem Grünland an der Saale und Weißen Elster in Mitteldeutschland und an der Böhmischen Elbe/Labe. Anzahl der Standorte mit Vorkommen der Arten und maximale Individuendichte (Adulti/0,25 m²) der Arten.

	Saale im Tschernosem-Gebiet		Weiße Elster im Parabraunerde-Gebiet		Böhmische Elbe im Tschernosem-Gebiet	
Untersuchte Standorte	4		7		2	
	A = Anzahl der Standorte mit Vorkommen adulter Tiere B = maximale Anzahl adulter Tiere pro 0,25 m²					
	A	B	A	B	A	B
Allolobophora chlorotica (Savigny, 1826)	1	3	1	2	2	2
Aporrectodea caliginosa (Savigny, 1826)	4	26	7	14	2	21
Aporrectodea longa (Ude, 1885)			7	3		
Aporrectodea rosea (Savigny, 1826)	4	12	6	5	2	4
Dendrobaena octaedra (Savigny, 1826)	1	2	1	1		
Eiseniella tetraedra (Savigny, 1826)					1	1
Lumbricus castaneus (Savigny, 1826)					2	10
Lumbricus rubellus Hoffmeister, 1843			1	4		
Lumbricus terrestris Linneaus, 1758	4	5			1	1
Octolasion cyaneum (Savigny, 1826)			1	1		
Octolasion lacteum (Örley, 1881)	1	7	1	2	1	1
Proctodrilus antipai (Michaelsen, 1891)					1	19
Proctodrilus tuberculatus (Černosvitov, 1935)	3	9	2	2	2	15

In allen vier Bodenlandschaften, die in Tabelle 1 genannt sind, wurden neben *Ap. caliginosa* und *Ap. rosea* auch *Lumbricus castaneus, L. rubellus* und *L. terrestris* angetroffen. *Proctodrilus antipai* und *P. tuberculatus* kommen in den Auen beiderseits des Erzgebirges vor. Die letztgenannte Art fehlt aber unseren Ergebnissen zufolge in den Auen der Bäche und kleinen Flüsse der Tschernosem-Gebiete.

Aufgrund der Gegebenheit, dass die untersuchten Bodenstandorte außerhalb geschlossener Auenwälder liegen, wurden nur wenige Laubstreu bewohnende (epigäische) Arten, z.B. *Dendrobaena octaedra* und *Dendrodrilus rubidus*, und diese in geringer Individuendichte vorgefunden. Nasse Standorte und damit Vorkommen von *Eiseniella tetraedra* sind zufällig repräsentiert.

Auen der Bäche und kleinen Flüsse

Es fällt auf, dass ausschließlich im Parabraunerde-Gebiet der Saale-Elster-Platte sowohl *P. tuberculatus* als auch *O. cyaneum* als Bewohner der Bach-Auen und Dellen angetroffen wurden. In den Querschnitten der Bach-Auen dieses Gebiets vikariieren *P. tuberculatus* und *P. antipai*. So tritt z.B. in der Aue des Wiesengrabens zwischen Thronitz und Döhlen *P. tuberculatus* in der bachnahen Auenmitte auf, während sich *P. antipai* auf den feuchteren Auenrand beschränkt (Abbildung 1). Im Gegensatz dazu ist *P. tuberculatus* in den untersuchten Tschernosem-Gebieten aus den Auenquerschnitten der weniger abflussreichen Fließgewässer ausgeschlossen, so festgestellt in zwei Bach-Auen der Saale-Elster-Platte (Renne, Der Bach) und in der Aue der Eger/Ohře. Anstelle der genannten Art kommt im fließgewässernahen Mineralboden dieser Auen die Art *P. antipai* vor.

Die Auenböden am Bach zwischen Kleinlehna und Kötzschau, die aus Sedimenten des Tschernosem-Gebietes entstanden sind, beherbergen auffällig häufig *Helodrilus oculatus*, wo unterhalb 2 dm Bodentiefe Wasserfilme sichtbaren Haftwassers vorkommen.

Auen großer Flüsse

An abflussreicheren Großflüssen, die durch ein Parabraunerde-Gebiet führen, und gleichermaßen an solchen, die ein Tschernosem-Gebiet durchschneiden, bewohnt *P. tuberculataus* den ufernahen Auenboden (Tabelle 2). Die Regenwurmfauna solcher flussbegleitender Böden erreicht einen größeren Artenreichtum als die anderer Auenböden. Sie ist besonders artenreich an der seitlichen Verschiebung einer Nebenflussmündung (=Mündungsverschleppung). So wurden an der Mündungsverschleppung der Ohře bei Mlékojedy an der Elbe neun Regenwurmarten auf 0,25 m² gefunden (Abbildung 2), während an anderen Auenstandorten (Abbildung 1) gewöhnlich etwa vier Arten pro Auenbodenfläche dieser Größe vorkommen. Am Standort bei Mlékojedy trat innerhalb des Bodenprofils deutliche ökologische Vikarianz von *P. antipai* und *P. tuberculatus* auf. Im humoseren, fein geschichteten obersten Dezimeter des Bodens, zumeist in 3−8 cm Tiefe, herrschte die erstgenannte, im tieferen Bereich desselben Profils die andere Art vor (Tabelle 3).

Übergang in andersartige Aueneinzugsgebiete

Im Bereich der Vereinigung zweier Wasserläufe, die aus sehr unterschiedlichen Bodenlandschaften kommen, bestehen dauerhafte Unterschiede in der Regenwurmfauna. Zweierlei Fälle wurden beim Übergang in andersartige Aueneinzugsgebiete festgestellt.

So verschwindet *P. tuberculatus* dort im Auenboden, wo die von ihm besiedelte, überwiegend durch Sedimente aus einem Parabraunerde-Gebiet geprägte Aue in eine andere einmündet oder übergeht, die hauptsächlich Tschernosem-Vorkommen entwässert. Beispiele dafür sind die Aue an der Mündung des Wiesengrabens in die Renne bei Kleinlehna und der Übergang von der oberen Čepel-Aue in die Aue der Eger/Ohře. Im erstgenannten Beispiel gelangt *P. tuberculatus* bis an den Stromstrich der vom Tschernosem-Gebiet kommenden Renne und tritt anscheinend in der Aue des weiteren, aus-

Tabelle 3. Vikarianz der *Proctodrilus*-Arten in Bodenprofilen einiger untersuchter Auen.

Fundort	Bodenstandort	Vikariierende Arten im Bodenprofil (oben – unten)	Lebensraum	Quellen
Mieresch (Mureş), bei Soimoş und Bata (RO)	Ufernähe, Bodenschichtung infolge lokalen Wechsels der Überflutungsdynamik, Eintritt in Hochflut-Strömungsschatten	*P. opisthoductus* oben	In 6−9 cm (Soimoş) oder 22 cm (Bata) mächtiger Auflage von humosem Auensediment	Höser (2003) und Feldprotokolle 1195, 1278/79, 1650
		P. tuberculatus unten	Im feinsandigen Auenlehm oder (bei Bata) auf dessen oberer Schichtgrenze bei 22 cm Tiefe	
Große Kokel (Tirnava Mare), bei Hoghilag (RO)	Auenmitte, im Wege einer Nebenströmung der Hochflut	*P. opisthoductus* oben	Am unteren Ende des 3 cm mächtigen Ah-Horizonts	Höser (2011) und Feldprotokoll 1169
		P. tuberculatus unten	Im auffällig tondurchschlämmten feinkörnigen Auenlehm über einer gröberkörnigen Schicht	
Elbe (Labe), bei Mlékojedy (CZ)	Ufernähe, Hochflut-Strömungsschatten	*P. antipai* oben	Etwa 3−8 cm tief im humosen, bindigen Oberboden	Hier vorgelegte Ergebnisse, Feldprotokoll 3684
		P. tuberculatus unten	Im feinsandigeren Auenlehm	

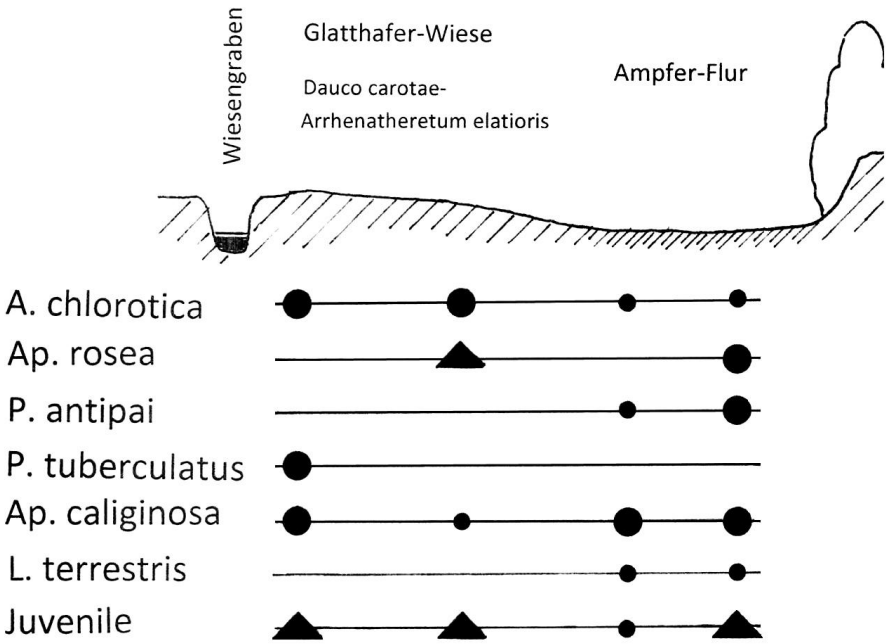

Abbildung 1. Regenwurmfauna im Querschnitt der Aue des Wiesengrabens zwischen Thronitz und Döhlen auf der Saale-Elster Platte. Die Punkte bzw. Dreiecke repräsentieren die Individuendichte der adulten Regenwürmer und der Juvenilen in drei Größenklassen: •1−3, ● 4−10, ▲ > 10 Individuen auf 0,25 m² untersuchter Fläche. Transsektlänge ca. 70 m.

schließlich Tschernosem-Gebiet durchschneidenden Fließgewässerverlaufs („Bach“) nach dem Zusammenfluss nicht mehr auf.

Im anderen Fall endet das Vorkommen von *P. antipai*, wo die von ihm bewohnte Aue in die eines abflussreicheren Flusses mündet. Das betrifft den Bereich an der Mündung der Eger/Ohře in die Elbe/Labe (Abbildung 2), die als Großfluss hier das Tschermosem-Gebiet der Böhmischen Niederung durchschneidet, und auf der Saale-Elster-Platte z.B. die Aue an der Mündung des Bachs in die Luppe (bei Löpitz).

Flachdellen-Talanfänge

An den Flachdellen-Talanfängen (Ahnert 1999) des Oberlaufs einiger Bäche des Parabraunerde-Gebiets auf der Saale-Elster-Platte wurde ausschließlich *P. tuberculatus* als Vertreter des vikariierenden *Proctodrilus*-Artenpaars nachgewiesen. Beispiele dafür sind die Befunde vom oberen Wiesengraben bei Räpitz, vom Luppegraben bei Großschkorlopp, von der Rützschke bei Eisdorf und vom westsüdwestlich von Rehbach liegenden Talanfang einer südwärts, zum Luppegraben hin führenden Delle. Diese vier Bodenstandorte befinden sich allesamt am sanderseitigen Rand von Endmoränen, der erstgenannte am Fuße der zwischen Meyhen und Dölzig verlaufenden, die übrigen an der Dehlitz-Rückmarsdorfer Endmoräne. An jedem dieser Bodenstandorte lebt *P. tuberculatus* in einer 0,4−0,6 m mächtigen, zur Parabraunerde entwickelten weichseleiszeitlichen Sandlöss-Decke, die durch eine Steinsohle an der Basis begrenzt ist (s. Abbildung 139 in Fiedler & Hunger 1970) und auf vorwiegend reinen glazifluviatilen Sanden und Kiesen (s. Abbildung 14 in Eissmann 1970) liegt. Fast alle Befunde ergaben deutlich, dass diese Regenwurmart dort die obersten zwei bis drei Dezimeter des Bodenprofils besiedelt, die stets von festerem Boden unterlagert sind. Nicht gefunden wurde sie an Sandlöss-Standorten über reinem Geschiebemergel.

Auch die Funde von *O. cyaneum* im Gebiet der Saale-Elster-Platte (Tabelle 1) beschränken sich auf Sandlöss-Parabraunerde-Decken der Flachdellen, die im Unterboden etwas verdichtet und von glazifluviatilen Sanden und Kiesen unterlagert sind (Rützschke, Dellen bei Kaja und Rehbach).

Funde endemischer Regenwurmarten

Dendrobaena auriculata (Rosa, 1897): Dolnooharská tabule: 17 ex., Břežany n. O., 05.06. 2010; 8+2+11+1 ex., Břežany n. O., 17.06. 2010. Oherský příkop (Egergraben): 7 ex., Königsberg a. d. Eger/Kynšperk n. O., 18.07. 2010.

Proctodrilus antipai (Michaelsen, 1891): Saale-Elster-Platte: 6 ex., Döhlen, 13.07.2013; 2 ex., Döhlen, 17.09.2013; 2 ex., Markranstädt, 16. 07.2013; 2 ex., Rampitz, 04.10.2013; 1+1 ex., Rampitz, 08.10.2013; 8 ex., Friedensdorf, 02.05.2014; 1 ex., Tragarth, 02.05.2014; 1 ex., Löpitz, 19.04.2014. Dolnooharská tabule: 2+3 ex., Priesen/Březno, 21.10.2006; 1 ex., Břežany n. O., 05.06.2010; 1+6 ex., Břežany n. O., 17.06.2010; 4 ex., Doksany, 20.10.2013; 1 ex., Dolánky n. O., 27.10.2013; 4 ex., Terezín, 27.10.2013; 10 ex., České Kopisty, 27.10. 2013; 19 ex., Mlékojedy, 13.03.2014.

Proctodrilus tuberculatus (Černosvitov, 1935): Saale-Elster-Platte: 9+5+2 ex., Kleinkorbetha, 12.10.2006; 12 ex., Räpitz, 17.09.2013; 1 ex., Thronitz, 01.06.2013; 6 ex., Döhlen, 04.08. 2013; 2 ex., Quesitz, 15.06.2013; 1 ex., Kleinlehna, 22.04.2014; 5 ex., Eisdorf, 30.06.2013; 3 ex., Großschkorlopp, 30.08.2013; 1+2 ex., Großschkorlopp, 13.09.2013; 4 ex., Rehbach, 24.09.2013; 1 ex., Rehbach, 12.12.2013; 2 ex., Zwenkau, 27.09.2013; 1 ex., Zwenkau, 01.10. 2013. Dolnooharská tabule: 15 ex., Nučničky, 20.10.2013; 10 ex., Mlékojedy, 13.03.2014; 4 ex., Kleneč, 13.03.2014.

Gesamtes Material Leg. N. Höser; ex. = exemplar (-ia)

DISKUSSION

13 der 16 gefunden Arten sind peregrin (Michaelsen 1903), von den übrigen gehören *D.*

auriculata dem ostalpinen, *P. antipai* dem zentraleuropäischen und *P. tuberculatus* dem transägäischen Verbreitungstyp an (Csuzdi *et al.* 2011).

Die Untersuchungsergebnisse widerspiegeln durchaus Unterschiede der Verbreitung der Arten. So ist das Fehlen von Funden der Arten *Ap. longa*, *O. cyaneum* und *H. oculatus* in unseren Untersuchungen des Tafellands der Unteren Eger ein Hinweis auf die Lage dieses Gebietes im Areal der Arten. Denn das Einzugsgebiet der Eger liegt am östlichen Rand des Areals von *Ap. longa*, im Falle von *O. cyaneum* und *H. oculatus* im offensichtlich nur spärlich besiedelten südlichen Arealteil bzw. am südöstlichen Arealrand (Bouché 1972, Csuzdi & Zicsi 2003, Pižl 2002, Plisko 1973, Sims & Gerard 1985). Im nördlichen Vorland des Erzgebirges tritt *O. cyaneum* erheblich häufiger auf (Höser 2012), insbesondere außerhalb der Auen.

Die ökologische Vikarianz von *P. antipai* und *P. tuberculatus* im Auenquerschnitt, nämlich dass die erstgenannte Art den Auenrand, die andere den flussnahen Bereich der Aue bevorzugt, ist mehrfach in früheren Arbeiten und ausschließlich für Auen der Parabraunerde-Gebiete belegt worden (Höser 1986, 2008, 2009, 2010). Dass in Auenquerschnitten außerhalb dieser Gebiete *P. antipai* anstelle von *P. tuberculatus* auftritt (Abbildung 2), wurde auch schon beobachtet (Höser 2010). Offensichtlich ist dieses Verschwinden von *P. tuberculatus* charakteristisch für solche Auen, deren Einzugsgebiete überwiegend saure, nährstoffarme Gebirgsbraunerden, nährstoffreiche Braunerden oder Tschernoseme entwässern. Derartige Böden entbehren einer Tonverlagerung. Folglich ist zu schlussfolgern, dass *P. tuberculatus* an die Tonverlagerung gebunden ist (Höser 1986, 2010), die als synsedimentärer Prozess auch in Hochflutlehmen stattfindet (Kopp 1964). Hervorzuheben ist, dass sich das Auftreten dieser Art in Tschernosem-Gebieten auf Aueböden in Ufernähe der Großflüsse beschränkt, so z.B. an Saale und Böhmischer Elbe (Tabelle 2, Abbildung 2). Dieser Sachverhalt führt zur Schlussfolgerung, dass dort die Auendynamik (Hochflut, Grundwasserschwankungen) stärker tonverlagernd wirkt als an Bächen und Kleinflüssen und somit fähig ist, die importierten, *P. antipai* bindenden Tschernosem-Merkmale weitgehend zu löschen.

Die ökologische Vikarianz von *P. antipai* und *P. tuberculatus* innerhalb des Bodenprofils an der Elbe bei Mlékojedy gründet sich anscheinend auf den unterschiedlichen Erfolg, mit dem der Fluss die aus dem Tschernosem-Gebiet stammenden Merkmale im Auenboden beseitigt. Im älteren, tiefer anstehenden Teil des Bodenprofils sind offensichtlich die angelandeten Tschernosem-Merkmale weitgehend gelöscht und das Substrat durch Tonverlagerung geprägt. Im Gegensatz dazu wird der jüngste, oberste Teil desselben Profils regelmäßig durch Sedimentnachschub aus dem Tschernosem-Gebiet mit Ton und organischem Material versorgt, was den Ansprüchen von *P. antipai* genügt. Die Tonverlagerung wird in diesem Profilteil vermutlich durch regelmäßigen Materialimport in einem Anfangsstadium gehalten. In Planosol-Gebieten wurde auch für das Artenpaar *P. opisthoductus* Zicsi, 1985 und *P. tuberculatus* eine ökologische Vikarianz im Bodenprofil gefunden (Höser 2011), so in den Auenböden der Flüsse Mieresch und Große Kokel in Rumänien (Tabelle 3).

Unsere Ergebnisse machen desweiteren deutlich, dass der nahe am Ufer großer Flüsse anstehende Auenboden und die Parabraunerde (Lessivé) auf Lössdecken einander ähnliche Lebensbedingungen für einige Regenwurmarten des Mineralbodens bieten. Indikatoren dieser Bedingungen sind *P. tuberculatus* und *O. cyaneum*. Beide Arten bevorzugen Böden, in deren Entwicklungsgang nach einer primären Phase der Bodenbildung die radikalen Prozesse der Erosion, Umlagerung und Sedimentation eingriffen und Merkmale umprägten (Transformation: Kubiena 1986). Offensichtlich brachte diese Transformation ein spezielles Angebot von Bodenmerkmalen hervor, das Ansprüche der Arten an das Habitat evolutionär differenzierte. Das deuten die hier vorgelegten (s. auch Tabellen 1 und 2) und zahlreiche weitere Befunde an, so z.B. das Auf-

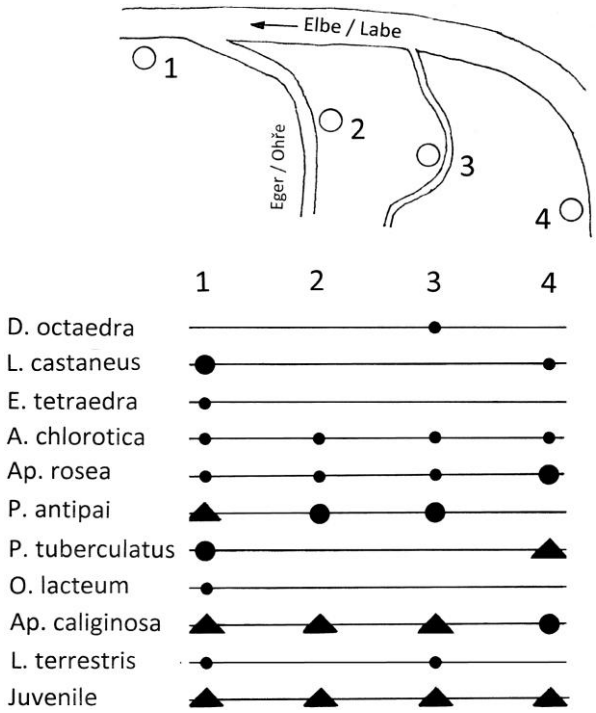

Abbildung 2. Regenwurmfauna im Querschnitt der Aue der Eger/Ohře vor der Eger-Mündung in die Elbe/Labe. Untersuchte Standorte: **1** Wiese am Ufer der Elbe/Labe bei Mlékojedy, unterhalb der Ohře-Mündungsverschleppung; **2** Wiese am Ufer der Eger/Ohře, 1 km nördlich Theresienstadt/Terezín; **3** Wiese am Ufer der Alten Eger/Stará Ohře, 0,5 km südwestlich von České Kopisty; **4** Wiese am Ufer der Elbe/Labe, 0,8 km südöstlich Nučničky. Die Punkte bzw. Dreiecke repräsentieren die Individuendichte der adulten Regenwürmer und der Juvenilen in drei Größenklassen: •1−3, ● 4−10, ▲ > 10 Individuen auf 0,25 m² untersuchter Fläche. Transsektlänge ca. 7,5 km.

treten des *P. tuberculatus* in einer flussnahen, feingeschichteten Auenterrasse (Tabelle 3 in Höser 2003), die Konzentration von *O. cyaneum* im flussnahen Abschnitt eines Transsekts durch die Aue (Höser 2009) oder das Vorkommen beider Arten am Hang (Höser 2012). Diese von beiden Arten bevorzugten Böden zeigen aus relativ feinkörnigem Substrat geschichtete Bodenprofile, die durch Perkolation und Tonverlagerung (Lessivierung) intensivsten Grades geprägt sind. Dabei scheint *P. tuberculatus* an die eluvialen, *O. cyaneum* an die mehr illuvialen Bodenmerkmale (Höser 2012) gebunden zu sein.

Für die erstgenannte Bindung sprechen die hier neu vorgestellten Funde von *P. tuberculatus* über der erkennbaren Einlagerungsverdichtung des Unterbodens an sanderseitigen Flachdellen-Talanfängen. Diese Verdichtung im Unterlagernden seines Lebensraums gewährleistet dem *P. tuberculatus* infolge periodischen Wasserstaus einen vertikalen Feuchtegradienten, somit für die Regenwurmart dieselbe ökologische Konsequenz, die das hängende Kapillarwasser (Mückenhausen 1993) im geschichteten Bodenprofil hat (Höser 2000, 2003). Besonders günstig für die Art ist an diesen Standorten vermutlich, dass sich nach abwärts eine flache Hohlform anschließt, die überschüssiges Bodenwasser talwärts abführt. Denn hier konvergiert die Wasserbewegung zur Längsachse der Hohlform hin (Ahnert 1999), versorgt dort die anliegenden, über der Einlagerungsverdichtung gut perkolierbaren Bodenstandorte mit Feuchtigkeit und gewährleistet damit wahrscheinlich das artgemäße Segment im Feuchtegradienten. Eine Bestätigung solcher Merkmale des Habitats von *P. tuberculatus* vermuten wir auch in den hier genannten Ergebnissen, dass diese Art anscheinend auf dem tonreichen Geschiebemergel fehlt und solche Auenböden meidet, die aus Sedimenten von Tschernosem-Gebieten entstanden sind. Im Tschernosem tritt Tonverlagerung nicht ein. Der demzufolge gemeinsam mit Tschernosem-Material in der Aue sedimentierte, mit fein dispergiertem Humus vermischte Ton, wie auch der von Braunerden gebildete, beide stellenweise im Auenboden aufgrund hochflutdynamischer Vorgänge angereichert, werden beide von *P. tuberculatus* gemieden. Sie sind jedoch offensichtlich für *P. antipai* lebensnotwendige Habitat-Faktoren, z.B. in der Form eines Sd-Horizonts (Höser 2008, 2010).

Die genannten Funde von *P. tuberculatus* und *O. cyaneum* an Flachdellen-Talanfängen der Saale-Elster-Platte lassen desweiteren vermuten, dass das Unterlagernde des Bodenprofils, der dort von Eissmann (1970) kartierte glazifluviatile Sand, Interferenzen bedingt, die beiden Regenwurmarten günstige Habitat-Faktoren bieten.

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New earthworm records from various parts of Greece (Oligochaeta: Lumbricidae, Acanthodrilidae, Megascolecidae, Ocnerodrilidae)

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Abstract. Elaboration of new earthworm materials collected from the continental and insular parts of Greece resulted in recording altogether 22 species and subspecies, of which three, namely *Pontodrilus litoralis* (Grube, 1855), *Ocnerodrilus occidentalis* Eisen, 1878 and *Dendrobaena pentheri* (Rosa, 1905) as senior synonym of *Dendrobaena aegea* (Cognetti, 1913) proved to be new to the fauna of Greece. Consequently, the number of the earthworm species recorded for Greece is raised to 59.

Keywords. Earthworms, faunistics, new records, Greece.

INTRODUCTION

The earthworm fauna of continental Greece is quite well-known. After Michaelsen (1902, 1914), several other scientists carried out researches here and published new data from the country (Tzelepis 1943, Omodeo 1955, Karaman 1972, Šapkarev 1972, Michalis 1975a, 1976, 1977, Zicsi 1973, 1974). Finally, Zicsi & Michalis (1981) summarized the knowledge on the lumbricid earthworms of Greece. After this comprehensive work, four new species and many new data were added to the earthworm fauna of Greece (Michalis 1982, 1983, 1987, 1995, Zicsi & Michalis 1993, Szederjesi & Csuzdi 2012).

The situation is just the opposite regarding the Greek islands, from where we have only sporadic data. Only five papers dealt with the insular earthworm fauna; Cognetti (1913) described two new species, *Perelia phoebea* and *Dendrobaena aegea* from Rhodes, and published new data from the island. Michaelsen (1928) described *Eisenia ariadne* from Naxos and recorded the presence of *Octodrilus complanatus* (Dugès, 1828) and *Lumbricus rubellus* Hoffmeister, 1843 from Lemnos. Cognetti (1906) and Černosvitov (1934) published new data from Crete and Michalis (1975b) from the island Kos.

Besides the 54 recorded earthworm species from the family Lumbricidae (Szederjesi & Csuzdi 2012), two species, namely *Microscolex dubius* (Fletcher, 1887) and *M. phosphoreus* Dugès, 1837 from the family Acanthodrilidae (Michalis 1975a, 1975b, 1987, Szederjesi & Csuzdi 2012) and two species, *Pheretima heterochaeta* (Michaelsen, 1891) and *Ph. peregrina* v. *papillosa* (Tzelepis, 1943) from the family Megascolecidae (Michalis 1976, 1982) are also recorded from Greece. To our present knowledge, these two *Pheretima* species are synonyms of *Amynthas corticis* (Kinberg, 1867) (Csuzdi 2012).

In the last decade, researchers of the Hungarian Natural History Museum organized several collecting trips to Greece, including continental and insular regions too. This present paper summarizes the results of the collecting expeditions to the Pindus mountain range, Thrace, Rhodes, Karpathos, Crete, and Naxos between 2012 and 2014.

MATERIAL AND METHODS

Earthworms were collected by the diluted formaldehyde method (Raw 1959), complemented with digging and searching under stones and under the bark of fallen logs. The specimens were killed and fixed in 96% ethanol, then transferred

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into 75% ethanol and deposited in the earthworm collection of the Hungarian Natural History Museum (HNHM). For later molecular studies, some specimens were placed into 96% ethanol.

RESULTS

Family Lumbricidae Rafinesque-Schmaltz, 1815

Aporrectodea caliginosa (Savigny, 1826)

Enterion caliginosum, Savigny 1826: 180.
Allolobophora caliginosa: Zicsi & Michalis 1981: 247., 1993: 302., Michalis 1982: 350., 1987: 61., 1995: 15.
Aporrectodea caliginosa: Szederjesi & Csuzdi 2012: 29.

