Opusc. Zool. Budapest, 2014, 45(2): 109–118

Contribution to the Macrochelidae Vitzthum, 1930 fauna of the Carpathian Basin and the Balkan Peninsula (Acari: Mesostigmata)

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Abstract. From different localities of the Balkan Peninsula and the Carpathian Basin altogether 19 macrochelid mite species are listed belonging to the genera *Geholaspis* Berlese, 1918 (three species), *Glyptholaspis* Filipponi et Pegazzano, 1960 (one species), *Longicheles* Valle, 1953 (four species), *Macrholaspis* Oudemans, 1931 (one species), *Macrocheles* Latreille, 1829 (five species), *Neopodocinum* Oudemans, 1902 (two species) and *Nothrholaspis* Berlese, 1918 (three species). New country occurrences are also given for Croatia (three species), Hungary (three species), Macedonia (five species) Romania (five species) and Serbia (seven species).

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

INTRODUCTION

Macrochelid mites are usually predators of nematodes, eggs and larvae of insects or weakly sclerotized mite species. They are inhabiting soil substrates, litter and decomposing organic matter (Mašán 2003).

The family is relatively well known in Europe, but information on their occurrences in the Balkan Peninsula and the Carpathian Basin is insufficient. We have more data on the macrochelid mites from Italy (Berlese 1918, Filipponi & Pegazzano 1962), the former U.S.S.R. (Bregetova & Koroleva 1960), the British Isles (Evans & Browning 1956, Hyatt & Emberson 1988), Germany (Karg 1993), Austria (Johnston 1970), Slovakia (Mašán 2003) and Hungary (Erőss & Mahunka 1971; Kandil 1983, Kontschán 2005).

From taxonomical point of view the family Macrochelidae is also underresearched however, an important revisionary work of the family was recently published by Emberson (2010).

Here, we report on several new occurrences from different countries of the Carpathian Basin and the Balkan Peninsula (e.g. Romania, Croatia, Bulgaria, Macedonia and Serbia) increasing substantially our knowledge on the Macrochelidae fauna of the region.

MATERIAL AND METHODS

During numerous collecting trips to Europe and other parts of the World many soil samples were taken which were deposited in the Soil Zoology Collection of Hungarian Natural History Museum. Examining the samples from the Carpathian Basin and the Balkan Peninsula, the macrochelid specimens were sorted out and prepared by using lactid acid. The specimens examined are stored in ethanol and deposited in the Soil Zoology Collection of the Hungarian Natural History Museum. The classification of Macrochelidae Vitzthum, 1930 follows Emberson (2010). The species' ecological characteristics are based on Mašán (2003). Figures are added to the species new to the Hungarian fauna. The collectors' abbreviations are as follows: AM: Andrej Mock, CSCS: Csaba Csuzdi, DL: László Dányi, HA: Attila Haltrich, HE: Edit Horváth, KJ: Jenő Kontschán, LK: Lubomir Kovač, MD: Dávid

urn:lsid:zoobank.org:pub:AC8E68D9-A7C2-448F-B938-0E7F7EE2F42A
HU ISSN 2063-1588 (online), HU ISSN 0237-5419 (print)

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RESULTS

Family Macrochelidae Vitzthum, 1930

Genus *Geholaspis* Berlese, 1918

Geholaspis berlesei Valle, 1953

Material examined. Carpathian Basin: Slovakia, „Klastromka fent" 02.VII.1991 MS. Slovakia, Hrabusice-Podlesok, Sucha Bela from beech litter 02.VII.1991 MS. Romania, Rimetea, from detritus 20.IX.2000 SZT. Romania, Cluj-Napoca, Negreni, beech litter and moss 06.X.2006 MD. *Balkan Peninsula*: Serbia, Đerdap Planine, Golubinje from litter 13.X.2006 DL, KJ, MD.

Published records. Austria (Johnston 1970), Slovakia (Mašán 2003), Hungary (Kontschán 2006a), Slovenia (Ujvári 2009).

Diagnosis. Majority of dorsal setae pilose. Seven pairs of dorsal setae smooth (z1, j5, j6, J2, J5, z5 and z6). Dorsal shield with dotted surface. Ventrianal shield with net-like structure. Three pairs of ventrianal setae (Zv1, Jv2, Jv3) prolonged.

Distribution. Central and South Europe (Poland, Slovakia, Austria, Italy) (Mašán 2003).

Remarks. Edaphic detriticole, inhabiting leaf litter, most abundant in beech forests. This species is firstly recorded here from Serbia and Romania.

Geholaspis longispinosus (Kramer, 1876)

Material examined. Carpathian Basin: Croatia, Kutjevo streamside 20.IV.2004 KJ. Croatia, Novo Zvecevo streamside 22.IV.2004 KJ. Hungary, Aggtelek, Baradla cave, leaf litter and humus 21.III.2013 AM, PL. Romania, Munţii Rodnei, litter 27.VI.2005 − 01.VII.2005 OK, MD, KJ. Romania, Rimetea, moss of rock 20.IX.2000 SZT. Romania, Pasul Vlăhiţa moss 01.VIII.1999 OA. Romania, Lacul Sfânta Ana from sphagnum 01.VIII.1999 OA. Romania, Cheile Turzii moss from rock 08.VII.1998 HE. Romania, Arieş vale moss 11.VII.1998 HE. Austria, Altenmarkt an der Triesting, moss from soil 11.X.2003 SZGY. Slovakia, Rakovecz, litter 03.VII.1991 MS. *Balkan Peninsula*: Serbia, Krajište Planine, Surdulica beech forest litter 20.X.2006 DL, KJ, MD. Macedonia, Maleševski Planina, Berovo beech forest litter 18.X.2006 DL, KJ, MD.

Published records. Austria (Johnston 1970), Hungary (Erőss & Mahunka 1971), Slovakia (Mašán 2003), Romania (Kontschán 2006b), Slovenia (Ujvári 2009).

Diagnosis. Shape of idiosoma rounded, most of dorsal setae slightly pilose except j2, j5, j6, J2, J5, z1 and z5. Surface of dorsal shield with network pattern on posteromedial part. Ventrianal shield wider than long with large and smooth network structure.

Distribution. Europe (British Isles, Holland, Belgium, France, Switzerland, Germany, Austria, Poland, Czech Republic, Slovakia, Hungary, Romania, Slovenia, Italy, Bulgaria, Lithuania, Ukraine, Russia) and New Zealand (Mašán 2003).

Remarks. Widely distributed in Europe, very common in humus and litter with a wide ecological tolerance. This is the first record from Serbia, Croatia and Macedonia.

Geholaspis pauperior (Berlese, 1918)

Material examined. Carpathian Basin: Slovakia, „Klastromka fent" 02.VII.1991 MS. Slovakia, Hrabusice-Podlesok, Sucha Bela beech litter 02. VII.1991 MS. *Balkan Peninsula.* Macedonia, Belasica Planinite, waterfall of Kolešino Stream, platan-beech forest above the village, from litter 18.X.2006 DL, KJ, MD.

Published records. Austria (Johnston 1970), Slovakia (Mašán 2003).

Diagnosis. Shape of idiosoma oblong, most of dorsal setae brush-like, j5, j6, J2, J5, z5, z6 smooth, z1, j2 serrate. Ventrianal shield with micropuncture pattern and with net-like structure. 5 pairs of ventrianal setae smooth, blade-like.

Distribution. Central and South Europe (Switzerland, Germany, Poland, Czech Republic, Austria, Slovakia, Italy) (Mašán 2003).

Remarks. It is an edaphic detriticole montane species distributed also in higher altitudes. This is the first record from Macedonia.

Genus *Glyptholaspis* Filipponi et Pegazzano, 1960

Glyptholaspis saprophila Mašán, 2003

Material examined. Carpathian Basin: Romania, Cluj-Napoca, Negreni, beech forest along the left streamside of Crisul Repede River, litter and moss 06.X.2006 MD.

Published records. Slovakia (Mašán 2003), Hungary (Kontschán *et al.* 2014).

Diagnosis. Shape of dorsal shield oval with dentate posterior margin. Most of dorsal setae relatively long, plumose, j5, j6, J2, z5 and z6 smooth and needle-like. Ventrianal shield wider than long, preanal setae long and plumose.

Distribution. Hungary (Kontschán *et al.* 2014), Romania, Slovakia and Turkey (Özbek *et al.* 2014).

Remarks. The single Hungarian data is from litter of bamboo. This species is new to the fauna of Romania.

Genus *Longicheles* Valle, 1953

Longicheles bulgaricus Balogh, 1958

Material examined. Carpathian Basin: Romania, Rimetea, detritus 20.IX.2000 SZT. Romania, Rimetea, moss of rock 07.VII.1998 HE. Romania, Rimetea, moss from a meadow 21.IX.2001 SZT. *Balkan Peninsula*: Serbia, Krajište Planine, Surdulica beech litter 20.X.2006 DL, KJ, MD. Macedonia, Belasica Planinite Kolešino platan-beech forest litter 18.X.2006 DL, KJ, MD. Macedonia, Šar Planina, Gorno Jelovce from beech forest, moss of soil 15.X.2006 DL, KJ, MD.

Published records. Bulgaria (Balogh 1958), Austria (Johnston 1970).

Diagnosis. Shape of idiosoma oblong, most of dorsal setae pilose, j2, j3, j6, J2, J3, J5, z1 and z5 blade-like. Setae j2 reach the bases of j3, z1 longer than j2. Ventrianal shield with 5 pairs of short setae.

Distribution. South East Europe. (Karg 1993)

Remarks. The original description by Balogh (1958) is based on type specimens collected in montane beech and coniferous forests in Bulgaria. Later, Johnston (1970) found this species in Austria and here we report it from Serbia, Romania, and Macedonia.

Longicheles hortorum (Berlese, 1904)

Material examined. Carpathian Basin: Romania, Cheile Turzii, moss 20.IX.2000 HE. Romania, three km from Corneşti 11.VII.1998 moss HE. Slovakia, „Klastromka fent” 02.VII. 1991 MS. *Balkan Peninsula*: Serbia, Đerdap Planine, Majdanpek from beech forest litter 13.X.2006 DL, KJ, MD.

Published records. Austria (Valle 1953), Slovakia (Mašán 2003).

Diagnosis. Surface of dorsal shield granulate with small microspicules. Dorsal setae brush-like, except j5, j6, J2, J5 and z6 which are smooth. Dorsal surface with net-like pattern posteriorly.

Distribution. Europe (Iceland, British Isles, Belgium, Germany, Switzerland, Poland, Lithuania, Austria, Slovakia, Italy, Turkey and Caucasus) (Mašán 2003).

Remarks. This is a rare edaphic detriticole species distributed in all over Europe. This is the first record from Serbia and Romania.

Longicheles longulus **(Berlese, 1887)**

(Figure 1)

Material examined. Carpathian Basin: Hungary, Aggtelek, Baradla cave, leaf litter and humus 21.III.2013 AM, PL.

Published record. Slovakia (Mašán 2003).

Diagnosis. Shape of idiosoma oblong with micropuncture surface, its length 600 µm. All dorsal setae short, most of them densely plumose, except j5, j6, J2, J5, z1, z5, z6, these needle-like. Sternal shield with micropuncture pattern, genital and ventrianal shield with reticulate structure. All ventral setae short and needle-like. Ventrianal shield longer than wide.

Distribution. Belgium, Switzerland, Slovakia, France, Holland Ireland, Italy, Sicily, Armenia (Mašán 2003).

Remarks. This is the first record from Hungary.

Longicheles mandibularis **(Berlese, 1904)**

Material examined. Carpathian Basin: Romania, Munții Bihorului, Boga vale beech forest litter 25.VII.2003 PT. Romania, Rimetea, Piatra Secuiului, detritus 20.IX.2000 SZT. Slovakia, Hrabusice-Podlesok, Sucha Bela beech litter 02.VII.1991 MS.

Published records. Austria (Johnston 1970), Slovakia (Mašán 2003), Hungary (Kontschán 2006a), Slovenia (Ujvári 2009), Romania (Manu 2010).

Diagnosis. Most of dorsal setae short, brush-like, j6, J2, J5, z5, z6 smooth, often blade-like. Bases of setae j1 close to each other. Ventrianal shield with micropuncture-reticulate pattern.

Distribution. Europe (Iceland, British Isles, Spain, Belgium, Switzerland, Germany, Poland, Czech Republic, Austria, Slovakia, Hungary, Lithuania, Ukraine, Bulgaria, Italy, Russia), Turkey and Australia (Mašán 2003).

Remarks. This species is widely distributed in Europe, very common in soil, litter and nests of birds and mammals.

Genus *Macrholaspis* Oudemans, 1931

Macrholaspis similiopacus **Mašán, 2003**

(Figure 2)

Material examined. Carpathian Basin: Hungary, Aggtelek, Baradla cave, leaf litter and humus 21.III.2013 AM.

Published records. Slovakia (Mašán 2003).

Diagnosis. Idiosoma expanded behind shoulders and tapered posteriorly with arranged microspicules on it, length of idiosoma 720 µm. All dorsal setae conifer-shaped and pilose, j1 enlarged. Ventral shields densely dotted, on ventrianal shield arranged to net-like pattern. Sternal shield micropunctate-reticulate. Metasternal platelets present.

Distribution. Slovakia (Mašán 2003).

Remarks. This edaphic detriticole species was previously known only from a few places in Slovakia and this is the first record from Hungary.

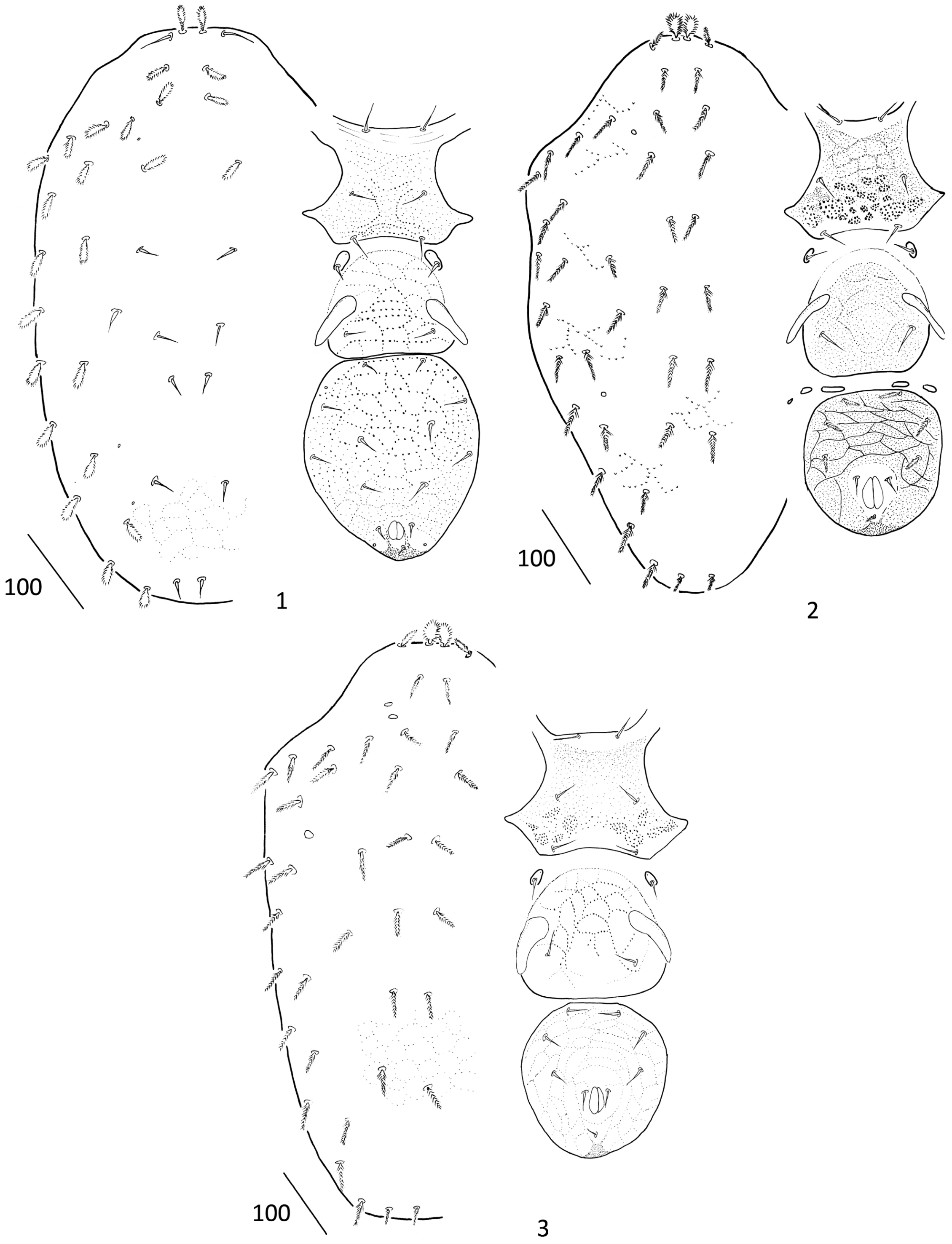
Genus *Macrocheles* Latreille, 1829

Macrocheles disneyi **Fain et Greenwood, 1991**

Material examined. Carpathian Basin: Romania, Cheile Turzii moss and litter 23.VII.2002 CSCS.

Published records. Slovakia (Mašán 2003).

Diagnosis. Shape of dorsum oblong, surface dotted. Most of dorsal setae smooth and needle-



Figures 1-3. 1 = *Longicheles longulus* dorsal and ventral view. 2 = *Macrholaspis similiopacus* dorsal and ventral view. 3 = *Macrocheles punctatissimus* dorsal and ventral view. Scale bar = 100 µm

like, j1 brush-like and J5, S5, Z5 slightly pilose. Linea media transvers, weekly appeared. Sternal shield with strongly reticulate and punctuate pattern.

Distribution. British Isles, Slovakia (Mašán 2003).

Remarks. The species is phoretic on flies and was also found in nests of birds and mammals in Slovakia. This is the first record from Romania.

***Macrocheles glaber* (J. Müller, 1860)**

Material examined. Carpathian Basin: Hungary, Gyöngyös, Sár-hegy from *Cetonia aurata* (Linnaeus, 1758) 07.VI.2014 KJ.

Published records. Bulgaria (Balogh 1958), Austria (Johnston 1970), Hungary (Erőss, Mahunka 1971), Slovakia (Mašán 2003), Romania (Kontschán 2006b), Slovenia (Ujvári 2009).

Diagnosis. Dorsal shield oval with net-like pattern. Most of dorsal setae smooth, needle-like, j1 and J5 pilose. Ventrianal shield with weekly punctuate-reticulate pattern. Ventral setae smooth and needle-like.

Distribution. Europe, Asia, North America, Australia (Mašán 2003).

Remarks. This species is abundant in decomposing organic substrates, mainly in fresh dung. It has phoretic activity the found species was also carried by *Cetonia aurata* (Linnaeus, 1758) which represents the first record of association between this host and *M. glaber*.

***Macrocheles insignitus* Berlese, 1918**

Material examined. Balkan Peninsula: Serbia, Golubac, Danube shore 12.X.2006 DL, KJ, MD. Serbia, Đerdap Planine, Moşna from oak forest litter 12.X.2006 DL, KJ, MD. Macedonia, Peštani, karstic forest litter 16.X.2006 DL, KJ, MD.

Published records. Hungary (Kandil 1983), Slovakia (Mašán 2003), Romania (Minodora 2012).

Diagnosis. Shape of dorsum oval, most of dorsal setae relatively long and needle-like, j1 short, spine-like and J5 serrate. Surface of dorsal shield with network pattern. Ventrianal shield with micropuncture structure laterally, all ventral setae needle-like.

Distribution. Europe (British Isles, France, Poland, Slovakia, Romania, Hungary, Bulgaria, Italy, Russia, Georgia), China, Siberia, Japan, Iran, Egypt (Mašán 2003).

Remarks. This species is coprophilous detriticole, it shows also phoretic activity. This is the first record from Serbia and from Macedonia.

***Macrocheles penicilliger* (Berlese, 1904)**

Material examined. Carpathian Basin: Croatia, Novo Zvecevo 22.IV.2004 KJ.

Published records. Balkan (Willmann 1941), Croatia (Leitner 1946), Austria (Johnston 1970), Hungary (Kandil 1983), Slovakia (Mašán 2003).

Diagnosis. Shape of dorsal shield oblong, most of the dorsal setae brush-like, j6, J2, z1, z5 and z6 needle-like. Surface of dorsum dotted, but without network structure in medial part. Ventrianal shield with reticulate and strongly micropuncture pattern laterally.

Distribution. Europe (Iceland, British Isles, Spain, France, Germany, Switzerland, Czech Republic, Poland, Austria, Slovakia, Hungary, Croatia, Bulgaria, Italy, Russia), Asia (India, Japan), USA, North Africa, Australia and New Zealand (Mašán 2003).

Remarks. Mainly found in decaying organic substrates or nests of birds.

***Macrocheles punctatissimus* Berlese, 1918**

(Figure 3)

Material examined. Carpathian Basin: Hungary, Aggtelek, Baradla cave, leaf litter and humus 21.III.2013 AM, PL.

Published records. Austria, (Krauss 1970), Italy, France, Germany (Bregetova 1977), Slovakia (Mašán 2003).

Diagnosis. The length of idiosoma 700 µm, dorsal shield oblong with a conifer-shaped, densely plumose setae, it can bear an unpaired seta between j6 and J3. Sternal shield dotted with sculptural lines. Genital and ventrianal shield with a weak net-like sculpture. Ventrianal shield rounded.

Distribution. British Isles, France, Germany, Austria, Slovakia, Italy, Turkey (Mašán 2003).

Remarks. The specimens examined didn't bear single setae, but in all other characters comply with the original description. This hygrophilous species is mainly found in soil with high humus content. This is the first record from Hungary.

Genus *Neopodocinum* Oudemans, 1902

Neopodocinum meridionalis (Sellnick, 1931)

Material examined. Carpathian Basin: Hungary, Visegrád, from *Geotrupes vernalis* (Linnaeus, 1758) 01.V.2014 HA.

Published records. Greece (Krantz 1965), Slovakia (Mašán 2003), Hungary (Kontschán 2006a).

Diagnosis. Dorsal shield egg-shaped and narrowed posteriorly. Most dorsal setae short, needle-like, j1 setae serrate and relatively long, s6, S2, S4, S5 setae serrate and 3 or 5 times longer than others. Sternal shield wider than long with a narrow medial part. Anal shield small and rounded.

Distribution. Germany, Poland, Czech Republic, Slovakia, Ukraine, Russia, Greece (Ionic Islands) (Mašán 2003).

Remarks. Coprophilous dertiticole, frequent on scarabeid beetles, mainly on *Geotrupes vernalis* (Linnaeus, 1758).

Neopodocinum mrciaki Sellnick, 1968

Material examined. Carpathian Basin: Romania, Munții Rodnei, moss from a cliff 02.VIII. 2002 OA. Romania, Munții Rodnei, from pine forest litter 27.VI.2005- 01.VII.2005 OK, MD, KJ. Slovakia, Hrabusice-Podlesok, Sucha Bela beech litter 02.VII.1991 MS.

Published records. Hungary (Ambros 1984), Slovakia (Mašán 2003), Romania (Kontschán & Ujvári 2008).

Diagnosis. Dorsal shield oval with fine micropunctures. Dorsal setae long, needle-like, slightly pilose, j1 serrate, z1 shortened. Sternal shield almost rectangular. Anal shield relatively large and oval shaped.

Distribution. Central and South East Europe (Poland, Slovakia, Hungary, Transcarpathian Ukraine, Romania, Macedonia) and China (Mašán 2003).

Remarks. Edaphic detriticole, inhabiting mainly coniferous forest's needle litter, humus, and soil detritus.

Genus *Nothrholaspis* Berlese, 1918

Nothrholaspis carinatus (C. L. Koch, 1839)

Material examined. Carpathian Basin: Romania, Cluj-Napoca, Negreni, beech forest along a left streamside of Crisul Repede River, beech litter and moss 06.X.2006 MD. *Balkan Peninsula*: Macedonia, Sveti Naum, springs and spring lake above the Ohrid Lake, from litter 16.X.2006 DL, KJ, MD.

Published records. Balkan (Szalay 1931, Willmann 1938, 1941), Bulgaria (Balogh 1958), Austria (Johnston 1970), Slovakia (Mašán 2003), Hungary (Kontschán 2006a), Romania (Manu 2010).

Diagnosis. Dorsal shield with reticulate and micropuncture pattern. Most of dorsal setae brush-like, j6, J2, z5 smooth and relatively short, z1 shorter than others and pilose. Sternal shield with puncture-reticulate structure. Ventrianal shield dotted on lateral parts.

Distribution. Europe (Iceland, British Isles, Holland, Belgium, Germany, Switzerland, Austria, Poland, Slovakia, Herzegovina, Bulgaria, Russia) (Mašán 2003).

Remarks. The species is edaphic detriticole, distributed mainly in moist soils. The species is new to the fauna of Macedonia.

***Nothrholaspis montanus* (Willmann, 1951)**

Material examined. Carpathian Basin: Croatia, Kutjevo, streamside 20.IV.2004 KJ. Hungary, Aggtelek, Baradla cave, leaf litter and humus 21.III.2013 AM. Romania, Rimetea, Piatra Secuiului, from a cliff vegetation 07.VII.1998 HE. Slovakia, Rakovec from moss of cliff 03.VII.1991 MS. *Balkan Peninsula*: Croatia, Štrmac from litter 21.IV.2004 KJ. Serbia, Đerdap Planine, Majdanpek from beech litter 13.X.2006 DL, KJ, MD.

Published records. Hungary (Ambros 1987), Austria (Johnston 1970), Slovakia (Mašán 2003), Romania (Manu 2010).

Distribution. Europe (British Isles, Germany, Poland, Czech Republic, Austria, Slovakia, Ukraine, Hungary, Slovenia, Russia) and Asia (Russia: Taymyr Peninsula) (Mašán 2003).

Diagnosis. Dorsal shield oblong, dorsal setae brush-like, except j5, j6, J2, J3, z5 which smooth, z1 short and pilose. Ventrianal shield mostly triangular, lateral parts dotted. Sternal shield with strongly punctuate-reticulate pattern.

Remarks. Edaphic detriticole with a wide distribution, mainly in Europe, very common in soil substrates. This is the first record from Croatia and Serbia.

***Nothrholaspis tardus* (C.L. Koch, 1841)**

Material examined. Balkan Peninsula: Croatia, Drenovac streamside 21.IV.2004. KJ. Serbia, Đerdap Planine, Mosna from oak litter 12.X.2006 DL, KJ, MD.

Published records. Bulgaria (Balogh 1958), Austria (Johnston 1970), Slovakia (Mašán 2003), Hungary (Kontschán 2006a).

Diagnosis. Shape of dorsal shield oblong, bearing mostly relatively long and brush-shaped setae, j6, J2, z5 and z6 needle-like, z1 long and smooth reaching beyond bases j2. Ventrianal shield with strongly punctuate-reticulate pattern.

Distribution. Europe (Iceland, British Isles, Holland, Belgium, Switzerland, Germany, Poland, Czech Republic, Austria, Slovakia, Hungary, Ukraine, Bulgaria, Italy, Greece, Russia) (Mašán 2003).

Remarks. Edaphic detriticole, inhabiting moist and humid soils. This is the first record from Croatia and Serbia.

DISCUSSION

Three macrochelid mites from the listed 19 species (*Longicheles longulus* (Berlese, 1887), *Macrholaspis similiopacus* Mašán, 2003, *Macrocheles punctatissimus* Berlese, 1918) are new to the Hungarian fauna and interestingly, all these were collected in the Baradla cave, Hungary. Unfortunately mite faunistical investigations in caves are quite rare. From Hungary just a few studies have been published in the first half of the last Century (Szalay 1931, Dudich 1932). The species found here are all fast moving predatory mites and either they colonized the subterranean habitats because of presence of available pray species or most probably they were accidentally introduced by insects or mammals.

The number of the known Macrochelid mite species in different countries of the Balkan Peninsula and Carpathian Basin are quite different. For example the macrochelid fauna of Serbia, Macedonia and Croatia were previously absolutely unknown. Due to new records reported here the numbers of the known species are increased in

Romania from 9 to 14, in Croatia from 3 to 6, in Macedonia from 1 to 6, in Hungary from 43 to 46 and in Serbia from 0 to 7 species.

Acknowledgement – We are grateful to the Hungarian Natural History Museum (HNHM) and all of the collectors for providing the material elaborated. The present work was supported by the Hungarian Scientific Research Fund (OTKA 108663).

REFERENCES

AMBROS, M. (1984): Mite species (Acari: Mesostigmata) new to the Hungarian fauna. *Miscellanea zoologica hungarica,* 2: 43–44.

AMBROS, M. (1987): Mites (Acari: Mesostigmata) from small mammals in Hungary. *Parasitologia Hungarica,* 20: 99–107.

BALOGH, J. (1958): Macrocheliden aus Bulgarien (Acari, Mesostigmata). *Acta Entomologica Musei Nationalis Pragae*, 32: 247–256.

BERLESE, A. (1918): Centuria quarta di Acari nuovi. *Redia,* 13: 113–190.

BREGETOVA, N. G. (1977): *Family Macrochelidae Vitzthum, 1930*. In. GHILYAROV, M. S.& BREGETOVA, N. G. (Eds.) Key to the Soil–Inhabiting Mites. Mesostigmata". Nauka, Leningrad, p. 346–411

BREGETOVA, N. G. & KOROLEVA, E. V. (1960): Mites of the family Macrochelidae VITZTHUM, 1930 in the fauna of the USSR. *Parazitologicheskii Sbornik Zoologicheskogo lnstituta Akademii Nauk SSSR,* 19: 346–411.

DUDICH, E. (1932): Biologie der Aggteleker Tropfsteinhöhle „Baradla" in Ungarn. *Speleologische Monographien*, *Wien,* 13: 1–246.

EMBERSON, R. M. (2010): A reappraisal of some basal lineages of the family Macrochelidae, with the description of a new genus (Acarina: Mesostigmata). *Zootaxa*, 2501: 37–53.

ERŐSS, J. & MAHUNKA, S. (1971): Investigations on coprophilous and stercoricolous Macrochelids (Acari, Gamasina) in Hungary, as possible agents in the control of synanthropous flies. *Parasitologia Hungarica*, 4: 215–226.

EVANS, G. O. & BROWNING, E. (1956): British mites of the subfamily Macrochelinae TRÄGÅRDH (Gamasina, Macrochelidae). *Bulletin of the British Museum (Natural History) Zoology,* 4: 1–55.

FILIPPONI, A. & PEGAZZANO, F. (1962): Specie italiane del gruppo-*glaber* (Acarina, Mesostigmata, Macrochelidae, *Macrocheles*). *Redia*, 47: 211–238.

HYATT, K.H. & EMBERSON, R.M. (1988): A review of the Macrochelidae (Acari: Mesostigmata) of the British Isles. *Bulletin of the British Museum (Natural History) Zoology,* 54: 63–125.

JOHNSTON, D. (1970): Notes on a collection of Austrian Macrochelidae with the description of *Macrocheles beieri,* n. sp. *Annalen des Naturhistorischen Museums in Wien,* 74: 145–150.

KANDIL, M. M. (1983): T*he Mesostigmata fauna of the Hortobágy National Park (Acari)*. In. MAHUNKA, S. (Ed.) The fauna of the Hortobágy National Park. Akadémiai Kiadó, Budapest, p. 365–373.

KARG, W. (1993): *Acari (Acarina), Milben Parasitiformes (Anactinochaeta) Cohors Gamasina Leach. Raubmilben*. Jena, Stuttgart, New York Gustav Fischer Verlag, p. 96–114.

KONTSCHÁN, J. (2005): Contribution of the Macrochelidae fauna of Hungary (Acari: Mesostigmata). *Folia Historico Naturalia Musei Matraensis,* 29: 77–80.

KONTSCHÁN, J. (2006a): Check list of the Hungarian Mesostigmatid mites. I.–II. Zerconidae and Macrochelidae. *Folia Historico Naturalia Musei Matraensis,* 30: 129–136.

KONTSCHÁN, J. (2006b): Mesostigmatid mites from Maramureş (Romania) (Acari: Mesostigmata: Uropodina et Gamasina: Zerconidae, Macrochelidae, Epicriidae, Eviphidae et Parasitidae). *Studia Universitatis Vasile Goldis, Seria Stiintele Vietii (Life Sciences Series)*, 17: 53–57.

KONTSCHÁN, J. & UJVÁRI, ZS. (2008): Mesostigmatid mites from Maramureş (Acari: Mesostigmata) I. *Studia Universitatis Vasile Goldis, Seria Stiintele Vietii (Life Sciences Series),* 18: 347–358.

KONTSCHÁN, J., ÁCS, A. & NEMÉNYI, A. (2014): Adatok a magyarországi bambuszok atkáihoz. *Növényvédelem,* 50 (7): 339–343.

KRANTZ, G. W. (1965): A review of the genus *Neopodocinum* OUDEMANS 1902 (Acarina: Macrochelidae). *Acarologia*, 7: 139–173.

KRAUSS, W. (1970): Die europäischen Arten der Gattungen Macrocheles Latreille, 1829 und

Geholaspis Berlese, 1918. *Acarologie, Schriftenreihe für vergleichende Milbenkunde*, 14: 1–60.

LEITNER, E. (1946): Zur Kenntnis der Milbenfauna auf Düngerstätten. *Zentralblatt für das Gesamtgebiet der Entomologie*, 1(3): 75–95.

MANU, M. (2010): Structure and dynamics of predator mite populations (Acari-Mesostigmata) in shrub ecosystems in Prahova and Doftana Valleys. *Studia Universitatis Babes-Bolyai, Biologia,* 1: 17–30.

MAŠÁN, P. (2003): *Macrochelid Mites of Slovakia (Acari, Mesostigmata, Macrochelidae).* Institute of Zoology, Slovak Academy of Sciences, Bratislava, pp. 149.

MINODORA, M. (2012): Similarities between predator mite populations (Acari: Gamasina) from natural forests in the Bucegi Massif, Romania. *Biologia*, 67(2): 390–396.

ÖZBEK, H. H., DOĞAN, S. & BAL, D. (2014): The genus *Glyptholaspis* FILIPPONI & PEGAZZANO (Acari: Macrochelidae) of Kelkit Valley (Turkey), with first description of male of the species *G. saprophila* MAŠÁN. *Turkish Journal of Zoology,* 38. doi:10.3906/zoo-1401-65

SZALAY, L. (1931): Adatok az Aggteleki barlang Arachnoidea-faunájának ismeretéhez. *Állattani Közlemények*, 29: 15–32.

UJVÁRI, ZS. (2009): Contribution to the Mesostigmata fauna of Slovenia (Acari: Mesostigmata: Zerconidae et Macrochelidae). *Acta entomologica slovenica,* 17: 115–124.

VALLE, A. (1953): Revisione di generi e sottogeneri Berlesiani di Acari (Primo contributo). *Redia*, 38: 316–360.

WILLMANN, C. (1938): Beitrag zur Kenntnis der Acarofauna des Komitates Bars. *Annales historico-naturales Musei nationalis hungarici, pars Zoologica*, 31: 144–172.

WILLMANN, C. (1941): Die Acari der Höhlen der Balkanhalbinsel nach dem Material der Biospeologica balcanica. S*tudien aus dem Gebiete der allgemeinen Karstforschung, der wissenschaftlichen Höhlenkunde, der Eiszeitforschung und den Nachbargebieten; Biologische Serie*, 14: (8): 1–80.

Opusc. Zool. Budapest, 2014, 45(2): 119–155

Miscellaneous earthworm types in the Natural History Museum, London (Annelida: Oligochaeta: Megadrilacea: Eudrilidae, Lumbricidae, Megascolecidae, Moniligastridae, Octochaetidae)

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Abstract. Recently restored *Lumbricus terrestris* Linnaeus, 1758 neotype (NHM Register No. 1973.1.1) is described in greater detail. A lectotype is designated for *Amynthas morrisi* (Beddard, 1892) and an informal *A. morrisi* clonal species-complex is proposed. Once combined under *A. gracilis* (Kinberg, 1867), the nominal taxon is revised since its restoration and representation of *A. morrisi* species-group *sensu* Sims & Easton (1972), now unwieldy with forty or so members. A restricted *A. morrisi sensu stricto* is proposed with re-evaluation of its erstwhile synonyms based on types. Limited DNA COI barcode comparisons are appended. A lectotype for *A. barbadensis* (Beddard, 1892) now becomes a junior synonym of *Amynthas gracilis* removing it from nomenclatural consideration. Lectotypes of contenders, *A. mauritianus* (Beddard, 1892) itself closer to *A. gracilis*, and *A. insulae* (Beddard, 1896) appear separate from *A. morrisi*. Next, *A. pallidus* (Michaelsen, 1892) is restored with retention of some of its synonyms, but *A. loveridgei* (Gates, 1968) syntype is maintained. An exotic species from Queensland, Australia is a new member of *A. morrisi* species-group described as *Amynthas talus* sp. nov. Taxonomic ‘housekeeping’ of Queensland taxa requires re-allocation of *Terrisswalkerius leichhardti* Jamieson, McDonald et James, 2013 to prior *Perionychella* Michaelsen, 1907. New Zealand’s possibly extinct *Tokea*? *orthostichon* (Schmarda, 1861) and imperfectly known *Anisochaeta antarctica* (Baird, 1871) are revised in new combinations with slight revision of the genus *Tokea* Benham, 1904. Samples labelled as Hamburg syntypes of Japanese *Metaphire hilgendorfi* (Michaelsen, 1892) are briefly noted as are various other megadriles, such as divers pheretimoids and lumbricids, some also on loan, in the Museum’s collection.

Keywords. Historical collection, curation, taxonomy, typification, review.

INTRODUCTION

During a short visit to the Natural History Museum in London, answers to several chronic yet immediate problems in earthworm taxonomy were sought that included restoration of *Lumbricus terrestris* Linnaeus, 1758 neotype, validating syntypes of *Amynthas diffringens* (Baird, 1869) and sinking lectotype of *Amynthas pingi* (Stephenson, 1925) as reported in Blakemore (2013b, 2013e). Inspections of types of species of type-genera also helped revision of world families (Blakemore, 2013d). The current work attempts resolution of separate issues based on types from Europe, Africa, America, Asia and Australasia held at the Museum, some loaned from other institutions.

Historically, Frank Evers Beddard (1858−1925) was Prosector at the Zoological Society of London and while there he received specimens of earthworms sieved from soil at Kew Botanic Gardens obtained with plants from around the Globe (see also Beddard 1906). In July, 1892, Beddard (1892b) published several pheretimoid (i.e. *Pheretima* auct.) species, mostly those intercepted at Kew; and, in 1896, he described species from Hawaii and elsewhere. Several of these have been subsequently reallocated as shown in Tables 1 and 2.

The *Amynthas morrisi* problem

Of particular concern is the status of *A. morrisi* (Beddard, 1892), that was soon implicated with *A.*

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HU ISSN 2063-1588 (online), HU ISSN 0237-5419 (print)

Table 1 of Beddard's 1892 *Perichaeta* species from Royal Botanic Gardens, Kew

Beddard 1892 page	Original name	Currently	Notes
155; Pl IX fig. 4	? *Perichaeta sumatrana* Horst	*Metaphire californica* ?	Or *Duplodicodrilus schmardae* ?
157; Pl IX, figs. 2, 8; Pl X, fig. 1	*Pe. dyeri*	*Amynthas rodericensis*	For W.T. Thistleton Dyer of Kew Gardens
158; Pl IX, figs. 3, 5; Pl X 2-4, 7-8	*Pe. sinensis*	*A. rodericensis*	
160	*Pe. bermudensis*	*A. gracilis* (or *A. bermudensis*?)	Cf. *A. loveridgei*?
163	*Pe. taprobanae*	*Polypheretima taprobanae*	First UK record
166; Pl IX, fig. 1	*Pe. morrisi*	*Amynthas morrisi*	Lectotype (missing)
167; Pl IX, fig. 6	*Pe. barbadensis* – a	*A. morrisi*?	No figure
167	*Pe. barbadensis* – b	*A. gracilis*	Actual fig. 6; new lectotype (missing)
167; Pl IX, fig. 7	*Pe. barbadensis* – c	*A. pallidus*?	Fig. 7 as stated
169	*Pe. hesperidum*	*M. californica*	
170; Pl X, figs. 5-6	*Pe. mauritiana*	*A. gracilis* (or *A. mauritiana*?)	Spermathecae 7&8 so not *A. morrisi*

Table 2 of Beddard's 1896 *Perichaeta* species from Sandwich Isles (Hawaii)*

Beddard 1896 page	Original name	Currently	Notes
197	*Pe. indica* Horst	*Amynthas corticis*	
198	*Pe. perkinsi*	*A. corticis*?	Types missing?
201	*Pe. molokaiensis*	*A. corticis*?	Type missing?
201	*Pe. hawayana* Rosa	*Amynthas gracilis*	
203	*Pe. sandvicensis*	*Metaphire californica*	Types inspected by RJB VI.2013
204, fig. 2	*Pe. insulae*	*Amynthas insulae*?	Types inspected by RJB VI.2013
205	*Pe. trityphla*	*Duplodicodrilus schmardae*	**Types re-inspected
205	*Pe. trinitatis*	*A. rodericensis*	Type 1904:10:5:170 not located

*Note that many specimens came from Mauna Loa Mountain where Keeling (1978) continuously recorded his atmospheric CO_2 readings. Soil preserved in the intestines of these worms from the time of collection is comparable to the current state of soils there.

**BMNH types for *trityphla* catalogued as 1904.10.5.169 are actually 1904:10:5:69.

hawayanus (= *A. gracilis*) by Beddard (1895) but later restored and made representative of an *A. morrisi* species-group by Sims & Easton (1972). This group has since become unwieldy gathering about 40 nominal species, but see comments in Blakemore *et al.* (2013).

The British Museum (Natural History) purchased Beddard's collection in 1904 (Coles 1981) and in the current study, Beddard's types were sought. The chequered history of *A. morrisi* is here reviewed taxonomically – an urgency due to the tide of new names continuously added to its group.

Chronology of *Amynthas morrisi* (Beddard, 1892) species-group

1892b (July) Beddard published poor descriptions of *morrisi*, *barbadensis* and *mauritiana*.

[1892 (Sept.) Michaelsen published *pallida* for two probably separate species].

[1894 Rosa describes *amazonica*].

1895: 394, 400, 411 Beddard (Monograph) redescribes *morrisi* adding only that the male pores are simple, not wide apart, and have minute glands opening in their neighbourhood (to explain presence of glands internally) but certainly makes no mention of there being distinct papillae there.

[1895: 394, 391, fig. 44d, 400, 412 Beddard (Monograph) also revised *barbadensis* that has lateral male pores and variable GMs and he tabulates and describes mainly his example "a" that is possibly the same as *morrisi*. Note originally "a" and "b" were described as 4¼" long (= ~106 mm), specimen "c" was smaller at 84 mm with 64 segments. Although now missing, specimen "b" is here designated as lectotype in order to force problematical name *barbadensis* into synonymy of *A. gracilis*].

[1895: 394, 400, 415 Beddard (Monograph) redescription of *mauritiana* as 80 mm with 85 segments, markings on 18 and spermathecae in 7 & 8, *i.e*., different to *morrisi* but possibly same as *barbadensis* specimen "b" and thus a synonym of *hawayana* (= *gracilis*)].

[1895: (overlooked on pg. 394) 397, 400, 415 Beddard (Monograph) comments on *pallida* Michaelsen 1892 with two or three spermathecae in 6,7,(8); GMs two pairs on 7, sometimes two or three papillae in 5/6 and 6/7 or 7/8, plus with 2−4 papillae around each male pore and a pair on 19, *i.e*., different to *morrisi* proper].

1896 Rosa redescribes *morrisi* on somewhat variable specimens from Padang, Sumatra. Markings are said mid-ventral in some of 6−8 and 18, sometimes with extra markings in 7 near the spermathecae. Intestinal caeca had no trace of lobulations but it is not certain that these were all *A. morrisi* proper.

[1896 Beddard describes *insulae* as revised herein].

[1900: 238, 244, 254 Michaelsen (Tierreich) has *Amynthas barbadensis* with syns. *pallida* Michaelsen, 1892: 227, *amazonica* Rosa, 1894: 14, *sanctijacobi* Beddard, 1895: 61, *cupulifera* Fedarb, 1898: 445 – but this is in error as only *barbadensis* specimen "c" complies, so *pallida* should resume priority of this group].

[1900: 238, 276 Michaelsen (Tierreich) maintains *Pheretima insulae* separately].

1900: 238, 287 Michaelsen (Tierreich) provides a good summary of *Pheretima morrisi* based on Beddard and Rosa's accounts that was, for a time, reasonable and stable.

1900a: 420 Beddard (Hawaiiensis paper) places *bermudensis, barbadensis, morrisi, mauritiana, mandhorensis, pallida, amazonica* and *cupulifera* in synomymy of *Perichaeta hawayana* Rosa, 1891 (= *gracilis*). This is obviously excessive.

1900b: 645 (May) Beddard (*Amyntas* paper) places same species in synonymy of *Amynthas hawayanus* (Rosa, 1891) (= *gracilis*) plus he adds *P. carnosa* Goto & Hatai and *P. insulae* Beddard, 1896: 204. Again somewhat excessive, although some names are now found to belong.

1905 Ude separated *morrisi* (page 434) and *hawayana* (page 457).

1931, 1933 Chen also separated *hawayana* and *morrisi*.

1920−1982 Gates made various contributions, many confused and contradictory, whilst also rejecting the proper genus *Amynthas* for a decade. His (1937) review of types did not provide definitive resolution and also failed to locate Beddard's original types (his specimens from Hong Kong are obviously not syntypes).

1972 Sims & Easton treat synonyms equally with valid names in their study but made *Amynthas morrisi* a species-group exemplar, without justification as to its specific merits; they did not inspect the type thus their figures may not be correct.

1981, 1982 Easton retained the species but his figure may also be incorrect/composite.

1999 Sims & Gerard described *Amynthas morrisi* with synonyms *barbadensis* and, the highly unlikely, *mauritiana*, their description is also composite.

2003 Blakemore (Japanese earthworms) listed *A. morrisi* with syns. *barbadensis*; *?pallida*; *hawayana lineata* Gates, 1926.

2005: 21, 24 Shen & Yeo list synonyms of *A. morrisi* as *barbadensis* (part.), *pallida* (part.), *amazonica, insulae, cupulifera* and *hawayana lineata*.

2007/2008 Blakemore questioned synonyms *?barbadensis* (part.), *?mauritiana*, *?pallida* part.), *?amazonica*, *?sanctijacobi* and *?cupulifera*, but accepted *hawayana* and *lineata*. Simultaneously, *A. insulae* was maintained separately.

2009: 60 Chang *et al.* provide Taiwan description that seems to comply more with *pallida* or one of its junior synonyms rather than the currently restricted sense of *A. morrisi* (see their figure from http://clitellates.taibif.tw/pages/660).

2009: Sun *et al*. provided four new species to the *A. morrisi* group from Hainan.

2013: 41 Blakemore in Blakemore *et al.* (2013) questions some of Sims & Easton's inclusions being a part of the *A. morrisi* species group as for several Korean species – rather they strictly comply with Sims & Easton's *canaliculatus*-group, as indeed does *A. tripunctus* (Chen, 1946).

2013a Zhao *et al.* provided two new species to the *A. morrisi* group from Hainan.

2013b Zhao *et al.* provided three new species to the *A. morrisi* group from Hainan.

2014 Jiang *et al*. provided four new species to the *A. morrisi* group from Hainan.

2014 Shen *et al*. provided another new species to the *A. morrisi* group from Taiwan.

The current paper aims to review and revise these earliest taxa based on their types for resolution of the several conflicts as noted above and in the synonymy of *A. morrisi* below.

The chronic saga of the *Amynthas* Kinberg, 1876 vs. *Metaphire* Sims & Easton, 1972 polyphyly quandry that I thought had been solved (*e.g.* Blakemore, 2003, 2010, 2013a: 62) lingers, missing the point that under ICZN the members of a genus comply with the type of that genus and thus *Metaphire javanica* (Kinberg, 1867) and its ilk having non-superficial male pores belong, regardless of whether these are within copulatory pouches or not – this only relevant for genera such as *Duplodicodrilus* Blakemore, 2008. Notwithstanding that anything above the species level (genera, family) is more a taxonomic 'convenience' construct – as was clearly stated by Sims & Easton (1972: 170) – it is yet phylogenetically reasonable to expect that any deviation of the primitive superficial male pore must be a "non-superficial" derivative, unless proven otherwise. Hence *Metaphire hilgendorfi* (Michaelsen, 1892) in the following review is again placed in its currently correct genus as per Blakemore (2003, 2013a) unlike by some contemporary Korean and Japanese workers who incorrectly keep it in *Amynthas* or even *Pheretima* as per Gates (1972, 1982).

MATERIALS AND METHODS

Abbreviations are: GM – genital markings, rhs and lhs – right and left-hand-side, NZ – New Zealand; Qld. – Queensland; TP – tubercula pubertatis; "?" indicates taxonomic uncertainty. Taxa are arranged alphabetically except for *Amynthas morrisi* spp-group which is chronological. Discussion is confined to remarks after species' accounts.

TAXONOMIC RESULTS

Family EUDRILIDAE Claus, 1880

***Eudrilus eugeniae* (Kinberg, 1867)**

Lumbricus eugeniae Kinberg, 1867: 98. [Type locality humid mounts and valley of St Helena Island (British protectorate) in South Atlantic, by introduction. Types from Stockholm Museum now seemingly transferred to Natural History Museum London by Beddard and sometimes quoted as BMNH 1904.10.5.549 [that is actually Kinberg's *L. capensis*] or 1904.10.5.550 – this specimen now labelled: "*Lumbricus eugeniae Kinberg 1867 TYPE sent to Dr Beddard by Professor Loven. St Helena*", Beddard's label with "*Lumbricus*" crossed out in favour of "*Eudrilus eugeniae* .... [illegible] *550 St Helena* "; and a Swedish Museum label: "*Lumbricus Eugeniae Kinberg St Helena Swed. State Museum*." The specimen is coiled and seems a bit macerated but looks in moderate condition – pers. obs].

Note. Specimen not dissected further in order to preserve the type's integrity.

Family LUMBRICIDAE Rafinesque-Schmaltz, 1815

Aporrectodea caliginosa **(Savigny, 1826)** s. strict.

Enterion caliginosum Savigny, 1826. [Type locality in the Paris region. Types, claimed to be missing by some authors, listed by Reynolds & Cook (1976: 84) in Geneva: MHNG 3/77].

?*Lumbricus helenae* Kinberg, 1867: 98 [Type locality St Helena. Types moved from Stockholm to BMNH (pers. obs. RJB 20.VI.2013) labelled "*Lumbricus HELENAE Kinberg 1867* TYPES", "*1904:10:5:551 Loc: St Helena Don: Swedish State Museum via Beddard Collection. Ref:* ". One mature dissected and in two parts in poor condition, plus an immature lumbricid].