Material examined. HNHM/16176 2 ex., South Aegean, Rhodes regional unit, Vati, roadside spring E of the village, 75 m, N36°03.225' E27°54.486', leg. J. Kontschán, D. Murányi, 08. 11.2012. HNHM/16188 1 ex., South Aegean, Rhodes regional unit, Afandou, olive groove N of the village, 105 m, N36°18.167' E28°08.964', leg. J. Kontschán, D. Murányi, 13.11.1012. HNHM/16627 1 ex., South Aegean, Naxos regional unit, Mt. Zas, Filoti, vicinity of Zas Cave, 680 m, N37°01.9' E25°29.8', leg. J. Kontschán, D. Murányi, T. Szederjesi, 07.04.2013. HNHM/ 16633 1 ex., Crete, Rethymno regional unit, Ida Mts., spring and its outlet at an archeogical site and taverna, nest of ants, 1380 m, N35°12.388' E24°50.044', leg. J. Kontschán, D. Murányi, T. Szederjesi, 02.04.2013. HNHM/16639 1 ex., Crete, Lasithi regional unit, Zakros, Zakros Spring above the village, wet litter of plane tree, 265 m, N35°06.837' E26°12.827', leg. J. Kontschán, D. Murányi, T. Szederjesi, 04.04.2013. HNHM/16641 1 ex., Crete, Heraklion regional unit, Loutraki, stream and its gorge below the village, plane tree litter, 670 m, N35°03.413' E25°24.887', leg. J. Kontschán, D. Murányi, T. Szederjesi, 05.04.2013. HNHM/16647 1 ex., Crete, Lasithi regional unit, Thriptis Mts, Orino, stream in the village, 625 m, N35°04.883' E25°54.848', leg. J. Kontschán, D. Murányi, T. Szederjesi, 05.04.2013. HNHM/16658 1 ex., Crete, Lasithi regional unit, Agios Georgios, large reservoir below the village, 60 m, N35°03.042' E25°41.750', leg. J. Kontschán, D. Murányi, T. Szederjesi, 05.04.2013. HNHM/16666 1 ex., Crete, Chania regional unit, Lefka Ori Mts, Omalos, rocky grassland W of the village, 1060 m, N35°19.483' E23°53.507', leg. J. Kontschán, D. Murányi, T. Szederjesi, 31.03.2013.

Aporrectodea jassyensis (Michaelsen, 1891)

Allolobophora jassyensis Michaelsen, 1891: 15., Michalis 1987: 62.
Allolobophora jassyensis jassyensis: Zicsi & Michalis 1981: 250., 1993: 303. Michalis 1982: 352., Michalis *et al.* 1989: 5.
Aporrectodea jassyensis: Szederjesi & Csuzdi 2012: 30.

Material examined. HNHM/16075 1 ex., Thrace, Rhodope peripheral unit, Sapka Mts., Kizario, stream and pasture SW of the village, 140 m, N41°03.492' E25°45.672', leg. J. Kontschán, D. Murányi, T. Szederjesi, 27.05.2012. HNHM/ 16640 2 ex., South Aegean, Naxos regional unit, Dhamalas, rocky phrygana W of the village, 260 m, N37°02.921' E25°27.351', leg. J. Kontschán, D. Murányi, T. Szederjesi, 07.04.2013. HNHM/ 16644 1 ex., Crete, Lasithi regional unit, Karidi, rocky grassland W of the village, 290 m, N35°07.912' E26°12.849', leg. J. Kontschán, D. Murányi, T. Szederjesi, 04.04.2013.

Aporrectodea rosea (Savigny, 1826)

Enterion roseum Savigny, 1826: 182.
Allolobophora rosea: Zicsi & Michalis 1981: 249., Michalis 1975: 204., 1976: 156., 1977: 286., 1982: 350., 1987: 62.
Allolobophora rosea f. *typica*: Michalis 1975: 189.
Allolobophora rosea bimastoides: Michalis 1982: 350.

Material examined. HNHM/16626 1 ex., South Aegean, Naxos regional unit, Mt. Zas, Filoti, vicinity of Zas Cave, 680 m, N37°01.9' E25°29.8', leg. J. Kontschán, D. Murányi, T. Szederjesi, 07.04.2013. HNHM/16637 2 ex., South Aegean, Naxos regional unit, Ghalini, open

stream at the village, 35 m, N37°06.888' E25°25.715', leg. J. Kontschán, D. Murányi, T. Szederjesi, 06.04.2013.

Dendrobaena attemsi (Michaelsen, 1902)

Helodrilus (Dendrobaena) attemsi Michaelsen, 1902: 74.
Dendrobaena attemsi: Zicsi & Michalis 1981: 258., Michalis 1982: 356., Szederjesi & Csuzdi 2012: 31.

Material examined. HNMH/16657 3 ex., South Aegean, Naxos regional unit, Koronidha, streamin a gorge below the village, wet soil, 455 m, N37°08.580' E25°31.857', leg. J. Kontschán, D. Murányi, T. Szederjesi, 06.04.2013. HNHM/ 16946 1 ex., Thessaly, Trikala peripheral unit, Lakmos Mts., Chaliki, stream below Verliga Waterfall, 1935 m, N39°40.674' E21°07.818', leg. T. Kovács, D. Murányi, 09.05.2014.

Dendrobaena byblica byblica (Rosa, 1893)

Allolobophora byblica Rosa, 1893: 4–5.
Dendrobaena byblica: Zicsi & Michalis 1981: 259., Michalis 1982: 356., Michalis *et al.* 1989: 5.
Eiseniella oltenica: Zicsi & Michalis 1981: 243.
Dendrobaena byblica byblica: Szederjesi & Csuzdi 2012: 31.

Material examined. HNHM/16178 1 ex., South Aegean, Rhodes regional unit, Platania, 'Koinotis Platania' Spring W of the village, 285 m, N36°15.321' E28°00.129', leg. J Kontschán, D. Murányi. 09.11.2012. HNHM/16185 1 ex., South Aegean, Karpathos regional unit, Spoa, Plakakia, open spring along the road, 215 m, N35°39.380' E27°09.474', leg. J. Kontschán, d. Murányi, 11.11.2012. HNHM/16187 1 ex., South Aegean, Rhodes regional unit, Petaloudes, 'Butterfly Valley', stream gorge, 190 m, N36° 20.269' E28°03.716', leg. J. Kotschán, D. Murányi, 13.11.2012. HNHM/16620 1 ex., Crete, Heraklion regional unit, Agii Deka, small river and its gallery at Agios Tilos basilica, 160 m, N35°03.704' E24°56.792', leg. J. Kontschán, D. Murányi, T. Szederjesi, 02.04.2013. HNHM/ 16622 3 ex., Crete, Lasithi regional unit, Thriptis Mts, Agios Ioannis, stream and its gallery E of the village, 460 m, N35°03.615' E25°51.938', leg. J. Kontschán, D. Murányi, T. Szederjesi, 05.04. 2013. HNHM/16651 7 ex., Crete, Rethymno regional unit, Moni Veni, springs at the monastery, soil, 595 m, N35°16.228' E24° 36.377', leg. J. Kontschán, D. Murányi, T. Szederjesi, 01.04.2013. HNHM/16656 2 ex., South Aegean, Naxos regional unit, Koronidha, streamin a gorge below the village, wet soil, 455 m, N37°08.580' E25°31.857', leg. J. Kontschán, D. Murányi, T. Szederjesi, 06.04.2013. HNHM/ 16660 1 ex., Crete, Chania regional unit, Kakopetros, stream and its plane tree gallery near the village, plane tree litter, 430 m, N35°24.803' E23°45.391', leg. J. Kontschán, D. Murányi, T. Szederjesi, 31.03.2013. HNHM/16661 4 ex., Crete, Lasithi regional unit, Zakros, stream and its plane tree gallery N of the village, mixed soil and leaf litter, 190 m, N35°06.918' E26°13.153', leg. J. Kontschán, D. Murányi, T. Szederjesi, 04. 04.2013. HNHM/16662 4 ex., Crete, Rethymno regional unit, Mirthios, D. Dason Rethymnis spring E of the village, 155 m, N35°17.619' E24° 33.360', leg. J. Kontschán, D. Murányi, T. Szederjesi, 01.04.2013.

Dendrobaena byblica olympiaca (Michaelsen, 1902)

Dendrobaena ganglbaueri olympiaca Michaelsen, 1902: 47.
Debdrobaena byblica: Zicsi & Michalis 1981: 259 (part.)
Dendrobaena byblica olympiaca: Szederjesi & Csuzdi 2012: 32.

Material examined. HNHM/16625 2 ex., South Aegean, Naxos regional unit, Mt. Zas, Filoti, vicinity of Zas Cave, 680 m, N37°01.9' E25°29.8', leg. J. Kontschán, D. Murányi, T. Szederjesi, 07.04.2013. HNHM/16629 4 ex., South Aegean, Naxos regional unit, Apiranthos, olive orchard E of the village, 525 m, N37°04.408' E25°31.842', leg. J. Kontschán, D. Murányi, T. Szederjesi, 07.04.2013. HNHM/ 16649 2 ex., South Aegean, Naxos regional unit, Koronidha, stream above the village, 670 m, N37°08.071' E25°31.507', leg. J. Kontschán, D. Murányi, T. Szederjesi, 06.04.2013.

Dendrobaena cognettii (Michaelsen, 1903)

Helodrilus cognettii Michaelsen, 1903: 130.
Dendrobaena cognettii: Zicsi & Michalis 1981: 260., 1993: 306., Michalis 1982: 356., Szederjesi & Csuzdi 2012: 32.

Material examined. HNHM/16630 1 ex., South Aegean, Naxos regional unit, Apiranthos, olive orchard E of the village, 525 m, N37°04.408' E25°31.842', leg. J. Kontschán, D. Murányi, T. Szederjesi, 07.04.2013.

Dendrobaena hortensis (Michaelsen, 1890)

Allolobophora subrubicunda var. *hortensis* Michaelsen, 1890: 15.
Dendrobaena hibernica (Friend, 1892): Michalis 1982: 356.
Dendrobaena hortensis: Michalis 1995: 16., Szederjesi & Csuzdi 2012: 32.

Material examined. HNHM/16180 1 ex., South Aegean, Rhodes regional unit, Prophitis Ilias, rocky cedar forest at the monastery, 605 m, N36°16.624' E27°56.543', leg. J. Kontschán, D. Murányi, 07.11.2012. HNHM/16352 1 ex., South Aegean, Rhodes regional unit, Salakos, 'Butterfly River', a gorge NE of the city, 135 m, N36°17.391' E27°57.007', leg. J. Kontschán, D. Murányi, 10.11.2012. HNHM/16632 5 ex., Crete, Rethymno regional unit, Ida Mts., spring and its outlet at an archeogical site and taverna, nest of ants, 1380 m, N35°12.388' E24°50.044', leg. J. Kontschán, D. Murányi, T. Szederjesi, 02.04. 2013. HNHM/16642 2 ex., Crete, Heraklion regional unit, Loutraki, stream and its gorge below the village, plane tree litter, 670 m, N35°03.413' E25°24.887', leg. J. Kontschán, D. Murányi, T. Szederjesi, 05.04.2013.

Dendrobaena pentheri (Rosa, 1905)

Allolobophora (Notogama) pentheri Rosa, 1905: 1.
Dendrobaena pentheri: Szederjesi *et al.* 2014: 560.
Helodrilus (Dendrobaena) aegeus: Cognetti 1913: 4. **Syn. nov.**
Dendrobaena aegea: Zicsi & Michalis 1981: 260.

Material examined. HNHM/16179 1 ex., South Aegean, Rhodes regional unit, Prophitis Ilias, rocky cedar forest at the monastery, 605 m, N36°16.624' E27°56.543', leg. J. Kontschán, D. Murányi, 07.11.2012. HNHM/16181 3 ex., South Aegean, Rhodes regional unit, Aghios Nektarios, pine forest E of the monastery, 145 m, N36° 15.943' E28°04.822', leg. J. Kontschán, D. Murányi, 14.11.2012. HNHM/16184 3 ex., South Aegean, Rhodes regional unit, Mt. Atavyros peak region, rocky grassland, 1095 m, N36°12.233' E27°51.913', leg. J. Kontschán, D. Murányi, 07.11.2012. HNHM/16186 1 ex., South Aegean, Karpathos regional unit, Lefkos, pine forest S of the village, 135 m, N35°35.730' E27°05.577', leg. J. Kontschán, D. Murányi, 12.11.2012.

Remarks. Cognetti (1913) described *Dendrobaena aegea* from Rhodes. According to the original description, this species is very similar to *D. pentheri*; the slight differences are in the position of the tubercles (29–31 *vs*. ½ 28–½ 32) and the opening of the spermathecal pores (*d vs. d*–M).

Zicsi & Michalis (1981) also recorded *D. aegea* from Rhodes and mentioned that their specimens differ from the type material in the length of the tubercula pubertatis which is on ½ 28–½ 32.

The *Dendrobaena aegea* specimens (HNHM/ 6449) reported by Zicsi & Michalis (1981) and two syntype specimens (HNHM/12675), and also *D. pentheri* specimens from Turkey (HNHM/ 16583, 16604) and Cyprus (HNHM/1 4664) were re-examined to clear this question.

All the examined specimens' tubercles show very similar extension, stretching from *1/n* 28 to *1/n* 32, the *D. aegea* syntypes examined have tubercles on 29–½ 32. The position of the spermathecal pores show geographic transition. The spermathecae of the specimens from Rhodes open in setal line *d*, from Turkey in setal line *d* or just above *d*, and from Cyprus the specimens has openings between *d* and the mid-dorsal line, or

near the mid-dorsal line. Besides, all specimens have tanylobic head.

Considering all these facts *D. aegea* is proposed as a synonym of *Dendrobaena pentheri* and in this sense *D. pentheri* is a new species name in the list of the earthworm fauna of Greece.

Dendrobaena veneta (Rosa, 1886)

Allolobophora veneta Rosa, 1886: 674.
Dendrobaena veneta: Zicsi & Michalis 1981: 258., Michalis 1982: 355., 1995: 16.
Dendrobaena veneta veneta: Szederjesi & Csuzdi 2012: 34.

Material examined. HNHM/16189 6 ex., South Aegean, Rhodes regional unit, Afandou, olive groove N of the village, 105 m, N36°18.167' E28°08.964', leg. J. Kontschán, D. Murányi, 13.11.1012. HNHM/16619 1 ex., Crete, Heraklion regional unit, Agii Deka, small river and its gallery at Agios Tilos basilica, 160 m, N35°03.704' E24°56.792', leg. J. Kontschán, D. Murányi, T. Szederjesi, 02.04.2013. HNHM/ 16631 1 ex., Crete, Rethymno regional unit, Ida Mts., spring and its outlet at an archeogical site and taverna, nest of ants, 1380 m, N35°12.388' E24°50.044', leg. J. Kontschán, D. Murányi, T. Szederjesi, 02.04.2013. HNHM/16635 2 ex., Crete, Chania regional unit, Lefka Ori Mts, Samaria, spring in oak stand at the rest area, 1250 m, N35°18.481' E23°55.051', leg. J. Kontschán, D. Murányi, T. Szederjesi, 31.03.2013. HNHM/ 16643 1 ex., Crete, Lasithi regional unit, Dikti Mts., Pinakiano, slow stream in a meadow, W of the village, 815 m, N35°11.615' E25°25.976', leg. J. Kontschán, D. Murányi, T. Szederjesi, 03.04.2013. HNHM/16648 2 ex., Crete, Rethymno regional unit, Ida Mts., limestone rocks at a pasture towards the observatory, 1480 m, N35° 12.560' E24°52.536', leg. J. Kontschán, D. Murányi, T. Szederjesi, 02.04.2013.

Dendrodrilus rubidus subrubicundus (Eisen, 1873)

Allolobophora subrubicunda Eisen, 1873: 51.
Dendrobaena rubida subrubicunda: Zicsi & Michalis 1981: 257., Michalis 1982: 355., 1987: 63.
Dendrodrilus rubidus subrubicundus: Szederjesi & Csuzdi 2012: 35.

Material examined. HNHM/16183 1 ex., South Aegean, Karpathos regional unit, Aperi, spring and stream in the village, 265 m, N35°32.995' E27°10.187', leg. J. Kontschán, D. Murányi, 11.11.2012. HNHM/16664 1 ex., South Aegean, Naxos regional unit, Koronidha, stream above the village, 670 m, N37°08.071' E25° 31.507', leg. J. Kontschán, D. Murányi, T. Szederjesi, 06.04.2013.

Eisenia fetida (Savigny, 1826)

Enterion fetidum Savigny, 1826: 182.
Eisenia foetida: Zicsi & Michalis 1981: 254., Michalis 1982: 353., 1987: 63.
Eisenia fetida: Szederjesi & Csuzdi 2012: 35.

Material examined. HNHM/16182 4 ex., South Aegean, Karpathos regional unit, Aperi, spring and stream in the village, 265 m, N35°32.995' E27°10.187', leg. J. Kontschán, D. Murányi, 11.11.2012. HNHM/16663 1 ex., South Aegean, Naxos regional unit, Koronidha, stream above the village, 670 m, N37°08.071' E25° 31.507', leg. J. Kontschán, D. Murányi, T. Szederjesi, 06.04.2013.

Eisenia oreophila Szederjesi & Csuzdi, 2012

Eisenia oreophila Szederjesi & Csuzdi, 2012: 36.

Material examined. HNHM/16947 2 ex., Thessaly, Trikala peripheral unit, Lakmos Mts., Chaliki, open stream SW of the village, 1430 m, N39°40.267' E21°09.176', leg. T. Kovács, D. Murányi, 09.05.2014.

Remark. The specimens were found near the type locality.

Eiseniella tetraedra (Savigny, 1826)

Enterion tetraedrum Savigny, 1826: 184.
Eiseniella tetraedra tetraedra: Zicsi & Michalis 1981: 242., 1993: 308., Michalis 1982: 524., 1995: 16.
Eiseniella tetraedra: Michalis 1987: 63., Szederjesi & Csuzdi 2012: 37.

Material examined. HNHM/16177 5 ex., South Aegean, Rhodes regional unit, Vati, roadside spring E of the village, 75 m, N36°03.225' E27°54.486', leg. J. Kontschán, D. Murányi, 08.11.2012. HNHM/16621 1 ex., Crete, Heraklion regional unit, Agii Deka, small river and its gallery at Agios Tilos basilica, 160 m, N35°03.704' E24°56.792', leg. J. Kontschán, D. Murányi, T. Szederjesi, 02.04.2013. HNHM/16623 1 ex., Crete, Lasithi regional unit, Thriptis Mts, Agios Ioannis, stream and its gallery E of the village, 460 m, N35°03.615' E25°51.938', leg. J. Kontschán, D. Murányi, T. Szederjesi, 05.04.2013. HNHM/16628 1 ex., South Aegean, Naxos regional unit, Mt. Zas, Filoti, vicinity of Zas Cave, 680 m, N37°01.9' E25°29.8', leg. J. Kontschán, D. Murányi, T. Szederjesi, 07.04.2013. HNHM/16634 2 ex., Crete, Rethymno regional unit, Ida Mts., spring and its outlet at an archeogical site and taverna, nest of ants, 1380 m, N35°12.388' E24°50.044', leg. J. Kontschán, D. Murányi, T. Szederjesi, 02.04.2013. HNHM/16638 2 ex., South Aegean, Naxos regional unit, Ghalini, open stream at the village, 35 m, N37°06.888' E25°25.715', leg. J. Kontschán, D. Murányi, T. Szederjesi, 06.04.2013. HNHM/16646 2 ex., Crete, Rethymno regional unit, Sisarcha, stream and its plane tree gallery N of the village, plane tree litter, 575 m, N35°18.073' E24°54.800', leg. J. Kontschán, D. Murányi, T. Szederjesi, 03.04.2013. HNHM/16655 2 ex., Crete, Chania regional unit, Skafi, stream and its plane tree gallery S of the village, mixed soil and plane tree litter, 370 m, N35°18.806' E23° 47.612', leg. J. Kontschán, D. Murányi, T. Szederjesi, 31.03.2013.

Lumbricus rubellus Hoffmeister, 1843

Lumbricus rubellus Hoffmeister, 1843: 187., Zicsi & Michalis 1981: 255., Michalis 1975: 207., 1976: 163., 1982: 358., 1987: 63.

Material examined. HNHM/16069 1 ex., Thrace, Rhodope peripheral unit, Sapka Mts., Nea Sanda, open brook and pasture NE of the village, 790 m, N41°07.965' E25°54.052', leg. J. Kontschán, D. Murányi, T. Szederjesi, 26.05.2012. HNHM/16659 1 ex., Crete, Chania regional unit, Kakopetros, stream and its plane tree gallery near the village, plane tree litter, 430 m, N35°24.803' E23°45.391', leg. J. Kontschán, D. Murányi, T. Szederjesi, 31.03.2013. HNHM/16948 1 ex., West Macedonia, Kozani peripheral unit, Neapoli, Aliakmonas River NE of the city, 555 m, N40°19.976' E21°24.678', leg. T. Kovács, D. Murányi, 08.05.2014.

Octodrilus complanatus (Dugès, 1828)

Lumbricus complanatus Dugès, 1828: 289.
Octodrilus complanatus: Zicsi & Michalis 1981: 256., 1993: 305., Michalis 1982: 357., 1987: 64., Szederjesi & Csuzdi 2012: 38.
Octodrilus peleensis: Michalis, 1995: 15–20.

Material examined. HNHM/16092 3 ex., Thrace, Evros peripheral unit, Loutra Traianoupolis, river and thermal spring at the ruins, 15 m, N40°51.889' E26°01.881', leg. J. Kontschán, D. Murányi, T. Szederjesi, 28.05.2012. HNHM/16616 1 ex., HNHM/16617 2 ex., Crete, Rethymno regional unit, Axos, spring S of the village, 590 m, N35°17.934' E24°50.485', leg. J. Kontschán, D. Murányi, T. Szederjesi, 02.04.2013. HNHM/16618 3 ex., Crete, Heraklion regional unit, Agii Deka, small river and its gallery at Agios Tilos basilica, 160 m, N35°03.704' E24°56.792', leg. J. Kontschán, D. Murányi, T. Szederjesi, 02.04.2013. HNHM/16645 1 ex., Crete, Rethymno regional unit, Sisarcha, stream and its plane tree gallery N of the village, plane tree litter, 575 m, N35°18.073' E24°54.800', leg. J. Kontschán, D. Murányi, T. Szederjesi, 03.04.2013. HNHM/16650 1 ex., HNHM/16652 6 ex., Crete, Rethymno regional unit, Moni Veni, springs at the monastery, soil, 595 m, N35°16.228' E24°36.377', leg. J. Kontschán, D. Murányi, T. Szederjesi, 01.04.2013. HNHM/16653 1 ex., Crete, Rethymno regional unit, Apostoli, stream and its plane tree gallery N of the village, 320 m, N35°16.211' E24°36.821', leg. J. Kontschán, D. Murányi, T. Szederjesi, 01.04.2013. HNHM/16654 1 ex., Crete, Rethymno regional unit, Goulediana, olive grove with oak stands at the village, 440 m, N35°17.206'

E24°29.949', leg. J. Kontschán, D. Murányi, T. Szederjesi, 01.04.2013. HNHM/16665 1 ex., Crete, Lasithi regional unit, Dikti Mts., Katharo, rocky evergreen oak forest E of the settlement, mixed soil and leaf litter, 1070 m, N35°09.242' E25°35.185', leg. J. Kontschán, D. Murányi, T. Szederjesi, 03.04.2013.

Octodrilus croaticus (Rosa, 1895)

Allolobophora lissaensis var. *croatica* Rosa, 1895: 5.
Octodrilus croaticus: Zicsi & Michalis 1981: 257., 1993: 305., Michalis 1982: 358., Szederjesi & Csuzdi 2012: 39.

Material examined. HNHM/16944 2 ex., Thessaly, Trikala peripheral unit, Lakmos Mts., Chaliki, rocky grassland W of the village, 1715 m, N39°40.516' E21°08.583', leg. T. Kovács, D. Murányi, 09.05.2014. HNHM/16945 3 ex., Thessaly, Trikala peripheral unit, Lakmos Mts., Chaliki, stream below Verliga Waterfall, 1935 m, N39°40.674' E21°07.818', leg. T. Kovács, D. Murányi, 09.05.2014.

Octodrilus transpadanus (Rosa, 1884)

Allolobophora transpadana Rosa, 1884: 45.
Octodrilus transpadanus: Zicsi & Michalis 1981: 257., 1993: 305., Michalis 1982: 358., 1995: 16., Szederjesi & Csuzdi 2012: 39.
Octodrilus transpadanum: Michalis 1987: 64.

Material examined. HNHM/16076 4 ex., HNHM/16079 4 ex., Thrace, Evros peripheral unit, Lesitse Mts., Loutros, stream and its gallery N of the village, 55 m, N40°55.485' E26°03.673', leg. J. Kontschán, D. Murányi, T. Szederjesi, 27.05.2012. HNHM/16086 3 ex., Thrace, Rhodope peripheral unit, Tsifliki, slow stream SW of the village, 35 m, N41°03.085' E25°37.569', leg. J. Kontschán, D. Murányi, T. Szederjesi, 26.05. 2012.

Family Acanthodrilidae Claus, 1880

Microscolex dubius (Fletcher, 1887)

Eudrilus dubius Fletcher, 1887: 378.
Microscolex dubius: Cognetti 1913: 1., Michalis 1975a: 202., 1976: 154., 1985: 348., 1987: 61., Szederjesi & Csuzdi 2012: 40.
Microscolex dibius: Michalis 1975b: 189.

Material examined. HNHM AF/5565 1 ex., South Aegean, Naxos regional unit, Mt. Zas, Filoti, vicinity of Zas Cave, 680 m, N37°01.9' E25°29.8', leg. J. Kontschán, D. Murányi, T. Szederjesi, 07.04.2013. HNHM AF/5567 1 ex., South Aegean, Naxos regional unit, Apiranthos, olive orchard E of the village, 525 m, N37°04.408' E25°31.842', leg. J. Kontschán, D. Murányi, T. Szederjesi, 07.04.2013. HNHM AF/5568 1 ex., Crete, Heraklion regional unit, Krasi, spring system in the village, 610 m, N35°14.010' E25°28.154', leg. J. Kontschán, D. Murányi, T. Szederjesi, 03.04.2013. HNHM AF/5569 5 ex., Crete, Chania regional unit, Sougia, seashore tamarisk stands at the village, 0 m, N35°14.917' E23°48.706', leg. J. Kontschán, D. Murányi, T. Szederjesi, 31.03.2013.

Microscolex phosphoreus Dugès, 1837

Lumbricus phosphoreus Dugès, 1837: 17.
Microscolex phosphoreus: Michalis 1975a: 202., 1976: 154.

Material examined. HNHM AF/5566 1 ex., South Aegean, Naxos regional unit, Mt. Zas, Filoti, vicinity of Zas Cave, 680 m, N37°01.9' E25°29.8', leg. J. Kontschán, D. Murányi, T. Szederjesi, 07.04.2013.

Family Megascolecidae Rosa, 1891

Pontodrilus litoralis (Grube, 1855)

Lumbricus litoralis Grube, 1855: 127.
Pontodrilus litoralis: Blakemore 2007: 4.

Material examined. HNHM AF/5562 6 ex., Thrace, Evros peripheral unit, Dikelle, rocky seashore SE of the village, 0 m, N40°50.910' E25°42.440', leg. J. Kontschán, D. Murányi, T. Szederjesi, 27.05.2012.

Remarks. Pontodrilus litoralis is a cosmopolitan shoreline species, distributed from the

Mediterranean see-shores to India (Narayanan *et al.* 2014) the Caribbean (Csuzdi & Pavlíček 2009) and the pacific regions (Blakemore 2007). This is the first record from Greece.

Family Ocnerodrilidae Beddard, 1891

Ocnerodrilus occidentalis Eisen, 1878

Ocnerodrilus occidentalis Eisen, 1878: 10., Blakemore 2008: 149.

Material examined. HNHM AF/5561 1 ex., South Aegean, Rhodes regional unit, Aghios Nektarios, pine forest E of the monastery, 145 m, N36°15.943' E28°04.822', leg. J. Kontschán, D. Murányi 14.11.2012.

Remark. This species is new to the fauna of Greece.

DISCUSSION

Out of the 22 earthworm species and subspecies found, three proved to be new to the fauna of Greece. *Dendrobaena pentheri* was described from Turkey (Rosa 1905). It has later been reported from Azerbaijan (as *Helodrilus (Eisenia) schemachaensis* Michaelsen, 1910) Gerogia, Armenia (Kvavadze 1985) and, recently from Cyprus (Pavlíček & Csuzdi 2006, Pavlíček *et al.* 2010). Here we proved that *D. aegea* described from Rhodes is a synonym of *Dendrobaena pentheri* and in this sense *D. pentheri* is a new species name in the list of the earthworm species of Greece.

Pontodrilus litoralis is of uncertain origin (Blakemore 2007) and found all over the world on the shorelines of warmer oceans and seas. Our specimens were found in seashore debris on the Aegean coast.