Notes. Michaelsen (1900: 518) listed this species as *incertae sedis* but Gates (1977) placed it in his *caliginosa* species-complex that differs from that *sensu* Blakemore (2012b). A relatively common worm in temperate regions with many synonyms.

Aporrectodea trapezoides **(Dugès, 1828)**

Lumbricus trapezoides Dugès, 1828. [Type locality Montpellier. Types missing, however, Gates (1972: 79), Reynolds & Cook (1976: 182) and Blakemore (2012b) all advocated recollection and designation of a Neotype].

?*Lumbricus Novae Hollandiae* Kinberg 1867: 99. [Locality Sydney. Types in Stockholm]. [Current correct spelling is "*novaehollandiae*"].

Lumbricus capensis Kinberg, 1867: 100. [Locality Cape of Good Hope (Cape Town) SA. Type moved from Stockholm to London: BMNH 1904:10:5:549 – "*Lumbricus CAPENSIS Kinberg 1867* TYPES", "*1904:10:5:549 Loc: Cape of Good Hope Don: Swedish State Museum via Beddard Collection Ref:*"; a single dissected specimen in poor condition – pers. obs. RJB 20.IV.2013].

Notes. A relatively common worm in mostly sub-tropical or Mediterranean climes.

Eisenia fetida **(Savigny, 1826)**

Enterion fetidum Savigny, 1826. [Type locality Paris. Types in Paris Museum].

Lumbricus annulatus Hutton, 1876/7: 352. [From Dunedin, New Zealand - see Benham (1898) when material was in the Otago Museum; syntype now in BMNH: "*1886:11:18:14 Loc: DUNEDIN N.Z. Coll: OTAGO UNIVERSITY MUSEUM Ref:..*" with old Otago label "*6:11:18:14*"; one mature specimen in good condition tied to a film – dark with possibly lighter intersegments and paler in 9−11; clitellum 26−32 and TPs in 28−30,31½]. [Non *annulatus* Perel, 1975: 995 (= *L. polyphemus*)].

Notes. L. annulatus is just one of about fourteen taxa included in synonymy of *E. fetida* that have priority over *Eisenia fetida andrei* Bouché, 1972 (see Blakemore 2013c, Blakemore & Lee 2013: appendix).

Lumbricus castaneus **(Savigny, 1826)**

Enterion castaneum Savigny, 1826: 180. [Type locality Paris. Types missing from Paris Museum]. [Non *L. castaneus* Risso, 1826 which is listed as *incertae sedis* in Michaelsen (1900: 518), see also Gates (1972: 115)].

Lumbricus josephinae Kinberg, 1867: 98. [St Helena. Types NHRS: 1928 with a specimen labelled "*Lumbricus josephinae Kinberg, 1867 PARA/ SYNTYPE 1904:10:5:554 Loc; St Helena Coll: Natuh..Riksmuseet, Stockholm Ref:* "; one specimen in poor condition].

Notes. Widely distributed in holarctic and introduced to Australia and NZ.

Lumbricus terrestris **Linnaeus, 1758**

(Figure 1)

Lumbricus terrestris (part) Linnaeus, 1758: 647. [Type locality Sweden. Neotype in British Museum (Sims 1973) – BMNH 1973:1:1 (as restored by Blakemore 2013e)]. [Note: Original spelling was as "*L. terreſtris*" in older style long-s typography.

Linnaeus included in its early synonymy *Lumbricus laevis, L. terrestris minor, L. terrestris minor rubicundus, L. major, L. intestinorum teres* and *Lumbricus humanus* Vallisneri, the latter being the intestinal nematode worm − *Ascaris lumbricoides* (Linnaeus, 1758)].

[?Non *Enterion terrestre* Savigny, 1822– *sp. dub.* often misdated "1820". Egypt].

Enterion herculeum Savigny, 1826: 180. [From Paris. Type in Paris claimed by James *et al.* 2010 to be a "*cryptic species*" of *L. terrestris* but other synonyms, as provided by Sims (1973: 28) not checked; note this species already maintained in *Lumbricus* by Garman (1888: 73) who says Eisen found it in New England, USA but these maybe misidentifications for *L. terrestris* or *L. friendi*].

Lumbricus herculeus: Dugès 1837 (cf. Sims 1973: 29); James *et al*. 2010 attempted restoration (but see Blakemore 2013e).

[Non *Lumbricus terrestris*: Dugès 1837: 17,18 (misid. of *A. longa* (Ude)].

Lumbricus agricola Hoffmeister, 1842. [From neighbourhood of Berlin. Types lost].

Lumbricus infelix Kinberg, 1867: 98. [From Port Natal. Type Stockholm, 1930].

Lumbricus americanus Perrier, 1872. [Type in Paris].

Lumbricus studeri Ribaucourt, 1896. [Types?].

Lumbricus terrestris: Johnston 1865; Michaelsen 1900: 511 (syn. *herculeum*, *agricola*, *infelix*, *americanus*, *studeri*); Sims & Gerard 1999: 106, figs. 1, 4, 6, 9j, 37, 38; Blakemore 1997; 2002; 2012b (syns. as above and all references cited); Csuzdi & Zicsi 2003: 188. [Non Tetry (1937: 151), nec Bouché (1970: 541), nec James *et al.* (2010)? – see Sims 1983; Blakemore 2013e].

Diagnosis. Length 90−350 mm. Chestnut to violet brown above, paler below. Body cylindrical, posterior characteristically depressed and spade-shaped. Prostomium tanylobous. First dorsal pore 7/8/9. Spermathecal pores in 9/10/11 in cd lines. Clitellum saddle-shaped 32−37,$^{1}/_{n}$38. Tuberculae pubertates longitudinal ridges on 32,33−36,37 lateral to *b* lines; tumescences around *ab* in some or all of 8−14, 24 and around clitellar region. Setae closely paired. Male pores lateral to *b* lines on 15 in prominent lips commonly impinging onto adjacent segments.

Material examined. NHM London neotype, a mature specimen previously dissected dorsally with cuticle partly removed, in jar with three labels: "*Lumbricus terrestris* L. 1758 Neotype. Uppsala. 1973.1.1."; "*Lumbricus terrestris* Linnaeus 1758 TYPE Loc. Uppsala"; "Lumbricus terrestris *Linnaeus no longer contains NEOTYPE 1973.1.1 Loc: Uppsala. Note: Originally this number was designated for the L. terrestris neotype determined by R.W. Sims in 1973. Following examination by V. Pop (visiting at NHM, 2009) and S. James (James et al. PLOS ONE Dec 2010, vs, issue 12e15629) it was discovered that this jar no longer contains Sims' described neotype, which must now be considered missing*.". Plus one label I added restoring its status as Neotype in 2013 (see Blakemore, 2013: fig. 1). Sims (1973: 32) gives details as collected from lawn close to the Botanical Garden, Uppsala, Sweden; 13th Oct. 1972, collectors B. Axelsson, U. Lohm and T. Persson. Preserved in formalin and 80% alcohol.

Locality of other specimens. Found by the author in supposedly 1,000 yr old paddock and organic field at Haughley farm in 1980 (Blakemore 2000). Numerous 'middens' seen at organic orchards at UC Davis, California in 2000 (also R.L. Bugg pers. comm). Launceston, north Tasmania; escaping over soil surface of suburban garden when digging drains to 1 m depth in black clay at 145 Holbrook St., Invermay; R.J. Blakemore, 29th June, 1997 (mature, complete specimen; fixed in 10% formalin, preserved in 80% ethanol in QVM collection). Found by author at Mt Wellington, Auckland in paddock soil (Blakemore 2012a); specimen in Auckland Museum (AMNZ 5265); also collected by RJB at Y Plas Machynlleth, Wales on 22nd VI 2013 (large specimen released in NHM gardens with help from Emma Sherlock).

Distribution. (Full citations in Blakemore 2012b). Holarctic: Greenland, Iceland, Scandinavia, Siberia, Russia, western Europe and British Isles including Isle of Man and Jersey, to the northeast of Iberian peninsula. Introduced to Azores, Madeira, USA (widespread but sometimes deliberately transported for fishing bait as noted by Gates 1972: 120), Canada (e.g. Alberta, British Columbia, New Brunswick, Newfoundland,

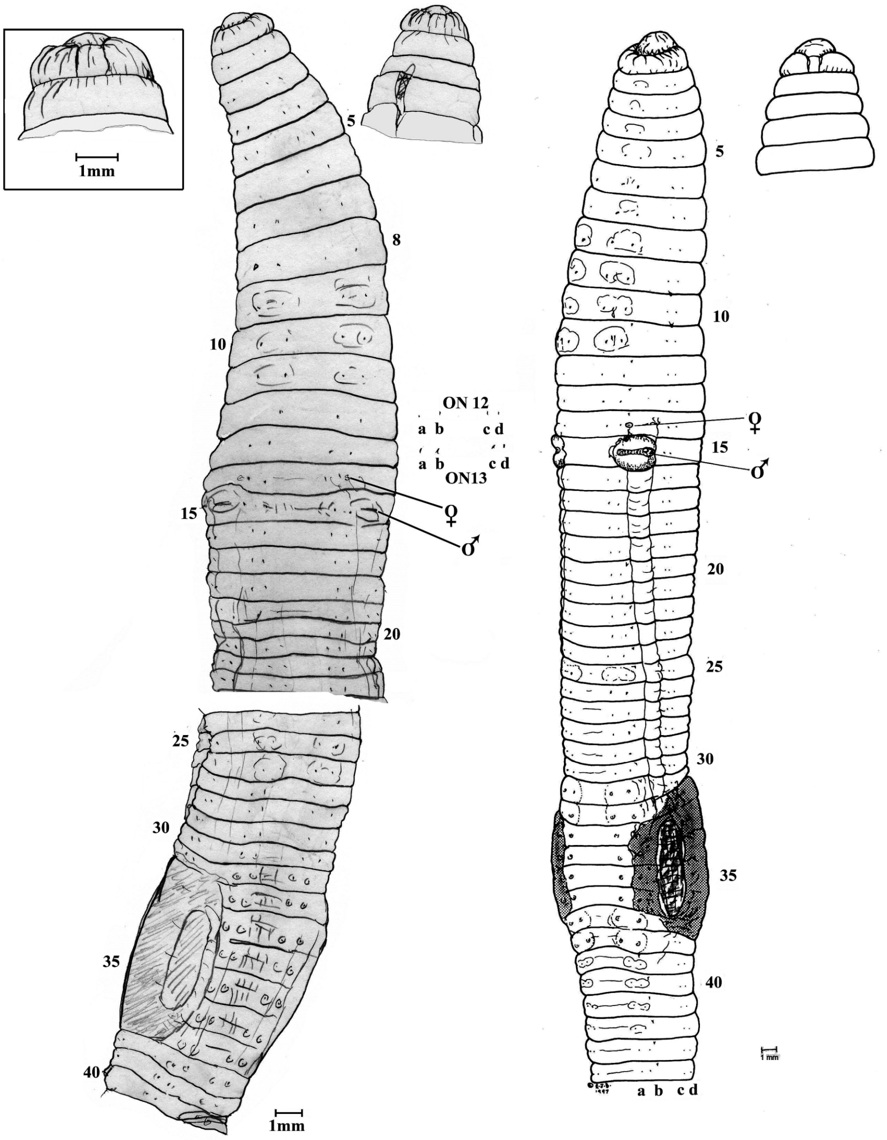


Figure 1. *Lumbricus terrestris* Linnaeus, 1758. Natural History Museum, London neotype (lhs with enlargement of tanylobous prostomium) compared to (rhs) first recorded Australian specimen from Tasmania after Blakemore (1997).

Nova Scotia, Ontario, Prince Edward Island, and Quebec although a report from Saskatoon, Saskatchewan is a mis-identification); temperate regions of Central and South America; India (and western Himalayas); South Africa [? Gates (1972: 119)]; N.Z. (Lee 1959), Tasmania – a new Australian record by (Blakemore 1997). Note, James *et al.* (2010) when attempting to restore the synonym state "*L. herculeus has yet to be found outside of Europe*" but overlooked earlier USA references noted in synonymy above.

Habitat. Mull soils, fields, pastures orchards and deciduous forests, mud flats, manure heaps, taiga, forests and steppes, common in grasslands (avoids pine/beech forests?). In alkaline soils of pH 6.2–10.0; especially abundant in clay. Sometimes caves, often in golf courses.

Behaviour. Nocturnal copulating and feeding on surface; posterior third assumes flattened spade-like shape when agitated and worms retreat backwards. Maintains permanent burrow systems and forms ‘middens’ around entrances which may be clogged with leaves, feathers or other debris.

Body length. Anterior circular, posterior often dorso-ventrally flattened; 90−350 mm (neotype 155 mm but coiled and twisted; *cf*. 165 mm Sims 1973).

Width. 6−12 mm (neotype *ca*. 7−9 mm maximum).

Segments. *Ca*. 120−155 [neotype ~151 but with secondary schizo-metameres, see Blakemore (2013: fig. 2), cf. Sims (1973) 153 segments].

Colour. Anterior dorsum deep ruddy to gun-metal grey to *d* setal lines with blue iridescence, retained as dark mid-dorsal line to posterior; ventrum pale (pink in life); clitellum buff (yellowy in life); preserved specimens uniform buff.

Prostomium. Tanylobous.

Clitellum. ½31, 32−37, $^1/_n$38 saddle-shaped mostly to *bb* lines (neotype ½31, 32−37).

Dorsal pores. 7/8 small, from 8/9 larger.

Setae. 8 per segment, closely paired in regular rows; ratio aa:ab:bc:cd:dd:C *ca*. 6:1:5:1:22:0.5C, *cf*. 5:1.5:4:1:0.5C or 4:1.3:2.1 in neotype (Sims, 1973: 32).

Nephropores. Large at anterior margin of segment just lateral level of *b* setal lines on many segments (*e.g.* on right-hand side on 11−15, 20, 22−25, 28, 30−36, 39−44, etc.), irregularly alternating to between *d* and mid-dorsum (*e.g.* on rhs seen in dorsal position on 3−7, 9, 17−19, 21, 26−27, 29, 33−34, 37−39, 44−45); in some segments the pores appear to be in both positions on one side but reasons for this are unknown.

Spermathecal pores. In 9/10/11 in *cd* nearer to *c* lines; [Sims (1973: 32) says inconspicuous in *b* lines but I could not locate them there in the dissected neotype].

Female pores. Paired just lateral of *b* setae on 14.

Male pores. Towards lateral extremity of equatorial slits within tumid lips between *a* and *c* setal lines confined to 15; distinct mound tract (formed by parallel seminal duct grooves) extends from male pores to clitellum between *bc* lines on both sides.

Genital markings. Tubercula pubertatis as elongate smooth pads just median of *c* lines in 33−36; ventral setal couples within slightly tumid pads, especially 8,9−11, 25, 26, and 31,32 often to 37,38; Sims (1973: 32) has *ab* tumid on 25 and 26 as reconfirmed here.

Septa. 6/7/8/9 thickened; or none especially muscular.

Hearts. Paired in 7−11.

Gizzard. Muscular in 17−19.

Calciferous glands. Calciferous sacs opening posteriorly into the oesophagus of segment 10 ventrally and just in front of septum 10/11. Calciferous lamellae continued along lateral walls of the sacs in 11−12.

Intestine origin (caeca, typhlosole). In 14, swelling in 15−16 to form crop; caeca absent; typhlosole mid-dorsal beginning from about 21−23.

Nephridia. Holoic, bladders J-shaped.

Male organs. Testes/funnels holandric testis in sacs in 10 & 11; seminal vesicles paired in 9, 11 and 12, the latter pair may also fill 13.

Ovaries. Small, paired in 13.

Prostates. None.

Spermathecae. Two pairs in 9 & 10 as small globular sacs dorso-ventrally placed.

Gut contents. Depends on habitat and diet.

Cocoons. *Ca*. 4x7mm diameter but elongate (Sims & Gerard 1999: fig. 38b).

Ecology, life-cycle, symbionts and parasites. Provided by Gates (1972), etc.

Notes. *L. terrestris* is probably one of the main species about which Darwin (1881) wrote (*cf*. *A. longa*). A species that has, until relatively recently, been continually confused with *L. terrestris* is *Aporrectodea longa* (Ude) (see Gates 1972: 76).

Family MEGASCOLECIDAE Rosa, 1891 *s*. Blakemore 2000

Genus **Anisochaeta Beddard, 1890**

Anisochaeta antarctica **(Baird, 1871) comb. nov.**

(Figure 2)

Megascolex (*Perichaeta*) *antarctica* Baird, 1871: 96. [From “New Zealand”. Type BMNH 1845:6:18:1 – one of the first worm specimens from NZ, collected by Dr Andrew Sinclair RN surgeon on Ross's ~1841−1844 'Lords of the Admiralty Antarctic Expedition' that had earlier specimens from Bay of Islands. Later Dr Sinclair was Colonial Secretary to NZ and founder of Auckland Museum].

Diporochaeta shakespeari Benham, 1906b: 254, figs. 7, Pl. XLI. [From bank of stream in dense bush, Little Barrier Island collected by W. B. Benham, 1906. Specimens "*about a dozen individuals*" but types Otago A. 43−48 (six?) at least one of which was inspected by Michaelsen (1916: 51); (syn. by Lee 1962: 177)].

Spenceriella shakespeari: Michaelsen 1907: 161.

Megascolex shakespeari: Michaelsen 1916: 51.

Megascolex antarcticus: Lee 1959: 348 (dates as "1871" and provides synonymy but classes as *"incertae sedis"* due to lack of information).

Spenceriella antarctica: Lee 1962: 177 (syn. *shakespeari*).

Celeriella antarctica: Blakemore, 2004; 2012a: 130 (syn. *shakespeari* as per Lee, 1962).

Diagnosis. The entire original description is "*Body consisting of about 180 rings. Setae, surrounding the body, short, black, rather distant. Rings not keeled; larger and more distinct at the anterior extremity, closer at the posterior end, and all smooth. Length 7 inches. Hab. New Zealand.*" The type was inspected by Beddard and by Lee (1962) neither of whom dissected it, as here, since there was only a single unique specimen. Lee gave a length of 125 mm with 192 segments each with about 50 setae, but the specimen is now closer to 170 mm due to maceration. A sketch is for the first time provided confirming Lee's contention that its GMs are similar to those of *D. shakespeari* that is described in more detail by Benham, Michaelsen and subsequently by Lee (1959).

Material Examined. Lectotype BMNH 1845:6:18:1 a mature specimen, aclitellate or the clitellum weak, with cuticle removed but otherwise in good condition apart from being macerated in the mid-body. Labelled: *"45:6:18:1"*; *"Megascolex antarctica Baird, 1873 TYPE 1845:6:18:1 Loc; New Zealand Dr. A. Sinclair R.N. Ref. J. Linn. Soc. 11, 1873, p. 96"*; "*Current name is Spenceriella antarctica (Baird), 1873 (Idet. Dr K.E. Lee 1961)*". Note, sample jar also contains a myriapod that is ca. 10 mm long with 70 legs, possibly the first one collected from N.Z. too. Lee (1959: 348) mistakenly has specimen as "*1845.6.8.1*". Other severely macerated and fragmented specimens labelled "B.M. [18?]40:5:27−9", "*Lumbricus? sp.?, Bay of Islands, New Zealand; Antarctic Exped. the Admiralty*" were identified by Lee (1962: 179) as *Megascolides* sp – these probably the actual first specimens collected from NZ.

Under ICZN (1999: Art. 74.5) the lectotype designation is deemed by Lee (1962: 177, 179) where he says it "*becomes the type of* Spenceriella antarctica". The original article says published February 1870, but read on April 7, 1870 and the paper is most often dated 1871, e.g. by Lee (1959, 1962), whereas the Volume cover states published 1873; possibly preprints were issued thus the actual date of publication is currently uncertain.

Distribution. Widespread on North Island and Northland peninsular islands, NZ (Lee, 1959: 348 for *Diporochaeta shakespeari*).

Notes. Michaelsen (1916: 51) inspected a type specimen and found Benham incorrect to class the tubuloracemose prostates as "*tubular*" hence he reallocated the species to *Megascolex* Templeton, 1844 s, strict. that is now restricted for Indian taxa, whereas *Anisochaeta* Beddard, 1890 is available for Australasian taxa following its restoration by Blakemore (2000). Neither Lee (1962) nor Blakemore (2012a) had recognized Michaelsen's (1916) revisionary work on *Diporochaeta shakespeari* published a Century ago at the height of the 1914−1918 Great War, hence the previous generic misallocations.

Michaelsen (1916: 52) did not secure a specimen of *Megascolex giganteus*, but thought it so close to the previous species that he allowed for its prostates to essentially agree, thus it too is provisionally held as *Anisochaeta*? *gigantea* (Benham, 1906b) **comb. nov.** It is then most likely the two remaining Celeriellas, viz. Lee's 1959 *argillae* and *pallida* also comply as **combs. novae** in *Anisochaeta* which then entirely removes the genus *Celeriella* Gates, 1958 from NZ although it apparently still resides in Australia. *Celeriella* is an Indian genus that by default received the residue of species from Australia and four from New Zealand actually having ‘primitive’ tubular prostates that were formerly part of *Spenceriella* Michaelsen, 1907, after removal of the type-species of the latter genus claimed with a non-tubular prostate to prior Australasian *Anisochaeta* Beddard, 1890 (see Blakemore, 1997b, 2000a, b). Other ‘advanced’ megascolecid genera are Indian *Lampito* Kinberg, 1866 s. strict. and Oriental pheretimoids such as *Amynthas* Kinberg, 1867 itself revived by Sims & Easton (1972).

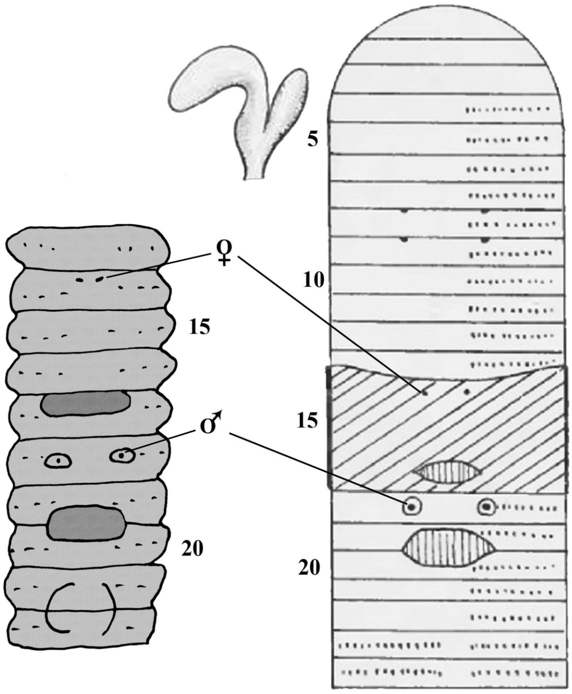


Figure 2. *Anisochaeta antarctica* (Baird, 1871) lectotype sketch (crease on 21–22 is just a fold not a marking) compared to synonym *Diporochaeta shakespeari* Benham, 1906 (his figs. 7 of a spermatheca, and Pl. XLI exterior diagramatic).

Genus **Amynthas Kinberg, 1867**

Amynthas gracilis **(Kinberg, 1867)**

(Figures 3a–b)

Nitocris gracilis Kinberg, 1867: 102. [Type locality Rio de Janeiro. Types in Stockholm Museum, 1944 (Reynolds & Cook, 1976: 108), immatures (Sims & Easton, 1972: 214)].

Perichaeta bermudensis Beddard, 1892a: 160. [Thirty or forty spirit specimens from Surgeon-Major Windle of Bermuda (not from Kew Gardens). Syntypes British Museum: 1904:10.5.1362–65 (these inspected by Sims & Easton, 1972: 180 put in an *hawayana*-group and checked by RJB in June, 2013. Labels “*Perichaeta bermudensis Beddard 1892 Types 1904:10.5.1362/65 Loc. Bermuda Beddard Coll Ref. Proc. Zool. Soc. Lond. 1892 p.160*”, “*Perichaeta hawayana 1904:10:5:1362–65*”, “*Types of Perichaeta bermudensis*”. Jar contains many specimens, several found to be dissected, possibly of two or three different species, most look more like *A. corticis*); Beddard 1896: 208 (specimens from Hong Kong); 1900a: 410 he again confused description of *bermudensis* by saying “*Spermathecae two pairs in VI, VII, VIII*”!]. [Non *Pontodrilus bermudensis* Beddard, 1891].

Perichaeta barbadensis (part., spec “b” which now = lecotype) Beddard, 1892a: 167. [Types British Museum 1904:10.5.11-13 inspected by RJB June, 2013 – see *A. morrisi* below. With spermathcal pores in 5/6/7/8 and shown in fig. 6 that was said to be specimen “a” by Beddard (p. 167), but is actually specimen “b”].

?Perichaeta mauritiana Beddard, 1892a: 170, Pl X, figs. 5–6 [From Kew originating in Mauritius. Types in British Museum 1904:10:5:203–5 (the numbers suggest three specimens although the original one was misplaced by Beddard 1900a: 425 and thus these specimens were not inspected by RJB). [Described with two pairs of spermathecae in 7 & 8 and genital markings median to male pores; *cf. A. morrisi*]; ?Beddard 1900a: 425 (he described a possibly different taxon?).