The South American *Ocnerodrilus occidentalis* is widespread as well in tropical and Mediterranean regions, and can be found even in cooler climates, e.g. in Hungary in greenhouses (Csuzdi *et al.* 2007).

Together with these new records, the number of earthworm species recorded for Greece is 59.

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New records for the pseudoscorpion fauna of the Bakony Mts, Hungary (Arachnida: Pseudoscorpiones)

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Abstract. The pseudoscorpion fauna of the Bakony Mts, Hungary is investigated. Thirteen species are recorded, seven of them new to the area. *Neobisium brevidigitatum* (Beier, 1928) and *Withius hispanus* (L. Koch, 1873) are new for the fauna of Hungary.

Keywords. Pseudoscorpions, Hungary, faunistics, new records.

INTRODUCTION

The Bakony Mountains are situated at the western part of Hungary, north of Lake Balaton. In a wider sense the Balaton Uplands and the Keszthelyi Mountains also belong to the Bakony Mts, consequently these areas are also covered.

Tömösváry (1882) carried out the first faunistic study of the Bakony Mts in which he recorded *Neobisium carcinoides* (Hermann, 1804) (as *Obisium carcinoides* Hermann, 1804), *Neobisium sylvaticum* C. L. Koch, 1835 (as *Obisium sylvaticum* C. L. Koch, 1835), *Roncus lubricus* L. Koch, 1873, *Chernes cimicoides* (Fabricius, 1793), *Dinocheirus panzeri* C. L. Koch, 1837 (as *Chernes rufeolus* Simon, 1879), *Chelifer cancroides* (Linnaeus, 1758), *Dactylochelifer latreillii* Leach, 1817 (as *Chelifer degeeri* C. Koch, 1837), and *Rhacochelifer peculiaris* (L. Koch, 1873) (as *Chelifer peculiaris* L. Koch, 1873). Later Daday (1888) added *Withius piger* (Simon, 1878) (as *Chelifer subruber* Simon) to the species list of the region (synonymies after Harvey 2013).

During his surveys Loksa (1960, 1966) broadened the list with *Chthonius tetrachelatus* (Preyssler, 1790), *Neobisium erythrodactylum* (L. Koch, 1873) and *Neobisium simile* (L. Koch, 1873). In the 21th century Novák (2011) and Novák & Kutasi (2014) have investigated the pseudoscorpion fauna of the Bakony Mts, and reported three species new to the area: *Chthonius ressli* Beier, 1956, *Pselaphocernes scorpioides* (Hermann, 1804) and *Atemnus politus* (Simon, 1878).

The aim of this paper is to contribute to our knowledge on the pseudoscorpion fauna of the region.

MATERIAL AND METHODS

Within this survey the pseudoscorpion material of the Hungarian Natural History Museum and the Bakony Museum of the Hungarian Natural History Museum were studied. The specimens were collected by sampling, sifting and using pitfall traps. Acronyms of the collectors are as the followings: AP – Attila Podlussány; CsK – Csaba Kutasi; IK – István Kovács; JW – János Wachsmann; LSz – László Szalay; LT – László Tóth; TN – Tamás Németh; VSz – Vilmos Székessy; ZKa – Zoltán Kaszab; ZKo – Zoltán Korsós.

The material was examined using stereo and compound light microscope. The specimens were

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cleared in lactic acid. Drawings were made with the aid of a Zeiss Axioskop 2 microscope. Measurements were carried out by the use of Olympus Soft Imaging analySIS work 5.0 software. The specimens are preserved in 70% ethanol and deposited at the Hungarian Natural History Museum and at the HNHM Bakony Museum. Each item is accompanied by an inventory number ('HNHM Pseud-Nr.' in case of Hungarian Natural History Museum and 'NHMB Pseud-Nr.' in case of HNHM Bakony Museum).

RESULTS

List of species

Family Chthoniidae Daday, 1888

Chthonius (Ephippiochthonius) tetrachelatus (Preyssler, 1790)

Locality. Zirc: 08.1896, JW (2♀ HNHM Pseud-1430).

Remarks. *Chthonius tetrachelatus* is a common species in Hungary (Kárpáthegyi 2007). It has been reported earlier from the area by Loksa (1966) and Novák (2011).

Family Neobisiidae Chamberlin, 1930

Neobisium brevidigitatum (Beier, 1928)

(Figures 1A–D)

Locality. Vászoly, 15.05.1941, ZKa&VSz (1♂, 1♀ HNHM Pseud-1385).

Short description of the specimens. Carapace (Fig. 1A) as long as broad, smooth, epistome triangular, two pairs of well-developed eyes; 21–22 long setae and 1–2 preocular setae on each side; setal formula: 4:6:4:7–8.

Coxal area. Manducatory process with 6 setae, pedipalpal coxa with 10–14 setae; pedal coxa I with 8–9 setae; II: 5–8; III: 6–10; IV: 10–14. Anterolateral process of coxa I long and triangular; medial process prominent, with denticles.

Opisthosoma. Chaetotaxy of tergites I–X: 8:10:10:11:12:11:11:10:11:10. Tergite XI with 10 setae, 4 of them tactile. Anal cone with 2+2 setae. Chaetotaxy of sternites IV–X: 16:16:13:14:15:14:12. Female genital area: sternite II with 17 small setae, sternite III with 15 small setae in a row. Male ophistosomal characters could not be investigated in detail due to their poor condition.

Chelicera (Fig. 1B). Hand with 7 setae; female spinneret flattened, male prominent and rounded; fixed finger with 10–13 small teeth, movable with 6–8 teeth.

Pedipalp (Fig. 1C). Surface smooth, trochanter with one button-like tubercle on antiaxial face; femur 3.32–3.67, patella 2.02–2.33 times as long as broad. One tubercle on antiaxial face of femur; fixed chelal fingers with 50–55 close-set teeth of equal length; movable chelal finger with 46–50 flattened teeth; trichobothria as in Fig. 1D; distance between trichobothria *ib* and *ist* twice that between *ist* and *it*.

Measurements (in mm) and ratios. Body length 2.72. Carapace 0.81–0.92/0.91. Chelicera 0.53/0.31; movable finger 0.31. Palpal femur 1.02–1.11/0.31(3.32–3.67x), patella 0.73/0.31–0.35 (2.02–2.33x), hand 0.75–0.81, pedicel 0.08–0.11, finger 1.02.

Remarks. This is a new species for the fauna of Hungary. It was previously reported from Georgia, Poland, Slovakia, and from Romania (Harvey 2013).

Neobisium carcinoides (Hermann, 1804)

Localities. Bakonybél, 07.04.1898, JW (1♂: HNHM Pseud-1373); Balatonhenye, Lake Monostori, sifting,10.04.2012, CsK, (1♀ NHMB Pseud-0003); Réde, acacia grove, pitfall trap, 26.05.2011–08.07.2011, CsK (1♂ NHMB Pseud-0011); Tés, 04.04.2012, TN&CsK (1♂ NHMB Pseud-0025); Zirc, Bocskor Hill, 21.10.1941 LSz&IK (2♂, 3♀ HNHM Pseud-1400); Pintér Hill, sifting, 17.10.1941, LSz&IK (1♂, 3♀ HNHM Pseud-1429); (2♂ HNHM Pseud-1397); (1♂, 2♀ HNHM Pseud-1398).

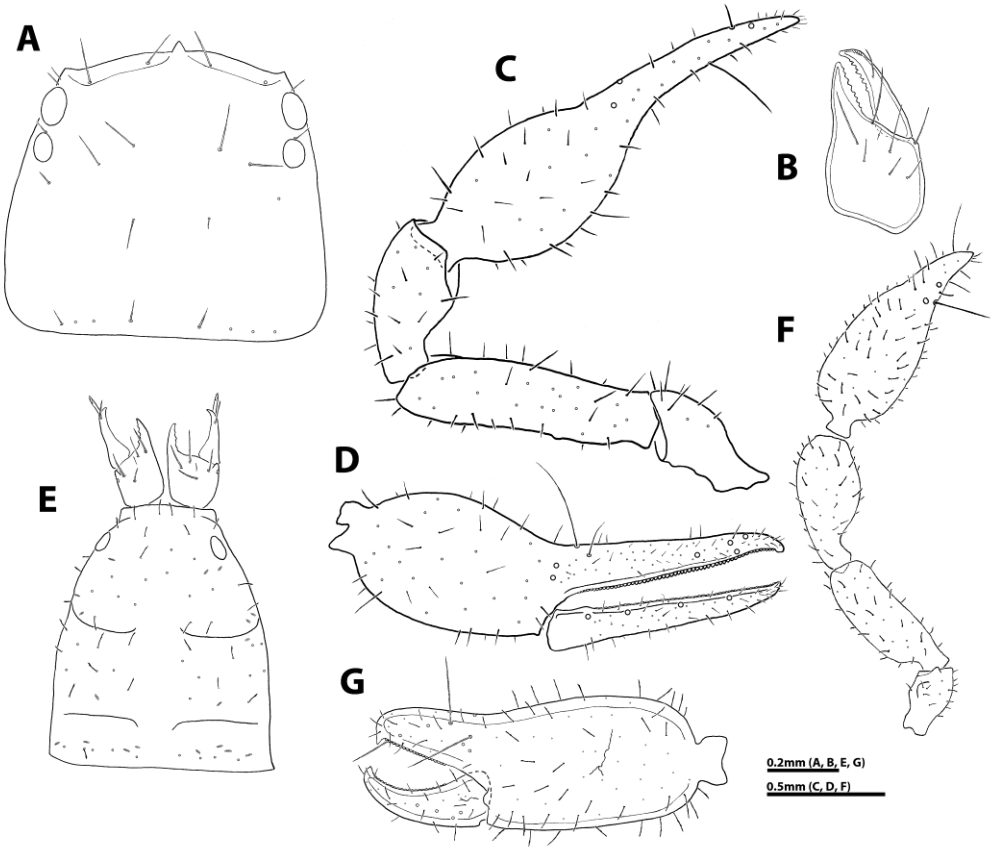

Figure 1. *Neobisium brevidigitatum* ♀: A = carapace, B = right chelicera, C = left pedipalp, dorsal view; D = right chela, lateral view; *Withius hispanus*: E = carapace and chelicerae, F = left pedipalp, G = left chela, lateral view.

Remarks. The species is widespread across Hungary, and it was already known from the area before the present study (Tömösváry 1882, Loksa 1960, Novák 2011).

Neobisium sylvaticum (C. L. Koch, 1835)

Localities. Bakonybél, 07.04.1898, JW (5 ad.: HNHM Pseud-1372); Balatonkenese, Soós Hill, pitfall trap, 03.04.2012, CsK (1♂ NHMB Pseud-0007); Soós Hill, loess steppe, pitfall trap, 03.04.2012–26.04.2012, CsK (6♂, 7♀ NHMB Pseud-0013); 29.09.2011–11.11.2011, CsK (6♂, 6♀ NHMB Pseud-0014); Eplény, Malom Valley, sifting, 26.11.2006, CsK (1♀ NHMB Pseud-0021); Farkasgyepű, 'old Fagetum wood', pitfall trap, 09.12.1975–19.04.1976, LT (6 ad. HNHM Pseud - 1370); Hárskút, Rák-tanya, 01.07.2007, CsK (1♂, 2♀ NHMB Pseud-0039); Hegymagas, 03.11.2006. CsK (1♂ NHMB Pseud-0018); Réde, false acacia grove, pitfall trap, 18.08.2011–23.09. 2011, CsK (1♀ NHMB Pseud-0024); Vászoly, 15.05.1941, ZKa&ISz (1♀ HNHM Pseud-1386); Zirc, Arboretum, pitfall trap, 12.01.2005–29.03.2005, CsK (1♀ NHMB Pseud-0017); Arboretum, sifting, 14.04.2006, AP&CsK (1♀ NHMB Pseud-0028); Bocskor Hill, 21.10.1941 LSz&IK (1♀ HNHM Pseud-1381); (2♀ HNHM Pseud-1401); Pintér Hill, 18.10.1941, LSz&IK (1♂ HNHM Pseud-1383); 17.10.1941, LSz&IK (1♀ HNHM Pseud-1384); (1♀ HNHM Pseud-1399).

Remarks. Common species in Hungary. *N. sylvaticum* was reported from the Bakony Mts before (Tömösváry 1882, Loksa 1966, Novák 2011).

Family Cheiridiidae Hansen, 1894

***Cheiridium museorum* (Leach, 1817)**

Locality. Zirc, Deák Ferenc Street No39, from house, 07.03.2012, CsK (1♀ NHMB Pseud-0004).

Remarks. New species for the fauna of the Bakony Mts.

Family Cheliferidae Risso, 1826

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

Locality. Vászoly, 15.05.1941, ZKa&ISz (1♀ HNHM Pseud-1387).

Remarks. Tömösváry (1882) has reported yet this species from that area.

Family Chernetidae Menge, 1855

***Allochernes peregrinus* Lohmander, 1939**

Locality. Tihany, 15.05.1941, ZKa&VSz (1♀, 2 juv. HNHM Pseud-1380).

Remarks. New for the region. After the Hortobágy National Park (Mahnert 1983) the Bakony Mts is the second occurrence of the species in Hungary.

***Chernes cimicoides* (Fabricius, 1793)**

Locality. Bakonybél, 07.04.1898, JW (2♀ HNHM Pseud-1375).

Remarks. The species has data from several localities from Hungary (Kárpáthegyi 2007), and it was reported from the Bakony Mts by Tömösváry (1882).

***Chernes montigenus* (Simon, 1879)**

Locality. Réde, acacia grove, pitfall trap, 26. 05.2011–08.07.2011, CsK (1♀: NHMB Pseud-0010).

Remarks. New for the area. This is the third known locality of the species in Hungary (Kárpáthegyi 2007).

***Chernes similis* (Beier, 1932)**

Locality. Tihany, 15.05.1941, ZKa&VSz (2♂, 1♀ HNHM Pseud-1379).

Remarks. New for the fauna of the Bakony Mts. The species was known so far only from the Bükk Mts in Hungary (Novák 2012).

***Lamprochernes chyzeri* (Tömösváry, 1882)**

Localities. Noszlop, Széki Forest, oak-hornbeam (*Quercus* sp., *Carpinus betulus*) forest, 25.09.1999, ZKo (1♂ HNHM Pseud-1393).

Remarks. In Hungary the species was known so far only from the Somogy Hills (Tömösváry 1882) and the Csepel Island (Novák 2013), thus the Bakony Mts is its third occurrence in the country.

***Pselaphochernes scorpioides* (Hermann, 1804)**

Locality. Zánka, Pál Hill, under bark of the trees, 19.04.2011, CsK (1♀: NHMB Pseud-0006).

Remarks. *P. scorpioides* has numerous occurrences in Hungary (Kárpáthegyi 2007, Novák 2013). The species was reported from the Bakony Mts. by Novák (2011).

Family Withiidae Chamberlin, 1931

***Withius hispanus* (L. Koch, 1873)**

(Figures 1E–G)

Locality. Berhida, loess steppe, 07.2013. CsK (1♀: NHMB Pseud-0084).

Remarks. The species is reported from Austria, Azerbaijan, Bosnia-Herzegovina, Bulgaria, France, Georgia, Italy, Montenegro, Morocco, Portugal, Russia, Spain, Switzerland, Turkey (Harvey 2013), and recently has been reported from the

neighbouring Slovakia as well (Christophoryová *et al.* 2012).

Short description of the new female specimen. Carapace (Fig. 1E) reddish brown, granulate, with two transverse furrows and a pair of eyes with lens; 52 clavate setae, 6 of them at the anterior and 9 at the posterior margin; 12 slit-like lyrifissures, 8 of which occur along the posterior margin.

Coxal area. Setae acuminate; manducatory process with 2 long and 3 short setae, pedipalpal coxa with 11–13 setae; pedal coxa I with 5–6 setae; II: 5; III: 5–6; IV: 11–16.

Opisthosoma. Tergites granulate. Tergite I partly divided, II-X divided, XI undivided; tergal chaetotaxy tergites I-X (right+left hemitergite): 6+5: 5+4: 6+6: 7+8: 7+8: 6+7: 8+8: 8+8: 7+7: 6+5, tergite XI with 9 setae, 4 of them tactile. Lyrifissures on tergites I-X (right+left hemitergite): 2+2: 3+3: 3+2: 4+4: 3+4: 4+2: 3+4: 3+3: 3+4: 3+4, tergite XI with 2 lyrifissures. Anal cone with 2+2 dorsal setae. Sternite II partly divided, III-X divided, XI undivided. Sternite II with 18 setae; sternites III-IX (right+eft hemisternite): 5+4: 5+5: 7+8: 7+8: 7+8: 7+7: 8+8: 6+6; sternite XI with 12 setae, 2 of them tactile. Genital structure agrees with descriptions of Heurtault (1971) and Christophoryová *et al.* (2012).

Chelicera (Fig. 1E). With 5 setae on hand and one seta on movable finger; fixed and movable fingers with small and non-sclerotized teeth; rallum with 4 blades, serrula exterior with 18 blades; galea with 5 terminal rami.

Pedipalp (Fig. 1F). Palps robust, surface granulate, with clavate setae; chelal hand subcylindrical, movable finger as long as the width of the hand; fixed finger with 19 contiguous teeth, movable finger with 22; trichobotria as in Figure 1G: *it* dorsal, *ist* internal. Pedal tarsus IV bearing a long tactile seta distal to the middle of the article.

Measurements (in mm) and ratios. Body length 3.32; carapace 0.73/0.68 (1.06x); chelicera 0.23/0.13; movable finger 0.17; galea length 0.06. Pedipalp: trochanter 0.31/0.18 (1.68x), femur 0.60/0.22 (2.74x), patella 0.59/0.27 (2.22x), chela with pedicel 0.97/0.34 (2.87x), pedicel 0.08, movable finger length 0.35.

DISCUSSION

During the course of the study 13 pseudoscorpion species belonging to six families were found in the area of the Bakony Mts, seven of which (*Neobisium brevidigitatum*, *Cheiridium museorum*, *Allochernes peregrinus*, *Chernes montigenus*, *C. similis*, *Lamprochernes chyzeri*, *Withius hispanus*) are new for the region, furthermore, *Neobisium brevidigitatum* and *Withius hispanus* are new for the fauna of Hungary. Consequently, the number of pseudoscorpion species known from the Bakony Mts is increased to 22 (Tömösváry 1882, Daday 1888, Loksa 1960, 1966, Novák 2011, Novák&Kutasi 2014).

The main taxonomic characters of *Neobisium brevidigitatum* and *Withius hispanus* correspond to the literature (Beier 1963, Christophoryová *et al.* 2012). However, in the case of *N. brevidigitatum*, a larger variability at the morphometric ratios of femur and tibia was documented. The *W. hispanus* female specimen shows minor differences in the number of carapace setae and slit-like lyrifissures compared to the description of Christophoryová *et al.* (2012).

With respect to our present knowledge regarding to the fauna of Hungary, the occurrence of further species are expected in the Bakony Mts [*Chthonius (Chthonius) ischnocheles* (Hermann, 1804); *Chthonius (Ephippiochthonius) tuberculatus* Hadzi, 1937; *Neobisium validum* (L. Koch, 1873); *Neobisium macrodactylum* (Daday, 1888); *Larca lata* (Hansen, 1884) and *Dendrochernes cyrneus* (L. Koch, 1873.

However, the pseudoscorpion fauna of large areas still remained understudied in Hungary, which indicates the necessity of further investigations on this group in the country.

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Klapálek's *Kamimuria* (Plecoptera: Perlidae) types in the National Museum Prague

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Abstract. Three species of the genus *Kamimuria* Klapálek, 1907 are redescribed or a complementary description is provided on the basis of specimens kept in the National Museum Prague (NMP): male, female and egg of *K. fulvescens* Klapálek, 1912 is redescribed from syntypes, the male of *K. lepida* Klapálek, 1913 is redescribed on the basis of original specimen. Also, a complementary description based on the holotype of *K. similis* is provided. Furthermore, comments are provided on the basis of type or original specimens of the nine additional *Kamimuria* taxa that can be found in the NMP. Distribution area of the genus is discussed and depicted on a map.

Keywords. Stoneflies, *K. fulvescens, K. lepida, K. similis,* redescription, China, Taiwan, Vietnam

INTRODUCTION

Genus *Kamimuria* Klapálek, 1907b was erected for two new and an already described Japanese species, as a subgenus of *Perla* Geoffroy, 1762. Soon, Klapálek elevated it to generic rank (Klapálek 1912a), and later established type species as *Perla tibialis* Pictet, 1841 from Japan (Klapálek 1923). Altogether, he described 15 species in this genus (Klapálek 1907b, 1912a, 1912b, 1913, 1916, 1921, 1923), but the generic definition remained poorly established. Six of his *Kamimuria* were transferred to different genera (*Agnetina* Klapálek, 1907a, *Paragnetina* Klapálek, 1907b, *Tyloperla* Sivec & Stark, 1988 (in: Sivec *et al.,* 1988), *Xanthoneuria* Uchida, 2011 (in: Uchida *et al.* 2011)), while an additional four species were transferred to *Kamimuria* from the genera *Marthamea* Klapálek, 1907a and *Paragnetina*. Illies (1966) even synonymized *Kamimuria* with *Perla*. Finally, Zwick (1977) redefined it as a valid genus, and subsequently it is treated as the Asian sister group of *Perla*.

After his death in 1919, the collection of František (Franz) Klapálek came to Jaromír Šámal, who edited and published many of his half-done manuscript years later (e.g. Klapálek 1923). However, Šámal was executed in 1942, and finally the collection was acquired by the National Museum Prague (NMP) after the World War II, in chaotic order, but survived still in good condition. Since then, many stonefly researchers have studied it and traced most of the types (Bojková & Soldán 2013, Raušer 1968, Sivec *et al.* 1988, Zwick 1982), but still, we are in need of a careful overview as was done on the Plecoptera types of Burmeister, Pictets and Enderlein (Zwick 1971, 1973).

During July 2014, the first author searched and databased all the types that were recognizable, in the frame of a SYNTHESYS project. In this paper the *Kamimuria* types available in the NMP are enumerated. Some of Klapálek's original but non-type *Kamimuria* specimens, especially those that were included in Klapálek's revisionary works ('plesiotypes'), are also enumerated. NMP types of the species originally described as *Kamimuria* but later transferred to other genera (*Agnetina circumscripta* (Klapálek, 1912a), *A. praetusta* (Klapálek, 1912a), *Kamimuria schenklingi* Kla-

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pálek, 1912 (junior synonym of *Tyloperla formosana* (Okamoto, 1912)) and *Xanthoneuria bolivari* (Klapálek, 1907)) are excluded from the present work.

Many type specimens of Klapálek's taxa that were described on the basis of materials borrowed from foreign collections, especially those from Museum National d'Histoire Naturelle, Paris (MNHN) and Zoological Institute, Russian Academy of Sciences, St. Petersburg (RAS) were left in his personal collection after his early death. Later, these were transferred to NMP together with his own properties and treated together as the 'Klapálek Collection' even though these specimens were stated in the original descriptions to be deposited in their original collections. Many of the specimens are even labelled with the museum's name but after a hundred years it is obviously more convenient to keep these specimens together with the bulk of his materials, especially because the Klapálek Collection has just received proper new storage facilities and a well searchable database.

MATERIAL AND METHODS

The specimens examined are stored dry in the Department of Entomology, Natural History Museum, National Museum Prague (NMP).

Specimen terminalia was cleared in KOH and the aedeagus for each was everted with the cold maceration technique (Zwick 1983). Terminalia and aedeagus for each specimen are stored in a microvial with glycerine pinned beneath the specimen. Drawings were made with the aid of a drawing tube applied to a Nikon SMZ800 microscope. SEM images were made using gold-palladium coating and a Hitachi S-2600N scanning electron microscope. Further illustrations were made with Nikon D70s and Leica C cameras. Terminology mainly follows Sivec & Stark (2008).

Distributional data were compiled from literature information from various sources referenced in Plecoptera Species File (PSF) (DeWalt *et al.* 2015). Whereabouts of type localities were traced in various travel reports by, or about the collectors (Basset 2009; Kozlov 1947).

TAXONOMY

Kamimuria amoena Klapálek, 1912a

(Appendix figures 1–2)

Kamimuria amoena Klapálek, 1912: Klapálek, 1912a: 87. (original description of male and female); Klapálek 1923: 21. (complementary description of male and female); Wu 1935: 302. (catalogue); Wu 1938: 49. (monography); Claassen 1940: 121. (catalogue); Zwick 1977: 116. (comb. rev. by removing *Kamimuria* Klapálek, 1907b from synonymy of *Perla* Geoffroy, 1762); Sivec *et al.* 1988: 32. (checklist); Zhiltzova 1995: 12. (type catalogue of RAS specimens); Du *et al.* 1999: 60. (checklist); Sivec & Stark 2008: 137. (checklist); Stark & Sivec 2013: 117. (checklist); DeWalt *et al.* 2015 (catalogue).

Perla amoena (Klapálek, 1912): Illies 1966: 286. (comb. n. by synonymy of *Kamimuria* Klapálek, 1907b with *Perla* Geoffroy, 1762).

Type locality. Sogon Gomba a řekou I-Čju nad Modrou Řekou; and Čerku, basin Modré Řeky, Kham, J.V. Tibet, ve výši 11400' (Sogon Gomba refers to: Qinghai Province, Yushu Tibetan Autonomous Prefecture, upper reaches of Yangtze River between Sogon Gomba monastery and I Chu River, N33°35' E96°35', 3800m; Čerku refers to a village close to Sogon Gomba).

Material examined. Qinghai. Yushu Tibetan Autonomous Prefecture, upper reaches of Yangtze River between Sogon Gomba temple and I Chu River, around N33°35' E96°35', 3800m, end of vii.1900, leg. P.K. Kozlov: 2♀ *syntypes* (NMP, box III.11: pinned, one terminalia is in microvial) (Labels: Zwischen Sogon-Gom / ba u. d. Fl. I-Tschu / oberla d. Blauen Fl. / Kozlow Ende VII. 00. (handwritten); Sogon-gomba – r. / I-cju, ver. Goluboj / *Kozlov.* kon vii 00; amoena / Klapálek; Syntypus! / *K. amoena* Klp. / det. P. Zwick 1980).

Distribution. The species was described on the basis of one male and five females collected in Kham, along the upper reaches of Yangtze River. Apparently, both localities are in Qinghai Pro-

vince, close to the border with Tibet and Sichuan Province. It was not reported since description.

Remarks. In the original description, Klapálek (1912a) stated both the Sogon Gomba (1♂ 3♀) and the Čerku (2♀) syntypes were to be deposited in 'Mus. Cís. Akad. Petrohrad' (RAS). Two Sogon Gomba females remained in his collection and are now kept in NMP (Appendix figs. 1–2).

Kamimuria brunneicornis (Klapálek, 1921)

(Appendix figures 4–5)

Kamimuria brunneicornis (Klapálek, 1921): Sivec *et al.* 1988: 32. (comb. nov.); Du *et al.* 1999: 60. (checklist); Sivec & Stark 2008: 137. (checklist); Stark & Sivec 2013: 117. (checklist); DeWalt *et al.* 2015 (catalogue).

Marthamea brunneicornis Klapálek, 1921: Klapálek 1921: 147. (original description of female); Klapálek 1923: 102. (complementary description of female); Wu 1935: 303. (catalogue); Wu 1938: 62. (monography); Claassen 1940: 125. (catalogue); Illies 1966: 265. (catalogue).

Type locality. Kiang-Si (Jiangxi Province).

Material examined. Jiangxi. 1875, leg. A. David: ♀ *holotype* (NMP, box VI.5: pinned, terminalia and eggs are in microvial) (Labels: 649 / 1 S (handwritten, last two characters illegible; circular label with yellow reverse side); Museum Paris / Kiang-Si / A. David 1875; Typus; black label; *brunneicornis* / Kiang-Si (handwritten); ? *Kamimuria* sp. / det. I. Sivec 1987 / Prirod. Muzej Slov.).

Distribution. The species is known only from the holotype from Jiangxi Province, exact locality is unknown.

Remarks. In the original description, Klapálek (1921) stated the single type was to be deposited in 'Mus. Paris' (MNHM). However, it remained in his collection and now is kept in NMP (Appendix Figs. 4–5).

Kamimuria coarctata Klapálek, 1912a

(Appendix figure 6)

Kamimuria coarctata Klapálek, 1912: Klapálek 1912a: 94. (original description of male); Klapálek 1923: 26. (complementary description of male); Wu 1935: 302. (catalogue); Wu 1938: 52. (monography); Navás 1933: 83. (first data from Zhejiang); Claassen 1940: 122. (catalogue); Zwick 1977: 116. (comb. rev. by removing *Kamimuria* Klapálek, 1907b from synonymy of *Perla* Geoffroy, 1762); Sivec *et al.* 1988: 32. (checklist); Zhiltzova 1995: 12. (type catalogue of RAS specimens); Du *et al.* 1999: 60. (checklist); Sivec & Stark 2008: 137. (checklist); Stark & Sivec 2013: 117. (checklist); DeWalt *et al.* 2015 (catalogue).

Perla coarctata (Klapálek, 1912): Illies 1966: 289. (comb. n. by synonymy of *Kamimuria* Klapálek, 1907b with *Perla* Geoffroy, 1762).

Type locality. China (without any further details) and Nord Pekin (Beijing, northern part of the city or the municipality, N40° E116°).

Material examined. Beijing. North Beijing, N40° E116°, 1865, leg. A. David: ♂ *syntype* (NMP, box III.12: pinned, abdomen without terminalia is in microvial) (Labels: Museum Paris / Nord Pekin / A. David 1865; 1473 (handwritten); 232* / 6 S (handwritten, last character illegible; circular label with yellow reverse side); black label; Lectotypus / *K. coarctata* Klap. ♂ / det. P. Zwick 1980).

Distribution. The species was described on the basis of a male from the vicinity of Beijing, and a second male without exact locality data. Later, it was reported also from Zhejiang Province (Navás 1933), and there are NMP specimens from Jiangxi and Shandong Provinces. If these female specimens are indeed conspecific with the male types, the species has wide distribution in eastern China.

Remarks. In the original description, Klapálek (1912a) stated the male syntype from 'China' collected by Sjantsky was to be deposited in 'Mus. Petrohrad' (RAS), while the male syntype from Nord Pekin was to be deposited in 'Mus. Paříž' (MNHM). The latter remained in his collection and now is kept in NMP, but lacks terminalia (Appendix Fig. 6). The female of this species has never been described. However, there are two females in the NMP, pinned next to the male syntype. One of these has a locality label: Museum Paris / Kiang-Si / A. David 1878 (Jiangxi Province); but lacks an identification label. The

another one has a locality label: Kiautschau / China (Shandong Province, Jiaozhou); and was identified by P. Zwick in 1980.

Kamimuria fulvescens Klapálek, 1912a

(Figures 1–14)

Kamimuria fulvescens Klapálek, 1912: Klapálek 1912a: 89. (original description of male and female); Klapálek 1923: 23. (complementary description of male and female, first record from Shaanxi); Wu 1935: 302. (catalogue); Claassen 1940: 122. (catalogue); Zwick 1977: 116. (comb. rev. by removing *Kamimuria* Klapálek, 1907b from synonymy of *Perla* Geoffroy, 1762); Sivec *et al.* 1988: 32. (synonymy of *K. latior* Klapálek, 1912a with *K. fulvescens*); Zhiltzova 1995: 12. (type catalogue of RAS specimens); Du *et al.* 1999: 60. (species incertae sedis); Du & Sivec 2005: 44. (first record from Gansu); Sivec & Stark 2008: 137. (checklist); Stark & Sivec 2013: 117. (checklist) DeWalt *et al.,* 2015 (catalogue).

Perla fulvescens (Klapálek, 1912): Illies 1966: 290. (comb. n. by synonymy of *Kamimuria* Klapálek, 1907b with *Perla* Geoffroy, 1762).

Kamimuria flavescens Klapálek, 1912 (misspelling): Wu 1935: 55. (monography).

Kamimuria latior Klapálek, 1912: Klapálek 1912a: 91. (original description of female); Klapálek 1923: 24. (complementary description of female); Wu 1935: 303. (catalogue); Claassen 1940: 122. (catalogue); Kimmins 1946: 740. (first record from Tibet); Zwick 1977: 116. (comb. rev. by removing *Kamimuria* Klapálek, 1907b from synonymy of *Perla* Geoffroy, 1762).

Perla latior (Klapálek, 1912): Illies 1966: 290. (comb. n. by synonymy of *Kamimuria* Klapálek, 1907b with *Perla* Geoffroy, 1762).

Type locality. Si-Čuan, Tacienlu and Mou-Pin (Sichuan; Tacienlu refers to: Garzê Tibetan Autonomous Prefecture, Kangding County, Lucheng, N30° E102°; Mou-Pin refers to: Ya'an City, Baoxing County, Baoxing, 30°22' N 102° 49', 1000 m).

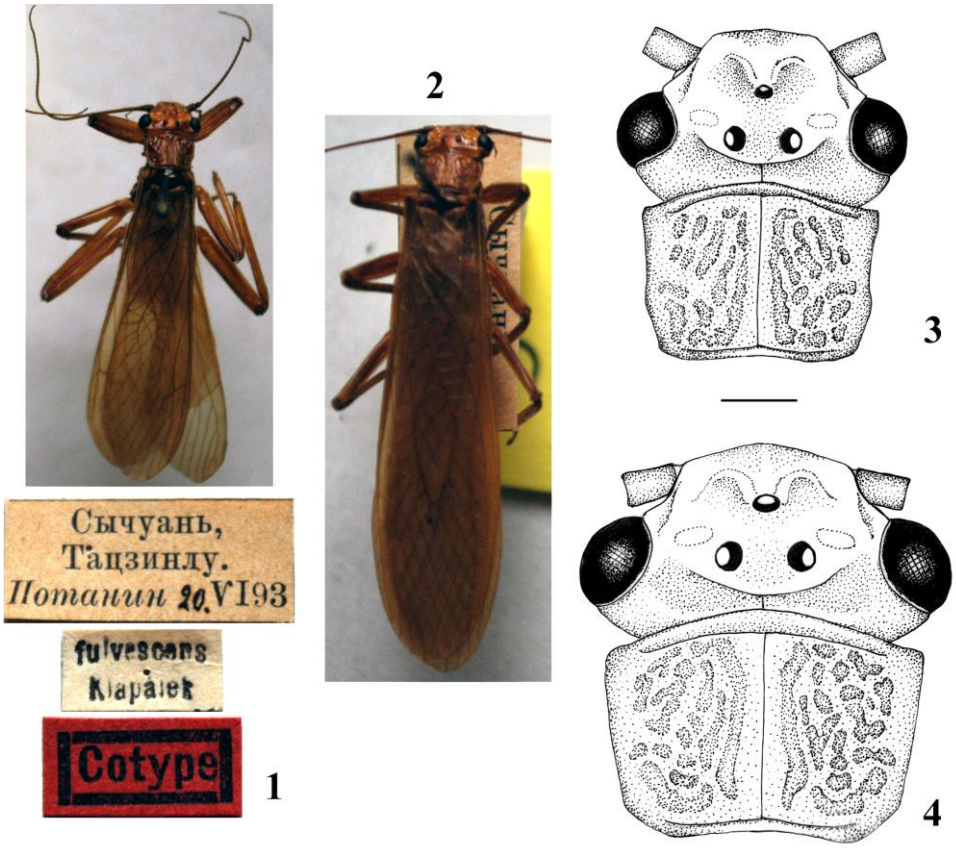
Material examined. Sichuan. Garzê Tibetan Autonomous Prefecture, Kangding County, Lucheng, N30° E102°, 20.vi.1893, leg. G.N. Potanin: 1♂ 1♀ *syntypes* (NMP, box III.11: pinned, both terminalia are in microvial, three eggs are prepared for SEM) (Labels (Fig. 1): Sicuan, / Taczinlu. / *Potanin* 20.VI93; fulvescens / Klapálek; Cotype).

Description. Adult habitus (Figs. 1–4). Large sized species, general colour pale brown. Head pale brown with brown areas posterior to M-line and occiptal suture. Tentorial callosities and M-line distinct; a wrinkle presents between M-line and the lateral margins. Eyes and ocelli are small; distance between posterior ocelli about one and half times diameter of one ocellus. Antennae darker than head. Pronotum square, anterior edges slightly angled; narrower than head with eyes. Its ground colour pale brown, with prominent, darker rugosities. Meso- and metanotum brown. Legs pale brown, wings hyaline, veins brown. Abdomen pale, only the male hemiterga are brown.

Male terminalia (Figs. 5–6). Abdominal segments are covered with soft and pale hairs. Tergum 9 with well delimited mesal lobe that is wider than one third of segment width, and starts from midlength. Sensilla basiconica covers all the lobe; sensillae are mixed with hairs, stout and short on all of the mesal field. Tergum 10 basally deeply cleft, hemiterga half as long as segment length at lateral sides; blunt and bent inwards in dorsal view, basally down-curved while apex bent up in lateral view. Hemiterga bear sensilla basiconica apically and introbasally, covered with fine and pale hairs. Epiproct basally well sclerotized, rounded and setose; paraproct blunt. Cercus long, covered with moderately long setae, each segment bears at least one stronger ventral seta.

Aedeagus (Figs. 8–10). Membranous with a medially subdivided, ventrobasal sclerotized plate. Apically to basal sclerite the aedegus is widened in dorsal view, being the widest at basal third, then gradually tapering; laterally, it is slightly bent ventrad from midlength. Basal portion bald, first sparse spinules occur medioventrally about fourth of aedeagus length. field of spinules become denser from midlength and spread laterally; spinules form a complete ring before apical third. The apical third is covered with larger spines, except bald dorsal surface and complete subapical spine row. The apex is bald around opening.

Female terminalia (Fig. 7). Sterna and terga simple and pale, sternum 8 bears large subgenital plate. The plate is triangular but with apex dis-



Figures 1–4. *Kamimuria fulvescens* Klapálek, 1912a, habitus of syntypes. 1 = habitus of male syntype, and its original labels; 2 = habitus of female syntype; 3 = head of male syntype, dorsal view; 4 = head of female syntype, dorsal view. Scale 1 mm, Figs. 1–2 not to scale.

tinctly notched; width more than half of segment width, slightly overhanging sternum 9. Sternum 7 and the subgenital plate covered with strong setae mixed with fine hairs, remainder of sternum 8, and sterna 9-10 clothed only with fine hairs. Vagina simple, membranous. Epiproct and paraprocts are blunt, cercus long.

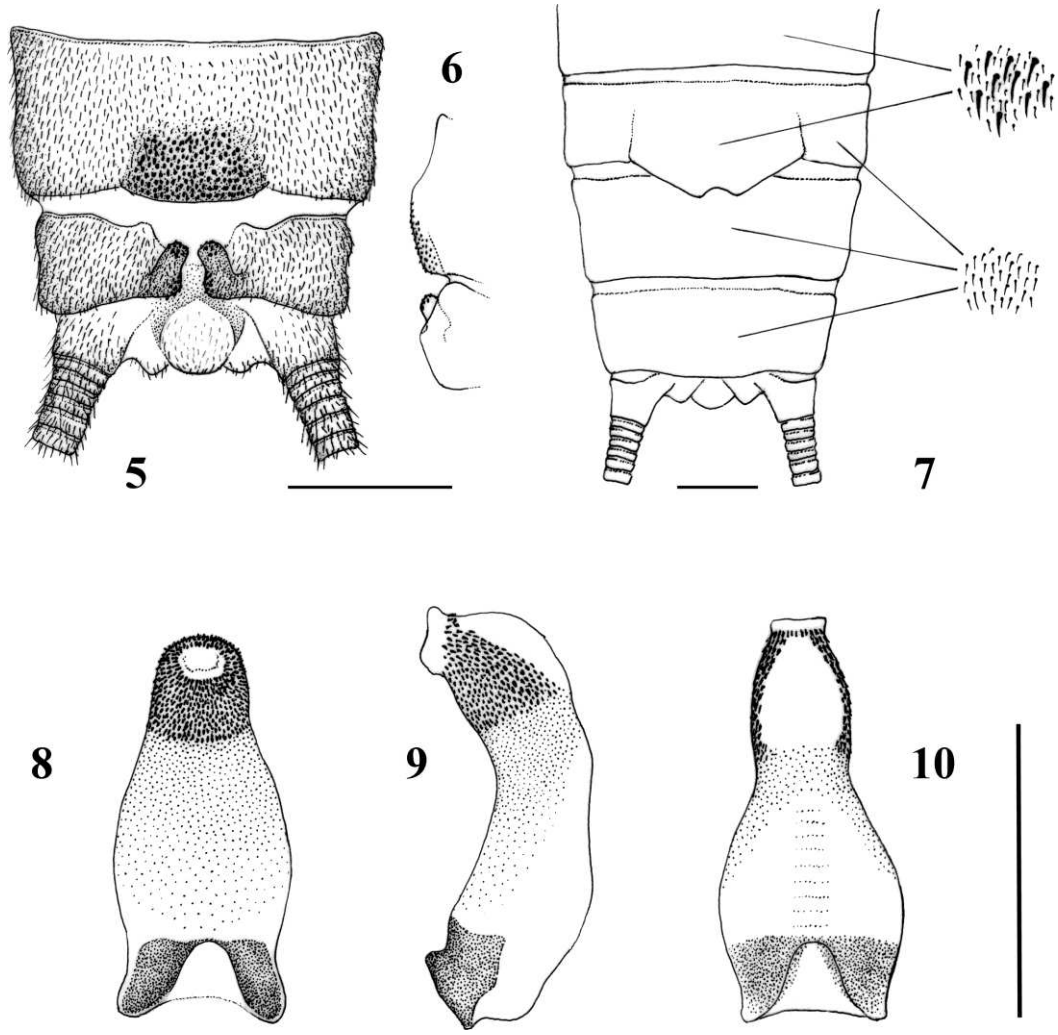
Egg (Figs. 11–14). Chorion dark brown, 0.40–0.45 mm long and 0.25–0.30 mm wide (N=3). Barrel shaped with pointed opercular end, cross section round. Hatching line inconspicuous. Micropyles with slightly raised rim, placed in a transverse row closer to the opercular end. Collar with raised and flanged rim, surrounded by an elongated row of FCIs; anchor not studied. Chorion is smooth in the medial third, opercular and collar end bear rows of hexagonal FCIs. Those on the opercular end with low rim with higher rim on collar end; all bear fine punctations within impression.

Larva. Unknown.

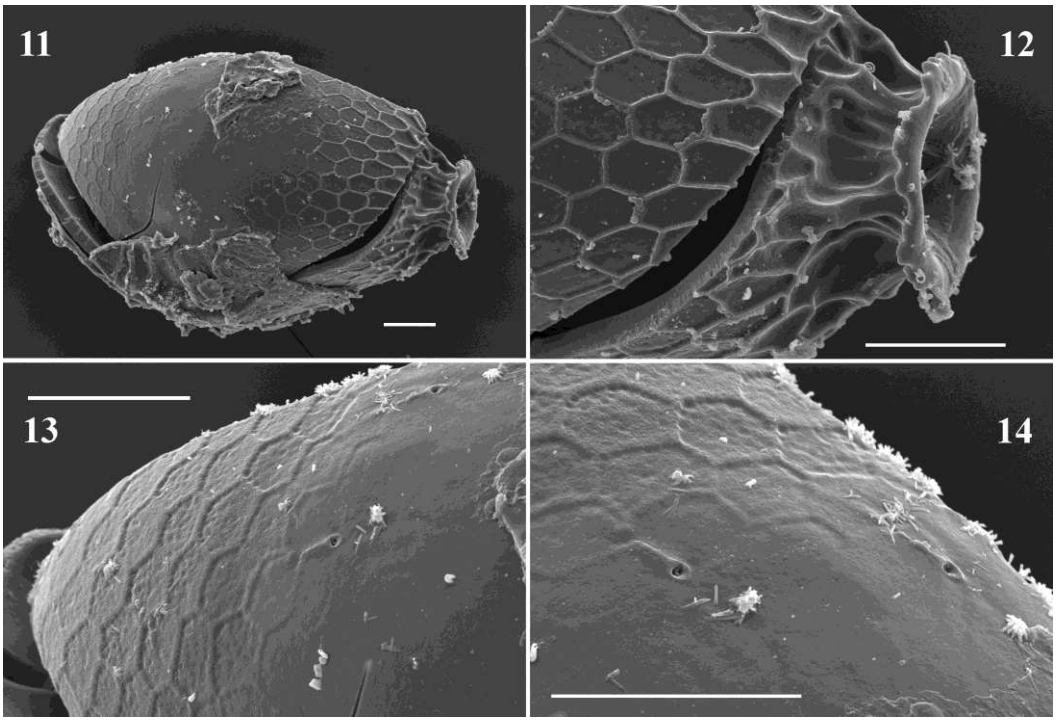
Affinities. The habitus and male terminalia are similar to many other member of the species group characterized by short hemiterga (e.g. *K. klapaleki* (Wu & Claassen 1934), *K. brevilata* Du, 2002 (in: Du & Ran 2002), *K. liui* Wu, 1940 (sensu Sivec 1981), *K. obtusa* Sivec & Stark, 2008). Distinctive characters of the male are the large basal sclerite of aedeagus combined with the shape and arrangement of aedeagal spines. The female has an elongate egg that is rather unusual in the genus. Apparently, the closest related species are *K. brevilata* (known only from Guizhou) and *K. klapaleki* (known only from Sichuan), both have a similarly built terminalia and aedeagus. *Kamimuria fulvescens* can be distinguished from

these two species by absence of swollen hemiterga and a more subtly curved aedeagus that bears more apical spines. One of us (WHL) examined the holotype of *K. klapaleki* kept in the United States National Museum, Washington (USNM). It also has the distinctive basal sclerite of the aedeagus, although this character was not illustrated or mentioned by Sivec & Stark, 2008.

Distribution. The species seems to be widely distributed in the mountainous areas of Central China. It was described from Sichuan Province, later reported also from Shaanxi and Gansu Provinces (Klapálek 1923, Du & Sivec 2005). *Kamimuria latior* Klapálek, 1912, a species regarded as synonymous with *K. fulvescens* (Sivec *et al.* 1988) was described from female syntypes collected in Qinghai Province part of Kham (close to the border with Tibet and Sichuan) and an additional female from the Helan Mts. (border range between Inner Mongolia and Ningxia), later reported also from Tibet (Kimmins 1946).



Figures 5–10. *Kamimuria fulvescens* Klapálek, 1912a, terminalia of syntypes. 5 = terminalia of male syntype, dorsal view; 6 = terga 9–10 of male syntype, lateral view (setation omitted); 7 = terminalia of female syntype, ventral view with details of setation enlarged; 8 = aedeagus of male syntype, ventral view; 9 = aedeagus of male syntype, lateral view; 10 = aedeagus of male syntype, dorsal view. Scales 1 mm.



Figures 11–14. *Kamimuria fulvescens* Klapálek, 1912a, egg of female syntype. 11 = egg, lateral view; 12 = collar end, lateral view; 13 = opercular end, lateral view; 14 = micropyles. Scales 0.05 mm.

Remarks. In the original description, Klapálek (1912a) stated the unspecified number of syntypes from Tacienlu was to be deposited in 'Mus. Petrohrad' (RAS), whereas the two syntypes from Mou-Pin were to be deposited in 'Mus. Paříž' (MNHM). Two RAS specimens remained in his collection and are now kept in NMP (Figs. 1–2), while in the MNHM three syntypes exist from Mou-Pin (according to a handwritten list received from Prof. Richard W. Baumann, Provo, USA). Klapálek (1923) also mentioned three Mou-Pin specimens.

Kamimuria integra (Klapálek, 1916)

(Appendix figure 3)

Paragnetina integra Klapálek, 1916: Klapálek 1916: 102. (original description of female); Wu 1935: 305. (catalogue); Wu 1938: 81. (monography); Claassen 1940: 130. (catalogue); Illies 1966: 496. (nomen oblitum).

Kamimuria integra (Klapálek, 1916): Sivec *et al.* 1988: 32. (comb. nov.); Du *et al.* 1999: 60. (checklist); Sivec & Stark 2008: 137. (checklist); Stark & Sivec 2013: 117. (checklist); DeWalt *et al.* 2015 (catalogue).

Type locality. Lanchovfu, Kansu (Gansu, Lanzhuo, N36°03' E103°50').

Material examined. Gansu. Lanzhou, N36°03' E103°50': ♀ *holotype* (NMP, box I.10: pinned, terminalia is in microvial) (Labels: Lanchowfu / Kansu; number; Typus; Typus; Paragnetina / integra / Klapálek det; ? Kamimuria sp. / det. I. Sivec 1987 / Prirod. muzej Slov.).

Distribution. The species is known only from the holotype from Gansu Province (Appendix Fig. 3).

Kamimuria kelantonica Klapálek, 1912a

Kamimuria kelantonica Klapálek, 1912: Klapálek 1912a: 95. (original description of male); Klapálek 1923: 28. (complementary description of male); Banks 1931: 377. (new record from Malaysia, Pahang State); Claassen, 1940: 122. (catalogue); Weidner 1962: 108. (type catalogue of ZMH specimens); Zwick 1977: 116. (comb. rev. by removing *Kamimuria* Klapálek, 1907b from synonymy of *Perla* Geoffroy, 1762); Sivec *et al.* 1988: 32.

(checklist); Sivec & Stark 2008: 137. (checklist); DeWalt *et al,* 2015 (catalogue).

Perla kelantonica (Klapálek, 1912): Illies 1966: 290. (comb. n. by synonymy of *Kamimuria* Klapálek, 1907b with *Perla* Geoffroy, 1762); Jewett 1975: 132. (first record from Thailand;

Non Kamimuria kelantonica Klapálek, 1912: Jewett 1975 = *Kamimuria trang* Sivec & Stark, 2008.

Type locality. Kelanton, Vých. Malakka (Malaysia, Kelantan State, N5°15' E102°).

Material examined. Malaysia. Kelantan State, N5°15' E102°: 2♂ (NMP, box III.12: pinned, both terminalia are in microvial) (Labels: Kelanton / Malakka; Kamimuria / kelantonica Klp. / det. Sivec 1987 (handwritten)).

Distribution. The species was described on the basis of a single male from Kelantan State. Later, it was reported from neighbouring Pahang State (Banks 1931) of peninsular Malaysia. Specimens from Thailand (Jewett 1975) proved to be *K. trang* Sivec & Stark, 2008. To date, this is the southernmost distributed member of the genus.

Remarks. In the original description, Klapálek (1912a) stated the male holotype was to be deposited in 'Mus. Hamburg' (Zoologischen Museums Hamburg, ZMH). According to the type catalogue of Weidner (1962), the ZMH indeed received it. However, there are two additional males in the NMP from the same locality, although neither have a type or original identification label. Jewett (1975) published Thailand data of the species based on specimens held in the National Museum of Natural History, Washington D.C. (USNM) and California Academy of Sciences (CAS), all from Trang Province. The USNM specimens proved to be *K. trang* Sivec & Stark, 2008, but the identity of the CAS specimens is questionable.

Kamimuria latior Klapálek, 1912a

(Appendix figure 7)

Synonymy detailed under *Kamimuria fulvescens* Klapálek, 1912a.

Type locality. Mezi Sogon Gomba a řekou I-Čju, na horním toku Modré Řeky; Darindo při horním toku Modré Řeky; and Již. Alašan, Gobi (Sogon Gomba refers to Qinghai Province, Yushu Tibetan Autonomous Prefecture, upper reaches of Yangtze River between Sogon Gomba monastery and I Chu River, N33°35' E96°35', 3800 m; Darindo refers to a village close to Sogon Gomba; Již. Alašan refers to southern part of the Helan Mountains that borders between Inner Mongolia Autonomous Region and Ningxia Hui Autonomous Region).

Material examined. Qinghai. Yushu Tibetan Autonomous Prefecture, upper reaches of Yangtze River, Darindo village, N33° E96°, 1–3. viii.1900, leg. P.K. Kozlov: 1♀ syntype (NMP, box III.11: pinned, terminalia is in microvial) (Labels: Umgebung des Ortes / Darindo, oberlauf / d. Blauen Fl., Kham. / S-O. Tibet Kozlow 1/3 VIII. 00. (handwritten); okr. ur. Darindo / Kam, ver. Goluboj / *Kozlov.* 1/3 viii 00; latior / Klapálek; Cotype).

Remarks. In the original description, Klapálek (1912a) stated all the syntypes (Sogon Gomba: 1♀, Darindo: 2♀, Alašan: 1♀) were to be deposited in 'Museu cís. Akademie v Petrohradě' (RAS). One of the Darindo females remained in his collection and is now kept in NMP (Appendix Fig. 7). Sivec *et al.* (1988) regarded this species to be synonymous with *K. fulvescens*. As the syntypes came from localities rather far from each other, we avoid judging this opinion on the basis of the single NMP specimen.

Kamimuria lepida Klapálek, 1913

(Figures 15–21)

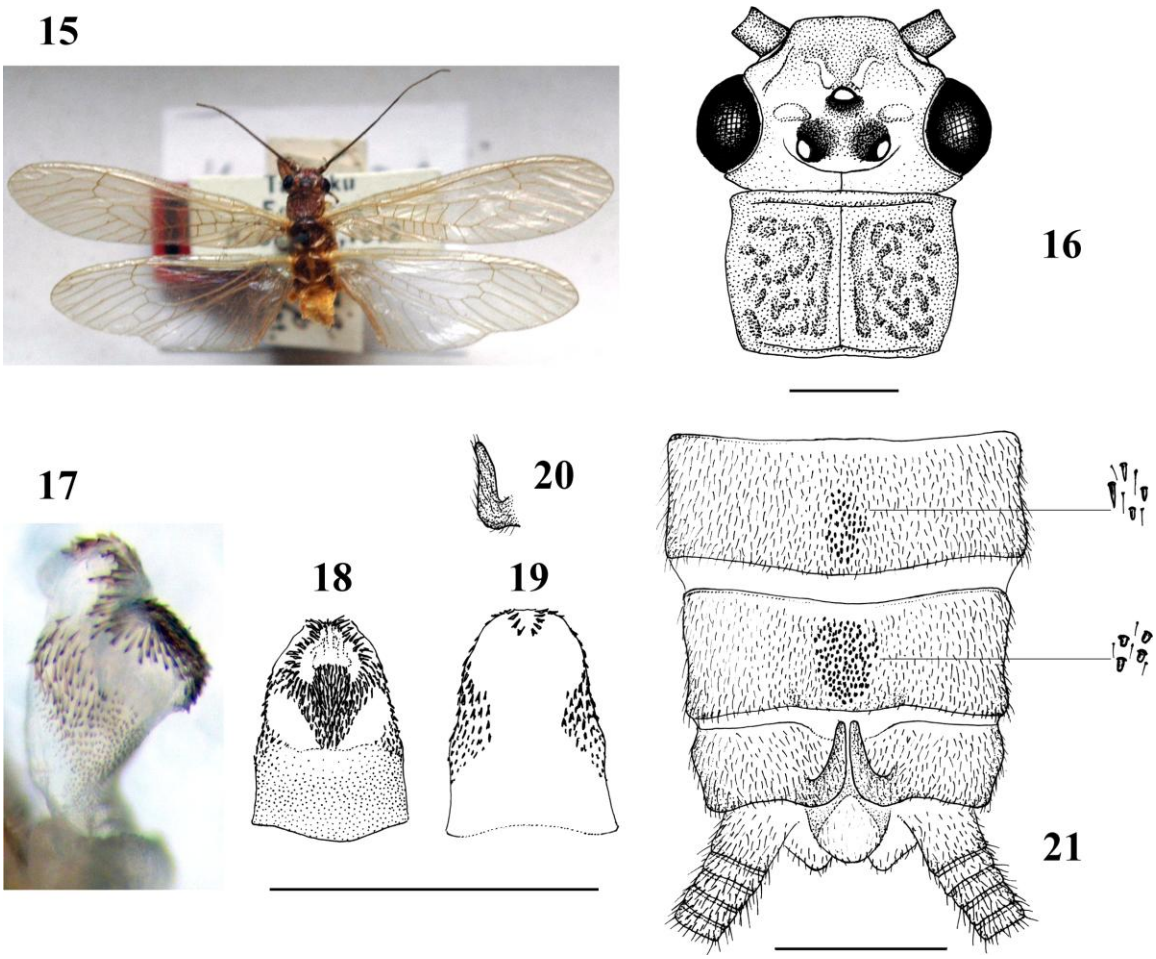
Kamimuria lepida Klapálek, 1913: Klapálek 1913: 112. (original description of male); Klapálek 1923: 34. (complementary description of male); Claassen 1940: 123. (catalogue); Zwick 1977: 116. (comb. rev. by removing *Kamimuria* Klapálek, 1907b from synonymy of *Perla* Geoffroy, 1762); Petersen & Gaedike 1968: 966. (type catalogue of DEI specimens); Sivec *et al.* 1988: 32. (checklist); Du *et al.* 1999: 61. (checklist); Sivec & Yang 2001: 402. (checklist); Sivec & Stark 2008: 137. (checklist); DeWalt *et al.* 2015 (catalogue).

Perla amoena (Klapálek, 1912): Illies 1966: 291. (comb. n. by synonymy of *Kamimuria* Klapálek, 1907b with *Perla* Geoffroy, 1762).

Type locality. Formosa, Suisharyo (Taiwan, Chiayi County, Alishan Mts., Shui, N23°31' E120°48').

Material examined. Taiwan. Taipei City, N25° 02' E121°31', 07.iv.1912, leg. H. Sauter: 1♂ (NMP, box VI.6: pinned, terminalia is in microvial) (Labels: Taihoku / Formosa / H. Sauter, 1912; 7.IV.; Kamimuria / lepida Klp. / Klapálek det. (handwritten); Cotype; K. lepida (handwritten, by I. Sivec)).