Notes. The above synonymy is partial, for full details and distribution, see Blakemore (2012b). I choose specimen 1904:10:5:12 as lectotype for Beddard’s (1892) *P. barbadensis*, this being the one he described as specimen “b” and figured (fig. 6 but mistakenly said it was specimen “a”). This specimen cannot now be traced in the Museum collection (pers. obs.) but it is reasonably accepted as *Amynthas gracilis* (Kinberg, 1867) and thus fixing the type to this specimen allows the name *barbadensis* to definitively enter synonymy of *gracilis*. The other two specimens, 1904: 10:5:11 & 13 – which are of two different and irrelevant taxa – now loose any nomenclatural

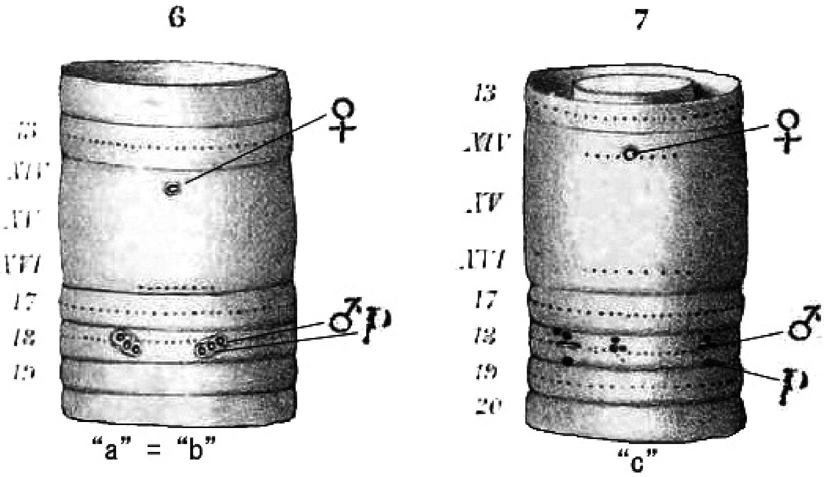


Figure 3a. *A. gracilis* (Kinberg, 1867) from Beddard (1892: Pl. IX, fig. 6-7) of his *A. barbadensis* – lhs of specimen claimed as "a" but actually "b" that is now lectotype and = *A. gracilis*; rhs specimen "c" of now irrelevant taxon (cf. *A. morrisi* group).

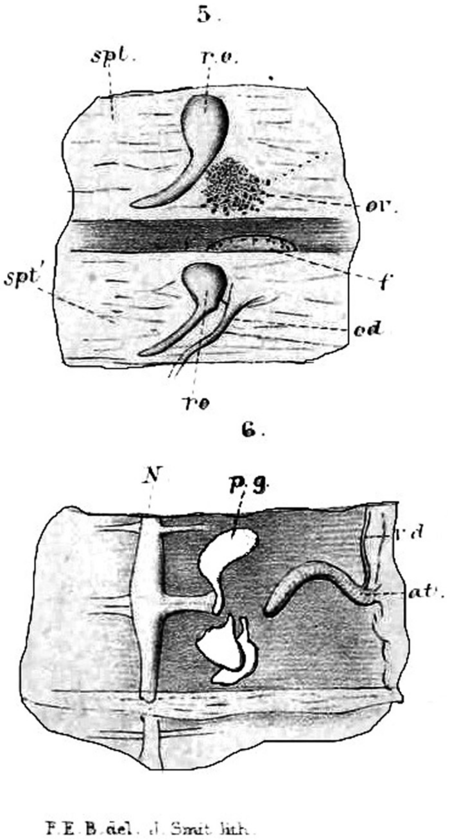


Figure 3b. *A. gracilis* after Beddard's (1982: figs. 5–6) of his *P. mauritiana* showing two pairs of ovisacs (fig. 5) and three white glands marked "p.g." median to the male pore on 18rhs (fig. 6). This taxon is a likely junior synonym of *A. gracilis*.

status with the restricted definition of *barbadensis* aiming to enhance the stability of nomenclature which has been highly confused for 120 years or so since Beddard (1872b).

Amynthas loveridgei (Gates, 1968)

(Figure 4)

Pheretima loveridgei Gates, 1968: 257. [Type-locality Honey Lake, 5 Miles W of Greenville, Madison County, Florida, collected 27th May, 1966 by E.V. Komarek. Syntypes (many specimens, some dissected) in British Museum 1967:5:8:26 (Gates, Sims & Easton 1972: 181 and pers. obs. RJB 19.VI.2013) stated as "*1967:5:8:28*" (sic) and Tall Timbers Research Station #142 (Reynolds & Cook 1976: 130) – this later corrected and a transfer noted]; Gates 1982: 57.

Amynthas loveridgei: Sims & Easton 1972: 236 (*A. morrisi* group).

Diagnosis. *Amynthas* with paired spermathecal pores ca. 1/2 body circumference apart in furrows 5/6/7. Length 90–110 mm. Segments 118–169. First dorsal pore 11/12. Male pores absent (or obscure). GMs as small discs in front of and behind spermathecal pores and as three sets of weak tubercles on each side of 18 in position of male pores and more medially. Prostates present or absent. Gates also reported loss of one or more spermathecae due to parthenogenesis.

*Material Examined***.** "*Pheretima loveridgei* Gates, 1968 SYNTYPE"; "*BMNH 1969.5.8/26 Loc. Greenville Madison Country (sic) Florida U.S.A 27th May 1966 Coll E.V. Komarck (sic) Ref. Gates 1968 J. nat. Hist. 2 p. 267*"; "*Cat. No. 142 Tall Timbers R.S. Pheretima loveridgei Fla. Madison Co. 5m W. Greenville 27 May 1966 E. V. Komarek, Sr TF 29*" (there were two labels like this last). Sample jar contained many specimens, some dissected, most in reasonable condition. Smithsonian catalogue lists "*Syntype*" and records 30 specimens with Accession Number 382788 and USNM #136910

Distribution. USA (e.g. Florida, Georgia, Minnesota) and Rose Cottage, Sandy Bay, St Helena in South Atlantic. The original oriental homeland (and full synonymy?) for this transported species is unknown.

Notes. Gates noted much mucus in the body cavity. He separated this taxon from *A. morrisi* on the basis of its "*GM pattern, number of segments, etc*." Gates (1968: 260) comments that the parthenogentic method of reproduction, as in other pheretimas, permits more rapid accumulation of mutations than if reproduction had remained amphimictic. However the possibility remains that *A. loveridgei* is a synonym of some other taxon with spermathecal pores in 5/6/7 (or some similar combination!), e.g. the forty or so taxa listed under *A. morrisi* and *cf.* Gates' own confused description of *Pheretima hawayana lineata* that is possibly retained on its distinctive male pores. *Amynthas infuscuatus* Jiang & Sun, 2014 is similar except it lacks the markings around the spermathecal pores and it apparently retains spermathecal diverticula and prostates.

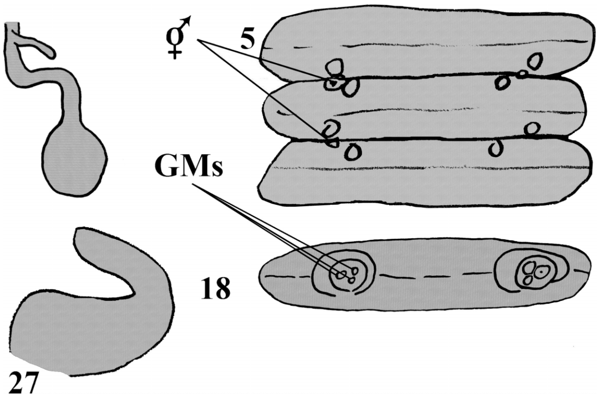


Figure 4. *Amynthas loveridgei* (Gates, 1968) rough sketch of a synytpe showing for the first time the spermathecal and male fields, a spermatheca and the caecum.

The *Amynthas morrisi* problem resolution

For the *A. morrisi* spp.-group, the conclusion is that the definition of *A. morrisi* is now restricted and compliant with Michaelsen's (1900: 238) assessment where it is separated from "*P. barbadensis*" – which is now *A. pallidus* as explained below – mainly due to their papillae being, respectively, ventromedian and unpaired (in 6,7−8 and possibly 18 in *morrisi*) or variable, often paired in 6−8 and 18−19 (in *pallidus*). Also agreeing with Michaelsen (1900: 238) is separation of *Amynthas insulae* mainly due to its shorter, swollen spermathecal diverticulum and arrangement of GMs plus, newly, on the basis of its serrate intestinal caecum which has yet to be proven in the other two taxa (contrary to Sims & Easton 1972: fig. 1H).

Amynthas morrisi **species-group** of **Sims & Easton (1972)**

[*Cf. A. browni* (Stephenson, 1912) and *A. loveridgei* (Gates, 1968)].

Tentatively included taxa having mid-ventral genital markings are:

A. morrisi (Beddard, 1892.)
A. pallidus (Michaelsen, 1892).
A. insulae (Beddard, 1896).
A. incongruus (Chen, 1933) Taiwan specimens have midline GMs on 18.
A. lubricatus (Chen, 1936) may be a synonym, lacking markings
A. monoserialis (Chen, 1938) has about 20 glands for each midline GM in 16−20.
Amynthas tripunctus (Chen, 1946) GMs mid-ventral in 6−8 and paired near male pores; spermathecal pores close to intersegments 5/6/7 but anteriorly in 6 & 7, *i.e.,* strictly complying with Sims & Easton's *canaliculatus*-group – (see Fig. 8b).

Several more recent Oriental taxa may also be implicated but DNA data are required for resolution, ideally based on published descriptions of topotypes or neotypes of these earlier species, as per Blakemore *et al.* (2010) (*cf.* limited data in Appendix).

Key to historical members of *A. morrisi*-complex with spermathecal pores 5/6/7

1. Genital papillae mid-ventral in (6),7−8,(18) but not near male pores--------------------*A. morrisi*
− Genital markings (absent?) or with different arrangement --------------------------------------- **2**
2. Spermathecal diverticulum longer, swollen (intestinal caecum form?) -----------*A. pallidus*
− Spermathecal diverticulum shorter, thin; intestinal caecum incised -------------------*A. insulae*

Amynthas morrisi (Beddard, 1892)

(Figure 5)

Perichaeta morrisi Beddard, 1892a (July): 166, Pl. IX, fig. 1. [From Kew Gardens from Penang type-locality (under ICZN, 1999: Art. 76.1.1). Types in British Museum 1904:10:5:199-201 "*three or four specimens, of which only one was sexually mature*", and labeled as from Hong Kong according to Gates (1972: 203) but this contradicted by the current study – see Materials Examined. Types in British Museum 1904:10:5:199−201 inspected by RJB 19. VI.2013 and (missing) specimen 199 newly selected as lectotype]; ?non Beddard 1900a: 420, 423 (describing Hong Kong non-type specimens as part of *Amyntas hawayanus*; two of these were redescribed by Gates 1937: 361).

[?*Perichaeta mauritiana* Beddard, 1892a: 170, Pl. X figs. 5−6. From Kew in material from Mauritius. Types in British Museum listed as BMNH 1904: 10:5:203−205 suggesting three specimens, but the original misplaced by Beddard (1900a: 425) who described other supposedly similar specimens. Possibly a morph of *gracilis* since spermathecae are in 7&8 and markings only near male pores – three per side but shown as more horizontal rather than oblique as usual in *A. gracilis*]; Beddard 1900a: 425 (describing two other supposed non-type specimens with spermathecae in 6−8,9 one that was more similar to *gracilis*)].

Perichaeta morrisi: Beddard 1895a: 394, 400, 411; Rosa 1896: 516, figs. 2-3 (of proatate and spermatheca) [specimens from Padang, Sumatra reasonably expanded the definition to include mid-ventral markings in 6 and 18, and first dorsal pore in 10/11].

[*Amynthas barbadensis*: Michaelsen 1900: 254 (syn. *pallida* Michaelsen, 1892: 227, *amazonica* Rosa, 1894: 14, *sanctijacobi* Beddard, 1895: 61, *cupulifera* Fedarb, 1898: 445 – I think this is in error as only *barbadensis* specimen "c" complies)].

Pheretima morrisi (part.?): Michaelsen 1900: 287; Ude 1905: 434; Chen 1931: 148; 1933: 267 [syn. *insulae*, *hawayana lineata*, *browni*: Chen says *sensu* Gates 1932 (not 1931)]; Gates 1937: 361 (inspecting BMNH alledged Hong Kong types); 1939: 453 (syn. *insulae, browni* part.); 1968: 253; 1972: 202 [syn. *browni* (part.) Stephenson 1912: 274 − this synonymy by Gates is obviously a mistake as *Pheretima browni* Stephenson, 1912 has spermathecal pores in 7/8/9 amongst other differences, *cf. Metaphire californica*; *hawayana lineata*]; Gates 1982: 59 (no synonyms listed just broad definition).

Amynthas morrisi (part.?): Sims & Easton 1972: 236, figs. 1A (of 18rhs male pore of non-type), 1H (of incised caecum they call "complex" of non-type); Easton 1981: 55 (syn. *exiloides*: Ohfuchi, *elongata*: Ohfuchi); Easton 1982: 729, fig. 4c; Sims & Gerard 1985: 132, fig. 47a (syn. *barbadensis*, *mauritiana*); Blakemore 2002, Blakemore 2003 [syns. *barbadensis*, *?pallida*, *hawayana lineata*, *exiloides*: Ohfuchi, 1956 (non Chen, 1936), *elongata*: Ohfuchi, 1956 (non Perrier, 1872)]; Shen & Yeo 2005: 24 [syns. *barbadensis* (part.), *pallida* (part.), *amazonica, insulae, cupulifera, hawayana lineata*]; Blakemore *et al.* 2006: 228 [syns.? *barbadensis* (parts ?"a" and "c"), *mauritiana* (most likely a variety of *gracilis*), ?*pallida*, ?*amazonica*, ?*sanctijacobi*, ?*cupulifera*]; Blakemore 2008; 2010; 2012b (providing full synomymy citations as herein); Chang *et al.* 2009: 60, fig. 26 [photos with 26A of 18rhs male pore and GMs corresponding almost exactly with the supposed type 1904:10:5:199 (pers. obs.), therefore a likely misidentification and probably close to *A. cupuliferus* itself a probable synonym of *A. pallidus* as Michaelsen thought].

Etymology. Named for Sir Daniel Morris, Assistant Director at Kew Gardens from 1886−1898 before he became Imperial Commissioner of the West Indian Agriculture Department (where organic pioneer Sir Albert Howard also worked from 1899−1902).

Diagnosis. The type-description is short: Length stated as 52mm (natural size of 80mm shown in his fig. 1 as noted by Rosa), segments 93. Spermathecal pores 5/6/7, male pores 18 not separated by a very wide interval (with minute papillae assumed nearby since there are glands internally). "*There are no papillae in the neigh-*

bourhood of the male pores…" but "*...in the neighbourhood of the spermathecal apertures*" are central discs, mid-ventral, presetal in 7 & 8, plus Rosa found them mid-ventral in 6 in one and in 18 in two of his non-type specimens. Gizzard in septal space of 8−10; oesophagus in 10−14 dilated; intestinal caeca the usual pair. Spermathecae with diverticulum un-dilated about as long as the ampulla. Copulatory pouches absent (i.e., male pores simple). (Beddard thought the setae on clitellum were characteristic but these are likely due to maturity and interval after shedding and thus are irrelevant).

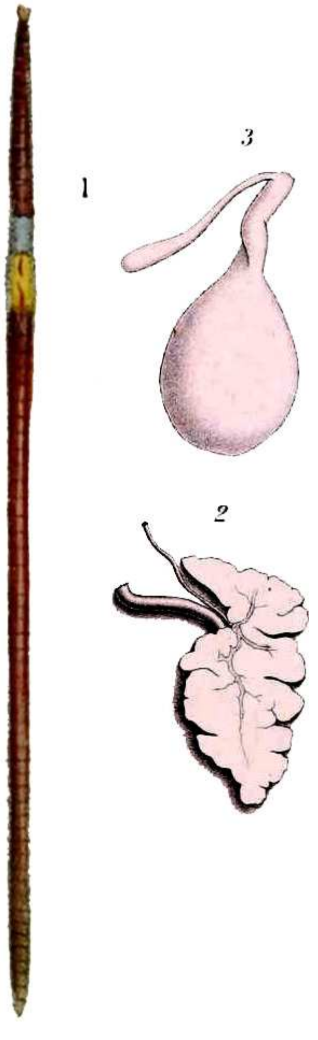


Figure 5. *A. morrisi* Beddard (1892, Pl. IX, figs. 1) from original of lectotype body and Rosa's (1896: figs. 2-3) of spermatheca and prostate, possibly of the same taxon as *A. morrisi*. The original description had no GMs around male pores.

Material examined. Natural History Museum, London 1904:10:5:199-201 labelled: "*Perichaeta morrisi* Beddard, 1892 TYPE 1904:10:5:199−201 Loc: Penang Island, west of Malakka, Sumatra (Padang). Ref. Proc. Zool. Soc. L. 9(1): 166"; "*Perichaeta Penang*"; plus a label from Beddard that is illegible. [NOTES: The location note "*Sumatra, Padang*" is seemingly a mistake (although it where Rosa (1896) recorded *morrisi* from), it is 700km from Malaysian Penang (5º 24'N 100º14'E) and far from Malacca; actually this location is copied from Michaelsen (1900: 287) who gives location: "*Insel Pinang westlich von Malakka, Sumatra (Padang)*". Reynolds & Cook (1976: 149) mistakenly give this same registration number for *P. padasensis* (Beddard & Fedarb, 1895)]. Sample contains four specimens, none dissected, one is mature and three are aclitellate. The mature specimen is figured here but cannot possibly be the type of *A. morrisi* as it is undissected and differs considerably; the other three sub-adults may be syntypes but were not used originally since Beddard (1892b: 166) says – "*Three or four specimens were forwarded to me, of which only one was sexually mature; the following description is based upon that specimen.*"

The lectotype is hereby designated as 1904:10:5:199 under ICZN (1999: Art. 74 with amendment) it being the sole name-bearing individual on which the original *A. morrisi* description by Beddard was based having a (contracted) length of 52 mm with 93 segments and illustrated at natural size in his fig. 1 (as 80 mm) and even though this specimen is now misplaced, the objective being to define this taxon in the interest of nomenclatural stability. The three aclitellate syntypes (1904:10:5:200−201) become paralectotypes only because Beddard mentioned them as "*three or four specimens*", they formed no part of the description and neither did the mature specimen that was presumably added to the jar subsequently (here figured and traced to same batch as Hong Kong specimens 1904:10:5:106−116, in particular one described by Beddard 1900a: 424).

Distribution. Described from Kew but originating from Penang the following records all now require verification. Possibly native to southern China, *A. morrisi* is supposedly peregrine in: Myanmar, Thailand, Vietnam, Taiwan, Malaysia inc. Penang, Singapore, and Sumatra; and outside the *Pheretima* domain in: Hawaii, USA, Mexico, South America and Caribbean [e.g. Equador, Chile, Argentina, Brazil, Guayana, Mexico, Barbados and Peru also Guatemala (Gates 1982)], Diego Garcia, Spain, Italy, Pakistan, India (Gates 1972: 204), South Africa, PNG and Australia. Only one previous report in Australia – from the grounds of the old Queensland Museum, Brisbane (Easton 1982) may now be suspect. How many of these reports are *A. morris* s. strict. is unknown as this distribution may now only refer to the *A. morrisi* spp-group, and that in part only with the current restriction of names and resurrection of synonyms.

Notes. It is now necessary to restrict the definition of *A. morrisi* to those specimens that agree with the original in having (paired or unpaired?) mid-ventral markings on 7 & 8 and none around male pores.

The listed NHM type is undissected and does not correspond to the original description by Beddard thus the samples have been mixed at some stage between 1892 and 1904 when they were lodged, or afterwards by Gates and/or Monro.

Gates (1937: 361) claimed to inspect British Museum material he cited as: “ *3 specimens labeled, ‘Pheretima barbadensis 1904:10:5:11−12. Barbados. coll. Beddard’ and 1 aclitellate and 1 partially clitellate specimen labelled ‘Pheretima morrisi. 1904:10:5:106−116. Hongkong. coll. Beddard’* ”. These are obviously not types of *A. morrisi*, but Gates goes on to say “*The British Museum specimens from Hongkong are, according to Dr. C.C.A. Monro, the types of P. morrisi*.”

The single clitellate syntype of Beddard’s Penang species – now missing – was described with markings only mid-ventral in 7 & 8. Gates (1937: 362) described two Hong Kong pseudotypes, one partially clitellate with markings mid-ventral in 6, 7 & 8 and also with paired lateral presetals each on 7, 18 & 19 along with two markings just median to each male porophore. This complies *exactly* with what Beddard (1900a: 424) said “*it was very general to find*” in several of his Hong Kong non-type specimens of “*morrisi*” with one individual in particular having median markings on each of segments 6−8. Another one Beddard (1900a: 424) said “*was anomalous by reason of the fact that the 7th segment had no less than six papillae arranged in an irregular line along the middle of that segment*” – which is *exactly* what the mixed-type specimen (in jar 1904:10:5:199-201) now has – but this was not recorded by Gates. Gates (1937: 362) described the second aclitellate Hong Kong specimen with three marking on 7 and four on 18 but this does not comply with any of those given particulars by Beddard (1900: 424) and can be ignored too. The registration numbers (BMNH 1904: 10:5:106−116) suggest there were originally eleven specimens in the sample, and Beddard (1900: 424−245) provides details of ten or eleven of these Hong Kong specimens, thus it is unclear why Gates (1937: 361) could only record two specimens. Nevertheless, it seems Gates is mistaken in his assumption about these being *A. morrisi* types. It is now important to try to trace the eight remainder of the eleven Hong Kong specimens as these may contain the actual missing type accidentally swapped with the one Hong Kong non-type material presently in jar BMNH 1904:10.5.199−201 [these numbers themselves indicating three specimens but actually comprised of four, with one being the Hong Kong non-type specimen, as noted above and in designation of a lectotype below].

Also often confused and contradictory in his work, Gates (1939: 446), for example, claimed to inspect BMNH non-types from Hong Kong labelled “*P. barbadensis* 1904.10.5.1219.1228” containing three specimens of “*Pheretima barbadensis* and varieties?” and “*P. morrisi* 1904.10. 5.453” that he said had four divers specimens; but a few pages later (Gates 1939: 453) said these two jars contained, respectively, 31 (!) specimens and just three specimens of “*Pheretima morrisi*”. This whilst he placed the type of *A. insulae* Beddard, 1896 and, even more unlikely, *A. browni* Stephenson, 1912 in synonymy of his confused concept of *A. morrisi*. Gates rarely provided figures for clarification.

Sims & Easton's (1972: fig. 1A H) was supposedly *A. morrisi* but the specimen concerned was not identfied. Interestingly, Sims & Gerard (1999: 132, fig. 47a, after Easton 1982: fig. 4d) later said: "Amynthas morrisi *(Beddard, 1892a: 166) originally recorded as* Perichaeta barbadensis *Beddard, 1892a: 167 and* P. mauritiana *Beddard, 1892a: 170*" and their figure of "*A. morrisi*" had genital markings below and just median to line of spermathecal pores in 6,7 and 8 and paired midventral in 18 and 19 and just above male pores and in a similar position on 19 (i.e., 14 total, all presetal but no single central as in the original!). These authors did not inspect types of any of these three taxa and their mistaken characterizations are now highly suspect (see Figs. 8a−c).

There is no evidence to support *P. mauritiana* being the same as *P. morrisi* and thus Sims & Easton's (1972: 236, figs. 1A, 1H) plus Easton's (1982: fig. 4c) and Sims & Gerard's (1985, 1990: fig. 47a) are not representative of the type and are themselves probably composites. Ironically, Sims & Easton (1972) did not list type of *A. morrisi* in their study, and the specimen they figured is unknown, possibly a composite or one of the synonyms? Maybe it is from the *A. insulae* type (1904:10:5:86) as briefly redescribed below?

Unfortunately, since the single type of *P. morrisi* cannot be located in the Museum collection, the definition of this species presently remains unverified.

Beddard's (1892b: 170, fig. 6) *Pe. mauritiana* was yet thought by Michaelsen (1900: 316) and Gates (1972: 217) to belong to *hawayana* (= *gracilis*), or *barbadensis*, or *robustus*. Because of its markings around the male pores, *mauritiana* is a possible morph of *A. gracilis* lacking the anterior pair of spermathecae but this too needs confirmation. *Cf.* Sims & Gerard (1999) who oddly include it in synonymy of *A. morrisi* even though its spermathecae are in 7 & 8 *not* 6 & 7 as in *morrisi*. Pending inspection of its type, it is perhaps judicious to retain it too as a *species incertae sedis*.

Pe. mauritiana was described on a single specimen with GMs on 18 only, three per side, below and median to the male pores, thus unlike those of *A. morrisi* but possibly the same as *A. gracilis*. If they are the same as *A. gracilis*, but lacking the first set of spermathecae having the pores in 6/7/8, this begs the question why Beddard did not recognize it as similar to his *Pe. barbadensis* specimen "b" although, as in typical *A. gracilis*, this has pores in 5/6/7/8? Probably it was because he put more weight on the setae retained on the clitellum even though this is not a valid characteristic of megadriles.

Probably Sims & Easton (1972) took Beddard (1900a: 424) too literally when he described two non-type specimens of *A. mauritianus* from Hong Kong that he likened to *A. morrisi*. The spermathecae of the single types of each: these being in 6 & 7 in *morrisi* and 7 & 8 in *mauritiana*, separate these two taxa regardless of subsequent embellishments. However the addition of the two Hong Kong specimens may account for the three registration numbers for *mauritiana* types (that were not found in the current study).

Beddard (1892a: 172) was further mistaken when he referred a single worm from Singapore via Kew as being similar to his *P. morrisi* and to his earlier *"Perichaeta ceylonensis*" as there is no such taxon and he probably meant his *Pe. ceylonica* that is now *Megascolex ceylonicus* (Beddard, 1886). The single Singapore specimen had intestinal caeca and a gland on the atrium that thus may qualify as a member of the genus *Manus* Blakemore, 2010 currently known only from Japan for type *Pheretima koellikeri* Michaelsen, 1928; thus quite different from *A. morrisi*.

Gates (1939: 454) had a table of setae and GMs in ten Szechwan specimens showing they are usually mid-ventral on 6−8 and paired laterally on 7 less often with only two specimens having GMS on 18 and one of these on 19 too. But, because he footnotes that these all had a pair of markings next to the male pores, they no longer comply with *A. morrisi* and probably represent one or more of its previous synonyms.

The previous broad definition of *A. morrisi* had allowed genital markings very rarely lacking, usually small discs presetal unpaired median in some or all of 5−8 or 6−9 and 18; paired and just median of spermathecal pore lines or more mesially in some or all of 6−9; occasionally two or more in 18 or 19; and almost constantly two just median to each male pore but one pre- and one post-setal. Intestinal caeca simple but (always?) with incised or lobate ventral margin. This definetion is now defunct and restricted, unless molecular evidence, such as that in the Appendix, can now show that specimens with mid-ventral GMs in 7 & 8 also have the variations as described for subsequent synonyms that are briefly presented below in chronological order.

Past synonyms of *A. morrisi* eligible for restoration progressively in date order

Amynthas pallidus (Michaelsen, 1892)

(Figure 6)

Perichaeta pallida Michaelsen, 1892 (Sept.): 227. From Porto Alegre, Brazil. Berlin types 441, supposedly more than two specimens, missing according to Reynolds & Cook, 1976: 149]. [It has two (or three?) pairs of spermathecae in 5/6/7(/8) and GMs variable in male field and near spermathecal pores, also some mid-ventral too but probably refering to two different taxa].

Perichaeta amazonica Rosa, 1894: 14. [From Manaus, Brazil. Turin(?) types missing].

Perichaeta sanctijacobi Beddard, 1895. [From Santiago, Chile. Hamburg type missing. Specimen lacked GMs but thought similar to *A. morrisi* because it had spermathecae in 6 & 7 but each with swollen diverticulum].

Perichaeta cupulifera Fedarb, 1898: 445, fig. 1. [From Dehra Dun in NW provinces, India. Types from Calcutta Museum? *Cf. A. gracilis* synonymy].

Pheretima pallida: Michaelsen 1900b: 254 (held in synonymy of *P. barbadensis* along with *amazonica, sanctijacobi, cupulifera*).

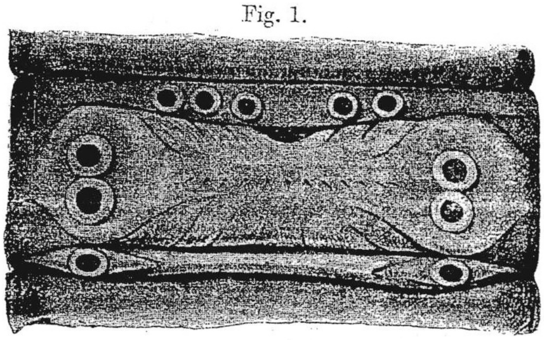
Pheretima hawayana lineata Gates, 1926: 154. [From Taungyi, Myanmar. Types lost. Gates described this species with spermathecae in 5/6/7 and with characteristic median preclitellar papillae (sometimes missing) and papillae internal to and either side of male pores plus a presetal pair on 19, *i.e.*, similar to *A. pallidus*].

?*Pheretima incongrua* Chen, 1933: 270. [From Linhai-hsien, Chekiang, China. Types in US National Museum 20175].

Diagnosis. Pale yellow-gold but pale brown dorsally (*sanctijacobi* greenish brown). Longest 125 mm by 5 mm with 95 segments. Setae 52−59 in midbody. First dorsal pore uncertain. Male pores widely separated on 18. Typically two pairs of spermathecae in 5/6/7 and GMs variable in male field and near spermathecal pores, also some mid-ventral too but possibly refering to different taxa. Michaelsen gives GMs as: two, three or four papillae particular to each of the male pores. Another pair just behind 18/19, close to each other and to the ventral midline, and two other couples on segment 7 in the ventral-median line. In other examples (different species?) those papillae near the male pores differed and papillae or groups (up to 3) were on the intersegmental furrows of 5/6 and 6/7 or 7/8. Gizzard occupies 9. Intestine in 14. Caeca from 26 (form not stated). Hearts 11−13. Holandric, metagynous. Prostates 18. Spermathecae in 6 and 7 (and sometimes 8?).

Distribution. Introduced to South America and India, probably from China. Its distribution is con-

Fig. 1.



Ventral surface of xviiith segment of *Perichæta cupulifera*, showing the cup-shaped papillæ.

Figure 6. *A. pallidus* (Michaelsen, 1892) after Fedarb's (1898: 445, fig. 1) of *Perichaeta cupulifera* synonym with GMs around male pores.

confused with that of *A. morrisi* s. stricto and subsequenty synonyms.

Notes. Michaesen's specimens with three pairs of spermathecae in 5/6/7/8 should strictly be excluded from the definition; they possibly comply with *A. rockefelleri* (Chen, 1933) or some similar taxon. Having markings around the male pores currently disqualifies *A. pallida* as a synonym of *A. morrisi* but unfortunately exact characterization is unavailable without access to the type of either taxon.

Because Michaelsen (1900b: 238, 244, 254) maintained a broadly defined *Pheretima barbadensis* with synonymys: *pallida, amazonica, sanctijacobi* and *cupulifera*, now that *barbadensis* is made synonym of *A. gracilis*, then these latter three should all probably now default as *A. pallidus* synonyms. Caeca are usually from 26 or 27, but the form in *A. pallidus* needs to be determined for comparison with *A. insulae*.

P. cupulifera was described with GMs a pair or a single papilla at the edge of the segment (7?) in line with spermathecal pores in 6/7; one worm from several was said to have two median papillae on 7 & 8 (as in *morrisi*); and others had markings near male pores as in Fedarb's figure. The two pairs of spermathecae in 6 & 7 have a diverticulum swollen at the extremity. Fedarb's figure of segments 18−19 (presumably of the type) is also particularly close to male field of the type of *A. insulae*. However, the author made no mention of the state of the intestinal caeca thus, for the present as in the past, it falls under *A. pallidus* as per Michaelsen (1900b).

Parthenogenetic *A. incongruus* (Chen, 1933 as described by Chang *et al.* (2009: 52) from China and Taiwan may now be comparable to degraded forms of *A. pallidus* as may its possible synonym *A. lubricatus* (Chen, 1936) that lacks markings. GenBank COI barcode for "*A. inconguus*" agrees 98% with *A. morrisi*, A. *aspergillus*, *A. triastriatus* and several other BLAST results, but with none of these identities confirmed.

Other possibly related species but lacking marking other than those immediately median to the male pores, is *A. infuscuatus* Jiang & Sun, 2014 that may be the same as *A. pallidus*. Also similar is *A. endophilus* Zhao & Qiu, 2013 that is said to lack markings despite these being shown as a pair mid-ventral on 18 in their fig. 1.

Amynthas insulae **(Beddard, 1896)**

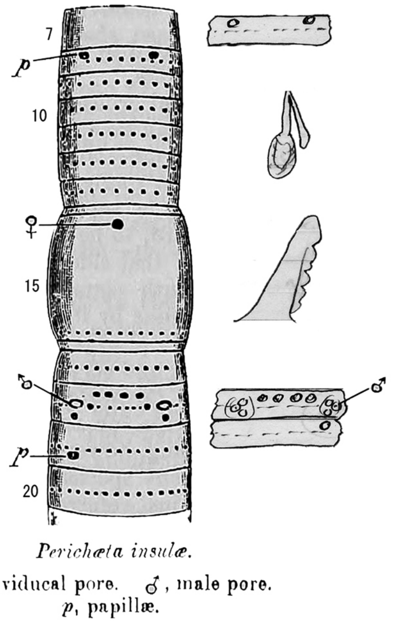
(Figures 7a−c)

Perichaeta insulae Beddard, 1896: 205, fig. 2. [From Hong Kong. Type BMNH 1904:10:5:86 inspected by Gates 1939: 454, by Sims & Easton 1972: 180 and herein].
Pheretima insulae: Michaelsen 1900: 276.
Amynthas insulae: Sims & Easton 1972: 237 (*morrisi* group); Blakemore 2008.

Diagnosis. (from Beddard and current inspection of type): 103 mm with 95 segments. Clitellum 14−16. GMs are described as papillae paired "*near the anterior margin on viith segment*" but figured by mistake on the 8th, here correctly shown on segment 7; eight papillae on 18 (but misfigured by Beddard compared to the current sketch) and a single papilla on 19 on "*left side of the body*" (actually on rhs as per current sketch). Glands correspond to the GMs internally on 18. Pharyngeal glands to the sixth segment. Septa 4/5−7/8 thin, those immediately after gizzard thicker. Seminal vesicles in 11 and 12. Prostates racemose. Spermatheca in 6 & 7 (opening to 5/6/7) with shortish, unswollen diverticulum as sketched. Intesine from 15, caeca in 27 newly found to be ventrally serrate/incised as sketched.

Material examined. BMNH 1904:10:5:86. Labels in jar state: "*Perichaeta insulae (Beddard) (Type?) 1904:10:5:86 Hong Kong Beddard Coll^{n}*"; "*Perichaeta insulae Hong Kong*" in Beddard's hand; "*Probably the type of Perichaeta insulae Beddard but now = P. morrisi*" in Gates' hand?; "*fide G.E. Gates*". Jar contains one previously dissected specimen in good contition with a separate vial containing a single spermatheca.

Distribution: Hong Kong, China.



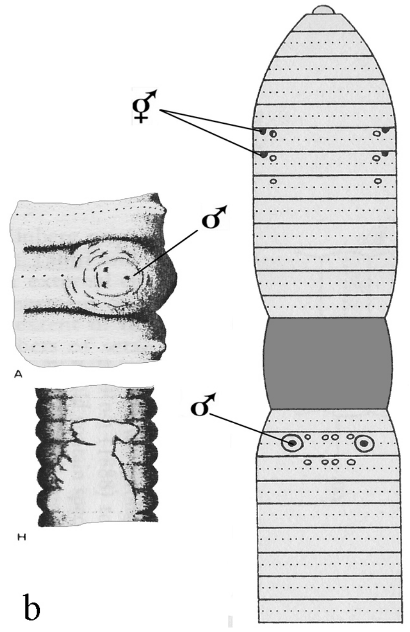


Figure 7a. *A. insulae* (Beddard, 1896) his fig. 2, with sketch of actual lectotype conditions of markings in 7 and 18–19 plus a spermatheca and distinctive serrated caecum. Possibly same as *A. pallidus* for which the condition of its caeca are unreported.

Figure 7b. Disparate "*Amynthas morrisi*" figures after Sims & Easton's (1972: figs. 1 A, H) enlargement of male pore and lateral view of an incised caecum that may be from specimen similar to either *A. pallidus* and/or to *A. insulae*; alongside Sims & Gerard's (1999: fig. 47a) sketch of "*A. morrisi*" (that is the same as Easton, 1982: fig. 4d) and is more likely *A. pallidus* (or a composite of several species?) lacking preclitellar mid-ventral markings.

Notes. It seems that *A. insulae* should be maintained separatedly from both *A. morrisi* and *A. pallidus* based on its serrate intestinal caeca and shorter, thin spermathecal diverticulum. Sims & Easton (1972: fig. 1H) claim a similar 'complex' caecum in *A. morrisi* from a non-type specimen that they fail to identify but this has yet to be confirmed. Furthermore, the precise arrangement of its GMs on 7 and 18−19 certainly differ from *A. morrisi* proper whilst helping to define the current taxon.

Summary of *A. morrisi* species-group revision results

- *Amynthas morrisi* is restricted to its lectotype and the original type-description; efforts should be made to relocate this missing type and to analyse DNA samples, preferably from Penang topotypes that comply morphologically. Only then can its relation to other *A. morrisi* group members be determined.
- *Amynthas barbadensis* is restricted to the lectotype which is specimen "b" that now complies with prior *A. gracilis* as its junior synonym.
- *A. mauritianus* may be provisionally restored although there is little to separate it from quadrithecal forms of prior *A. gracilis*. Certainly it is separate from the restricted *A. morrisi*.
- The other previous synonyms of *morrisi* that were questioned by Blakemore (2003, 2007, 2008) revert to the earliest name which is *Amynthas pallidus* that is also restored as per its original description. Whether species such as *A. insulae* and *A. cupuliferus* actually agree may again be settled by inspection of types and progressive DNA analysis of taxa representatives.
- It is noteworthy that DNA sequences currently posted on GenBank (Appendix) show that samples identified by different authors under the name *A. morrisi* represent different taxa – none of which may be the same as the current concept – thus there is justification for estab-

lishment of a species-complex and for urging further studies on actual species identities and boundaries of these in their Asian homeland and in translocated populations.

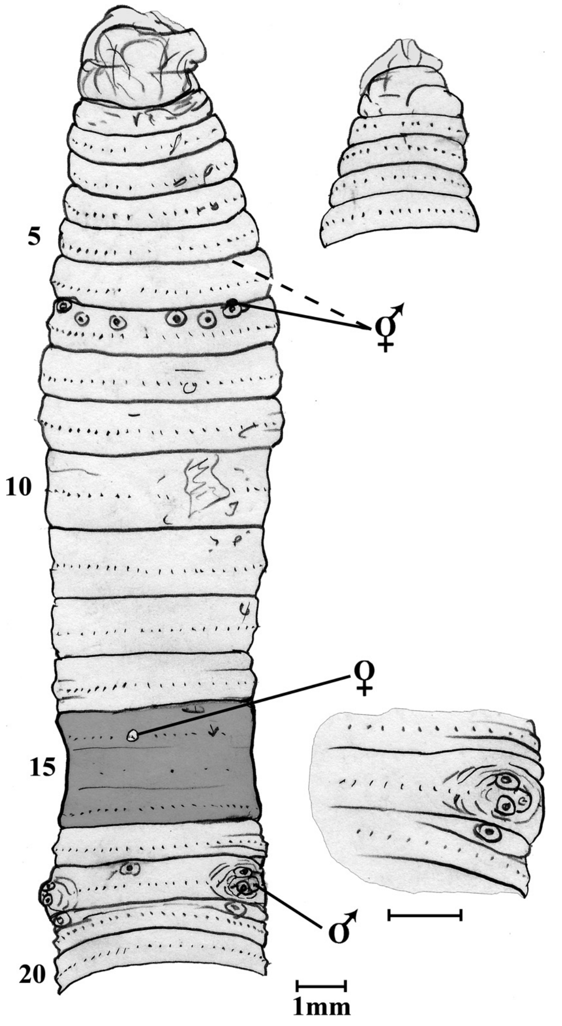


Figure 7c. Sketch of specimen 1904:10:5:199–201 from jar of "*A. morrisi* TYPE" is herein found exchanged: it cannot possibly be the same because it is undissected and its external characters do not agree. [This mature specimen is actually the anomalous specimen from Beddard's (1900a: 424) Hong Kong samples (1904:10:5:106–116) themselves mistakenly redescribed as *A. morrisi* types by Gates (1937: 361). This specimen here figured is superficially similar to *A. insulae* type (as is Sims & Easton's 1972: figs. 1A, 1H of "*A. morrisi*" non-type male pore and caecum!), whereas the remaining Hong Kong non-type sample descriptions are reminiscent of both *A. insulae* and several other members of the newly proposed *A. morrisi* spp-complex].

Amynthas talus **sp. nov.**

(Figures 8a–b *cf.* 8c)

Amynthas "morrisi group" (Sims and Easton 1972): Blakemore 1994: 353, fig. 1.27.

Material examined. University of Queensland farm at Mt Cotton (27°53'S, 153°14'E), collected by RJB, 19.I.1993 from pasture and under *Albizia spp.* in reddish soil; other material collected by D. Mercer in 1975 and A. Wilkie in 1992 from the same site. Numerous mature and immature specimens those lodged in ANIC (RB.95.1.1) listed as H and P1 other, supposedly still in collection at Queensland University. Contemporary details of the Mt Cotton site soils and vegetation are provided by Gutteridge (1990).

Habitat. Under pasture; sandy soil of lower creek bank almost in gravels of water line, also in moister clay under trees and shrubs at 0-20 cm depth.

Lengths. Current 75-100 mm (cf. 45-120 Gates for *morrisi*).

Width. 3−4 mm.

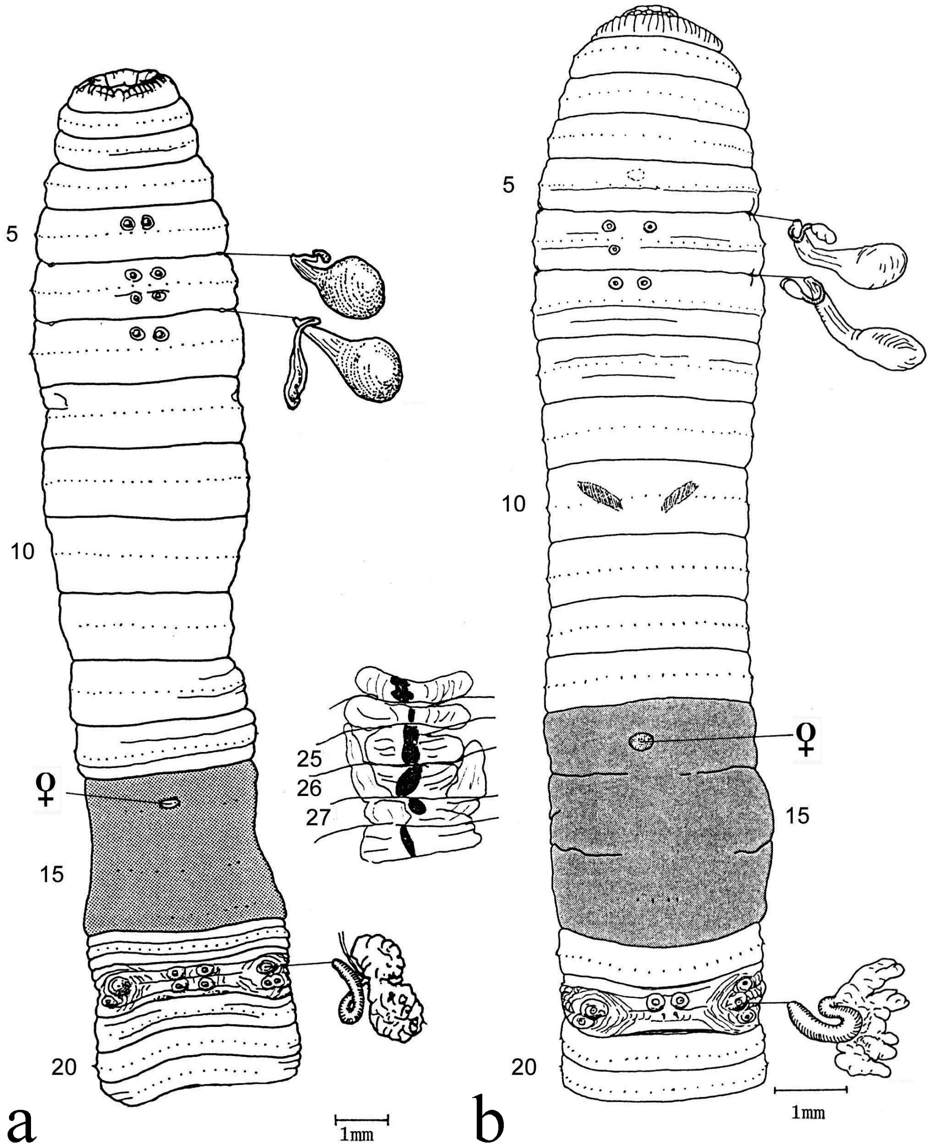
Segments. 122−156 body cylindrical anteriorly but tapering and becoming more trapezoid posteriorly, some secondary annulation in anterior, deep furrows in posterior. Segment 10 is wide and semi-transparent: paired ventral blood vessels show through.

Colour. Dark brown anterior and dorsum (but setal auriolae paler), paler ventrum, clitellum buff, after clitellum dark mid-ventral line. In formalin, a uniform buff but with deep puce clitellum.

Prostomium. Parallel open epilobous, often compressed.

First dorsal pore. 11/12 and then 12/13 but not on clitellum, although present subsequently and continuously to posterior.

Setae. Numerous ca. 40−50 per segment, ventral and dorsal gap slight if at all; only faintly retained ventrally on clitellum; typically setae occluded between male pores but in two specimens two larger (penial?) setae seen midventrally between male pores (figured).



Figures 8a–b. *Amynthas talus* sp. nov. from Mt. Cotton, Qld.; a = ventral view of H with spermathecae, intestinal caeca and prostate *in situ*; b = paratype with spermathecae and prostate *in situ* (note blood vessels showing in 10). Differs from other *A. morrisi* spp-group by GMs on 18 being outside male pores plus multiple, mid-ventral GMs paired in 5,6–7 and 18, (rather than 6,7 & 8), etc..

Nephropores. None visible.

Clitellum. Annular 14−16, furrows obliterated or faintly retained.

Male pores. 0.3 circumference apart on slightly raised equatorial porophores surrounded by several faint concentric grooves with markings nearby (see Genital markings).

Female pore. Single, central on 14 in small countersunk dish or in lateral groove.

Spermathecal pores. Two pairs in 5/6 and 6/7 lateral, *ca*. 0.4 circumference apart with slightly tumid lips concealed in furrows.

Genital markings. Variable as small mid-ventral paired (occasionally single, or quadruple) presetal discs in 5−7 or 6 and 7, and often a postsetal pair in 6 (and occasionally 5); plus always one pair mid-ventral and presetal on 18 between male pores, and often another pair postsetally. Also immediately lateral to the porophores on 18 a pair (may be doubled) of small raised papillae anteriorly and posteriorly; or one or both of the anterior pair may be absent. In sub-adults only the male pores are present, papillae and genital markings are lacking.

Septa. 4/5/6–7/8 getting progressively thicker and displaced posteriorly, with tendons reaching to succeeding segmental walls; 8/9 membranous or absent, 9/10 aborted; 10/11–14/15 getting progressively weaker with tendons persisting.

Dorsal blood vessel. Single continuous to pharynx in 4.

Hearts. Weak in 7 then strong in 10 (from dorsal vessel), 11–13 (from supra-oesophageal vessel). Supra-oesophageal vessel from region of 10/11 to 14. Ventral blood vessel bifurcated under gizzard from 10. In 5 and 6 numerous small blood vessels appear clustered together.

Gizzard. Large, tubular to bell-shaped and muscular with evenly spaced longitudinal blood capillaries occupying space between 7/8 and 9/10.

Calciferous glands. Small oesophageal pouches which appear pink due to blood capillaries and have internal lamellae present in 10 (annular) 11–13 (ventrally pouched) and 14 (weakly annular). These outgrowths of the oesophageal wall are easily deformed and in section the walls are thick and squamous but calciferous granules were not seen. (Beddard found oesophagus in segments 10–14 thickened and whitish in *A. morrisi*).

Intestine origin (caeca, typhlosole). Oesophageal valve in 14 or 15 opens into intestine in 15 or 16; caeca simple and extending from 27 to 24. At the region of the caecal origin, a large single lamelliform dorsal typhlosole commences.

Nephridia. Meroic, from 4–7 numerous tubules are obvious on the posterior septa, further anteriorly they are much larger, almost tufted; from segment 8 posteriorly micro-nephridia are equatorial on the body wall.

Male organs. Testes/funnels in membranous testis sacs in 10 and 11. Segments 7–14 are filled with white coagulum, but seminal vesicles (and pseudovesicles?) can be distinguished in 10–12 but not in 9.

Ovaries. Rather small pair ventrally from anterior septum of 13 as flattened palmate or clustered egg strings with oviducts in the posterior septum.

Prostates. Racemose, bi- or tri- or multipartite, from 17/18–19/20, large muscular ducts in single loops. Vasa deferentia enter the glands near the junction with the duct.

Spermathecae. Two pairs in 6 and 7 with long slender duct widening to sub-spherical (or flattened) ampulla, ectally a single diverticulum branches with a thin stalk and dilated bulb which is either elongate or lobular. The curved diverticula do not reach to the apices of the ampullae. Iridescence was generally not seen in the bulbs of the diverticula although some stalks possibly had an internal sheen; the ampullae were often filled with clear coagulum. In one specimen the spermathecae were noticeably heteromorphic: the ampullae of the anterior pair were flattened with small, bulbous (iridescent) diverticula on short stalks, whereas the posterior pair had larger, elongate diverticular bulbs filled with an opaque coagulum.

Behaviour. Two specimens (one with 135 segments) had autotmy of posteriors. Much ejected mucus adhered to dorsum in several specimens (see note below). Vigorous lashing escape response on being handled.

Gut contents. Fine soil and few pieces of organic debris suggesting a geophagous diet but possibly selective.

Etymology. From Latin *talus* for dice, after the GMs looking like dots on face of a dice.

Notes. Pharyngeal mass extends back to 5/6 obscuring the nephridial form. Internally, small, squat glands were associated with the genital markings, which were not clearly stalked but rather flattened to the body wall and were invested in a coagulum of sticky mucus. Mucus was also ejected onto the dorsal surface of several of the specimens and may be a natural defence against predators or desiccation, here activated by preservation. In the coelomic cavity the mucus may be a defence against parasites, *e.g.* Gates (1972: 203) reports spores and nematode eggs being discharged in coagulum through the most anterior dorsal pores in specimens he identified with *A. morrisi*.