Description. Adult habitus (Figs. 15–16). Medium sized species, general colour pale brown. Head pale brown in the occipital area, with dark brown patches around the ocelli, and brown anterior to the M-line. Tentorial callosities and M-line distinct; a wrinkle present between M-line and the lateral margins. Eyes and ocelli are large; distance between posterior ocelli about twice diameter of one ocellus. Antennae darker than head. Pronotum square, anterior edges slightly angled; narrower than head with eyes. Its ground colour brown, with prominent, darker rugosities. Meso- and metanotum brown. Legs pale brown, wings hyaline, veins brown. Abdomen pale, only the hemiterga are brown.



Figures 15–21. *Kamimuria lepida* Klapálek, 1913 male. 15 = habitus; 16 = head, dorsal view; 17 = aedeagus, lateral view; 18 = aedeagus, ventral view; 19 = aedeagus, dorsal view; 20 = hemitergum 10, lateral view; 21 = terminalia, dorsal view with details of sensilla basiconica enlarged. Scales 1 mm, Figs. 15, 17 not to scale.

Male terminalia (Figs. 20–21). Abdominal segments are covered with soft and pale hairs.Sterna 6–7 with hair brushes, lateral combs are on the lateroapical edge of segments 8–9. Tergum 8 with narrow mesal field of sensilla basiconica; sensillae are mixed with hairs, slim and elongated, basal ones are acute. Tergum 9 with hardly delimited mesal lobe, sensilla basiconica covers medial fourth of the segment nearly from its base to apex; sensillae are mixed with hairs, stout and short on all of the mesal field. Tergum 10 basally hardly cleft, hemiterga as long as segment length, finger-like; straight and pointed in dorsal view, apex slightly bent up in lateral view. Hemiterga bear no sensilla basiconica, but covered with fine and pale hairs. Epiproct basally well sclerotized, rounded and setose; paraproct blunt. Cercus long, covered with moderatelly long setae, each segment bears at least one stronger ventral seta.

Aedeagus (Figs. 17–19). Membranous, apex with a dorsal lobe that is expanded upwards. Basal portion covered with spinules ventrally and laterally, dorsal surface bald. Mediolaterally, spines gradually increase in size; these fields are connected to the large and elongated, rose-thorn shaped spines of the apical portion. These spines form a V-shaped field on the ventral surface, that is continued in a medioventral stripe to the opening of the aedeagus. Laterally, these spines surround the opening and join on the dorsal apex of the dorsal lobe.

Female, larva and egg. Unknown.

Affinities. The habitus and male terminalia are similar to many other members of the genus, although the apically bent-up hemiterga is rare within the *Kamimuria* species with long hemiterga (e.g. *K. hainana* Li *et al.,* 2012, *K. atra* Sivec & Stark, 2008, *K. tuberosa* Wu, 1973). However, the peculiar setation of the short aedeagus is distinctive. Apparently, the closest related species is *K. hainana* (endemic to Hainan Island) that has similarly built terminalia and aedeagus, but the two species can be easily distinguished by the less numerous large spines that are restricted to the apex of the aedeagus of *K. hainana*.

Distribution. The two male syntypes were collected in the Alishan Ranges of Central Taiwan, while the NMP specimen is from the north of the island. Most probably endemic to Taiwan.

Remarks. In the original description, Klapálek (1913) did not state the depository of the two male syntypes. However, they are held in the Deutschen Entomological Institutes (DEI), like most of his specimens published from Taiwan (Petersen & Gaedike 1968). The NMP male is not a type, even though it bears a 'Cotype' label (Fig. 15), but it was originally identified by Klapálek before the publication.

***Kamimuria quadrata* (Klapálek, 1907b)**

(Appendix figure 8)

Perla (Kamimuria) quadrata Klapálek, 1907: Klapálek 1907b: 15. (original description of male and female); Klapálek 1907c: 266. (German translation of the original description).

Kamimuria quadrata (Klapálek, 1907): Klapálek 1912a: 86. (key); Okamoto 1912: 119. (key); Klapálek 1923: 24. (complementary description of male and female); Kohno 1937: 92. (description of larva); Claassen 1940: 123. (catalogue); Uéno & Okamoto 1950: 84. (illustrations on the imago); Uéno 1959: 37. (illustration on the larva); Kawai 1967: 133. (monograph); Zwick 1977: 116. (comb. rev. by removing *Kamimuria* Klapálek, 1907b from synonymy of *Perla* Geoffroy, 1762); Sivec *et al.* 1988: 32. (checklist); Isobe 1988: 35. (description of egg); Uchida 1990: 183. (monograph); Isobe 1997: 359. (complementary description of egg); Sivec & Stark 2008: 137. (checklist); DeWalt *et al.* 2015 (catalogue).

Perla quadrata (Klapálek, 1907): Illies 1966: 294. (comb. n. by synonymy of *Kamimuria* Klapálek, 1907b with *Perla* Geoffroy, 1762).

Type locality. Japan (without any further details) and Oiwaki (probably Oiwake, a former town merged into Abira, Yūfutsu (Iburi) District of Hokkaido, N42°46' E141°49').

Material examined. Japan. Oiwaki, (probably Oiwake, a former town merged into Abira, Yūfutsu (Iburi) District of Hokkaido, N42°46' E141°49'): 1♂ syntype (NMP, box III.12: pinned) (Labels: 57 (handwritten); Oiwaki / Mus. Bruxell (handwritten); Collect / Klapálek / quadrata / Klapálek).

Distribution. The species was described on the basis of two male and one female syntypes from Oiwaki (probably Hokkaido) and a second female syntype without exact locality from 'Japan'. Since then it was discovered to be widespread on Hokkaido and Honshu, and is found also on Oki Isles of Japan (Uchida 1990).

Remarks. In the original description, Klapálek (1907b) stated the female syntype from 'Japan' was to be deposited in 'museum Berlinské' (Museum für Naturkunde Berlin, RAS), while the two male and one female syntypes from Oiwaki were to be deposited in 'mus. Brusselské' (Royal Belgian Institute of Natural Sciences, RBINS). A male from the latter remained in his collection and is now kept in NMP (Appendix Fig. 8).

Kamimuria sikkimensis (Enderlein, 1909)

Perla sikkimensis Enderlein, 1909: Enderlein 1909: 349. (original description of female); Claassen 1940: 145. (catalogue); Illies 1966: 508. (nomen dubium); Zwick 1973: 494. (complementary description of female, questioning generic identity).

Kamimuria sikkimensis (Enderlein, 1909): Sivec *et al.* 1988: 33. (comb. n.); Sivec & Stark 2008: 137. (checklist); DeWalt *et al.* 2015 (catalogue).

Type locality. Sikkim (India, Sikkim State).

Material examined. India. Sikkim State: 3♀ (NMP, box VIII.16: pinned) (Labels: Sikkim; Plesiotypus - under one of the specimens: Sikkim / Hag. (handwritten, instead of printed 'Sikkim' label of the other two specimens)).

Distribution. The species is known only from the holotype from Sikkim State and the exact locality is unknown. The three NMP specimens also lacks further details about their locality.

Remarks. The three NMP females are pinned next to a label: *Acroneuria sikkimensis* End., but lack individual identification labels. Apparently, Klapálek didn't publish this combination, although the specimens bear 'Plesiotypus' labels, indicating that he was about to redescribe the taxon on the basis of these specimens. However, the generic identity of these NMP specimens are unsure, but probably they are not *Kamimuria*.

Kamimuria similis Klapálek, 1912a

(Figures 22–25, Appendix figures 9–10)

Kamimuria similis Klapálek, 1912: Klapálek 1912a: 101. (original description of male); Klapálek 1923: 33. (complementary description of male); Wu 1935: 303. (catalogue); Wu 1938: 59. (monography); Claassen 1940: 124. (catalogue); Zwick 1977: 116. (comb. rev. by removing *Kamimuria* Klapálek, 1907b from synonymy of *Perla* Geoffroy, 1762); Sivec *et al.* 1988: 33. (checklist); Du *et al.* 1999: 61. (checklist); Sivec & Stark 2008: 123. (redescription of male); DeWalt *et al.* 2015 (catalogue).

Perla similis (Klapálek, 1912): Illies 1966: 294. (comb. n. by synonymy of *Kamimuria* Klapálek, 1907b with *Perla* Geoffroy, 1762).

Type locality. Frontière China-Tonkin, region de Laokay, et Ho-Kheou (Laokay refers to: Vietnam, Lào Cai Province, Lào Cai, while Ho-Kheou refers to: China, Yunnan Province, Hekou Yao Autonomous County; coordinates of the border crossing Hekou-Lào Cai bridge are N22°30.4' E103°57.8', 80m).

Material examined. Vietnam-Yunnan border. Lào Cai Province - Hekou Yao Autonomous County, Hekou-Lào Cai bridge, N22°30.4' E103° 57.8', 80m, 1900, leg. C. Dupont: ♂ *holotype* (NMP, box VI.6: pinned, terminalia is in microvial) (Labels: Museum Paris / Frontière Chine-Tonkin / Région de Lao-Kay / et Ho Kheou / Ch. Dupont 1900; black label; Holotypus / K. similis Klp. / det. P. Zwick 1980 (handwritten)).

Distribution. The species is known only from the holotype from the border of Vietnam and China.

Remarks. In the original description, Klapálek (19012a) stated the male holotype was to be deposited in 'Mus. Paris' (MNHN), however, it remained in his collection and now is kept in NMP (Appendix figs. 9–10). The terminalia and aedeagus were recently described in detail by Sivec & Stark (2008), but they had no access to the rest of the body. Herein we figure the distinct bicoloured head (Fig. 22), and present photos of the aedeagus to show the large basal sclerite (Figs. 23–25) that was not shown by Sivec & Stark (2008). In the NMP, there is a further specimen pinned next to

the holotype, from China, Chen-Si (Shaanxi Province), 1875, leg. A. David. This specimen was mentioned in the original description (Klapálek 1912a) as similar to *K. similis* and *K. praeusta* (now in *Agnetina*), but not included in either description. Later, in the monograph of the Perlinae (Klapálek 1923), this specimen was not mentioned. Now it lacks terminalia, and apparently is not conspecific, in all probability not even congeneric with the *K. similis* type.

Kamimuria tibialis (Pictet, 1841)

Perla tibialis Pictet, 1841: Pictet 1841: 217. (original description of imago); Walker 1852: 151. (catalogue); McLachlan, 1875: 171. (complementary description of imago); Jakobson & Bianki 1905: 616. (complementary description of male and female); Uéno 1929: 109. (description of larva); Illies 1966: 294. (comb. n. by synonymy of *Kamimuria* Klapálek, 1907b with *Perla* Geoffroy, 1762); Zwick, 1971: 1180. (report on lack of type).

Perla (Kamimuria) tibialis (Pictet, 1841): Klapálek 1907b: 13. (complementary description of male and female); Klapálek 1907c: 265. (German translation of the complementary description).

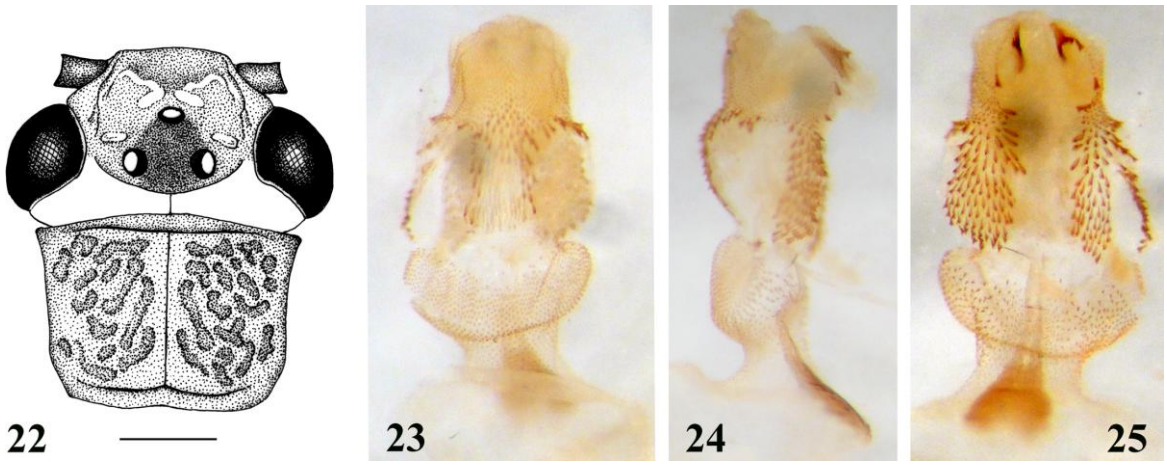
Kamimuria tibialis (Pictet, 1841): Klapálek 1912a: 86. (key); Okamoto 1912: 119. (key); Klapálek 1923: 20, 29. (designation as type species, complementary description of male and female); Claassen 1940: 124. (catalogue); Kohno 1947: 46. (complementary description of larva); Uéno & Okamoto 1950: 83. (illustrations on the imago); Uéno 1959: 38. (illustration on the larva); Kawai 1967: 135. (monograph); Zwick 1977: 116. (comb. rev. by removing *Kamimuria* Klapálek, 1907b from synonymy of *Perla* Geoffroy, 1762); Sivec *et al.* 1988: 33. (checklist); Isobe 1988: 35. (description of egg); Uchida 1990: 184. (monograph); Uchida & Isobe 1991: 66. (redescription, designation of a neotype); Isobe 1997: 359. (complementary description of egg); Sivec & Stark 2008: 137. (checklist); Teslenko & Zhiltzova 2009: 58, 292. (monograph); DeWalt *et al.* 2015 (catalogue).

Type locality. Japon (Japan, without any further details).

Material examined. Japan. Honshu, Gifu Prefecture, iv-v.1886: 1♂ 1♀ (NMP, box III.12: pinned, both terminalia are in microvial) (Labels: Gifu / ApMay (hardly legible) / 1886 (handwritten); tibialis / Klapálek; Collect / Klapálek); Honshu, Kanagawa Prefecture, Yokohama, N35° 26' E139°38': 1♂ (NMP, box III.12: pinned, lacks terminalia) (Labels: small red label; Perla / Tibialis Pict. / Yok. (hasndwritten)).

Distribution. The species was described on the basis of specimen(s) without exact locality from Japan. It proved to be widespread on the islands from Kunashir in the north to Kyushu in the south, but seems to be missing from the Asian mainland (Uchida & Isobe 1991, Teslenko & Zhiltzova 2009).

Remarks. In the paper where *Kamimuria* was described (Klapálek 1907b), only the Yokohama specimen was mentioned. The pair from Gifu were not even mentioned in the Perlinae monography (Klapálek 1923).



Figures 22–25. *Kamimuria similis* Klapálek, 1912a, male holotype. 22 = head, dorsal view; 23 = aedeagus, dorsal view; 24 = aedeagus, lateral view; 25 = aedeagus, ventral view. Scale 1 mm, Figs. 23–25 not to scale.

DISTRIBUTION OF THE GENUS *KAMIMURIA*

According to the latest checklists (DeWalt *et al.* 2015, Sivec & Stark 2008, Stark & Sivec 2013), there are 85 species classified recently in *Kamimuria*. Among these, 64 are considered valid, 4 are synonyms while 17 are nomen dubium with type specimens lost or destroyed.

The genus is confined to the Oriental and temperate East Palaearctic region (Fig. 26). Even though our knowledge is far from complete regarding both their faunistic and taxonomic details, some observations already can be made on their distribution. Apparently, the centre of their diversity is on the southern and eastern mountainous regions of the Qinghai-Tibet Plateau, from Gansu in the north southwards to Southeast Asia (lack of data from Laos and Cambodia are due to undersampling, and probably not of real absence). *Kamimuria* are missing from the plains and inhabits mostly medium high mountains, but have been found up to 4000 meters.

Acknowledgements – We owe thanks to Pável Chvojka (NMP) for help during work in NMP and information about the Klapálek Collection's history. We are also grateful to the anonymous reviewers for comments and linguistic corrections. The research was supported by the 2013–2015 Sino-Hungarian scientific and technological cooperative projects (No. 6-33 in China, TÉT_12_CN-1-2012-0006 in Hungary) and the SYNTHESYS Project, FP7 "Capacities" Program (CZ-TAF-3636).

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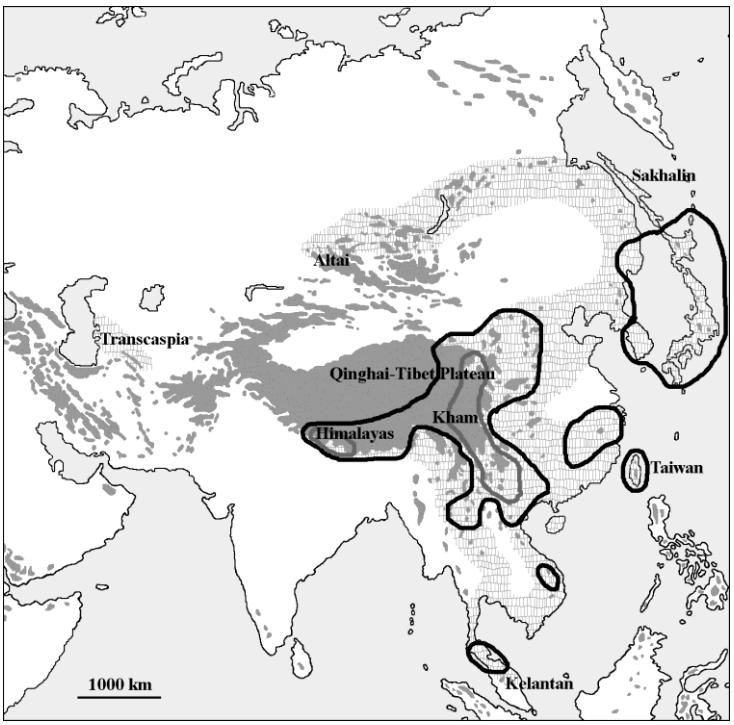

Figure 26. Distribution of the genus *Kamimuria* Klapálek, 1907b, with indication of geographical names important regarding occurrences. Reticulated pattern indicate areas where *Kamimuria* species are reportedly occur; black line deliminate areas where more than one species occur, while dark grey line deliminate areas where more than five species occur; grey areas are above 2000 meters.

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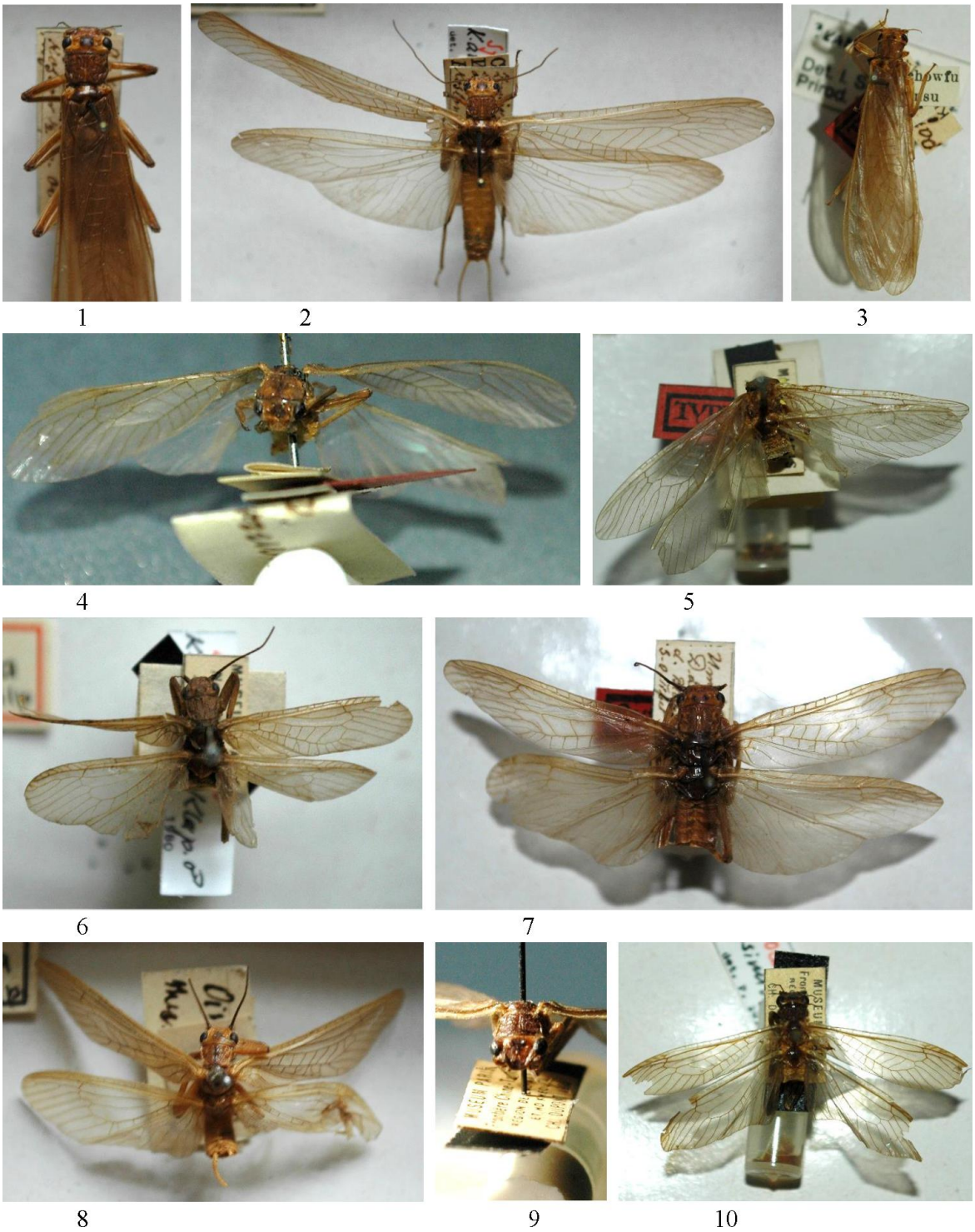

Appendix figures 1–10. Habitus photos of Klapálek's *Kamimuria* types kept in the NMP. 1–2 = female syntypes of *Kamimuria amoena* Klapálek, 1912a; 3 = female holotype of *Paragnetina integra* Klapálek, 1916; 4–5 = female holotype of *Marthamea brunneicornis* Klapálek, 1921; 6 = male syntype of *Kamimuria coarctata* Klapálek, 1912a; 7 = female syntype of *Kamimuria latior* Klapálek, 1912a; 8 = male syntype of *Perla (Kamimuria) quadrata* Klapálek, 1907b; 9–10 = male holotype of *Kamimuria similis* Klapálek, 1912a. Not to scale.

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Data to the earthworm fauna of Myanmar with notes on some little known species (Annelida, Oligochaeta)

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Abstract. The earthworm fauna of the Republic of the Union of Myanmar (Burma) is quite well studied due to the studious works of Gordon E. Gates. However, after the publication of the comprehensive monograph Burmese earthworms (Gates 1972) there has been no new data published from this country. In the last year the last author collected several earthworm samples from Burma, resulting in 7 species records belonging to the families Moniligastridae, Benhamiidae, Octochaetidae and Megascolecidae including some little known species like *Tonoscolex depressus* (Gates, 1929) and *Eutyphoeus constrictus* Gates, 1929. Examination of the *E. constrictus* specimens revealed that they show different states of metandry, they are morphologically very similar to *E. hastatus* Gates, 1929, and only differ by the functionality of the testes in segment 10, therefore it should be regarded as a synonym of *E. constrictus*.

Keywords. Burma, earthworms, *Eutyphoeus*, *Tonoscolex,* new synonym

INTRODUCTION

The first data on the earthworm fauna of Myanmar (Burma) was presented by Rosa (1888, 1890a, 1890b) working on rich material collected by Leonardo Fea, a renowned Italian naturalist. In this series of papers Rosa reported 13 species new to science and *Perionyx excavatus* Perrier, 1872 being present in Myanmar. In the subsequent years several other sporadic datasets have been presented by Michaelsen (1907, 1908) and Stephenson (1912, 1916) and later, in the monograph of the Oligochaeta of British India, Stephenson (1923) listed 20 species occurring within the territory of the present day Myanmar.

In the middle of the 1920's the earthworm research of Burma got under way through the work of Gates, who organized a thorough collecting campaign and described some 80 species new to science (Gates 1972, Blakemore 2006). Unfortunately these activities ended abruptly because of WWII and Gates had to leave behind the collection and flee to the USA (Gates 1972). However, as a result of his 20 years of research, Gates continued publishing on the earthworms of Burma and finally produced a comprehensive monograph of the earthworm fauna of Burma reporting on 174 species occurring in Burma proper and another 84 species present in the neighbouring regions (Gates 1972). This list of earthworms has recently been updated by Blakemore (2006) reporting altogether 195 species of which ca. 130 are thought to be endemic to Myanmar.

After Gates' (1972) work, to the best of our knowledge, there have been no earthworm records

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presented from Myanmar, until the last author (YH) organized several collecting trips to the country resulting in the description of the full mitochondrial genome of the giant Burmese earthworm *Tonoscolex birmanicus* (Gates, 1927) (Wang *et al.* 2015) and a report on some little known species presented herein.

MATERIAL AND METHODS

Earthworms were collected by the diluted formaldehyde method (Raw 1959), complemented with digging and searching under stones and under the bark of fallen logs. The specimens were killed and fixed in 96% ethanol, then transferred into 75% ethanol and deposited in the earthworm collection of the Hungarian Natural History Museum (HNHM). The penial setae were removed by dorsal dissecting of the animals, mounted in Euparal on a microscopic slide and were studied using a Nikon Eclipse 660 DIC microscope.

RESULTS

Family Moniligastridae Claus 1880

Genus *Drawida* Michaelsen 1900

Drawida sp. juv.

Material examined. HNHM AF/5637 7 ex. He Ywa Ywama, Taung Chaung Quarter, Inle lake (20° 29.26'N, 096° 53.08'E), 920m. Naungshwe Township of Taunggyi district of Shan State, drain and beside of drain. 24. August 2014, leg. Y. Hong, Tin Moe Win & Cho Nyi.

Remarks. We have several aclitellate specimens from this medium sized (50x3 mm) species. Their colour is grey with slight greenish hints. They have no clitellum and any other genital markings. Male pores obvious, lateral in 10/11. Four intestinal gizzards in segment 13−16. Prostates long, finger-like, muscular. Ovisac long extends back to 17. Taking into account these characteristics our specimens are most similar to *Drawida caerulea* Gates, 1926 but they lack the characteristic blue colour.

Family Benhamiidae Michaelsen, 1897

Genus *Dichogaster (Diplothecodrilus)* Csuzdi, 1996

Dichogaster (Diplothecodrilus) annae (Horst, 1893)

Benhamia annae Horst, 1893: 32.
Dichogaster curgensis Michaelsen, 1921: Gates 1961: 57, Gates 1972: 280.
Dichogaster (Diplothecodrilus) annae: Blakemore 2006:15, Csuzdi 2010: 194 (for complete synonymy).

Material examined. HNHM AF/ 5639, 10 ex. Quarter 3 B, Bo Aung Kyaw Street, Hopong Town, Southern Shan State. 22km distance from Taunggyi, found in soil nearby house. 22. August 2014, leg. Y. Hong, Tin Moe Win & Cho Nyi.

Remarks. This species has previously been recorded from Burma under its synonymous name *Dichogaster curgensis* by Gates (1961).

Dichogaster (Diplothecodrilus) saliens (Beddard, 1893)

Microdrilus saliens Beddard, 1893 683.
Dichogaster saliens: Gates 1942: 134, Gates 1972: 281.
Dichogaster (Diplothecodrilus) saliens: Blakemore 2006: 16, Csuzdi 2010: 116 (for complete synonymy).

Material examined. HNHM AF/ 5638, 2 ex. Quarter 3 B, Bo Aung Kyaw Street, Hopong Town, Southern Shan State. 22km distance from Taunggyi, found in soil nearby house. 22. August 2014, leg. Y. Hong, Tin Moe Win & Cho Nyi.

Family Octochaetidae Michaelsen, 1900

Genus *Eutyphoeus* Michaelsen, 1900

Eutyphoeus constrictus Gates, 1929

(Figure 1)

Eutyphoeus constrictus Gates, 1929: 28, Gates 1972: 290, Blakemore 2006: 16.
Eutyphoeus hastatus Gates, 1929: 32, Gates 1972: 295, Blakemore 2006: 16. **syn. nov.**
Eutyphoeus hamatus Gates, 1930: 332.
Eutyphoeus montanus Gates, 1933: 587.

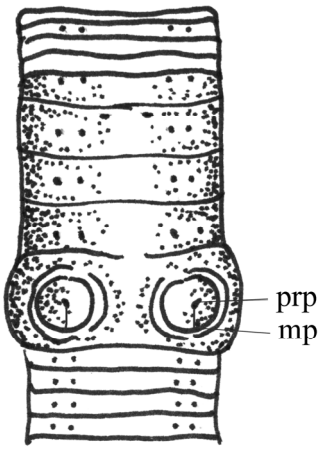

Figure 1. *Eutyphoeus constrictus*, ventral view of the clitellar region. prp = prostate pore, mp = male pore.

Material examined. HNHM AF/5642, 1 ex. Thar Si kone village. Laymyethna Township (17° 69.16' N, 95° 06.49' E), Laymyethna Township in the Hinthada District, Ayeyarwady Region, south-west Myanmar. 41.9 km from Hinthada, garden with leaf-litter, Yae phyu creek and garden. 15. August 2013, leg. Cho Nyi. HNHM AF/ 5643, 3 ex. Kala kone village, Aing Tha Pyu. (17° 53.13' N, 95° 12.75'E). Cowdung pile. 13. August 2013, leg. Cho Nyi.

Diagnosis. Length 103−125 mm, diameter 4 mm. Number of segments 180−216. Colour slightly red-violet on dorsum. Head schizolobous, first dorsal pore in 10/11. Clitellum circular on ½ 13−17. Female pores anterior and slightly median to setae *a* on 14. Prostatic pores on large circular porophores centered on 17. Male pores small on the posterior edge of the porophores near to 17/18. Spermathecal pores large in 7/8, in the setal line *c*.

Septa 5/6 thickened, 7/8 missing, 8/9 thin, 9/10−11/12 slightly thickened. Muscular gizzard large in 6. Dorsal vessel complete with last pair of hearts in 13. Calciferous glands large in 12. Typhlosolis from 28, lateral caeca small on 28. Ventral caeca numerous, 20-22 from segment 35. Supraintestinal glands large, 6−7 from around segment 60. Testes and funnels in 10 and 11. Those in 10 are small sometimes missing. Vesicles large in 12. Spermathecae in 7 bidiverticulate with short duct and larger oval ampoule. Prostates large, coiled in 17−20. Each prostate is accompanied with several penial setae. The mature setae slightly bent sabre-shaped, ca. 3−3.5 mm long 70 μ at the widest region (just under the tip), 50 μ at the middle. Ornamentation dense serrations.

Remarks. Our worms are clearly similar to *E. hastatus* Gates, 1929. The shape of spermathecae and the penial setae (Gates 1929 fig. 19) are completely identical with those of the present specimens, however *hastatus* is holandric, our specimens mainly metandric (with vestigial testis and male funnels in 10). But there are differences in the reduction of the first testes pairs, in one specimen it is much smaller but clearly functional, in the others hardly detectable, just the thin male duct can be seen. As the difference between *E. constrictus* and *E. hastatus* is quite small (absence or presence of functional testes in 10) Gates (1972) questioned the validity of this arbitrary distinction but formally kept the two species apart. As in our samples both forms appear, it is clear that *E. hastatus* Gates, 1929 is only a synonym name of *E. constrictus* Gates, 1929.

Eutyphoeus foveatus **Rosa, 1890**

(Figure 2)

Typhaeus foveatus Rosa, 1890a: 389.
Eutyphoeus foveatus: Gates 1972: 292, Blakemore 2006: 16.

Material examined. HNHM AF5641, 1 ex. Nyaung kone village, Aing Tha Pyu, Laymyethna Township in the Hinthada District, Ayeyarwady Region, south-west Myanmar. 41.9 km from Hinthada. (17° 53.68'N, 95° 17.17'E), garden with leaf-litter. 12. August 2013, leg. Cho Nyi.

Diagnosis. Length 180 mm diameter 5 mm. Color dark brownish-red on dorsum. Head epilobous, first dorsal pore in 11/12. Clitellum circular on ½ 13−½ 18. Female pore anterior to setae *a* left on 14. Prostatic pores in a large oval depression centered on 17. Male pores small, behind the prostatic pores. Spermathecal pores large in 7/8, in the setal line *ab*.

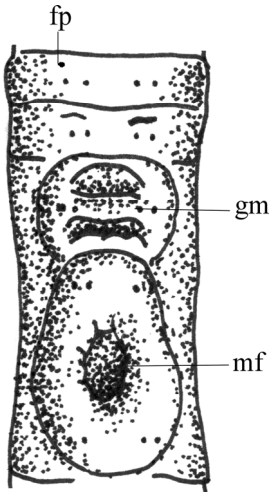

Figure 2. *Eutyphoeus foveatus*, ventral view of the clitellar region. fp = female pore mf = male field, gm = genital marking.

Muscular gizzard large in 8. Dorsal blood vessel aborted in front of segment 7. Calciferous glands large in 12. Metandric, testes and funnels 11. Vesicles large in 12. Spermathecae in 8 bidiverticulate with short duct and larger irregular ampoule. Prostates large, coiled, each prostate is accompanied with several penial setae. The mature setae slightly S-shaped, ca. 4.5 mm long and 25 µ wide. Ornamentation dense spines.

Genus *Octochaetona* Gates, 1962

Octochaetona surensis (Michaelsen, 1910)

Octochaetus surensis Michaelsen, 1910: 88.
Octochaetus (Octochaetoides) birmanicus Gates, 1925: 55.
Octochaetona surensis: Gates 1962: 213, Gates 1972: 309, Blakemore 2006: 17.

Material examined. HNHM AF/5635, 5 ex., 5636, 4 ex. South of Yangon, near Thilawa port, Kyauktan. Seikkan Township, Yangon Region. (16° 46.20'N, 96° 15.47'E). 26. August 2012, leg. Y. Hong & Tin Moe Win.

Family Megascolecidae Rosa, 1891

Genus *Tonoscolex* Gates, 1933

Tonoscolex depressus (Gates, 1929)

Notoscolex depressus Gates, 1929: 14.
Notoscolex choprai Stephenson, 1929: 230.
Tonoscolex depressus: Gates 1933: 484, Gates 1972: 228, Blakemore 2006: 11.

Material examined. HNHM AF/5640, 3 + 2 juv ex. Loi San Sit mountain, Lashio. Northern Shan State. (23° 25.30'N, 097° 05.80'E) 1441m. 15. August 2013, leg. Y. Hong & Tin Moe Win.

Diagnosis. Length 75–80 mm, diameter 3–4 mm. Colour yellowish. Setae lumbricine, head epilobous, first dorsal pore in 11/12. Clitellum not completely developed, circular on 12−16. Female pore between setae *aa,* right on 13. Combined male and prostatic pores open in V-shaped seminal groves in 17. Spermathecal pores two pairs in 6/7/8.

Muscular gizzard large in 6. Dorsal blood vessel complete, last hearts in 12. Calciferous glands paired, with small stalks and join the oesophagus in 9–12. Holandric, testes and funnels in 9–10. Vesicles in 10–11. Spermathecae in 6–7 unidiverticulate with short duct and larger irregular ampoule.

Remarks. The genus is characterized by the special enteroic excretory system and the seemingly unusual positions of the genital organs (female pores in13, prostatic pores in 17 testes in 9, 10). However, dissecting the buccal cavity revealed a retracted vestigial first segment (Fig. 3). Adding this to the segment count would mean all the strange positions would shift to the normal place (ie. testes 10, 11, female pores 14, prostatic pores 18).

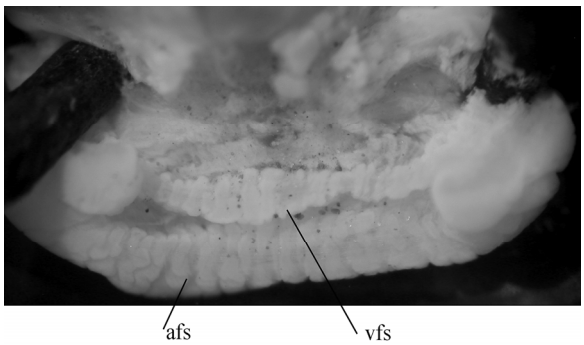

Figure 3. *Tonoscolex depressus*, buccal cavity. afs = apparent first segment, vfs = vestigial first segment retracted into the buccal cavity.

Our present specimens completely agree with the description of Gates (1929, 1972) and are well recognizable by the characteristic male field (Gates 1929, Fig. 6). However, all the three mature worms are at the lower range of the species' size variation (75−500 mm by Gates 1972).

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Microcrustacean diversity in the Gemenc-Béda-Karapancsa Floodplains (Danube-Drava National Park, Hungary): rare and alien species

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Abstract. The composition of microcrustacean fauna was investigated in different water bodies of Gemenc-Béda-Karapancsa Floodplains with special regard to the distribution of alien and rare taxa. Between 2002 and 2013 101 taxa (57 Cladocera, 27 Copepoda, 17 Ostracoda,) were recorded from the water bodies with differing degrees of connectivity to the main river (eu-, para-, plesio- and paleopotamon). 18 species are reported for the first time from the area of Danube-Drava National Park and among them *Daphnia ambigua*, *Pleuroxus denticulatus* and *Eurytemora velox* are allochtonous species in Hungary. *E. velox* and *P. denticulatus* have persistent populations in the area, but their contribution to floodplain biodiversity is still not significant. *Daphnia ambigua* has only local and temporal populations and its presence is confined to the disconnected side of the floodplain. The abundance of thirty species was very low and their distribution pattern in the floodplain is different. The microcrustacean diversity of the plesiopotamal side arms is remarkable, particularly in the Nyéki-Holt-Danube.

Keywords. Alien species, Cladocera, Copepoda, Ostracoda, species richness, Gemenc-Béda-Karapancsa Floodplains.

INTRODUCTION

Floodplains are an important area of biodiversity, providing habitat for endangered or threatened species**.** Floodplain rivers are disturbance-dominated ecosystems characterized by high levels of habitat diversity and biota adapted to exploit the spatio-temporal heterogeneity (Junk *et al.* 1989, Amoros & Roux 1988, Ward & Stanford 1995). Ecotones, hydrological connectivity, and succession processes play major role in structuring the spatio-temporal heterogeneity leading to the high biodiversity that characterizes floodplain rivers.

The Gemenc-Béda-Karapancsa Floodplains of the Danube River (rkm 1497–1440) part of the Danube-Drava National Park (Hungary) represents an exceptional example of river-floodplain systems in Europe with meanders, oxbow lakes, marshlands, and extended hardwood forests. These floodplains are also Natura 2000 areas and form an UNESCO Biosphere Reserve. This area is the largest active floodplain in Europe with unique natural value (Zinke 1996). It lies completely within the dike system, namely the characteristic hydrological processes of the river floodplain system are not disturbed.

Limited number of studies is dealing with the Cladocera, Copepoda and Ostracoda fauna of this area. The first data was presented by Bothár (1980) describing 18 Cladocera and 10 Copepoda species in the Vén-Danube and in the main arm near Baja. In 1994 Körmendi (2007) recorded 10 Cladocera and 10 Copepoda taxa from different dead arms and temporary pools of Gemenc floodplain. The most comprehensive description of the fauna was published by Forró & Meisch (1998). Their studies revealed 118 crustacean species (Anostraca, Notostraca, Cladocera, Copepoda, Ostracoda, Isopoda, Amphipoda and Mysida) from the Drava region of the Danube-Drava National Park based on collectings between 1995

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and 1997. In 1999 Körmendi and Lanszki (2002) recorded 37 Cladocera and 11 Copepoda taxa from various water bodies of Danube-Drava National Park. Between 1997 and 1998 Csányi *et al.* (1998) examined the zooplankton assemblages in the Vén-Danube, Nyéki-Holt-Danube and the main arm near to Baja reporting on 15 zooplankton taxa.

Between 2002 and 2013 detailed investigations were carried out and part of this project was to examine the zooplankton assemblages in water bodies with differing degrees of connectivity to the main river on a near natural temperate river-floodplain system (e.g. Schöll & Kiss 2008, Kiss & Schöll 2009, Kiss *et al*. 2014).

Here we summarize the faunistic results of this long-term study focusing the presence and distribution of rare and alien microcrustacean species and furthermore, the species composition of different water bodies on the floodplain.

MATERIALS AND METHODS

Study area

Covering some 25,000 ha, the Gemenc-Béda-Karapancsa Floodplains of the Danube River is situated between rkm 1497 and 1440. In this reach the mean annual discharge is 2400 m^3 s^{-1}, with a minimum of 618 m^3 s^{-1} and a maximum of 7940 m^3 s^{-1}. The water level is monitored by an official gauge at Baja (rkm 1479; 46 °10,41' N, 18° 55,29' E), which recorded a maximum amplitude of 9 m. In the main arm the slope is about 5 cm km^{-1}, with a velocity of 0.8–1.2 m s^{-1} at mean water level. The river starts to overflow into the floodplain above a water level of 500 cm at Baja.

Different riverine functional units can be observed in the study area, thus providing opportunity for simultaneous comparisons. The typology of the water bodies was based on the functional classification of Amoros *et al.* (1987), which depends on the flow velocity of the branches and on the intensity of lateral connectivity between the main channel, the side arms, and the backwaters.

For our investigation the following sites were chosen: *1. Eupotamon*: the main channel, with permanent flow; bottom composed of stones, gravel and coarse sand; macrophytes are absent. *2. Parapotamon*: side arms permanently connected to the main channel; bottom composed of gravel mixed with sand and silt; macrophytes are scarce. *3. Plesiopotamon*: permanent or temporary standing water bodies with no permanent and direct connection to the main arm, connection with the main arm at higher water levels; upstream end is often silted up; the bottom consists of silt and clay, macrophytes could grow densely and highly influenced by the discharge of the river. *4. Paleopotamon*: former anatomised channels or meanders with no direct connection to the river, slightly influenced by the river discharge, the bottom consists of silt and clay, macrophytes grow very densely (Guti 2001).

A total of 66 sampling sites were selected and divided into four functional groups: eupotamon (3 sites), parapotamon (Vén-Danube, Rezéti-Holt-Danube, 12 sites), plesiopotamon (Grébeci-Holt-Danube, Nyéki-Holt-Danube, Cserta-Danube, Sárkány-fok, Címer-fok, Külső-Béda, Mocskos-Danube, 35 sites), 4. paleopotamon (Riha Oxbow 16 sites) (Fig. 1.). Besides the regularly used sampling sites, additional sites were also selected between 2007 and 2009, during the floods (VDU5; RDU6, 7, 8, 9; GDU6) and among different macrohyte stands in the Mocskos-Danube and Riha Oxbow (19 sites). Sampling was carried out between April 2002 and October 2013, the sampling years were between 2002 and 2004, 2007 and 2009 and 2012 and 2013.

The sampling sites and sampling dates were the following:

Eupotamon

Main arm of the Danube

D1489: 1489 rkm, Érsekcsanád, N46° 16,403' E18° 54,547', in front of the mouth of Grébeci-Holt-Danube.

2002 (08. 04., 03. 07.), 2003 (07. 05., 08. 07., 15. 09. 27. 10.), 2004 (04. 14., 27. 05., 01. 07., 26. 08., 27. 10.), 2007 (23. 05., 11. 09., 25. 09.), 2008 (29. 07), 2009 (07. 04., 28.

04., 03. 06., 09. 06., 11. 06., 29. 06., 21. 06., 03. 08., 01. 09., 06. 10., 27. 10.)

D1482: Baja (N46º11,412' E18º55,610')

2008 (29. 07.), 2009 (29. 06., 21. 07., 03. 08.)

D1437: 1437 rkm, Mohács, N45º55,967' E18º 46,433', beyond the harbour of the ferry.

2007 (25. 07., 29. 08., 25. 10.), 2008 (18. 03., 10. 06.), 2009 (22. 06., 28. 07.), 2012 (16. 05., 19. 06., 04. 07., 07. 08., 04. 09., 09. 10.), 2013 (26. 06., 12. 10.)

Parapotamon

Vén-Danube (VDU)

5 km long side arm with constant flow. It was the part of the main arm until the interception in 1897-1898.

VDU2 (N46º11.880' E18º55.177'), VDU3 (N46º12.118' E18º53.843'), VDU4 (N46º12.754' E18º53.940'), small periodical inflow: VDU5 (N46º12.346' E18º53.732')

2002 (08. 04., 02. 05., 13. 06., 03. 07., 12. 11.), 2003 (07. 05., 08. 07., 15. 09. 27. 10.), 2004 (04. 14., 27. 05., 01. 07., 26. 08., 27. 10.), 2007 (23. 05., 11. 09., 25. 09.), 2008 (29. 07.), 2009 (29. 06., 21. 07., 03. 08.)

Rezéti-Holt-Danube (RDU)

15 km long side arm, it was the main arm until the interception in 1893-1894.

RDU2 (N46º14.224' E18º53.192'), RDU3.1 (N46º14.767' E18º52.541'), RDU4 (N46º16.015' E18º53.645'), RDU5 (N46º15.599' E18º53.623'), small periodical inflow: RDU6 (N46º16.208' E18º52.671'), RDU7 (N46º16.237' E18º52.373'), RDU9 (N46º13,412' E18º51,967'), stagnant temporary water body: RDU8 (N46º13.950' E18º51.918')

2002 (08. 04., 02. 05., 13. 06., 03. 07., 12. 11.), 2003 (07. 05., 08. 07., 15. 09. 27. 10.), 2004 (04. 14., 27. 05., 01. 07., 26. 08., 27. 10.), 2007 (23. 05., 11. 09., 25. 09.), 2008 (29. 07.), 2009 (29. 06., 21. 07., 03. 08.)

Plesiopotamon

Grébeci-Holt-Danube (GDU)

7 km long side arm, it was the part of the main arm until the interception in 1895-1896.

GDU1 (N46º16.495' E18º54.104'), GDU2 (N46º17.202' E18º52.921'), GDU3 (N46º17.451' E18º55.610'), GDU4 (N46º17.638' E18º53.162'), GDU5 (N46º17.641' E18º53.261'), small temporary inflow: GDU6 (N46º17.682' E18º53.210')

2002 (08. 04., 02. 05., 13. 06., 03. 07., 12. 11.), 2003 (07. 05., 08. 07., 15. 09. 27. 10.), 2004 (04. 14., 27. 05., 01. 07., 26. 08., 27. 10.), 2007 (23. 05., 11. 09., 25. 09.),

Nyéki-Holt-Danube (NYHD)

This strictly protected oxbow is situated in the right side of the Danube (rkm 1479) in the active floodplain. It is a natural cut-off river meander which evolved during the end of the 18th century. The oxbow together with the Cserta-Danube, Sárkány- and Címer-fok form a complex hydrological unit. The threshold level of the surface hydrological connection of NYHD up- and downstream is reached when the water level of the Danube River at rkm 1478.7 (Baja gauge station) is 520 cm and 570 cm, respectively. Upstream it is achieved through Vén–Duna (VDU), Cserta–Duna (CSDU) and Sárkány–fok (SÁF), while downstream – through the Címer-fok (CIF). Its channel is silting up and it has a high macrophyte cover (Ágoston-Szabó *et al.* 2014).

NYHD1 (46º 11,642' 18º 50,991'), NYHD2 (46º 11,563' 18º 50,834'), NYHD3 (46º 11,489' 18º 50,937'), NYHD4 (46º 11,573' 18º 51,175'), NYHD5 (46º 11,433' 18º 50,756')

2003 (07. 05., 08. 07., 15. 09.), 2004 (27. 05., 01. 07.), 2009 (07. 04., 28. 04., 03. 06., 09. 06., 11. 06., 29. 06., 21. 06., 03. 08., 01. 09., 06. 10., 27. 10.)

Cserta-Danube (CSDU)

CSDU (N46°11,783' E18°53,053') is a plesiopotamal side arm of the Vén-Danube (VDU). It together with Sárkány- and Címer-fok is part of the so-called fok-system, which are typical section of the local hydrological system. The creation of the fok-system (drainage canals) was the most important human impacts, which changed the hydrological condition of the floodplain (Guti 2001).

CSDU1 (N46º11,541' E18º52,431') CSDU2(N46º11,761' E18º53,121'), CSDU3 (N46º12,133' E18º53,756')

2003 (07. 05., 27. 10.), 2007 (25. 09.)

Sárkány-fok (SÁF)

SÁF (N46°11,816' E18°51,594') is a narrow channel between the NYHD and the CSDU.

2 sampling sites

2003 (07. 05., 08. 07., 15. 09.)

Címer-fok (CIF)

CIF (N46°46,781' E18°50,723') is a narrow channel between the NYHD and the main arm of the Danube. 2 sampling sites

2003 (07. 05.)

Mocskos-Danube (MDU)

This side arm (rkm 1442-1440) is situated in the active floodplain of Béda-Karapancsa area. Approximately 3.4 km long, 60 meter wide, with shallow water (average depth: 1.5 m) and very dense macrovegetation. It has a temporary connection with the Danube, the water flowing at 700 cm (gauge of Mohács rkm 1447) at the upper end and at 550 cm at the lower end of the oxbow. The water of MDU only rarely flows (1–5 times per year), and this take place only for short periods at a time (gauge of Mohács 550 cm).

MDU1 (N45º57'24,8" E18º46'24,7"), MDU2 (N45º57'35,3" E18º46'38,2"), MDU4 (N45º57'58,7" E18º46'43,9"), MDU5 (N45º58'06,2" E18º46'37,1"), MDU7 (N45º58'18,3" E18º 45'57,1") and further seven sampling points among the submerged macrovegetation near to the regularly used sites.

2009 (22. 06., 28. 07.), 2012 (16. 05., 19. 06., 04. 07., 07. 08., 04. 09., 09. 10.), 2013 (26. 06., 23. 07., 18. 09.)

Külső-Béda (BDU)

It is situated on the right bank of the Danube (N45º55,767' E18º45,420') in the active floodplain of Béda-Karapancsa. Its open water area is 4 km long, 90 m wide on average and is about 2.5 m deep. Its upstream junction with main channel of the Danube is at the rkm 1440.5, while the downstream junction, the mouth is at rkm 1437.5 of the Danube. The upstream surface connection of BDU occurs only during high floods, above 630 cm water level of the Danube (at gauge of Mohács rkm 1447) (Ágoston-Szabó *et al.* 2013). 5 sampling sites

2007 (25. 07., 29. 08., 25. 10.), 2008 (18. 03., 10. 06.)

Paleopotamon

Riha Oxbow (RIH)

This oxbow is located on the protected side of the floodplain and it has no connection with the main channel. It is 4.5 km long and 80 m wide. The average water depth is approximately 1-1.5 m. It is a strictly protected nature reserve areas covered by dense macrovegetation.

RIH1 (N46°00'08,1" E18°44'33,9"), RIH21 (N46°00'44,6" E18°45'10,3"), RIH22 (N46°00'35,4" E18°46'14,2"), RIH3 (N46°00'09,6" E18°46'30,9") and further 12 sampling points among the submerged macrovegetation near to the regularly used sites.

2012 (16. 05., 19. 06., 04. 07., 07. 08., 04. 09., 09. 10.), 2013 (26. 06., 23. 07., 18. 09.)

Collecting and identification

Microcrustaceans were collected with plankton net (mesh size 70 µm, N= 1) by filtering 10 X 10 L of water from the main arm and 5 X 10 L of water from the side arms, then preserved in 4% formalin. The three examined groups of crustaceans were enumerated by using inverted microscopy and identified to species level. Microcrustacean abundance, including copepodids, was evaluated by enumerating individuals in the whole sample. Gulyás & Forró (1999, 2001), Meisch (2000) and the nomenclature of Dussart (1967, 1969) were used for species identification.

RESULTS AND DISCUSSION

Faunistic results

Between 2002 and 2013 101 taxa (57 Cladocera, 27 Copepoda, 17 Ostracoda,) were recorded (Appendix 1) and 18 species reported which have not been mentioned earlier from the area of Duna-Drava National Park. These are the followings: Cladocera: *Alona intermedia* Sars, 1862; *Bosmina longispina* Leydig, 1860; *Ceriodaphnia dubia* Richard, 1894; *Chydorus gibbus* Sars, 1890; *Daphnia ambigua* Scourfield, 1946; *Dunhevedia crassa* King, 1853; *Holopedium gibberum* Zaddach, 1855; *Pleuroxus denticulatus* Birge, 1879; Copepoda: *Canthocamptus staphylinus* (Jurine, 1820); *Cyclops insignis* Claus, 1857; *Cyclops scutifer* Sars, 1863; *Eurytemora velox* (Lilljeborg, 1853); *Paracyclops affinis* (Sars, 1863); Ostracoda: *Bradleycypris obliqua* (Brady, 1868), *Bradleystrandesia reticulata* (Zaddach, 1844); *Cypris pubera* O. F. M., 1776; *Notodromas monacha* (O. F. Müller, 1776); *Paracandona euplectella* (Robertson, 1889).

Most of the collected microcrustacean species are widespread and characteristic of the fauna of the littoral zone in floodplain water bodies and lakes. The number of the detected taxa was significantly higher than the published results of pre

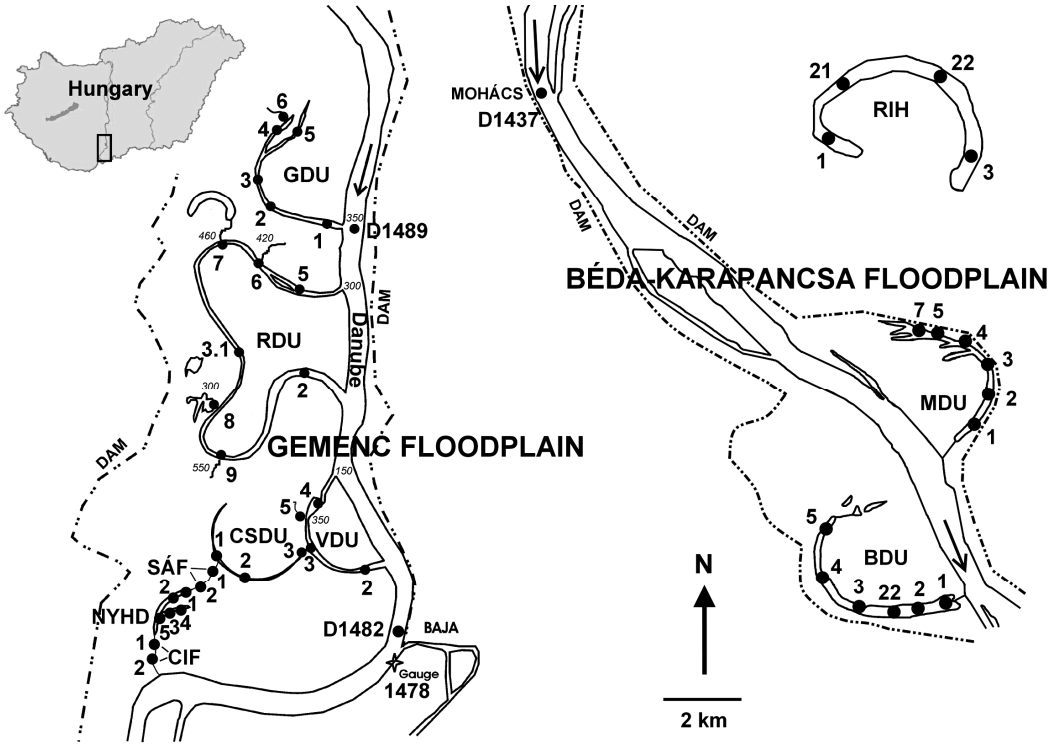

Figure 1. Sampling sites on the Gemenc-Béda-Karapancsa Floodplains (Gemenc floodplain: Grébeci-Holt-Danube (GDU), Rezéti-Holt-Danube (RDU), Vén-Danube (VDU), Cserta-Danube (CSDU), Sárkány-fok (SÁF), Nyéki-Holt-Danube (NYHD), Címer-fok (CIF), Béda-Karapancsa floodplain: Riha oxbow (RIH), Mocskos-Danube (MDU), Külső-Béda (BDU)

vious studies (Bothár 1980: 28 taxa; Csányi *et al.* 1998: 15; Körmendi & Lanszki 2002: 47; Körmendi 2007: 16) with the exception of the investigation of Forró & Meisch (1998) (111 taxa), but in our studies the area of sampling was more extensive and the duration of the survey was longer than any other studies. All of the species reported by Csányi *et al.* (1998) and Körmendi (2007) were also recorded in our studies. 27 species in the study of Bothár (1980), 43 in Körmendi and Lanszki (2002), as well as 73 taxa in the investigation of Forró and Meisch (1998) also occurred between 2002 and 2013.

There were significant differences in the species richness between water bodies with differing degrees of connectivity with the Danube (Appendix 1). Species richness was the highest in the plesiopotamon, which has no permanent and direct connection to the main arm. Among the newly detected species, *Daphnia ambigua*, *Pleuroxus denticulatus* and *Eurytemora velox* are alien or non-native (allochtonous) species in Hungary. The abundance of thirty species was irrelevant; in these species less than 10 individuals were collected between 2002 and 2013. These were regarded as rare species in Gemenc-Béda-Karapancsa Floodplains.