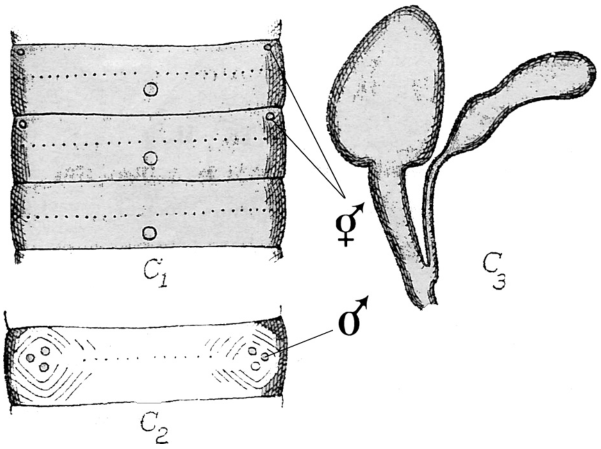


Figure 8c. *Amynthas tripunctus* (Chen, 1946) showing spermathecal and male fields and a spermatheca after Chen's original (the spermathecal pores are in segments 6 & 7 anteriorly thus strictly complying with *A. canaliculatus* spp-group of Sims & Easton, 1972). Note the similarity of male field to that of Sims & Easton's (1972: figs. 1 A)

Remarks. Queensland specimens described here comply with the *Amynthas morrisi* species-group of Sims & Easton (1972) for which *A. morrisi*, as diagnosed above, is the representative species. Considerable variation in the distributions of genital markings appears permissible within this species-complex, however, the current specimens are somewhat unusual in having more than 100 segments, closely paired mid-ventral anterior markings but with male field markings lateral of the male pores, plus a typhlosole that is well developed rather than rudimentary (*cf.* Gates' descriptions). It is therefore possible that they more closely resemble some other of the 30–40 nominal taxa within the *A. morrisi*-spp. group but no exact match has been found as yet from searches of the literature after twenty years.

I rejected the following possibilities of about 20 candidates, in order of priority: *morrisi* Beddard, 1892; *insulae* Beddard, 1896, *lalangi* or *silvestris* both by Michaelsen, 1923; *choeinus* Michaelsen, 1927; *incongruus* Chen, 1933; *alutus* Chen, 1936, *hainanicus, puerilis, sinuosus,* all by Chen, 1938; *gravis* or *sapinianus* Chen, 1946; *loveridgei* Gates, 1968; *nanulus* Chen & Yang, 1975 (only 51 mm long); *parvus* Chen & Zhifang; either of *A. campanoporophoratus* (Thai, 1982) and *A. plantopapillatus* (Thai, 1982), or one of Hong & James', 2001: *draconis, naejangensis, piagolensis, taebaekansis*. But these should all now be compared with the revised version of *A. morrisi*, *A. pallidus* and some quadrithecal synonyms of *A. gracilis*.

A species that perhaps comes closest to the current is *Amynthas instabilis* Qiu & Jiang, 2014 just published in Jiang *et al.* (2014: 3, fig. 1) from Hainan and Guangdong, itself compared to parthenogenetic *A. incongruus* (Chen, 1933) from Taiwan and China and possibly to *A. tripunctus* (Chen, 1946) from China. It is similar in having only a few setae (0–2 stated, 0–3 figured) between the male pores but lacks the mid-ventral markings there (although it too has paried markings lateral to the male pores, in their holotype at least). Its spermathecal pores are each preceded by a small papilla, plus a postsetal papilla is mid-ventral in 6 and a presetal pair is mid-ventral in 7. This comparison also serves to indicate likely region of origin for *A. talus* in Hainan and/or Guangdong, China.

Amynthas tokioensis (Beddard, 1892)

Perichaeta tokioënsis Beddard, 1892d: 762. [Published December, 1892 according to Michaelsen (1900: 272)]. [From Japan (probably Tokyo as in "tokioensis"). Lectotype in British Museum: BMNH: 1904.10.5.166 inspected and designated by Sims & Easton (1972: 181, 191) and re-inspected and refigured by RJB when on loan to YNU in October, 2004 and again in NHM, London in June, 2013; the specimen was 65 mm long with 67 segments but looks like a posterior amputee as the last segment has setae and is blunt rather than tapering. It is browny-grey in preservative and the clitellum is darker. The specimen had been dissected by Beddard and was slightly damaged: spermathecae in 8 were removed, only one remained in the jar that I put in a calcium vial along with a detached diverticulum, also the glands from 7rhs looked to have been removed, as was 18lhs prostate. The three labels inconsistenly state:

"*Perichaeta tokioensis*";

"*Pheretima tokioensis* (Bedd.) 1892 1904:10.5.166 Loc? Coll Beddard";

"*Perichaeta tokioënsis* Beddard, TYPE 1974.1.172 Loc. Japan Col. Mr Masataka Rokugo Ref. Zool. Jahrb. Syst. v6 p. 762"].

Notes. The same person collected Beddard's *P. masatakae* and *P. rokugo* (see *M. hilgendorfi*), perhaps also from Tokyo. As re-described by Blakemore (2010: fig. 2), nothing in the description of Korean *Amynthas sonjaesiki* Hong & James, 2009 separates this from prior *A. tokioensis*.

Genus *Duplodicodrilus* Blakemore, 2008

Duplodicodrilus schmardae schmardae (Horst, 1883)

(Figure 9)

Megascolex schmardae Horst, 1883: 194. [From "Japan". Syntypes in Leiden: 1818 (inspected by Sims & Easton 1972: 181 and 191 where the multiple = manicate condition of caeca was noted since Horst omitted its mention); types also (erroneously?) reported as in Vienna: 3970 by Reynolds & Cook (1976)]. [Non *Megascolex schmardae* Michaelsen, 1897. Since these taxa have not been considered congeneric after 1899, *e.g.* Michaelsen (1900) had them in separate genera, a replacement name is not required and prevailing usage is maintained (ICZN, 1999: Art. 23.9.5)].

Perichaeta trityphla Beddard, 1896: 205, [From Barbados. Types actually BMNH 1904:10:5:69 (listed as BMNH:1904.10.5.169) with labels: "*Metaphire scmardae (Horst, 1883)*"; "*Perichaeta trityphla Beddard 1896 TYPE*": "*1904:10:5:69 Loc: BARBADOS W.I. REF:- BEDDARD 1896 PROC. ZOOL. SOC. LOND. 1886: 205*"; "..... *trityphla* [crossed out] *schmardae Type ...arbados*" faded; and "*Perichaeta trityphla Barbados*". Jar contains a dark and brittle specimen about 35 mm long that had been dissected previously with several organs removed and floating in the jar; also included was the intestinal caecal section of another specimen]. [Note, name misspelt "trityphia" e.g. Sims & Easton (1972: 246), or "triphyla"].

Remarks. This species is included only to confirm that *trityphla* is a junior synonym of *schmardae* since the specimen had the copulatory pouches fore and aft of the prostatic duct internally and the intestinal caeca were clearly manicate. For some reason, this taxon is often mutually confused with *Metaphire californica* that lacks both structures.

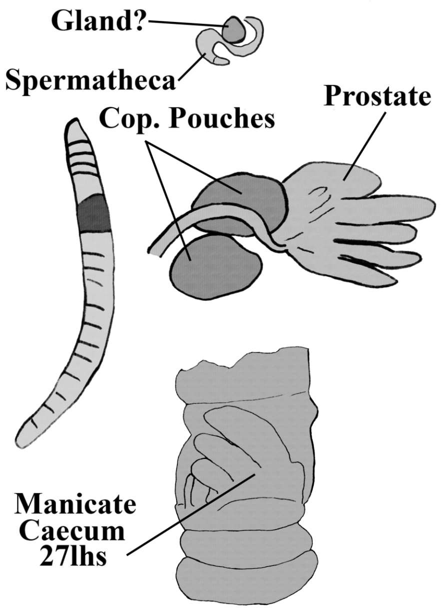


Figure 9. *Duplodicodrilus schmardae* (Horst, 1883) sketch of type of *P. trityphla* Beddard, 1886 synonym showing outline of whole body, a spermatheca loosely atttached in 7 or 8, 18rhs prostate with swollen copulatory pouches either side and manicate caeca around intestine from segment 27.

Genus *Metaphire* Sims & Easton, 1972

Metaphire hilgendorfi (Michaelsen, 1892)

(Figure 10)

Perichaeta Hilgendorfi Michaelsen, 1892: 235, fig. 15. [Published in September, 1892 therefore has priority over Beddard's December, 1892 *P. rokugo* and *P. tokioensis*]. [From 'Japan' (Hakodate, Yokohama and possibly another locality). Types of five specimens of the original seven specimens (*i.e.*, two missing) in Zoological Museum, Berlin. In NHM, London are Hamburg Museum specimens marked with red tape to indicate type material (none of which are the two of five types missing from Berlin):

1. Sample V.314 labelled "*O. Meg V314 Pheretima Hilgendorfi Mich. Hilgendorf Japan*" comprises one previously dissected specimen with its intestines loose in jar; it lacks male pores and only has a spermathecal pore in 6/7rhs and GMs on 7lhs and 7rhs. This is here sketched, agreeing with *Amynthas vittatus* (Goto & Hatai, 1898).
2. Sample V.315 labelled "*O. Meg V315 Pheretima Hilgendorfi Mich. Hilgendorf Japan*" comprises

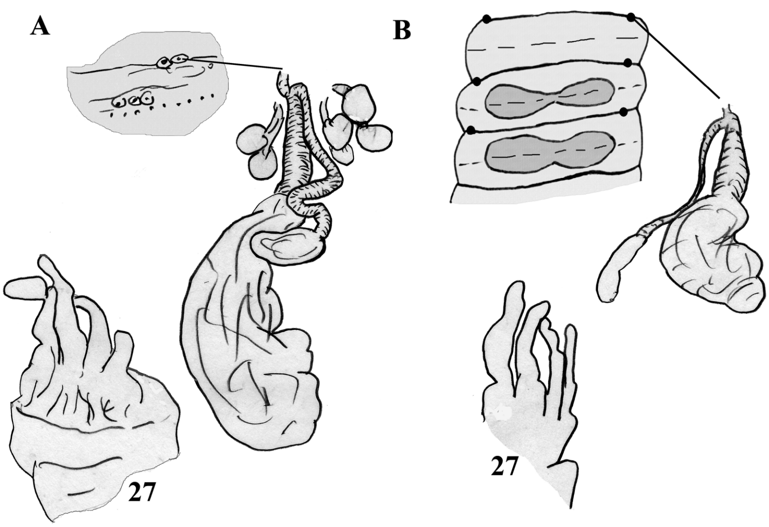


Figure 10. *Metaphire hilgendorfi* (Michaelsen, 1892) specimen V315 agreed; A = V314 specimen, actually *A. vittatus* as for V8505; B = V4008 specimens, actually *A. agrestis*.

one macerated, undissected mature; it lacks male pores and has spermathecal pores in 6/7/8 and GMs mid-ventrally on 8. This agrees with *Metaphire hilgendorfi* (Michaelsen, 1892).

3. Sample V.4008 labelled "*O. Meg. V.4008 Pheretima Hilgendorfi Mich 2 XII* [18]*95 Linz Nakahama*" comprises four specimens two previously dissected one of which is sketched here, that all agree with *Amynthas agrestis* (Goto & Hatai, 1899) as figured by Blakemore (2010: fig. 3lhs, that of fig. 3rhs may be a different species as the caeca differ) and see also Blakemore (2013a: fig. 1).
4. Sample V.8508 labelled "*O. Meg V8508 Pheretima Hilgendorfi Mich. Vega Exp. Japan Fujiyama*" comprises one previously dissected mature with its intestines loose in jar; it lacks male pores and only has a spermathecal pores in 6/7/8lhs and GMs 7lhs and 7rhs. This also agrees with *Amynthas vittatus* (Goto & Hatai, 1898).

Perichaeta rokugo Beddard, 1892d: 756, tab. 32, figs. 1–7 (published in December, 1892). [From "*Japan*" collected by Mr Masataka Rokugo, stated types BMNH 1904:10.5.144–145, actually apparently now also recatalogued as BMNH 1974.1.166–167 "*1904:10:5 144/145 Perichaeta rokugo Beddard, 1892 Loc: Japan Coll: Mr Masataka Rokugo Ref. Zool Jahrb. Syst V6 p756*" inspected by RJB 2010 and again in 2013 – three previously dissected specimens that are a composite of two species – one is indeed *M. hilgendorfi* with GMs mid-ventral on 8, and two that have rows of two-three markings paired on 7 as found in *A. vittatus* (Goto & Hatai, 1898)].

Notes. Revision is by Blakemore (2003, 2010, 2012b, 2012c: fig. 3 of "*M. glandularis*" = *M. hilgendorfi*, 2013a: fig. 6), but full re-description based on types is yet in progress.

Metaphire sandvicensis (Beddard, 1896)
sp. incerti sedis.

Perichaeta sandvicensis Beddard, 1896: 203. [From Lanai, 2000 ft; Mauna Loa, Hawaii, Molokai and from Hong Kong. Type material NHM 1904:10:5: 87–88 labelled: "*1904:10:5:87-88 Perichaeta sandvicensis Bedd. 1996 ?SYNTYPES Lanai, Mauna Loa, olokai Ref P.Z.S. 1896: 194–211*"; "*Perichaeta lanaiensis (Lanai) cliff on Mauna Loa, Hawai*" – in Beddard's hand; plus a note from Ed Easton dated 4/2/1974 that this latter is a probable MS name and that the "*specimen*" (sic) is *M. californica* whereas it actually contains two specimens. Both are dissected, with spermathecal pores in 7/8/9 no GMs and male pores everted or inverted in a small copulatory pouch, with simple intestinal caeca. This pers. obs. RJB June, 2013].

Note. The conclusion is possibly *M. javanica* but most likely *M. californica* Q.E.D.

Genus ***Perionychella*** **Michaelsen, 1907**

Notes. Type of genus is *Perichaeta dendyi* Spencer, 1893 from Victoria, Australia.

Taxonomic 'housekeeping' of recently described *Terrisswalkerius leichhardti* Jamieson, McDonald *et* James, 2013 with tubuloracemose prostates like in the type-species of that genus (viz. *Perichaeta canaliculata* Fletcher, 1887) requires it too to comply with *Perionychella* under ICZN (1999) Principle of Priority, as was clearly explained by Blakemore (2000: 292) and by Michaelsen (1907: 163) when he included *P. canaliculata* in his genus *Perionychella*. Some other taxa mistakenly placed in the congeries named *Terriswalkerius* with actual tubular prostates belong in prior *Diporochaeta* Beddard, 1890 or in *Reflechtodrilus* Blakemore, 2005.

The description of *P. leichhardti* is confused as the key gives the spermathecae in 5/6/7 in *cd* lines, whereas the text has them in 5/6/7 in *f* lines or "*opening anteriorly in VI and VII*" (i.e., 6 & 7), whereas the sketch figure twice shows them in segments VII and VIII (*i.e.*, 7 & 8). Moreover, the tubuloracemose prostates are misconstrued as "*elongate racemose*" contradicting the earlier stated generic diagnosis of "*tubular or tubuloracemose prostates*" that is of itself clearly unacceptable in a single genus.

Blakemore (2011b: 42–43, 2012a: 122) already remarks on oversights and shortcomings in recent cladograms by non-specialists from New Zealand cited in Jamieson *et al.*'s (2013) Queensland paper that there should be no need to repeat here save to remind that the types of neither the prior *Diporocheta* nor *Perionychella* have yet been tested genetically thus there is no definitive conclusion as those authors imply (especially since several claimed taxa are clearly misidentifications as already explained).

Genus ***Tokea*** **Benham, 1904** (1905?)

Tokea Benham, 1904: 240; Lee 1952: 26; 1959: 259, 284; Blakemore 2012a: 120.

Remarks. Of the N.Z. genus, Benham (1904: 284) said: "*The genus Tokea (from the Maori toke, an earthworm) is very widely distributed over the North Island, as will be seen from the varied localities at which it has been collected from Ohaeawai at the north to Ruatahuna in the south-east portion of the island. It is probably the commonest earthworm in these parts, as two species occur in and around Auckland, three species at Ruatahuna, and from the majority of the other localities no other genus has been received. It is, so far, unknown in the South Island*". Its history and reasons for revival is described by Blakemore (2012a) who, after Lee (1959: 284), confirmed type fixation as *T. esculenta* Benham, 1904.

It should be here re-emphasized that the state of the prostates is key for morphological placement for all megascolecids (Blakemore, 2013d), as eruditely determined by Benham (1904: 262, 1941: 30), Michaelsen (1907: 160, 1916) and Stevenson (1923: 316). The "*tongue-shaped*" tubular form in *Tokea* has been discussed by Benham (1904, 1941) and Lee (1952: 26; 1959: 259) – as noted by Blakemore (2012a: 121) – and in greater detail with clarity of purpose by Michaelsen (1916: 48) from his inspection of the type specimen of *T. esculenta* and several other species such as *Tokea*? *orthostichon* as noted in the description of this latter taxon below.

The conclusion is building that Michaelsen was once again correct and that those prostates with small but generally unbranched offshoot 'canalicules' (or lacunae. later termed "*mere evaginations*" by Benham 1941: 31) are a derivation from the strictly tubular form as found in Ocnerodrilidae, Acanthodrilidae, Octochaetidae and 'primitive' members of the Megascolecidae such as *Plutellus* Perrier, 1873 *s. stricto*. Thus the prostates in *Tokea* may indeed be classed as first-stage, non-tubular derivatives as per Blakemore (2000a, b) – here termed 'quasi-tubular' (although 'tubulo-lingual' better defers to Benham's classification) – and this again raises the possibility that the currently cohesive genus *Tokea* may merge with *Aporodrilus* Blakemore, 2000 that, nevertheless, is maintained on its more definitive tubuloracemose prostates as found in its Tasmanian type and most congeners there. This does not preclude the reallocation of the four New Zealand species currently placed in *Aporodrilus* to *Tokea* – in fact *Tokea equestris* (Benham, 1942), *T. aotea* (Blakemore, 2011) and *T. ponga* (Blakemore, 2011) **combs. novae** certainly comply leaving only *A. mortenseni* (Michaelsen, 1924) with more clearly tubuloracemose prostates remaining as a New Zealander *Aporodrilus*. Neither does *Tokea* require absorption with prior *Notoscolex* that has more definitive tubuloracemose to racemose prostates and typically retains dorsal pores in its members. It is still indeterminate which genus *Notoscolex napierensis* (Benham, 1941) belongs in, nor whether it is a NZ native. As noted by Michaelsen (1916: 54), only exotics in NZ have truly racemose prostates.

From reappraisal of *Tokea maorica* Benham, 1904 below, it appears the definition of the genus should be further amended from its having quasi-tubular prostates, to further allow dorsal pores sometimes present but in the segments posterior to the clitellum. Thus *Tokea reptans* (Ude, 1905) **comb. nov.** is now reallocated since it is described with "*Rükenporus vorhanden...Rückenporen sind als sehr kleine Öffnungen hinter dem Gürtel sichtbar*" (dorsal pores present behind clitellum) and ditto *Tokea unipapillata* (Ude, 1905: 426, fig. 4) **comb. nov.** which has "*Rückenporen habe ich hinter dem Gürtel erkannt*". Then too *Tokea neglecta* (Congnetti, 1909: 327) **comb. nov.** is reallocated since it is described with "*pori dorsali irriconoscibile*", and also *Tokea fusca* (Lee, 1952: 32) **comb. nov.** should now likely be transferred since it is described with dorsal pores in every intersegmental groove posterior to the clitellum (*i.e.*, >18/19).

The only five N.Z. taxa now provisionally remaining in *Megascolides* are: *M.*? *albus* Lee, 1952: 35, *M.*? *irregularis* Lee, 1959: 299, *M.*? *raglani* Lee, 1952: 306, *M.*? *ruber* Lee, 1952: 28 [held as *Tokea*? *ruber* (*sic laps. pro T*? *rubra* by Blakemore, 2012a: 131)] and *M.*? *rubicundus* Lee, 1959: 309, for which the presence or absence of their dorsal pores were not noted. Should their prostate glands also prove quasi-tubular, then there should be little reason to retain these latter species in that genus.

Tokea kirki Benham, 1904

(Figure 11)

Tokea kirki Benham, 1904: 251. [From Ohaeawai in North Auckland. Five Otago syntypes (A.02.137), collected by Professor H.B. Kirk, re-examined by Lee, 1959: 301]; Benham 1905: 283; Blakemore 2012a: 131.
Megascolides kirki : Michaelsen 1907: 2.
Notoscolex kirki: Michaelsen 1916; Blakemore 2004; 2010; 2011.
Megascolides kirki: Lee 1952: 26; 1959: 301, fig. 312.

Diagnosis. Reddish. 80–100 by 6 mm with 110 segments. Spermathecae in 7/8/9. No GMs. Clitellum 13–17 saddle-shaped. Tanylobous. Setae evenly spaced. Gizzard in 5, oesophageal glands in 14. Last hearts in 12. Meroic. Holandric, seminal vesicles in 11 & 12 (*cf. T. morica* and *T.*? *orthostichon*). Prostates "*tubular*" (quasi-tubular?). Spermatheca with neither distinct nor muscular duct has small diverticulum (see fig.).

Distribution. Ohaeawai, near Kaikohe, NZ.

Remarks. This species is included to differentiate it from *T. maorica* next below.

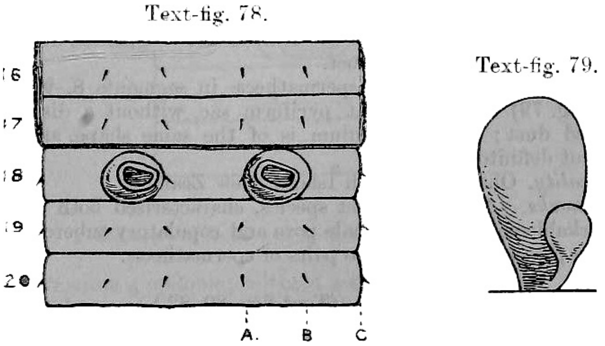


Figure 11. *Tokea kirki* Benham, 1904 from Benham's original text-figs. 78−79.

Tokea maorica Benham, 1904

(Figure 12)

Tokea maorica Benham, 1904: 252, text-figs. 80–82. [From "*neighbourhood of Auckland*" in Waitakerei Bush and Nikau Palm Bush. Eight Otago syntypes (now A.04.97 two specimens according to Lee, 1959: 302), collected by Mr H. Suter, plus specimens "*from the sheaths of nikau and Astelia leaves, Auckland (C. Cooper)*" Benham 1906a: 241]; Benham 1906a: 240, figs. 1, 8–9 (part?).

Tokea decipiens Benham, 1906a: 241, fig. 2. [From Waitakerei Bush near Auckland (H. Suter) "*some half-dozen specimens*" apparently from the original eight Otago syntypes. One at least sent to Hamburg and inspected by Michaelsen (1916: 50)].

Notoscolex decipiens: Michaelsen 1916: 50.

Megascolides maorica: Lee 1952: 26 (syn. *decipiens*).

Megascolides maoricus: Lee 1959: 301, fig. 312 (syn. *decipiens*); Blakemore 2012a: 131.

Notoscolex maorica: Blakemore 2004; 2010; 2011 (syn. *decipiens*).

Megascolides orthostichon: (laps.) Lee 1962: 175, tab. (from inspection of same BM material as re-examined below).

Material examined. BMNH 1904:10:5:488–490 non-type specimens of unknown provenance from the British Museum 'Beddard Collection', (two clitellate matures, both having GM in 14 but one entire and one dissected along the dorsal mid-line (by Lee?), plus four aclitellate specimens, total six specimens, whereas Lee says five) labelled: "*BMNH 1904.10.5 488–490 Hypogaeon orthostichon Schmarda, 1861 ?SYNTYPES Vienna Museum see Beddard Bibliog. ITEM 80*"; "*Megascolides* [crossed out] *Megascolex orthostichon - - - -9*[8?]*8 -0* [illegible]" (in Beddard's hand?); "*Current name is Megascolides orthostichon (Schmarda), 1861 (Idet. Dr K.E. Lee 1961)*". A small vial has Ken Lee's label "*Megascolides orthostichon spermatheca*".

Notes. Benham (1904) had eight original syntypes but Lee (1959) only found two remaining in Otago, and one syntype (by then was called *T. decipiens*) was sent to Michaelsen (1916: 50) in Hamburg (and returned?); hence there is a slight chance these six NHM specimens are missing syntypes. However, this is difficult to reconcile with their registration date of "*1904*". Cole (1981) says four Vienna specimens were inspected by Beddard (1892: 113–134) – this being referenced as "*Bibliog. ITEM 80*" in the sample jar's label – that were probably *H. heterostichon* and, moreover, the number of current specimens (six of) contradicts this, plus it is more likely Beddard visited Vienna rather than just borrowed and, moreover, Beddard (1892) only saw one *H. orthostichon* type specimen in Vienna (as described under that species name below).

Diagnosis. [From Benham, Lee (in part) and pers. obs.]. Dark reddish-brown. From 25 x 2 to 75 x 4 mm with 75–90 segments (BM specimens are *ca.* 36 by 3.5 mm with 64–66 segments). Epilobic (Benham and pers. obs.) or tanylobic (Lee 1962). Setal *ca.* ab<cd<bc; bc=ab=aa; dd=2aa (Lee has slightly different ratios). Clitellum annular ½13,14–17. GMs as tumid central pads below female pores on 14 and around male pores on 18 with corresponding glandular mass internally (sometimes that on 14 missing in what was to be called "*decipiens*"). Spermathecal pores posterior in 7 & 8 (mistakenly said to be in 8 & 9 by both Benham initially and by Lee 1962). Dorsal pores absent from the anterior **are present**, "*at least in the postclitellar region*" (Benham, 1904: 254 but not noted by Lee nor found in these BM specimens). Last hearts in 12. Gizzard small distinct in 5; oesophageal glands absent (Benham 1906a) or in 13 (Lee 1962); intestine from 16. Meroic. Holandric (testis 10 & 11); seminal vesicles in 9 & 12 from generic definition (Benham 1904: 240) but in 9–12 in present dissected specimen (pers. obs. but *cf.* 11 & 12 by Lee 1962: 176). Prostates flattened, quasi-tubular reaching to segment 25rhs (pers. obs.). Spermathecae each with small pyriform diverticulum on broad duct in types (or narrower in BM specimens – see Figs.).