Alien species

The copepod genus *Eurytemora* occupies a wide range of habitat types throughout the Northern Hemisphere, with among the broadest salinity ranges of any known copepod. *Eurytemora velox,* as originally salt water species is widely distributed in the brackish waters from the Arctic Ocean and the Baltic Sea shore to South-eastern Europe, the Sea of Azov, and the Caspian Sea. This euryhaline species migrated from the estuaries of the North Sea upstream of many rivers (Tollinger 1911) and from the Black Sea

upstream in the Danube River (Gaviria & Forró 2000). In the Middle Danube Basin this species was collected for the first time in Hungary in 1991 (Forró & Gulyás 1992), also in Slovakia (Vranovský 1994) and Austria (Gaviria & Forró, 2000) in the very same year. In the last twenty years *E. velox* was presumably spread in the whole Hungarian section of the Danube and in many freshwater habitats of Hungary also. For example, in the Lake Fertő (the westernmost and largest steppe lake in Eurasia, situated on the Hungarian-Austrian border) this species showed up for the first time in 2009 then spread gradually and in 2012 a total of 492 specimens were collected (Kiss *et al.* 2014).

In the area of the Danube-Drava National Park the presence of *E. velox* was recorded in 2002 (Kiss & Schöll 2009), the previous faunistic works (Körmendi 2007, Körmendi & Lanszki 2002, Forró & Meisch 1998) did not mention this species. In our investigation altogether 622 individuals of *E. velox* were collected between 2002 and 2013. Most of the individuals were in the plesiopotamal Mocskos-Danube (297 individuals) and the distribution of this calanoid differed significantly between the examined water bodies (Fig. 2. A). Larger part of the collected specimens occurred in the plesiopotamal wetlands which are situated close to the main arm and often connected with the Danube. Similarly to our observation in Lake Fertő (Kiss *et al.* 2014), the number of the collected individuals differed year by year and there was a significant increase from 2009 (Fig. 2. B).

In the sampled habitats this calanoid often coexisted with other calanoids, *Eudiaptomus vulgaris* and/or *Eudiaptomus gracilis*. The number of *E. velox* was significantly higher than the two *Eudiaptomus* species (Fig. 3.) similarly to the observation of Vad *et al.* (2012). Opposite to other observations, e.g. soda pan in western Hungary (Horváth & Boros 2010) or two artificial lakes in the region of the North Hungarian Mountains (Vad *et al.* 2012), *E. velox* is still not a dominant member of Copepoda assemblages in Gemenc-Béda-Karapancsa Floodplain. In the area of Szigetköz (Northwestern Hungary, 1850–1793 rkm) the abundance of this species was also not significant at the monitoring sites of Szigetköz Monitoring Network between 1999 and 2013. During the fourteen years of monitoring only 155 specimens were collected from the three section of Szigetköz (main arm connected and reconnected floodplain).

Pleuroxus denticulatus is also an allochtonous species in the Middle Danube Basin. It was described from North America (Birge 1879) and its range is restricted to the northern hemisphere (Frey 1993). This North-American Cladocera occurs in Europe since the 1970s. This species is a new invader from Western to Central Europe and its occurrence in the Danube probably corresponds with the opening of the Rhine-Main-Danube Canal (Hudec & Illyová 1998). The first occurrence of *P. denticulatus* in the Hungarian section of the main channel was reported in 1992 at rkm1669 (Bothár 1994), since then it has been spread in the main arm (Gulyás 1995, Kiss & Schöll 2009, Vadadi *et al.* 2009). Similar to *E. velox, P. denticulatus* was also not revealed by the previous studies from the Danube-Drava National Park (Körmendi 2007, Körmendi & Lanszki 2002, Forró & Meisch 1998, Csányi *et al.* 1998). In the study area, *P. denticulatus* was firstly collected in 2003 from the Cserta-Danube and Sárkány-fok, then it was spread the whole active floodplain, but in the protected side of the floodplain this species does not occur yet (Fig. 2. C).

According to our result, this species was spread in the whole river-floodplain system and it supposedly has permanent population in the floodplain, but its density was very low, only forty specimens were collected between 2003 and 2012. Similar trend can be observed in the area of Szigetköz, where only 67 individuals were collected between 1999 and 2013 (A. Kiss unpublished result). This alien cladoceran was mostly found in the littoral zone, between submerged or emergent macrophytes. It was usually found together with typical littoral cladocerans, especially *Pleuroxus aduncus*, *P. truncatus*, similar to the observations of Hudec and Illyová (1998) and Vad *et al.* (2012).

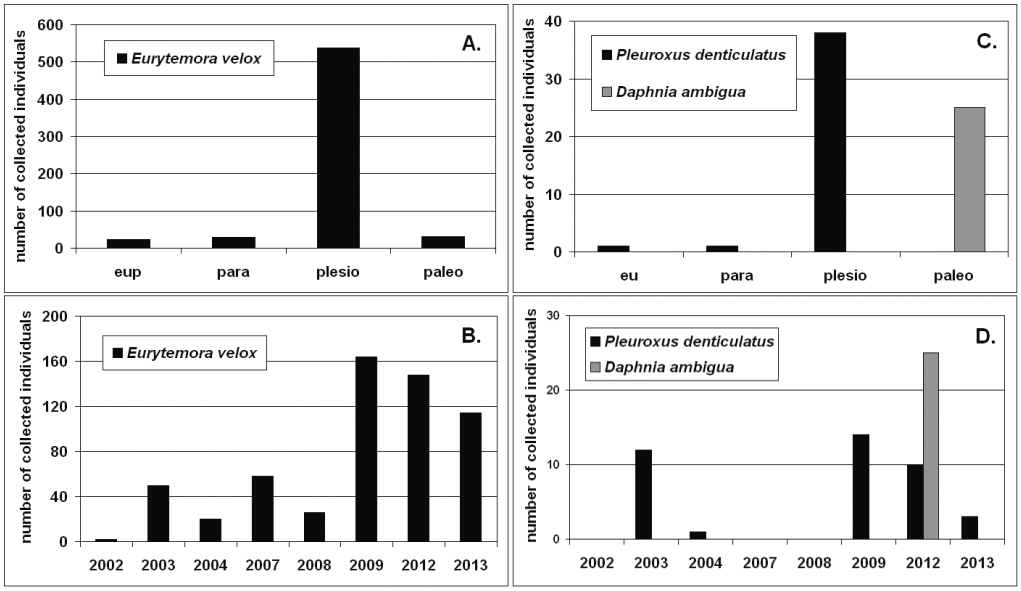

Figure 2. The distribution of the three alien species in the study area between 2002 and 2013 (A and B = *Eurytemora velox*, C and D = *Daphnia ambigua* and *Pleuroxus denticulatus*).

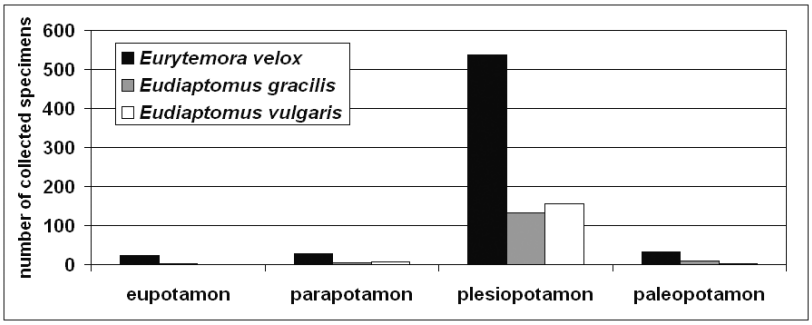

Figure 3. Distribution of the three Calanoida species in the study area between 2002 and 2013.

Daphnia ambigua, one of the most broadly distributed members of its genus, occurs in Europe as well as in North and South America (Herbert *et al.* 2003). This species is native to the temperate regions of North America and it was introduced to Europe where it is now broadly distributed (Maier 1996). Similarly to *Pleuroxus denticulatus*, it has been spreading from Western to Central Europe in the last few decades (Vranovský & Terek 1996). In Hungary *D. ambigua* is a rare species, their presence was confirmed especially from the Danube (Gulyás & Forró 1999, Kiss & Schöll 2009), but Vad *et al.* (2012) found this species in an artificial lake in the region of the North Hungarian Mountains as well. In our studies *D. ambigua* was found only at two sampling sites of the paleopotamal Riha Oxbow, in May 2012. Only 25 individuals were collected together with *Daphnia cucullata*, *D. longispina*, *Bosmina longirostris*, *Ceriodaphnia pulchella*, *Chydorus sphaericus*, *Eurytemora velox*, and seven other species. In the area of Szigetköz (northwest Hungary) between 1999 and 2013, only one individual of *D. ambigua* was found in 2006, in the Schisler-dead arm (A. Kiss unpublished result).

It is obvious that *Eurytemora velox* and *Pleuroxus denticulatus* have a permanent population in Gemenc-Béda-Karapancsa Floodplains,

but according to our results *D. ambigua* is still not permanent member of the fauna and its local and occasional presence could be correlated with bird-mediated dispersal (Riha Oxbow is an important area used by migratory birds).

Species of zooplankton, especially cladocerans can easily spread with passive transport (via wind, water or birds), mainly due to their ability to create resting eggs (Havel *et al.* 1995). The role of human-mediated vectors is also noteworthy especially for species dispersal across geographical barriers and into large aquatic ecosystems. Diapausing stages facilitate species survival during movement across geographical barriers under extreme conditions, such as in ballast tanks of ships (MacIsaac *et al.* 2001).

Rare species

The abundance of thirty species (13 Cladocera, 10 Copepoda, 7 Ostracoda) is insignificant, less than ten individuals were collected between 2002 and 2013. In case of nine species only one individual was found in the whole period of sampling. Twenty-two species were mentioned by earlier works (Bothár 1980, Forró & Meisch 1998, Körmendi & Lanszki 2002, Körmendi 2007), accordingly these species are supposedly permanent members of the local fauna.

Most of the rare species were distributed in the connected floodplain, in the plesiopotamon and especially in the Nyéki-Holt-Danube (Fig. 4. A-C). Among the sampling years, the number of rare species was the highest in 2003 and 2009. This result could be subsequent upon our sampling program and the hydrological events. In 2003 all of the potamon-types were investigated at the same time and extensive macrovegetation developed in many places in the floodplain because the water level was low in the main arm. In 2009, a detailed study was launched in the Nyéki-Holt-Danube, which is the most diverse area in Gemenc-Béda-Karapancsa-Floodplains.

Among the rare species, *Holopedium gibberum*, *Ceriodaphnia dubia*, *Cyclops insignis*, *Cypris pubera*, *Paracyclops affinis*, *Bradleystrandesia reticulata*, *Notodromas monacha* and *Paracandona euplectella* are new species for the Danube-Drava National Park.

Holopedium gibberum is one of the most infrequent microcrustacean species in Hungary being reported only from the Danube (Gulyás & Forró 1998). In our study, three individuals of *Holopedium* were collected in September 2007 from the Rezéti-Holt-Danube (Kiss & Schöll 2009). In the beginning of September 2007 there was an extreme water level (797 cm, Baja gauge) in the flooding period and our sampling was in the receding period when the mixing floodplain waters start to flow back toward the main arm. This holarctic species prefers mainly cool, oligotrophic, soft-water lakes with low pH (Balcer *et al.* 1984) and it is noteworthy that the resting eggs of *Holopedium* are poorly adapted for transfers among habitats (Cox & Hebert 2001). Supposedly we found a small temporary population of *Holopedium*, which was transported by the flood.

Similarly to *Holopedium*, the two individuals of *Cyclops insignis* were detected in September 2007 as well in the receding period of the flood. Both species prefer mainly small standing water habitats and lower water temperature. The carnivorous cladoceran, *Polyphemus pediculus* was also reported from many localities of Hungary (Gulyás & Forró 1999), but only eight specimens was collected from Nyéki-Holt-Danube. Among the former works, it was only reported by Forró and Meisch (1998) from two localities of Drava region.

Out of the seven rare ostracods three (*Bradleystrandesia reticulata*, *Candona weltneri*, *Paracandona euplectella*) were collected in the Nyéki-Holt-Danube in 2003, when the water level of the oxbow was extremely low. These species prefer small water bodies with swampy or boggy bottom. The neustonic ostracod, *Notodromas monacha* is widely distributed across the Holarctic region and common everywhere in suitable habitats (Meisch 2000). In Hungary it is recorded from many localities and sometimes was multitudinous in the plankton (e.g. Kiss 2007). Curiously, the only collected specimen of *Notodromas* occurred in the main arm.

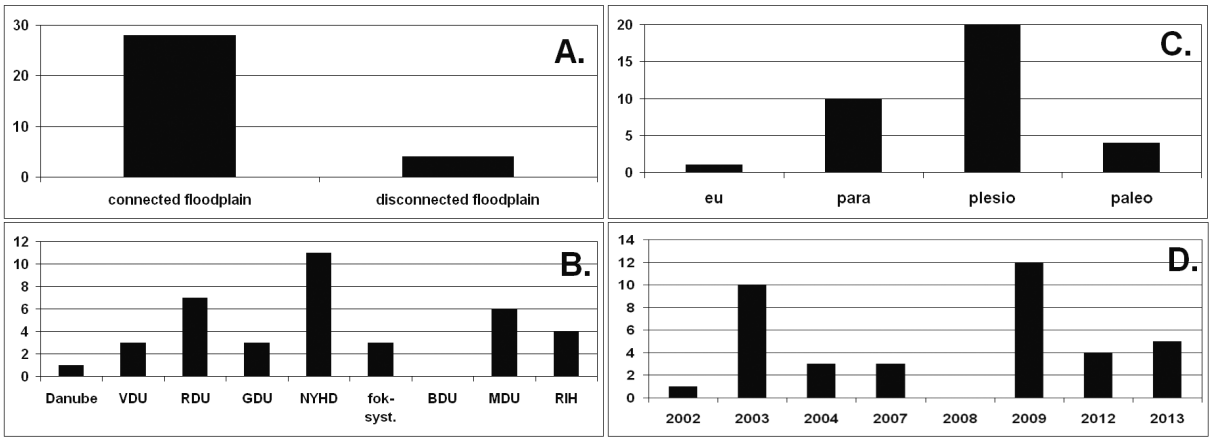

Figure 4. Species richness of the rare species in the study area. A = the number of taxa in the connected (eu-, para- and plesiopotamon) and in the disconnected (paleopotamon) floodplain, B = the number of taxa in the sampling sites, C = the number of taxa the different functional units, D = The occurrence of rare species in the different sampling years.

In our studies, the scarce occurrence of some taxa, e.g. benthic *Paracyclops* spp., *Ectocyclops phaleratus*, Harpacticoida or bottom-dwelling ostracods (Candonidae, Limnocythere) is evident because we did not collect from the benthos.

Microcrustacean species richness in water bodies with differing degrees of connectivity with the main arm

The species richness, the average, and maximum number of taxa were different in the studied water bodies and were the highest in the plesiopotamon (Fig. 5).

36 taxa (N = 54) were collected from the eupotamon, the most frequent species were *Bosmina longirostris*, *Chydorus sphaericus* and *Acanthocyclops robostus* which are typical for the Hungarian section of Danube. The average number of taxa was 3.85 and the differences between the three sampling sites of the main arm were irrelevant.

In the parapotamon the species richness (57 taxa, N = 143) and the number of rare taxa (10) increased and 9 taxa occurred in this functional unit alone. Among these species, *Holopedium gibberum* and *Diaphanosoma mongolianum* were found in the conjuctive water bodies in the receding period of the flood. These water bodies are small channels, branching out from side arms, hydrologically interconnecting them to the floodplain (Schöll *et al.* 2012). Compare to the main arm, there was no difference in the average number of taxa, 9 but the maximum number of taxa per sample (10) was higher than the eupotamon. The most significant species were the characteristic species of the main arm and *Thermocyclops* spp., but the tychoplanktonic and phytophilous taxa were also occurred.

The species richness (83 taxa: 45 Cladocera, 26 Copepoda, 12 Ostracoda) and the number of rare taxa (20), the average (7.23) as well as the maximum (22) number of taxa were the highest in the plesiopotamon. 28 taxa reported from the plesiopotamon alone and the number of tychoplanktonic and phytophilous taxa was significant. There were significant differences in the species richness between the studied plesiopotamal side arms. In the Gemenc-Béda-Karapancsa Floodplains, Nyéki-Holt-Danube was proved to significantly important area of microcrustacean diversity. Despite of the relatively small number of samples (N = 50), the species richness (60 taxa) and the number of rare taxa (11) were the highest in the area. The species richness was also notably in the fok-system (41 taxa, N =13), but contrary to this, only 22 taxa were detected in the Külső-Béda (22).

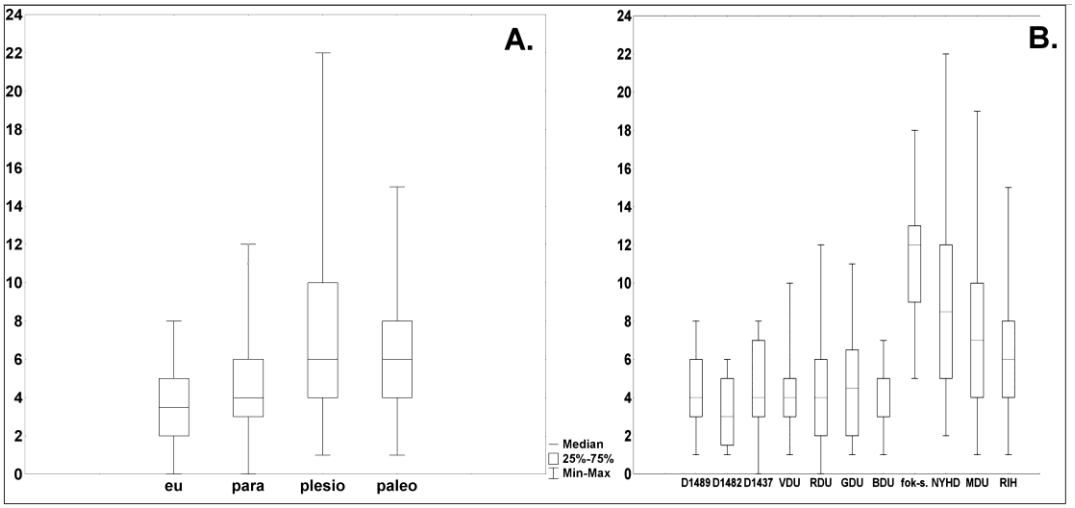

Figure 5. The species richness of microcrustaceans in the different potamon-types (A) and in the different sampling sites (B) (see text for further explanation.)

In the paleopotamon (N = 72) 43 taxa were collected and average (6.23) and maximum number of species (15) as well as the number of rare taxa (4) decreased compare to the significant part of the plesiopotamal side arms. The high proportion of tychoplanktonic and phytophilous taxa in the assemblages is obvious. Many works (e.g. Tockner *et al.* 1998) published positive correlation between the species richness and the degree of connectivity between the main channel and the backwaters, but according to our observation the species diversity of microcrustaceans was the highest in the plesiopotamon and not in the disconnected floodplain.

CONCLUSION

Between 2002 and 2013 101 taxa were recorded in the area of Gemenc-Béda-Karapancsa Floodplains and 18 species proved to be new for the region. The species richness and composition of the fauna were different in the examined floodplain water bodies and the number of microcrustacean species was most significant in the plesiopotamon. The fauna of the plesiopotamal Nyéki-Holt-Duna is noticeably diverse and this oxbow is a "diversity hotspot" in the floodplain. This study proved the presence of *Dahnia ambigua*, *Pleuroxus denticulatus* and *Eurytemora velox* and confirmed the expansion of these non-native species in the floodplain. *E. velox* and *P. denticulatus* have persistent populations in the area, but their contribution to floodplain biodiversity is still not significant. *Daphnia ambigua* has only local and temporal populations and its presence is confined to the disconnected side of the floodplain.

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Appendix 1. List of Cladocera, Copepoda and Cladocera taxa collected in Gemenc-Béda-Karapancsa Floodplains between 2002 and 2013

	eup.	parapotamon		plesiopotamon					paleop.
	Danube	**RDU**	**VDU**	**GDU**	**NYHD**	**MDU**	**BDU**	**fok-syst.**	**RIH**
Number of samples	**54**	**78**	**65**	**60**	**50**	**95**	**47**	**13**	**72**
CLADOCERA									
Acroperus harpae (Baird, 1834)	X				X	X		X	X
Alona affinis (Leydig, 1860)		X							X
Alona costata Sars, 1862	X	X	X	X	X	X		X	X
Alona guttata Sars, 1862	X	X		X		X	X		
Alona intermedia Sars, 1862					X	X			
Alona quadrangularis (O. F. M., 1785)	X	X	X			X		X	X
Alona rectangula Sars, 1862	X				X		X		
Alonella excisa (Fischer, 1854)					X	X		X	X
Alonella nana (Baird, 1850)		X	X		X			X	X
Bosmina coregoni Baird, 1857	X	X	X	X		X			
Bosmina longirostris (O. F. M.,1785)	X	X	X	X	X	X	X	X	X
Bosmina longispina Leydig, 1860			X			X			
Camptocercus rectirostris Schoedler, 1862					X				X
Ceriodaphnia dubia Richard, 1894									X
Ceriodaphnia laticaudata P. E. M., 1867	X						X	X	
Ceriodaphnia megops Sars, 1862	X				X	X		X	X
Ceriodaphnia pulchella Sars, 1862	X	X			X	X			X
Ceriodaphnia quadrangula (O.F.M., 1785)	X		X	X	X	X		X	X
Ceriodaphnia reticulata (Jurine, 1820)				X	X		X	X	X
Chydorus gibbus Sars, 1890					X				
Chydorus sphaericus (O. F. M., 1776)	X	X	X	X	X	X	X	X	X
Daphnia ambigua Scourfield, 1946									X
Daphnia cucullata Sars, 1862	X	X	X	X	X	X	X		X
Daphnia hyalina Leydig, 1860			X						
Daphnia longispina O. F. M., 1785	X	X		X			X	X	X
Daphnia obtusa Kurz, 1874						X			
Daphnia pulex Leydig, 1860					X				
Diaphanosoma brachyurum (Liévin, 1848)	X	X	X	X		X	X		X
Diaphanosoma mongolianum Uéno, 1938		X							
Disparalona rostrata (Koch, 1841)	X	X	X	X			X	X	X
Dunhevedia crassa King, 1853		X			X				
Eurycercus lamellatus (O. F. M., 1785)					X				
Graptoleberis testudinaria (Fischer, 1848)	X			X	X	X			X
Holopedium gibberum Zaddach, 1855		X							
Iliocryptus agilis Kurz, 1878	X	X	X	X	X		X		
Iliocryptus sordidus (Liévin, 1848)			X						

	Danube	RDU	VDU	GDU	NYHD	MDU	BDU	fok-syst.	RIH
Leydigia leydigi (Schoedler, 1863)			X						
Macrothrix hirsuticornis Norm. et Br., 1867	X	X	X	X					
Macrothrix laticornis (Fischer, 1848)		X	X						X
Moina brachiata (Jurine, 1820)	X	X	X	X	X	X	X		X
Moina macrocopa (Straus, 1820)					X				
Moina micrura Kurz, 1874						X			
Monospilus dispar Sars, 1862			X						
Oxyurella tenuicaudis (Sars, 1862)					X				
Pleuroxus aduncus (Jurine, 1820)	X	X	X	X	X	X		X	X
Pleuroxus denticulatus Birge, 1879	X		X		X	X	X	X	
Pleuroxus laevis Sars, 1862					X	X			
Pleuroxus truncatus (O. F. M., 1785)		X	X	X	X	X		X	X
Pleuroxus uncinatus Baird, 1850		X							
Polyphemus pediculus (Linné, 1761)					X				
Pseudochydorus globosus (Baird, 1843)						X			
Scapholeberis mucronata (O. F. M., 1785)	X	X	X	X	X	X	X	X	X
Scapholeberis rammneri Dum. & P. 1983		X				X			X
Sida crystallina (O. F. M., 1776)	X	X	X		X	X			X
Simocephalus serrulatus (Koch, 1841)					X				
Simocephalus vetulus (O. F. M., 1776)	X	X	X	X	X	X		X	X
Tretocephala ambigua (Lilljeborg, 1900)									X
COPEPODA									
Acanthocyclops robustus (Sars, 1863)	X	X	X	X	X	X	X	X	X
Canthocamptus staphylinus (Jurine, 1820)	X	X		X				X	
Cyclops insignis Claus, 1857		X		X	X				
Cyclops scutifer Sars, 1863					X				
Cyclops strenuus Fischer, 1851		X	X	X	X	X		X	
Cyclops vicinus Uljanin, 1875	X	X	X	X	X	X	X	X	X
Diacyclops bicuspidatus (Claus, 1857)			X	X	X				
Ectocyclops phaleratus (Koch, 1838)		X						X	
Eucyclops macruroides (Lilljeborg, 1901)									
Eucyclops macrurus (Sars, 1863)			X	X		X			
Eucyclops serrulatus (Fischer, 1851)	X	X	X	X	X	X	X	X	X
Eucyclops speratus (Lilljeborg, 1901)						X			
Eudiaptomus gracilis (Sars, 1863)	X	X	X	X	X	X	X		
Eudiaptomus vulgaris (Schmeil, 1896)		X			X				X
Eurytemora velox (Lilljeborg, 1853)	X	X	X	X	X	X	X	X	X
Macrocyclops albidus (Jurine, 1820)					X	X		X	X
Macrocyclops distinctus (Richard, 1887)						X			
Macrocyclops fuscus (Jurine, 1820)						X		X	
Megacyclops viridis (Jurine, 1820)			X	X	X	X		X	X
Mesocyclops leuckarti (Claus, 1857)	X	X	X	X	X	X		X	X

	Danube	RDU	VDU	GDU	NYHD	MDU	BDU	fok-syst.	RIH
Paracyclops affinis (Sars, 1863)					X			X	
Paracyclops fimbriatus (Fischer, 1853)	X	X							
Paracyclops poppei (Rehberg, 1880)					X				
Thermocyclops dybowski (Lande, 1890)				X			X		
Thermocyclops crassus (Fischer, 1853)	X	X	X	X	X	X		X	X
Thermocyclops oithonoides (Sars, 1863)	X	X	X	X	X		X	X	
OSTRACODA									
Bradleycypris obliqua (Brady, 1868)								X	
Bradleystrandesia reticulata (Zaddach, 1844)					X			X	
Candona weltneri Hartwig, 1899					X				
Candona sp. (juv.)				X	X	X		X	
Cyclocypris laevis (O. F. M., 1776)		X							
Cyclocypris ovum (Jurine, 1820)		X	X		X	X			X
Cypria ophtalmica (Jurine, 1820)		X			X	X	X	X	X
Cypris pubera O. F. M., 1776		X		X					
Cypridopsis vidua (O. F. Müller, 1776)			X	X	X	X		X	X
Dolerocypris fasciata (O. F. Müller, 1776)					X				
Limnocythere inopinata (Baird, 1843)		X							
Notodromas monacha (O. F. Müller, 1776)	X								
Paracandona euplectella (Robertson, 1889)					X				
Physocypria kraepelini G. W. Müller, 1903		X		X	X			X	
Pseudocandona compressa (Koch, 1838)								X	
Pseudocandona sp. (juv.)									X
Ostrcacoda sp. (juv.)									X
Number of Taxa:	**36**	**47**	**39**	**38**	**60**	**46**	**22**	**41**	**43**

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The diversity of zerconid mites (Acari, Zerconidae) in Giresun province, with a new record for the Turkish fauna

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Abstract. The zerconid mites collected from the Giresun province between December 2009 − April 2011 are evaluated and the following species are recorded: *Prozercon buraki*, *P. demirsoyi*, *P. giresunensis*, *P. mersinensis*, *P. murati*, *P. satapliae*, *P. traegardhi*, *P. turcicus*, *Zercon adoxyphes*, *Z. agnostus*, *Z. berlesei*, *Z. bulancakensis*, *Z. bulgaricus*, *Z. colligans*, *Z. denizliensis*, *Z. imperfectsetosus*, *Z. karadaghiensis*, *Z. mirabilis* and *Z. ozkani*. Of these, *Z. karadaghiensis* is recorded for the first time from Turkey. Description and drawings of the newly recorded species are given. On the basis of the collected specimens, measurements of nineteen species are given and their geographic distributions are discussed. Additionally, altitude and habitat preferences of the zerconid species are presented with 3 figures and 4 tables.

Keywords. Acari, Zerconidae, new record, *Zercon karadaghiensis*, Giresun, Turkey

INTRODUCTION

According to recent molecular systematic studies, the family Zerconidae belongs to the suborder Monogynaspida, cohort Gamasina and the superfamily Zerconoidea (Sikora 2014).

Zerconid mites are important members of the soil fauna and these free-living mites colonize various soil substrates (Karaca & Urhan 2015a). They are mostly associated with humus, decomposed litter, leaf mold, decaying plant materials, and mosses (Urhan 2010), however, there are rare records from woody substrates, ant-hills, nests of birds and small terrestrial mammals (Mašán & Fend'a 2004) as well. These small, predatory mites feed on the eggs, larvae, and nymphs of other mites and springtails (Shereef *et al*. 1984, Martikainen & Huhta 1990). Their wide range of habitats and diverse functional traits make the zerconid mites suitable as bioindicators of environmental changes (Sikora 2014).

The average body length of a zerconid mite can vary between 200−700 micrometers. Their dorsal shields are divided into two separate parts: podonotum and opisthonotum. These mites are weakly sclerotized and their life cycle includes four active stages; larva, protonymph, deutonymph and adult. The most important characters distinguishing zerconid mite species are the number of setae situated on the peritremal shield, the shape and length of peritremal setae, the shape of the posterior part of the peritremal shield and its connection with the ventrianal shield, the shape of the slit between the lateral margin of the peritremal shield and the podonotal shield, condition of the adgenital shields and gland openings gv2, the number of setae of the ventrianal shield, the condition of the dorsal cavities, the number of setae in the marginal setal series of the opisthonotum, the setal pattern of opisthonotal setae and the shape of epistome (Sikora 2014).

The members of the family Zerconidae are well known from the Holarctic region (Krantz 1978), however, in recent years there have been reports from the alpine zone of Central Mexico and Thailand (Ma *et al*. 2011, Ujvári 2011a, b, 2012) as well. At present, approximately 40

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*A summary of *Zercon karadaghiensis* was presented as a poster and published as an abstract at 21st National Biology Congress, which was held at Ege University, between 3–7 September 2012, in İzmir, Turkey.

genera consisting of some 400 species are known worldwide. From Turkey, until now only two genera, *Prozercon* and *Zercon*, and 88 species were recorded (Karaca & Urhan 2014, 2015b).

The first study on Turkish zerconids was published by a Polish acarolog, C. Błaszak (1979) based on samples collected by B. Dominiak and J. Pawlowski in the Amanos Mountains and the surrounding Bolu province. From 1992 to date, further studies on zerconids were published by R. Urhan and his team.

As a contribution to the knowledge of Zerconidae and understanding of the mite faunal richness of Turkey, here we report on nineteen zerconid species belonging to two genera (*Prozercon* and *Zercon*) from the Giresun province. Their localities in Giresun and known distributions in the world are given. Furthermore, detailed description and drawings of the newly recorded *Zercon karadaghiensis* are presented. Altitude and habitat preferences of the zerconid species collected are also discussed.

MATERIAL AND METHODS

Soil and litter samples were taken from 309 different localities in forestlands of Giresun province. Giresun province is located in the Eastern Black Sea Region of Turkey (Fig. 1). It is surrounded with the Black Sea coasts from the north and the range of North Anatolian Mountains from south. Although the Kelkit valley is covered with steppes, the area between coast and mountains is covered with forests. Total land area of the province is 6934 square kilometers.

The samples collected were placed in plastic bags, labelled and transferred to the laboratory and placed in combined Berlese funnels. Mites were extracted for 5−7 days according to the humidity of the samples. At the end of this process, the contents of the bottles were transferred to Petri dishes and the mites were separated under a stereo-microscope. They were placed in 60% lactic acid for clearing and mounted on permanent microscope slides using a glycerine medium. The examination and drawing of mites were carried out using an Olympus BX50 microscope with DP25 camera. The examined materials are stored in 70% ethanol and deposited in the Acarology Laboratory of Pamukkale University, Denizli (Turkey). Morphological terminology, idiosomal chaetotaxy and poidotaxy (Fig. 2) used in the description follows that of Mašán & Fend'a (2004). All measurements are given in micrometers (µm).

RESULTS

Family Zerconidae Canestrini, 1891

Genus *Prozercon* Sellnick, 1943

Type species. *Zercon fimbriatus* C. L. Koch, 1839

Prozercon buraki Urhan, 2008

Material examined. 228 ♀♀ and 78 ♂♂.

Average length and width of idiosoma: 300/238 µm (in females); 245/202 µm (in males).

Localities in Giresun. Centre, Bulancak, Piraziz, Eynesil and Yağlıdere.

Known distribution. Turkey (Urhan 2008).

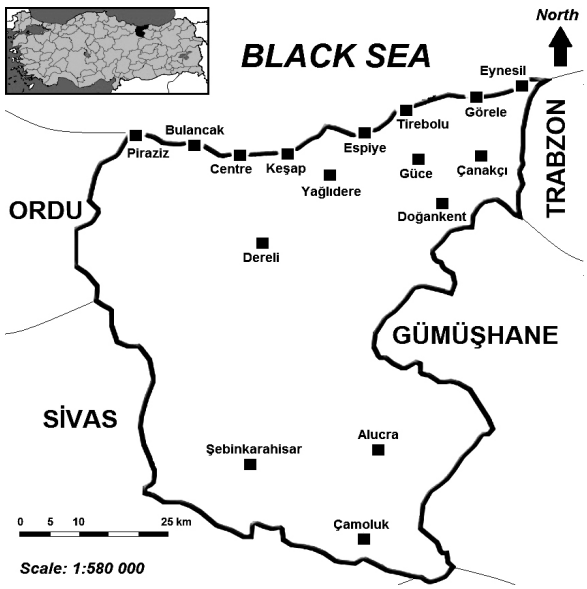

Figure 1. Location of Giresun province and its districts.

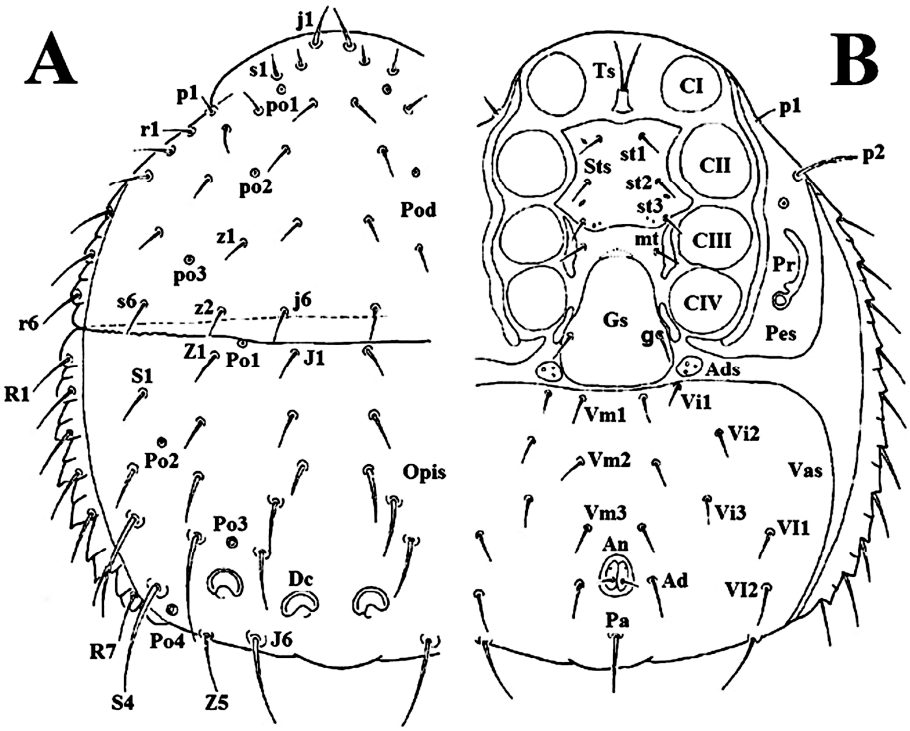

Figure 2. General view of a zerconid mite (female): A) dorsal view, B) ventral view. Abbreviations: (Pod) podonotum, (j1-6, z1-2, s1-6, p1-2 and r1-7) podonotal setae, (po1-3) podonotal glands, (Opis) opisthonotum, (J1-6, Z1-5, S1-4 and R1-7) opisthonotal setae, (Po1-4) opisthonotal glands, (Dc) dorsal cavities, (Ts) tritosternum, (Sts) sternal shield, (st1-st3) sternal setae, (mt) metasternal seta, (Gs) genital shield, (g) genital seta, (CI-CIV) endopodal shields, (Ads) adgenital shield, (Pr) peritreme, (Pes) peritremal shield, (Vas) ventroanal shield,(Vm1-Vm3) ventromediales setae, (Vi1-Vi3) ventrointernales setae, (VI1-VI2) ventrolaterales setae,(An) anal orifice, (Ad) adanal setae, (Pa) postanal seta (modified after Masan & Fend'a, 2004).

Prozercon demirsoyi Urhan & Ayyıldız, 1996

Material examined. 779 ♀♀, 1130 ♂♂, 42 deutonymphs and 6 protonymphs.

Average length and width of idiosoma: 344/283 µm (in females); 289/197 µm (in males).

Localities in Giresun. All counties (except Espiye, Şebinkarahisar, Alucra and Çamoluk).

Known distribution. Turkey (Urhan & Ayyıldız 1996d).

Prozercon giresunensis Urhan, 2013

Material examined. 20 ♀♀ and 2 ♂♂.

Average length and width of idiosoma: 343/242 µm (in females); 286/195 µm (in males).

Localities in Giresun. Şebinkarahisar and Doğankent.

Known distribution. Turkey (Urhan 2013).

Remark. Type materials of this species were collected from Giresun province.

Prozercon mersinensis Urhan, 1998

Material examined. 101 ♀♀ and 35 ♂♂.

Average length and width of idiosoma: 350/252 µm (in females); 289/225 µm (in males).

Recorded localities in Giresun. Şebinkarahisar and Doğankent.

Known distribution. Turkey (Urhan 1998).

Prozercon murati Urhan, 2013

Material examined. 12 ♀♀ and 2 ♂♂.

Average length and width of idiosoma: 308/226 µm (in females); 255/185 µm (in males).

Localities in Giresun. Tirebolu.

Known distribution. Turkey (Urhan 2013).

Remark. Type materials of this species were collected from Giresun province.

Prozercon satapliae Petrova, 1977

Material examined. 57 ♀♀ and 3 ♂♂.

Average length and width of idiosoma: 344/265 µm (in females); 285/214 µm (in males).

Localities in Giresun. Espiye, Eynesil and Doğankent.

Known distribution. Russia and Turkey (Urhan & Ayyıldız, 1996e).

Prozercon traegardhi (Halbert, 1923)

Material examined. 188 ♀♀, 62 ♂♂ and 19 deutonymphs.

Average length and width of idiosoma: 337/242 µm (in females); 272/184 µm (in males).

Localities in Giresun. All counties (except Tirebolu, Şebinkarahisar and Çamoluk).

Known distribution. Cosmopolitan in the Holarctic region (Urhan & Ayyıldız 1992, Karaca 2015).

Prozercon turcicus Urhan & Ayyıldız, 1996

Material examined. 111 ♀♀ and 41 ♂♂.

Average length and width of idiosoma: 331/265 µm (in females); 275/207 µm (in males).

Localities in Giresun. Bulancak and Doğankent.

Known distribution. Turkey (Urhan & Ayyıldız 1996a).

Genus *Zercon* C. L. Koch, 1836

Type species. Zercon triangularis C. L. Koch, 1836

Zercon adoxyphes Błaszak, 1979

Material examined. 13 ♂♂ and 40 deutonymphs.

Average length and width of idiosoma: -/- µm (in females); 432/347 µm (in males).

Localities in Giresun. Doğankent.

Known distribution. Iran and Turkey (Urhan & Ayyıldız 1994b).

Zercon agnostus Błaszak, 1979

Material examined. 44 ♀♀, 85 ♂♂ and 66 deutonymphs.

Average length and width of idiosoma: 496/363 µm (in females); 391/284 µm (in males).

Localities in Giresun. Alucra.

Known distribution. Turkey (Urhan *et al*. 2007).

Zercon berlesei Sellnick, 1958

Material examined. 14 ♀♀, 10 ♂♂ and 2 deutonymphs.

Average length and width of idiosoma: 505/365 µm (in females); 396/271 µm (in males).

Localities in Giresun. Yağlıdere, Doğankent.

Known distribution. Iceland, British Isles, Poland, Czech Republic, Slovakia, Hungary, Romania, Italy, Spain and Turkey (Urhan & Ayyıldız 1996c, Mašán & Fend'a 2004).

Zercon bulancakensis Urhan, 2012

Material examined. 579 ♀♀, 126 ♂♂, 34 deutonymphs and 12 protonymphs.

Average length and width of idiosoma: 427/339 µm (in females); 338/255 µm (in males).

Localities in Giresun. Bulancak, Espiye, Görele, Şebinkarahisar and Doğankent.

Known distribution. Turkey (Urhan 2012).

Remark. Type materials of this species were collected from Giresun province.

Zercon bulgaricus Balogh, 1961

Material examined. 7 ♀♀, 5 ♂♂ and 2 deutonymphs.

Average length and width of idiosoma: 448/311 µm (in females); 356/240 µm (in males).

Localities in Giresun. Doğankent.

Known distribution. Albania, Bulgaria, Crimea and Turkey (Urhan & Ayyıldız 1996b, Ujvári 2010).

Zercon colligans Berlese, 1920

Material examined. 396 ♀♀, 539 ♂♂, 229 deutonymphs and 44 protonymphs.

Average length and width of idiosoma: 428/320 µm (in females); 337/232 µm (in males).

Localities in Giresun. Eynesil, Alucra and Çamoluk.

Known distribution. Cosmopolitan in the Holarctic region (Sellnick 1958, Urhan & Ayyıldız 1994b, Karaca 2015) .

Zercon denizliensis Urhan, 2011

Material examined. 40 ♀♀, 5 ♂♂ and 3 deutonymphs.

Average length and width of idiosoma: 440/367 µm (in females); 337/263 µm (in males).

Localities in Giresun. Centre and Piraziz.

Known distribution. Turkey (Urhan, 2011).

Zercon imperfectsetosus Urhan, 2012

Material examined. 68 ♀♀, 40 ♂♂ and 7 deutonymphs.

Average length and width of idiosoma: 467/357 µm (in females); 367/278 µm (in males).

Localities in Giresun. Alucra and Çamoluk.

Known distribution. Turkey (Urhan 2012).

Remark. Type materials of this species were collected from Giresun province.

Zercon karadaghiensis Balan, 1992

(Figures 3A–D)

Material examined. 25 ♀♀ and 23 ♂♂.

Average length and width of idiosoma: 446/327 µm (in females); 353/237 µm (in males).

Localities in Giresun. Bulancak.

Known distribution. Ukraine and Turkey (Balan 1992, Ujvári 2009, Urhan *et al*. 2012).

Description. Female.

Dorsal side (Figure 3A). 20 pairs of different setae present on podonotum's dorsal side: j-row with 6 pairs, z-row with 2 pairs, s-row with 6 pairs, r-row with 6 pairs. 2 pairs of different setae present on podonotum's ventral side: p-row with two pairs. On podonotum, all setae short, smooth and needle-like (except setae j1–2 and r1–6). Setae j1 densely barbed, j2 and r1–6 finely barbed. 22 pairs of different setae present on opisthonotum's dorsal side: J-row with 6 pairs, Z-row with 5 pairs, S-row with 4 pairs, R-row with 7 pairs. On opisthonotum, all setae smooth, finely barbed without hyaline ending or finely barbed with hyaline ending. Setae J1–2 and Z1–2 smooth and needle-like. Setae J3–6, Z3–4 and S3–4 long, finely barbed with hyaline endings. Seta J6 longest seta on opistonotum. On opistonotum setae J3–5 and Z3–4 reaching base of the following seta in the series. Setae S1–2 finely barbed with hyaline ending. Setae J5 and S2 reaching the margin of opistonotum but setae Z4 and S3–4 reaching beyond of opistonotum. Seta Z5 short but finely barbed with hyaline ending. Marginal R setae finely barbed without hyaline ending (except R7). Seta R7 smooth and needle-like, similar in appearance to setae J1–2. The distance between setae J6 and Z5 25–30 µm.

Pores (Fig. 3A). 3 different pores present on podonotum. Pores po1 under base of s1, po2 inside line connecting j4 and s4, po3 on line connecting z1 and s5, closer to s5. Podonotum

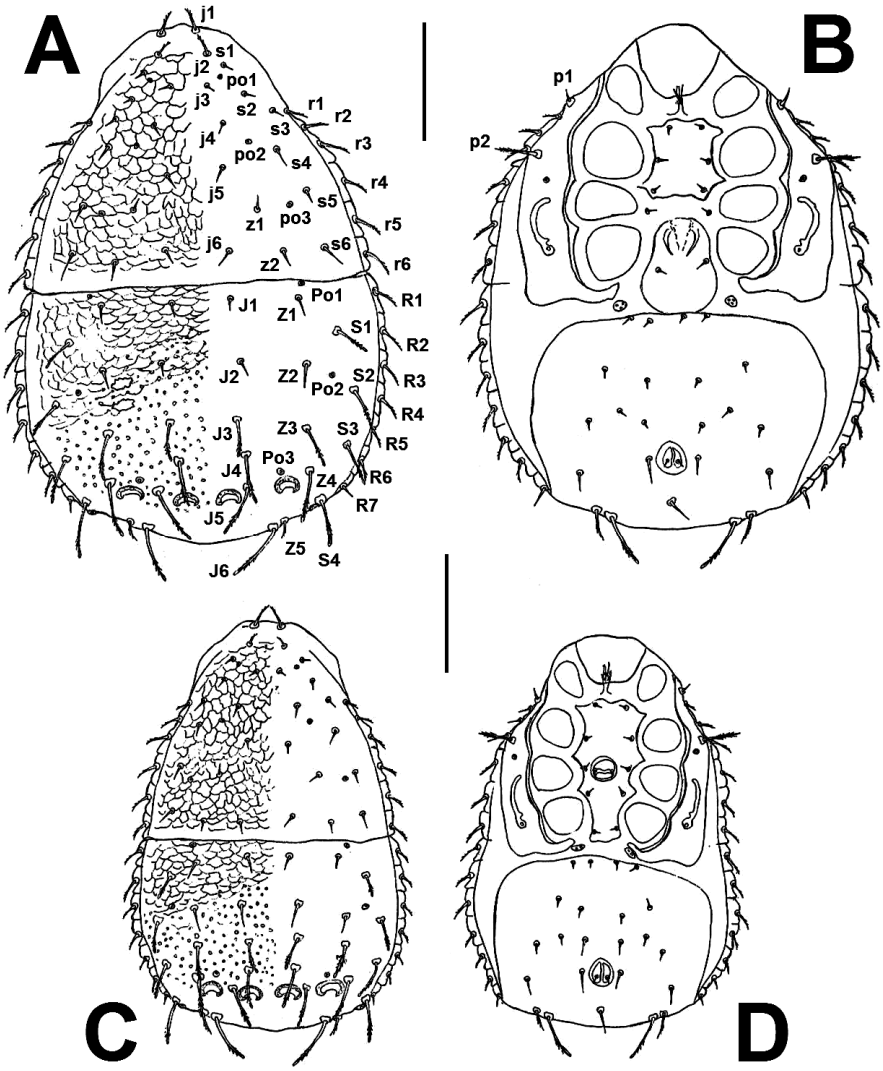

Figure 3. *Zercon karadaghiensis*. A) Dorsal view of female, B) Ventral view of female, C) Dorsal view of male, D) Ventral view of male (Scale bars = 100 µm).

covered by tile-like pattern. 4 different pores present on opisthonotum. Pores Po1 located above base of Z1, Po2 on line connecting Z2 and S2, Po3 outside the line connecting J5 and Z4, Po4 located close to the base of seta S4. Opisthonotal shield with a distinct reticulate pattern in the anterior region and spotted pattern in the posterior region. Dorsal cavities of general size and appearance, saddle-like, axes parallel to that of the body.

Ventral side (Fig. 3B). Ventral shields' shape, chaetotaxy and the shape of peritremes typical for genus *Zercon*. Setae p1 short, smooth and needle-like, seta p2 markedly elongated, finely plumose and feather-like. The shapes of peritremes bent, comma-like. Lateral ends of peritremal shield reach R1. Adgenital shields present (with three opening valves). Ventroanal shield with 9 pairs of setae. Anterior margin of ventroanal shield with 4 setae and postanal seta is single. All of them smooth and needle-like.

Lengths of opisthonotal setae and distances between setae within longitudinal rows of female and male specimens: see Table 1.

Male. *Dorsal side* (Fig. 3C), *ventral side* (Fig. 3D), shapes of setae on idiosoma, sculpture of

podonotum and opisthonotum, size and appearance of dorsal cavities basically similar to that of female.

Remarks. Original description of this species was given by Balan (1992) from Ukraine. Ujvári (2009) recorded this species for the second times in the country and provided a detailed redescription.

Distinguishing characters of *Z. karadaghiensis* specimens known from Ukraine and Turkey are compared on the basis of the available literature (Table 2). The negligible different positions of pores may be a result of variation in Zerconidae species.

Zercon mirabilis Urhan & Öztaş, 2013

Material examined. 216 ♀♀, 44 ♂♂, 150 deutonymphs and 83 protonymphs.

Average length and width of idiosoma: 466/354 µm (in females); 378/272 µm (in males).

Localities in Giresun. Şebinkarahisar and Doğankent.

Known distribution. Turkey (Urhan & Öztaş 2013).

Remark. Type materials of this species were collected from Giresun province.

Zercon ozkani Urhan & Ayyıldız, 1994

Material examined. 30 ♀♀, 9 ♂♂ and 74 deutonymphs.

Average length and width of idiosoma: 491/359 µm (in females); 397/271 µm (in males).

Localities in Giresun. Bulancak, Şebinkarahisar and Doğankent.

Known distribution. Turkey (Urhan & Ayyıldız, 1994a).

Altitude preferences of zerconids

Samplings was carried out from 0 to 2000 meters. No samples were collected between 600–800 and 1300–1500 meters because of a lack of suitable forestlands. The sampling localities in the research area were grouped according to 100 meter wide elevation ranges. Altitudinal distribution data of the detected zerconid specimens are listed in Table 3.

Habitat preferences of zerconids

According to the sampling localities in the research area, the following habitats were included: alder: *Alnus* sp., chestnut: *Castanea sativa*, common hazel: *Corylus avellana*, common

Table 1. Length intervals of opisthonotal setae and the distances between their bases in J-, Z- and S- rowsof *Zercon karadaghiensis*.

Seta	♀♀	♂♂	Seta	♀♀	♂♂	Seta	♀♀	♂♂
J1	10-14	11-13	Z1	12-17	11-14	S1	26-31	19-23
↕	51-61	38-45	↕	55-59	40-43	↕	51-61	36-40
J2	14-18	14-17	Z2	16-20	11-16	S2	40-44	29-34
↕	45-49	30-34	↕	50-56	33-39	↕	51-54	32-38
J3	27-35	24-30	Z3	38-46	32-39	S3	49-52	37-42
↕	32-42	23-25	↕	40-44	26-33	↕	43-45	28-32
J4	51-53	39-41	Z4	54-59	48-52	S4	52-55	45-47
↕	24-31	16-19	↕	38-45	23-26			
J5	54-56	43-46	Z5	13-23	13-17			
↕	22-30	24-28						
J6	62-66	56-60						
J6-J6	98-117	91-96						

Table 2. Distinguish characters between Ukrainian and Turkish specimens of *Zercon karadaghiensis* (measurements in micrometers, n: number of examined specimens).

	Balan (1992)	**Ujvári (2009)**	**Turkish specimens**
Length and width intervals of idiosoma (♀♀)	513–576 x 410–428	410 x 393 (n:2)	421–470 x 314–339 (n:25)
Length and width intervals of idiosoma (♂♂)	416–450 x 296–319	360 x 273 (n:2)	339-367 x 223–250 (n:23)
Setae in r and R series	finely barbed without hyaline ending	finely barbed and flared distally	finely barbed without hyaline ending
Seta J3 (♂♂)	apically hyaline tip	not hyaline tip	apically hyaline tip
Seta J5	not reach beyond of opistonotum	reach beyond of opistonotum	not reach beyond of opistonotum
Seta S1	smooth	finely barbed with hyaline ending	finely barbed with hyaline ending
Seta S2	reach beyond of opistonotum	not reach beyond of opistonotum	not reach beyond of opistonotum
Adgenital shields	?	with 4 valves	with 3 valves

Table 3. Altitudinal ranges of zerconid mite species.

Altitude (meters)	*P. buraki*	*P. demirsoyi*	*P. giresunensis*	*P. mersinensis*	*P. murati*	*P. satapliae*	*P. tragardhi*	*P. turcicus*	*Z. adoxypes*	*Z. agnostus*	*Z. berlesei*	*Z. bulancakensis*	*Z. bulgaricus*	*Z. colligans*	*Z. denizliensis*	*Z.* [illegible]	*Z. karadaghiensis*	*Z. mirabilis*	*Z. ozkani*
0–100	+	+			+	+	+					+		+	+				
100–200	+	+					+								+				
200–300		+					+												
300–400		+					+												
400–500	+	+	+				+				+	+			+			+	+
500–600							+												
600–700																			
700–800																			
800–900	+	+									+								
900–1000			+	+			+											+	
1000–1100		+		+		+	+	+	+		+	+	+					+	+
1100–1200												+						+	+
1200–1300			+	+								+						+	
1300–1400																			
1400–1500																			
1500–1600										+				+		+			
1600–1700							+	+		+		+		+		+	+		
1700–1800							+	+				+					+		+
1800–1900								+				+		+		+	+		
1900–2000														+		+			

Table 4. Habitat preferences of zerconid mite species.

	Alnus sp.	*Castanea sativa*	*Corylus avellana*	*Ficus carica*	*Juglans regia*	*Mespilus germanica*	Moss	*Picea orientalis*	*Pinus brutia*	*Pinus sylvestris*	*Platanus orientalis*	*Populus* sp.	*Prunus domestica*	*Prunus*	*Quercus* sp.	*Rhododendron*	*Rosa canina*	*Rubus caesius*
P. buraki	+		+			+	+				+	+		+	+			+
P. demirsoyi	+		+	+			+		+	+		+		+	+	+		+
P. giresunensis										+		+	+					
P. mersinensis	+						+			+		+				+		
P. murati	+		+															
P. satapliae	+		+				+		+	+						+		
P. tragardhi	+	+	+		+	+	+		+	+	+	+		+	+	+		+
P. turcicus	+						+	+		+						+		
Z. adoxypes							+			+						+		
Z. agnostus						+				+					+			
Z. berlesei							+											
Z. bulancakensis			+		+		+	+	+	+			+		+	+		
Z. bulgaricus	+						+			+								
Z. colligans						+	+			+		+			+			
Z. denizliensis	+		+			+									+			+
Z. imperfectsetosus						+	+					+			+		+	
Z. karadaghiensis							+	+		+								
Z. mirabilis							+			+		+			+	+		
Z. ozkani							+			+		+			+			

fig: *Ficus* carica, persian walnut: *Juglans regia*, common medlar: *Mespilus germanica*, moss, oriental spruce: *Picea orientalis*, Turkish pine: *Pinus brutia*, scots pine: *Pinus sylvestris*, oriental plane: *Platanus orientalis*, poplar: *Populus* sp., plum: *Prunus domestica*, cherry laurel: *Prunus laurocerasus*, oak: *Quercus* sp., yellow azalea: *Rhododendron luteum*, dog-rose: *Rosa canina* and European dewberry: *Rubus caesius*. The habitats of the different zerconid species are given in Table 4.

DISCUSSION

According to Table 3, the specimens of *P. murati* and *Z. denizliensis* occur only at lower altitudes (0–500 meters). In contrast, *Z. adoxypes*, *Z. imferfectsetosus* and *Z. karadaghiensis* occur only at higher mountain zones (over 1500 meters). *P. tragardhi*, *Z. bulancakensis* and *Z. colligans* show a wide range of occurrances from sea level up to high mountain zone. The remaining species have no clear preference in terms of altitudinal ranges.

According to Table 4, specimens of *P. Tragardhi* show no preferences towards the different forest types occurring in 14 different habitats. *P. murati* however, shows up in only two habitat types, under alder and common hazel.

In terms of species richness, under alder 7 species occured and in moss pads 6 species belonging to *Prozercon* were determined. Under chestnut, oriental spruce and plum only one species of *Prozercon* is recorded. However, under dog-rose no species of *Prozercon* is observed.

From the species of the genus *Zercon*, *Z. bulancakensis* is the most widespread occurring in 9 different habitats. This shows that *Z. bulancakensis* has a wider tolerance than the other *Zercon* species in the Giresun province. In contrast, *Z. berlesei* occurs only in one habitat type (in moss pads). In terms of species richness, in moss pads 9 species, under scots pine 8 species and under oak 7 species of the genus *Zercon* were recorded. Under chestnut no *Zercon* species were observed.

The unique zoogeographical position of Turkey between Asia, Europe and North Africa, in the western Palearctic region provides a rich biological diversity in terms of both floral and faunal elements. Zerconid mites are closely related to litter types and plant communities which are specific to a particular area, this may allow spreading endemic zerconid species associated with these special floral elements. The type locality of 58 zerconid species are in Turkey, of these, only *Prozercon yavuzi* was recorded out of the country; from Greece (Ujvári 2008, 2011c).

As this vast country is still understudied, with local faunistic investigations (especially in the Black Sea and Mediterranean regions) further new species and new records of zerconids in Turkey are anticipated.

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