Distribution. Benham and Lee provide distribution around Auckland and nearby islands.

Remarks. It is unclear why Lee (1962) missed the overwhelming evidence of the London non-types, as re-examined here, being *Tokea maorica* in favour of what was then *N. orthostichon.*

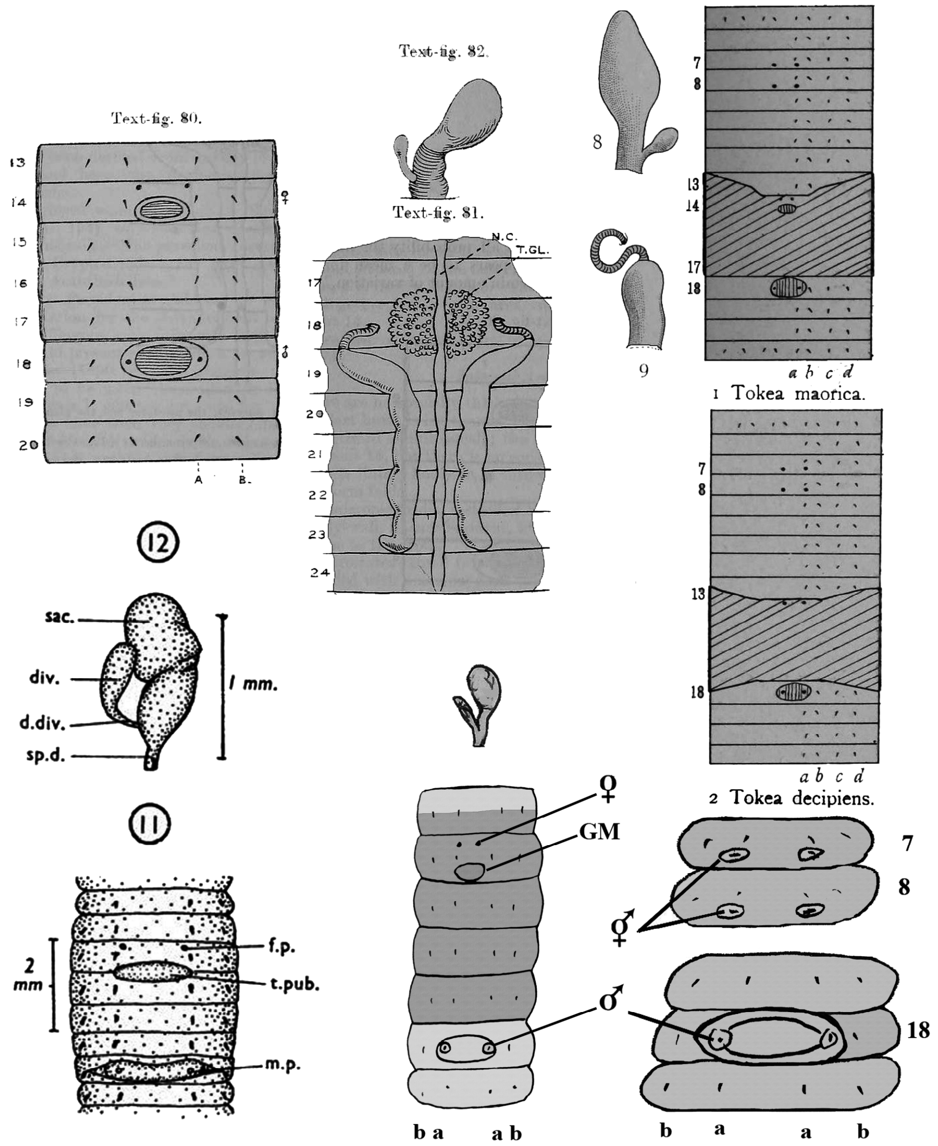


Figure 12. *Tokea maorica* from Benham's originals (1904: figs. 80−82; 1906a, figs. 1−2, 8−9) and Lee's subsequent (1962: figs. 11−12 mislabelled as *"M. orthostichon*") plus on bottom rhs sketches of two of the same NHM specimens (that on lhs previously dissected that on rhs aclitellate and lacking marking in 14) and both having spermathecal pores posteriorly in segments 7 & 8 (cf. Lee *laps*. in 8 & 9).

Possibly he was guided by the Museum labels by Beddard written at a time (1904) before the publication of Benham's species. Or perhaps because Lee's (1959) monograph omitted details of GMs and dorsal pores, the obvious compliance was lost. What is interesting is that the London specimens have some slight differences to the type description of *T. maorica*, however there is insufficient evidence to attribute them to *T.*? *orthostichon* for reasons given in the account of that taxon below.

This species is returned to *Tokea* on the grounds that its overall similarity is with other member of the genus and, furthermore its (vestigial?) dorsal pores, although stated by Benham to be at least postclitellar in the type, were not located in the present specimens that undoubtedly agree on most other points. Whereas *Tokea kirki* Benham, 1904 has intersegmental spermathecal pores in 7/8/9, *Tokea maorica* has them segmentally in posterior of 7 & 8, and **not** 8 & 9 as Benham originally stated and inadvertently retained by Lee (1959: 302). [This correction according to Benham (1906a: 240, pl XL, figs. 1–2, 8–9) or where Benham unconventionally records segments 7 & 8 as "7/8" and 8 & 9 as "8/9"]. Lee (1962: 176) apparently also erred in having spermathecal pores at anterior margins of 8 & 9 since my reinspection of the same BM specimens clearly locates them posteriorly in 7 & 8 (see Figs.).

Tokea maorica was originally described by Benham (1904), but then divided into two taxa by Benham (1906a: 240) who said in his first account the external features were for the smaller specimens (*maorica*) and the internal characters for larger specimens lacking the distinctive markings in 14 that he separated off as *decipiens*; both were recombined by Lee (1952; 1959) and put in genus *Megascolides* whereas Michaelsen (1916), on inspection of a type of *decipiens*, had it in *Notoscolex*. Lee (1962) was seemingly unconvinced of Michaelsen's (1916) reallocation of *decipiens* to *Notoscolex* but this is where its senior synonym also then belonged, and both are now combined and returned to their original genus following Blakemore's (2012a) restoration of *Tokea*.

***Tokea*? *orthostichon* (Schmarda, 1861)**

(Figure 13)

Hypogaeon orthostichon Schmarda, 1861a: 12, Pl. 18, fig. 159. [From Mt Wellington Auckland, not Tasmania (see Blakemore 2012a). Syntype in Vienna inspected by Beddard (1882) and later deemed lectotype by Beddard (1895: 495) who said "*..I had only the type of* SCHMARDA*, which it was necessary to respect.*" before its transfer to Hamburg as ZMUH 8615 where Michaelsen (1916) said it was by then poorly preserved].

Megascolides orthostichon: Beddard 1892a: 130; 1895: 496; Lee 1959: 349; (non Lee 1962: 175–176, figs. 11, 12 of non-types of a different species – see below); Blakemore 2000: 261–263, fig. 105; 2010; 2011; 2012a: 121.

Notoscolex orthostichon: Michaelsen 1900: 189; Benham 1904: 255; 1916: 38–40, figs. 12–14.

Other material. None known. Coles (1981) reports: firstly, that Beddard (1892a) re-inspected Vienna Museum type specimens of *Hypogaeon orthostichon* [4 specimens (= syntypes?) but this probably a mistake for *Hypogaeon heterostichon*]; and secondly, that he found *Perichaeta vitiensis* Beddard, 1892 [= *Pheretima (Pheretima) montana* Kinberg, 1867] had a single specimen in the Vienna Museum mislabeled as "*Hypogeon orthostichon Schm. Viti Ins.* [= Fiji]." Interestingly, this was the species described by Beddard (1892a: 131) immediately following his description of *M. orthostichon*, perhaps accounting for the mislabelling. Lee (1962) described several specimens in NHM, London as *Megascolides orthostichon* but this in error as noted above (under *T. maorica* description) and also below in current account.

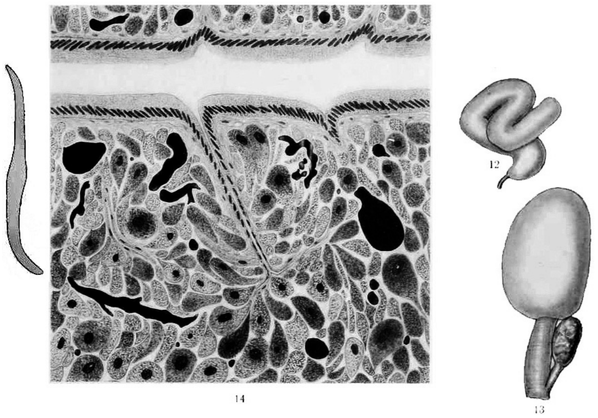


Figure 13. *Tokea*? *orthostichon* after Schmarda's original text-fig. magnification of a seta (far lhs) and Michaelsen's (1916: vol. 52 No. 13, Tafel 1, figs. 12-14) of: 12 - the prostate (X12), 13 - a spermatheca (X25) and 14 - part of a horizontal section through a prostate gland in the plane of the central channel (X500) [cf. Benham's (1941: figs. 9-11) of prostate sections of *T. esculenta* that are similar].

Original description (in full). "*Hypogaeon orthostichon. Schmarda. Taf. XVIII Fig. 159. Char.: Corpus teretiusculum cingulatum. Segmenta 60. Octo series setarum paralellae. Der Körper ist drehrund. Der Kopflappen ist etwas zugespitzt. Der Gürtel beginnt hinter dem 13*

Ringe. Seine Ringelung ist undeutlich; hinter ihm stehen 48 Ringe. Die Länge ist bis 80mm, grösste Breite 4mm. Die Farbe ist dunkelroth. Die Borsten stehen in 8 Reihen und sind rückwärts am deutlichsten. Der festsitzende Theil ist stärker gekrümmt und abgerundet, der freie Theil wenig hakenförmig gekrümmt, von der Mitte gegen das Ende allmählig verschmächtigt. Neu-Seeland, Mount Wellington in der Dammerde."

Diagnosis. (From Schmarda, Beddard, and Michaelsen). Dark red. Prostomium pointed. Dorsal pores? Length 80 (Schmarda, Michaelsen) or 180 (lapsus by Beddard) by 2.5–4 mm. Segments 65. Setae 8 in equidistant rows in the anterior, in the posterior Michaelsen gives ratio aa:ab:bc:cd:dd = 5:3:4:4:6. (Spermathecae in 7/8/9 or 7 & 8?). Clitellum annular ½13,14–17. Male pores on 18 on moderately roundish porophores in line with missing setae *a*. No GMs (but Michaelsen thought they may have rudiments posteriorly on 17). Gizzard in 5. Nephridia meroic but also with meganephridia in the last eleven segments (Michaelsen 1916). Seminal vesicles in 10–12 (Beddard). Ovaries in 13; ovisacs in 14. Prostates flattened quasi-tubular (described in detail by Michaelsen (1916) who found them with significant multiple and minute side branches to the lumen). No penial setae noted. Spermathecae two pairs in 8 & 9 each with a small, pyriform diverticulum (see Michaelsen's figure).

Distribution. Only from Mt Wellington, N.Z., possibly extinct (Blakemore 2012a).

Remarks. For the male pores Michaelsen (1916: 39) said: "*Die männlichen Poren liegen ungefähr (genau?) an Stelle der fehlenden Borsten am des 18 Segments auf je einem kleinen dunklen, von einem mässig breiten hellen Bande eingefassten Feldchen. Das männliche Geschlechtsfeldchen der rechten Seite ist fast kreisrund und nimmt ungefähr eine halbe Segmentlänge ein, das der linken Seite zeigt hinten einen schmalen Vorsprung und ist fast ohrförmig. Von akzessorischen Pubertätsorganen ist nichts zu erkennen; doch erscheint es mir fraglich, ob nicht etwa am ventralen Hinterrande des 17 Segments etwaige Papillen oder Grübchen gewesen und postmortal zerstört sein mögen*". He thus indicates that the male pores are on separate dark and roundish porophores which are interconnected by a wide lighter band, and that GMs are absent nearby, which is perhaps a different configuration to the male field of the either of the two *Tokea* species described above with which it was compared (as noted below).

As noted by Benham (1904: 284) Schmarda's worm may indeed belong in his genus *Tokea* Benham, 1904 since Michaelsen (1916: 39) described the fine branching details of the prostates being similar to those already noted by Lee (1952: 26) in *Tokea* as restored by Blakemore (2012a: 121) and wherein this species is also summarized. Also similar, but not unique, is the posterior meganephridia. Lee (1962) had apparently overlooked Michaelsen's (1916) type redescription as he omitted citing this key paper.

The present uncertainty of *orthostichon* placement is due to the required reduction of dorsal pores in *Tokea* allowing default to *Megascolides* (if with tubular prostates) or less likely to *Notoscolex* (if tubuloracemose-racemose rather than current interpretation from Michaelsen as 'quasi-tubular'). Its similarities were discussed by Benham (1904) and by Lee (1962: 176) who thought the non-type BM specimens he inspected resembled *Tokea kirki* Benham, 1904 (originally and currently in *Tokea* after Blakemore (2012a: appendix II). However, Lee's non-type specimens as redescribed above are actually much closer to *Tokea maorica*.

The type of *Tokea*? *orthostichon* still requires confirmation and comparison with both *T. kirki* and *T. maorica* especially with regards nature of its spermathecal, male, and dorsal pores in order for its extinct status to be confirmed.

Family MONILIGASTRIDAE Claus, 1880

Genus ***Drawida*** **Michaelsen, 1900**

Type-species. *Moniligaster barwelli* Beddard, 1886 by original designation.

Drawida barwelli (Beddard, 1886)

Moniligaster barwelli Beddard, 1886: 94, figs. 4–6. [Type locality "*from the neighbourhod of*" Manila, Luzon, P.I.; Gates (1937: 307) said the twenty aclitellate syntypes were either dissected, sectioned or mounted between 1886–1891 and he questioned whether any were undispersed. Types in British Museum (BMNH 1904:10:5:522–3) were disputed by Easton (1984: 112) who re-described the species from new material after finding that the type series, that he labelled "*(BMNH: 1904:10.5.2–3)*", comprised a posterior portion and an associated slide that produced no useful data (although DNA is retained?)].

Material Examined. In May, 2010 I received the BMNH types in Tokyo, apparently re-numbered 1974.1.101–102 and labelled: "*Moniligaster barwelli TYPE 1974.1.101–102 Loc. Manila, Philippines Coll. Mr H*[erbert]. *E. Barwell Ref. Ann. Mag. Nat. Hist. 5 xvii p. 74"* and *"Beddard 1886 Manila, Phillipines [sic] Collector: H.E. Barwell*" plus another note: "*These fragments are far too large to be types of M. barwelli which is less than 40 mm long EGE*[aston] *April, 1981*". This material comprised one tail portion with the anterior end cleanly cut (length = 35mm, segments = 152) and one mid-portion that is cleanly cut at both ends (length = 30mm, segments = 198), both blackened and neither yielding useful information but small tissue samples were taken from each for COI barcoding (JET002-10 http://www.boldsystems.org) that was unsuccessful with current techonlogy on such old material.

Note. This material was reinspected and details confirmed, they are yet possibly syntypes and were previously commented on by Blakemore & Kupriyanova (2010).

Family OCTOCHAETIDAE Michaelsen, 1900

Type-species. Octochaetus multiporus (Beddard, 1885: 813) from Dunedin, NZ.

Note. An unregistered old jar on the museum shelf has label "*Octochaetus multiporus [Duplicates]*" contains four immature specimens (syntypes?) without any further information. Reynolds & Cook (1976: 142) have types BMNH 1904:10: 5:877, other types are supposedly 1904:10:20:47–55, 58–60 and Hamburg 7314 (lost). Lee (1959: 116) was unsure the type was in London and gave registration only as "*1904:10*".

Dedications − This paper is dedicated to two renowned Soil Ecologists: Dr Gregor W. Yeates (1944–2012) of Palmerston North, N.Z. who very kindly sent me a copy of Lee's 1959 Earthworm book and also to Ken Lee (1927–2007) who himself passed down to me his copy of Michaelsen's 1900 *Tierreich* given him by Sir W. B. Benham (1860–1950). These three gentleman scientists greatly inspired revisionary work on NZ earthworms.

Acknowledgements − Thanks to friends and colleagues for support: to Emma Sherlock, curator of free-living worms of the "Aquatic Invertebrates Division" (sic) of the Natural History Museum, and to Dr Csaba Csuzdi (Eötvös Loránd University, Budapest) for their help in accessing the collection and in publication of the results. Some partial travel fund for this study was provided by Prof. Wonchoel Lee of Hanyang University, Seoul. Drs. Toshiaki Kuramochi of National Museum of Nature and Science, Tokyo and Dr. Andreas Schmidt-Rhaesa Biozentrum Grindel/Zoological Museum, Hamburg are also thanked for assistance with loan of types. Colleagues in China kindly sent me their reprints regarding the *A. morrisi* morass. This study supports the adage by J.F. Kennedy "*as a wise man once said: "An error doesn't become a mistake until you refuse to correct it.* ""

REFERENCES

Baird, W. (1871): Description of some new Species of Annelida and Gephyrea in the Collection of the British Museum. *Journal of the Linnean Society of London, Zoology,* 11(50): 94−97.

Beddard, F.E. (1885): On the Specific Characters and Structure of certain New Zealand Earthworms. *Proceedings of the Zoological Society of London*, 1885: 810−832.

Beddard, F.E. (1886): Notes on some earthworms from Ceylon and the Philippine Islands, including a description of two new species *Annals and Magazine of Natural History (series 5)*, 17: 89−98.

Beddard, F.E. (1892a): The earthworms of the Vienna Museum. *Annals and Magazine of Natural History*, (*series 6*) 9: 113−134.

Beddard, F.E. (1892b): On some species of the genus *Perichaeta* (sensu stricto). *Proceedings of the Zoological Society of London*, 1892: 153−172.

BEDDARD, F.E. (1892c): On some new species of earthworms from various parts of the world. *Proceedings of the Zoological Society of London*, 1892: 666−706.

BEDDARD, F.E. (1892d): On some Perichaetidae from Japan. *Zoologische Jahrbücher, Abteilung für Systematik*, 6: 755−766.

BEDDARD, F.E. (1895): *A monograph of the Order Oligochaeta.* Clarendon Press, Oxford, pp. 769.

BEDDARD, F.E. (1896): On some earthworms from the Sandwich Islands collected by Mr. R. L. Perkings; with an Appendix on some new species of *Perichaeta,* etc. *Proceedings of the Zoological Society of London*, 1896: 194−211.

BEDDARD, F.E. (1900a): The earthworms of the Hawaiian Archipelago. *Fauna Hawaiiensis*, II (IV): 413−426.

BEDDARD, F.E. (1900b): A revision of the earthworms of the genus *Amyntas* (*Perichaeta*). *Proceedings of the Zoological Society of London*, 1900: 609−652.

BEDDARD, F.E. (1906): The Wild Fauna and Flora of the Royal Botanic Gardens, Kew. Annelida. Oligochaeta. *Bulletin of Miscellaneous Information. Additional Series, Kew*. 5: 66−67.

BENHAM, W.B. (1904). On some Edible and other New Species of Earthworms from the North Island of New Zealand. *Zoological Society of London*, 1904(II): 220−235.

BENHAM, W.B. (1906a): An account of some earthworms from Little Barrier Island. *Transactions and Proceedings of the Royal Society of New Zealand*, 38: 239−245 + Plate XL.

BENHAM, W.B. (1906b): Additional notes on the earthworms of the North Island of New Zealand. *Transactions and Proceedings of the Royal Society of New Zealand*, 38: 248−256 + Plates XLI−XLII.

BENHAM, W.B. (1941): *Megascolides napierensis*, a new species of earthworm. *Transactions and proceedings of the Royal Society of New Zealand*, 71: 27–31.

BLAKEMORE, R.J. (1994): *Earthworms of south-east Queensland and their agronomic potential in brigalow soils*. Unpublished PhD Thesis, University of Queensland, pp. 605.

BLAKEMORE, R.J. (1997): First 'common earthworm' found in Tasmania. *Invertebrata*, 9: 1−5.

BLAKEMORE, R.J. (2000): *Tasmanian Earthworms*. ICZN compliant CD-ROM with Review of World Families. VermEcology, Kippax 2615. Canberra, December, 2000, pp. 800.

BLAKEMORE R.J. (2003): Japanese Earthworms (Annelida: Oligochaeta): a Review and Checklist of Species. *Organisms, Diversity and Evolution*, 3(3): 241−244. [Electronic Supplement 2003−11 http://www.senckenberg.de/odes/0311.htm].

BLAKEMORE, R.J. (2004): *Checklist of New Zealand Earthworms updated from Lee (1959)*. In. MORENO, A.G. & BORGES, S. (Eds) Avances en taxonomia de lombrices de tierra/Advances in earthworm taxonomy (Annelida: Oligochaeta). Editorial Complutense, Universidad Complutense, Madrid, Spain, p. 175−185.

BLAKEMORE, R.J. (2010): Saga of Her Hilgendorf's worms. *Zoology in the Middle East,* 49(s2): 7−22.

BLAKEMORE, R.J. (2011): Further records on non-cryptic New Zealand earthworms. *Zookeys,* 160: 23−46.

BLAKEMORE, R.J. (2012a): On Schmarda's lost worm and some newly found New Zealand species. *Journal of Species Research*. 1(2): 105−132.

BLAKEMORE, R.J. (2012b): *Cosmopolitan Earthworms – an Eco-Taxonomic Guide to the Peregrine Species of the World.* Vth Edition. VermEcology, Yokohama, pp. 900.

BLAKEMORE, R.J. (2012c): On Opening a Box of Worms (Oligochaeta, Megascolecidae) – Historical Earthworm Specimens Transferred to Tokyo from the Saito Ho-on Kai Museum of Natural History in Sendai. *Bulletin of the National Science Museum, Tokyo Series A*. 38(3): 95–124.

BLAKEMORE, R.J. (2013a): Ulleung-do earthworms − Dagelet Island revisited. *Journal of Species Research.* 2(1): 55−69.

BLAKEMORE, R.J. (2013b): *Megascolex* (*Perichaeta*) *diffringens* Baird, 1869 and *Pheretima pingi* Stephenson, 1925 types compared to the *Amynthas corticis* (Kinberg, 1867) and *A. carnosus* (Goto & Hatai, 1899) species-groups (Oligochaeta: Megadrilacea: Megascolecidae). *Journal of Species Research*. 2(2): 99−126.

BLAKEMORE, R.J. (2013c): Earthworms newly from Mongolia (Oligochaeta, Lumbricidae, *Eisenia*) *ZooKeys*. 285: 1−21.

BLAKEMORE, R.J. (2013d): The major megadrile families of the World reviewed again on their taxonomic types (Annelida: Oligochaeta: Megadrilacea). *Opuscula Zoologica Budapest*: 44(2): 107–127.

BLAKEMORE, R.J. (2013e): Restoration of London type of first earthworm – *Lumbricus terrestris* Linnaeus, 1758 (Annelida: Oligochaeta: Lumbricidae), and setting aside of a 'neo-neotype'. *Opuscula Zoologica Budapest*: 44(2): 211−212.

BLAKEMORE, R.J. & KUPRIYANOVA, E.K. (2010): Unravelling some Kinki worms (Annelida: Oligochaeta: Megadrili: Moniligastridae) Part I. *Opuscula Zoologica Budapest,* 40: 3−18.

BLAKEMORE, R.J. & LEE, S. (2013): Survey of Busan Oligochaeta earthworms supported by DNA barcodes. *Journal of Species Research*, 2(2): 127−144.

BLAKEMORE, R.J., KUPRIYANOVA, E. & GRYGIER, M.J. (2010): Neotypification of *Drawida hattamimizu* Hatai, 1930 (Oligochaeta: Megadrili: Moniligastridae) and the first COI sequence from an earthworm type. *ZooKeys*, 41: 1−29.

BLAKEMORE, R.J., LEE, S., LEE, W. & SEO, H-Y. (2013): Two new Korean earthworms (Annelida, Oligochaeta, Megadrilacea, Megscolecidae). *ZooKeys*, 307: 35–44.

CHANG, C.-H., SHEN, H.-P. & CHEN, J.-H. (2009): *Earthworm Fauna of Taiwan*. National Taiwan University Press, Taipei, Taiwan, pp. 174.

CHEN, Y. (1931): On the terrestrial Oligochaeta from Szechuan with descriptions of some new forms. *Contributions from the Biological Laboratory of the Science Society of China (Zoology),* 7: 117−171.

CHEN, Y., (1933): A preliminary survey of the earthworms of the lower Yangtze Valley. *Contributions from the Biological Laboratory of the Science Society of China (Zoology)*, 9: 177−295.

COGNETTI, L. (1909): Nuove specie dei generi *Megascolides* e *Pheretima. Annalin del Museo civico di storia naturale di Genova,* 44: 327−334.

COLES, J.W. (1981): Bibliography on the contributions to the study of the Annelida by Frank Evers Beddard with details of the material reported. *Archives of Natural History,* 10(2): 273−315.

CSUZDI, CS. & ZICSI, A. (2003): *Earthworms of Hungary (Annelida: Oligochaeta; Lumbricidae).* In. CSUZDI, CS. & MAHUNKA, S. (Eds), Pedozoologica Hungarica 1. Hungarian Natural History Museum, Budapest, pp. 271.

DARWIN, C.R. (1881): *The Formation of Vegetable Mould through the Action of Worms with Observations on their Habits*. Murray, London, pp. vii + 326.

EASTON, E.G. (1981): Japanese earthworms: a synopsis of the Megadrile species (Oligochaeta). *Bulletin of the British Museum (Natural History) Zoology*, 40(2): 33−65.

EASTON, E.G. (1982): Australian pheretimoid earthworms (Megascolecidae: Oligochaeta): a synopsis with the description of a new genus and five new species. *Australian Journal of Zoology*, 30: 711−735.

EASTON, E.G. (1984): Earthworms (Oligochaeta) from islands of the south-western Pacific, and a note on two species from Papua New Guinea. *New Zealand Journal of Zoology,* 11: 111−128.

FEDARB, S.M. (1898): On some earthworms from British India. *Proceedings of the Zoological Society of London*, 1898: 445−450.

GARMAN, H. (1888): On the Anatomy and Histology of a New Earthworm (*Diplocardia communis*, gen. et sp. nov.). *Bulletin of the Illinois State Laboratory of Natural History,* 3: 47−77.

GATES, G.E. (1926): Notes on earthworms from various places in the Province of Burma with descriptions of two new species. *Records of the Indian Museum*, 28: 141−170.

GATES, G.E. (1937): The genus *Pheretima* in North America. *Bulletin of the Museum of Comparative Biology, Harvard*, 80: 339−373.

GATES, G.E. (1939): On some species of Chinese earthworms with special reference to specimens collected in Szechuan by Dr. D.C. Graham. *Proceedings of the United States National Museum*, 85: 405−507.

GATES, G.E. (1968): On an anthropochorous species of the earthworm genus *Pheretima* (Megascolecidae, Oligochaeta). *Journal of Natural History*, 2: 253−261.

GATES, G.E. (1972): Burmese Earthworms, an introduction to the systematics and biology of Megadrile oligochaetes with special reference to South-East Asia. *Transactions of the American Philosophical Society*. 62(7): 1−326.

GATES, G.E. (1977): La faune terrestre de l'ile de Sainte-Helene. *Koninklijk Museum voor Midden-Afrika Tervuren Belgie Annalen Zoologische Wetenschappen,* 220: 469−491.

GATES, G.E. (1982): Farewell to North American megadriles. *Megadrilogica,* 4: 12−80.

GUTTERIDGE, R.C. (1990): Agronomic evaluation of tree and shrub species in southeast Queensland. *Tropical Grasslands*, 24: 29−34.

HORST, R. (1883): New species of the genus *Megascolex* Templeton (*Perichaeta* Schmarda) in the collections of the Leyden Museum. *Notes from the Leyden Museum*, 5: 182−196

HUTTON, F.W. (1876). On the new Zealand earthworms in the Otago Museum. *Transactions and Proceedings of the Royal Society of New Zealand*. 9: 350−353.

ICZN (1999): *International Code of Zoological Nomenclature.* 4th Edition. Published by the International Trust for Zoological Nomenclature, c/o Natural History Museum, Cromwell Road, London, SW7 5BD, UK.

JAMES, S.W., PORCO, D., DECAËNS, T., RICHARD, B., ROUGERIE, R. & ERSÉUS, C. (2010): DNA barcoding reveals cryptic diversity in *Lumbricus terrestris* L., 1758 (Clitellata): resurrection of *L. herculeus* (Savigny, 1826). *PLoS ONE*, 5: e15629.

JAMIESON, BG.., MCDONALD, K.R. & JAMES, S.W. (2013): A new species of *Terrisswalkerius* (Megascolecidae, Megascolecinae, Oligochaeta) from the Wet Tropics of Queensland, *Memoirs of the Queensland Museum*, 58: 15−21.

JIANG, J., SUN, J., ZHAO, Q. & QIU, J.P. (2014): Four new earthworm species of the genus *Amynthas* Kinberg (Oligochaeta: Megascolecidae) from the island of Hainan and Guangdong Province, China. *Journal of Natural History*, 2014: DOI: 10.1080/ 00222933.2014. 931480

KEELING, C.D. (1978): The Influence of Mauna Loa Observatory on the development of atmospheric CO_2 research. In: *Mauna Loa Observatory: A 20th Anniversary Report*. (National Oceanic and Atmospheric Administration Special Report, September 1978), J. Miller (Ed.), Boulder, CO: NOAA Environmental Research Laboratories, pp. 36–54.

KINBERG, J.G.H. (1867): Annulata nova. *Öfversigt af Kongliga Vetenskaps-Akademiens Förhandlingar*, 23: 97−103.

LEE, K.E. (1952): Studies on the earthworm fauna of New Zealand – 3. *Transactions of the Royal Society of New Zealand*, 80: 23–45.

LEE, K.E. (1959): *The earthworm fauna of New Zealand.* New Zealand Department of Scientific & Industrial Research Bulletin 130, Wellingzon, N.Z. pp. 486.

LEE, K.E. (1962): New Zealand earthworms in the collections of the British Museum (Natural History). *Transactions of the Royal Society of New Zealand,* 2: 169−180.

LINNAEUS, C. (1758): *Systema Naturae* (10th Edition). 1: 1–824. Salvi: Holmiae, pp. 824.

QI, Z., JING, S., JIBAO, J. & QIU, J.P. (2013): Four new species of genus *Amynthas* (Oligochaeta, Megascolecidae) from Hainan Island, China. *Journal of Natural History*, 47: 2175−2192.

MICHAELSEN, W. (1892): Terricolen der Berliner Zoologischen Sammlung. II. *Archiv für Naturgeschichte*, 58(1): 209−255.

MICHAELSEN, W. (1900): *Das Tierreich, 10: Vermes, Oligochaeta*. Friedländer & Sohn, Berlin, pp. 575.

MICHAELSEN, W. (1907): Oligochaeta *Die Fauna Südwest-Australiens*, 1(2): 117−232.

MICHAELSEN, W. (1916): Results of Dr E. Mjoberg's Swedish Expedition to Australia 1910−1913. *Kungliga Svenska Vetenskapsakademiens Handlingar*, 52(13): 3−74.

REYNOLDS, J.W. & D.C. COOK (1976): *Nomenclatura Oligochaetologica: A Catalogue of Names, Descriptions and Type Specimens of the Oligochaeta.* University of New Brunswick, Fredericton, Canada, pp. 216.

ROSA, D. (1896): I Lombrichi raccolti a Sumatra dal Dott. Elio Modigliani. *Annali del Museo Civico di Storia Naturale di Genova Serie 2a*, 16: 502−532.

SCHMARDA, L.K., (1861): *Neue Wirbellose Thiere Gesammelt auf einer Reise um die Erdr* (sic) *1853 bis 1857*. Vol. 1(2). Verlag von Wilhelm Engelmann, Leipzig, pp. 164.

SIMS, R.W. (1973): *Lumbricus terrestris* Linnaeus 1758 (Annelida, Oligochaeta): designation of a neotype in accordance with accustomed usage. Problems arising from the misidentification of the species by Savigny (1822 & 1826). *The Bulletin of Zoological Nomenclature*, 30(1): 27–33.

SIMS, R.W. & EASTON, E.G. (1972): A numerical revision of the earthworm genus *Pheretima* auct. (Megascolecidae:Oligochaeta) with the recognition of new genera and an appendix on the earthworms collected by the Royal Society North Borneo

Expedition. *Biological Journal of the Linnean Society*, 4: 169−268.

SIMS, R. W. and GERARD, B.M. (1999): *Earthworms: Notes for the identification of British species. 4th Edition*. Published for The Linnean Society of London and The Estuarine and Coastal Sciences Association by Field Studies Council, Montford Bridge, Shrewsbury, UK, pp. 169.

SHEN H.-P. & YEO, D.C.J. (2005): Terrestrial earthworms (Oligochaeta) from Singapore. *The Raffles Bulletin of Zoology*, 53(1): 13−33.

SHEN, H.-P., CHEN, C.-H. & CHIH, W.-J. (2014): Five new earthworm species of the genera *Amynthas* and *Metaphire* (Megascolecidae: Oligochaeta) from Matsu, Taiwan. *Journal of Natural History*, 48: 495−522.

STEPHENSON, J. (1923): *Oligochaeta. The Fauna* of *British India, including Ceylon and Burma*. Taylor & Francis, London, pp. 518.

SUN, J., ZHAO, Q. & QIU, J.P. (2009): Four new species of earthworms belonging to the genus *Amynthas* (Oligochaeta: Megascolecidae) from Diaoluo Mountain, Hainan Island, China. *Revue Suisse de Zoologie*, 116(2): 289−301.

UDE, H., 1905. Terricole Oligochäten von den Inseln der Südsee und von verschiedenen andern Gebieten der Erde. *Zeitschrift für wissenschaftliche Zoologie*, 83: 405−501.

ZHAO, Q., JIANG, J., SUN, J. & QIU, J.P. (2013a): Four new earthworm species and subspecies belonging to genus *Amynthas* and *Metaphire* (Oligochaeta, Megascolecidae) from Hainan Island, China. *Zootaxa*, 3619(3): 383−393.

ZHAO, Q., SUN, J., JIANG, J. & QIU, J.P. (2013b): Four new species of genus *Amynthas* (Oligochaeta, Megascolecidae) from Hainan Island, China. *Journal of Natural History*, 47: 2175−2192.

Appendix I.

DNA (barcodes)

From ENA (www.ebi.ac.uk/ena/data/search?query=amynthas%20morrisi) and GenBank (www.ncbi.nlm.nih.gov/genbank**)**.

1). "*Four new earthworm species of the genus Amynthas Kinberg (Oligochaeta: Megascolecidae) from Hainan and Guangdong Provinces, China*" Jiang J., Sun J., Zhao Q., Qiu J. (2014) |KF021247.1 *Amynthas morrisi* voucher Sichuan, China SC201006-03 cytochrome c oxidase subunit I (COI) gene, partial cds; mitochondrial. : Location: 1..700

2). Shen (2012) "*Three new earthworms of the genus Amynthas (Megascolecidae: Oligochaeta) from eastern Taiwan with redescription of Amynthas hongyehensis Tsai and Shen, 2010*." J. Nat. Hist. 46: 2259–2283; JX290441-5 eg. |JX290441.1 *Amynthas morrisi* voucher mor1 cytochrome c oxidase subunit 1 (COI) gene, partial cds;mitochondrial. Location: 1...658

3). "*Molecular phylogeny and systematics of Japanese pheretimoid earthworms (Oligochaeta: Megascolecidae).*" Minamiya et al. Submitted (JAN-2010) AB542516-8 from Okinawa eg: AB542516.1 *Amynthas morrisi* mitochondrial COI gene for cytochrome oxidase subunit 1, partial cds, isolate: Amor-1242. Location: 1...637

4). Huang, et al. (2007) "Identifying earthworms through DNA barcodes." Pedobiologia 51: 301–309: |EF077578 – EF077590 Amynthas morrisi voucher 06-252 from China cytochrome c oxidase subunit I (COI) gene, partial cds; mitochondrial. : Location: 1...602

5). >HY14|Amynthas gracilis - Jeju1 from Blakemore *et al*. 2014 (in press).
GAGCAGGAATAAGACTACTTATTCGAATTGAGCTCAGACAGCCGGGATCGTTTCTGGGAAGAGATCAAT
TATATAATACAATTGTAACAGCTCATGCATTCGTAATAATTTTCTTTCTAGTAATACCAGTATTCATTGGTG
GATTTGGAAACTGACTACTACCTCTAATGCTGGGTACACCAGACATAGCATTTCCGCGGCTTAATAATATA
AGATTTTGGCTACTCCCCCCGTCACTTATCTTACTAGTAAGATCCGCGGCCGTTGAAAAGGGGGCGGGA
ACTGGATGGACAGTATATCCCCCGCTGGCAAGAAATATTGCACATGCTGGTCCATCAGTAGATCTAGCAA
TCTTCTCACTACACTTAGCAGGGGCATCATCTATTCTTGGGGCCATTAACTTTATTACAACTGTAATTAAT
ATGCGATGATCTGGATTACGGCTAGAGCGAATCCCCCTATTTGTATGGGCCGTAGTAATTACTGTAGT
ACTTCTACTATTATCTCTACCTGTACTAGCCGGAGCTATTACTATACTATTAACAGATCGAAACCTTA
ACACATCATTCTTTGATCCCGCTGGAGGTGGAGACCCTATTCTATATCAACACCTATTT
Blast result: *Amynthas gracilis* (AB542489.1 & 542491.1 from Japan), 100%.

July, 2013 **BLASTn** and **megaBLAST** (www.ncbi.nlm.nih.gov/**BLAST**/) comparisons; Max Identities:

	1	2	4
1, KF021247	–		
2	601/658 (91%)		
3a, AB542516	636/637 (99%)		
3b, AB542517	580/637 (91%)		
3c, AB542518	580/637 (91%)		
4, EF077579	601/602 (99%)		
5	520/614 (85%)	525/614 (86%)	85%

I.e., both "*morrisi*" haplotypes different to *A. gracilis*.

It appears that genetic data differ so at least some (if not all) identifications must be incorrect for *A. morrisi* thus it is beholden on Chinese/Taiwan and Japanese workers to confirm their species and/or vouchers against the types.

Opusc. Zool. Budapest, 2014, 45(2): 157–164

A few new Western Australian earthworms (Oligochaeta: Megadrilacea: Megascolecidae *sensu* Blakemore, 2000)

R. J. BLAKEMORE

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Abstract. Earthworm samples, apparently collected in the 1980's from the northern Jarrah (*Eucalyptus marginata*) forests of Western Australian and deposited in the London Natural History Museum, were studied. Due to limited time and budget only a few of the hundred samples were inspected. Description of just five new taxa are reported here.

Keywords. Soil biodiversity, Australasia, Perth region, earthworm taxonomy, new species.

INTRODUCTION

The only broadly systematic survey of south-western Australian earthworms was nearly one hundred ten years ago by Michaelsen (1907) as reviewed by Jackson (1931). Thirty years ago, in the early 1980's, native earthworms were collected in parts of the northern Jarrah (*Eucalyptus marginata*) forests of Western Australia (Abbott 1985), but unfortunately taxonomic identification was not budgeted in the study and the samples were simply sent to London for storage. A brief visit to London gave the opportunity to inspect some of these specimens in the Natural History Museum's collection but, due to limited time and resources, only a few of the hundred plus samples were inspected resulting in description of just five new taxa herein.

MATERIALS AND METHODS

Dr Ian Abbot (pers. comm. email 19th June, 2013) informs: "*I looked up my 1985 paper, and find that all the collection sites use the Forests Dept. grid ref system. State forest is divided up into forest blocks, each named e.g. Chandler, and of c. 5 kha in size. I suggest that Chandlers Block 16 probably refers to Chandler block, compartment 16.*"

Chandler Block of the northern Jarrah Forest is located *ca.* 10 km north-east of Jarrahdale township (32.339°S, 116.062°E) itself 45 km south-east of Perth in the Darling Range with online WA Forestry map available giving Chandler co-ordinates approximately Lat. -32.26922 Long. 116.18561 (here: www.fpc.wa.gov.au/content_migration/_assets/documents/native_forests/harvest_plans/2013/Indicative_2013_harvest_plan_map_swan.pdf). Myara block is about 15 km due South of Jarrahdale.

Material was fixed in 4% formalin (Allan Wills pers. comm.) which combined with age of samples means that DNA extraction and analysis is unlikely with current methods.

Taxonomy uses Michaelsen's (1907: 160) excellent regulation table (also presented by Jackson 1931: 84) to determine genera that are updateed to follow the most recent taxonomy from species/genera reviews by Blakemore (2000: tab. 1, 2005, 2008, 2012).

Abbreviations are: DPs – dorsal pores; GMs – Genital Markings; l/rhs – left/right-hand-side viewed from above; NHM – Natural History Museum, London; WA – state of Western Australia.

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HU ISSN 2063-1588 (online), HU ISSN 0237-5419 (print)

TAXONOMIC RESULTS

Family MEGASCOLECIDAE Rosa, 1891 *sensu* Blakemore, 2000

Genus ***Graliophilus*** **Jamieson, 1971**

Graliophilus chandleri **sp. nov.**

(Figures 1a, b)

Material Examined. H, holotype NHM Accession No. 415 one mature of ten specimens (a posterior amputee, here dissected and figured) from "*Chandler block 4 (Burnt 1976)*", "*Species A*"; remainder of batch were five matures (paratypes P1–5), three subadults and an immature (P6–9). Sample 416 with nine specimens (P10–18) and sample 417 with one mature specimen (P19) had same location labels.

Description. Pale unpigmented with yellow clitellum when preserved. Body length (H) 42+ with 81+ segments; paratypes were (P1) 60 mm with 137 segments, and (P19) 58 mm with 138 segments; other mature paratypes were 50–60 mm. Prostomium tanylobous. Setae small, lumbricine in series (sensory papillae on equators of all non-clitellar segments). First dorsal pore 5/6. Nephropores not found. Clitellum 13–18 mostly saddle-shaped. Spermathecal pores in 7/8 & 8/9 in a-lines. Female pores on 14 in a-lines. GMs are paired, mid-ventral discs in 16/17, single pads in 17/18 and 18/19 and unilateral or paired in a-lines in 19/20; in paratypes GMs were as in H except they were paired in 19/20 (P1, P19) or sometimes missing and P1 uniquely had extra paired markings in 20/21. Male pores superficial with penial setae protruding in position of missing *ab* in mid-*ab*-lines.

Septa mostly thin. Gizzard large, muscular in 5. Spermathecae in 8 & 9 with short duct branching at joint of large, leaf-shaped and possibly multiloculate diverticulum (iridescent = inseminated) and larger, saccular ampulla itself on a short stalk. Oesophagus dilated but no clear evidence of calciferous glands in 14–16. Intestinal origin 17. Male organs holandric, seminal vesicles in 9 & 12; testes (iridescent) in 10 & 11. Dorsal blood-vessel single. Hearts in 10–12. Ovaries as delicate sheets in 13 without obvious ovisacs in 14. Prostates tubular in 18 on short, thin duct with long (*ca.* 3 mm) penial setal ensheaved. Nephridia avesiculate, holoic but their exit duct not noted. Gut contains soil (geophagy); no typhlosole found.

Distribution. Jarrahdale, Western Australia.

Etymology. Named after type-locality.

Remarks. Michaelsen (1907) described nine WA *Plutellus* species (here *Graliophilus*) with spermathecal pores paired in 7/8/9, *viz.*:- *P. termitophilus*, *P. wellingtonianus*, *P. strelitzi*, *P. woodwardi*, *P. murrayensis*, *P. mendilai*, *P. blackwoodianus*, *P. schuemanni* and *P. carneus*. Closest match, with similar leaf-shaped spermathecal diverticulum, is with *Graliophilus strelitzi* (Michaelsen, 1907: 168) from Lion Mill that has an annular clitellum, slightly different GMs, calciferous glands in 17 and a small typhlosole. Next similar, especially with regards its spermathecal pores and lack of calciferous glands, is *G. woodwardi* (Michaelsen, 1907: 171) from Collie with GMs paired in 15/16/17 & 18/19/20. Then, somewhat similar to the last two, *G. murrayensis* (Michaelsen, 1907: 175) from Jarrahdale has GMs mid-ventral in 8 & 9 amongst other differences. In contrast, *G. blackwoodianus* (Michaelsen, 1907: 179) from Bridgetown has closely paired spermathecal and male pores and usually unpaired GM pads in 12/13, 16/17 & 19/20; while *G. candidus* (Jackson, 1931) from Roleystone typically has GMs in or near anterior of 8 & 9 as well as markings widely paired in 16/17 & 18/19. Having several features in common, *G. wellingtonianus* (Michaelsen, 1907: 168), however, is differentiated on its twin spermathecal diverticula.

All comparable taxa also share long penial setae. Unique combination of features in this relatively small species are tanylobous prostomium (*cf.* canaliculate prolobous in *G. candidus*, mostly epilobous in others), saddle-shaped clitellum (as in *G. candidus*, mostly annular in others), lack of calciferous glands (as in *G. woodwardi*, in 16 and/or 17 in others) plus the distribution of the GMs and the distinctive spermathecal shape (as figured).

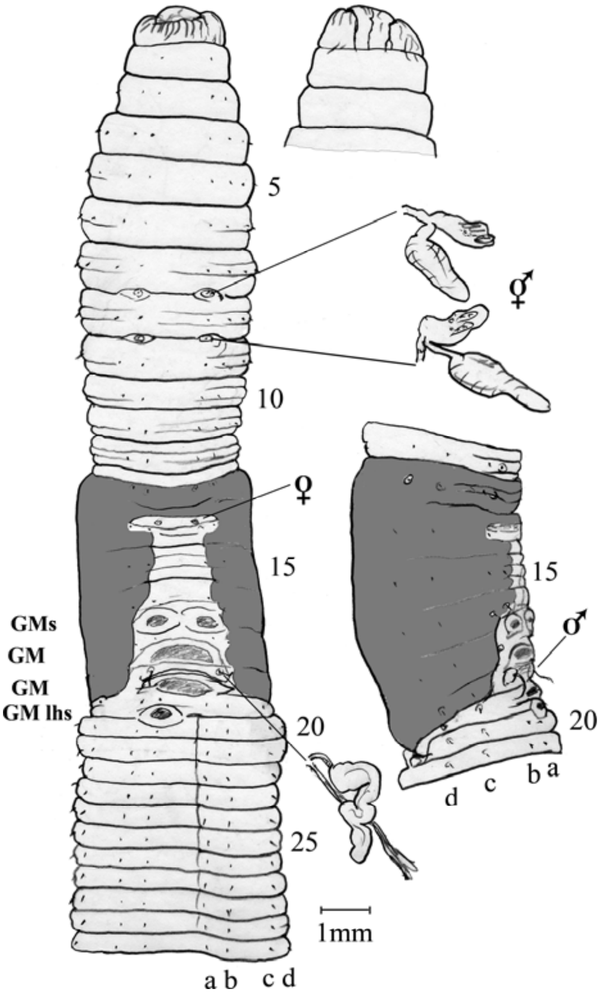

Figure 1a. *Graliophilus chandleri* sp. nov. holotype, H.

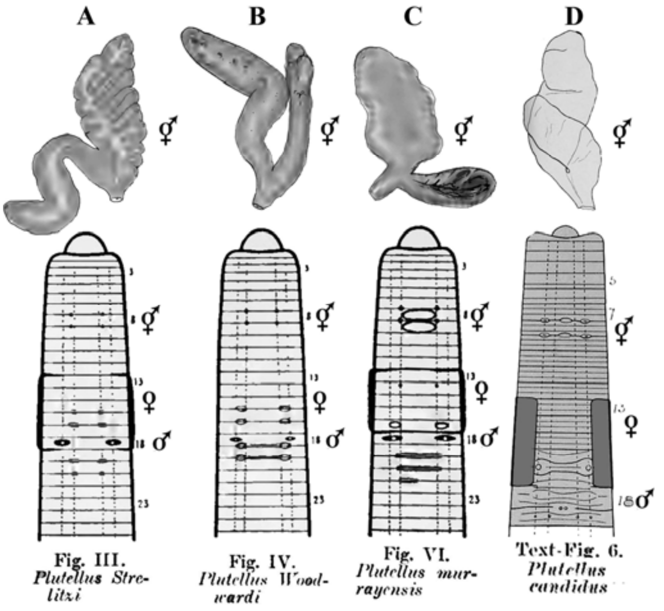

Figure 1b. A = *Graliophilus strelitzi*, B = *G. woodwardi*, C = *G. murrayensis* and D = *G. candidus* compared after Michaelsen's (1907) and Jackson's (1931) original figures (not to scale and sketches of penial setae omitted).

Graliophilus myara sp. nov.

(Figure 2)

Material Examined. H, holotype NHM Accession No. 418–1 one mature (here dissected and figured) from "*Myara block 16*", "*Species B*"; paratype (P1) 419–1 only mature from batch of four specimens (419) that agrees superficially from "*Chandlers block Chandler Rd 8/8/83*", "*Species B*"; other three specimens are an immature posterior-amputee, (P2) 419–2, possibly the same taxon, and two aclitellates that are of a taxon described separately below.

Description. Unpigmented yellowish when preserved. Body length 77 mm with 161 segments. Prostomium tanylobous. Setae lumbricine in series but converge in 25–30 where body narrows. First dorsal pore 4/5. Nephropores not found. Clitellum 14–17, saddle-shaped. Spermathecal pores, each appearing doubled but this not confirmed, in 7/8 & 8/9 in *ab*-lines. Female pores on 14 just anterior to setae *a*. GMs are paired, median to *a*-lines in 8–11, in 16/17 & 19/18 with less distinct mid-vental pads in 17/18, (18/19) & 20/21. Male pores on small papillae slightly median to position of missing *ab*.

Septa mostly thin. Crop large in 4, gizzard muscular in 5. Spermathecae in 7 posteriorly and 9 anteriorly with particularly long and thin duct leading to junction of saccular ampulla and almost equi-sized diverticulum (inseminated). Note that each pair of spermathecae are con-joined and compressed within a shared saccular sheath or septal pocket. Oesophagus narrow in 12–14, calciferous gland annular in 15. Intestinal origin 16. Male organs holandric, seminal vesicles absent from 9, present in 10 anteriorly and in 11 & 12; testes (iridescent) free in 10 & 11. Dorsal blood-vessel single. Commissurals in 8–9, hearts in 10–12. Ovaries as delicate sheets in 13; ovisacs absent. Prostates convoluted tubular in

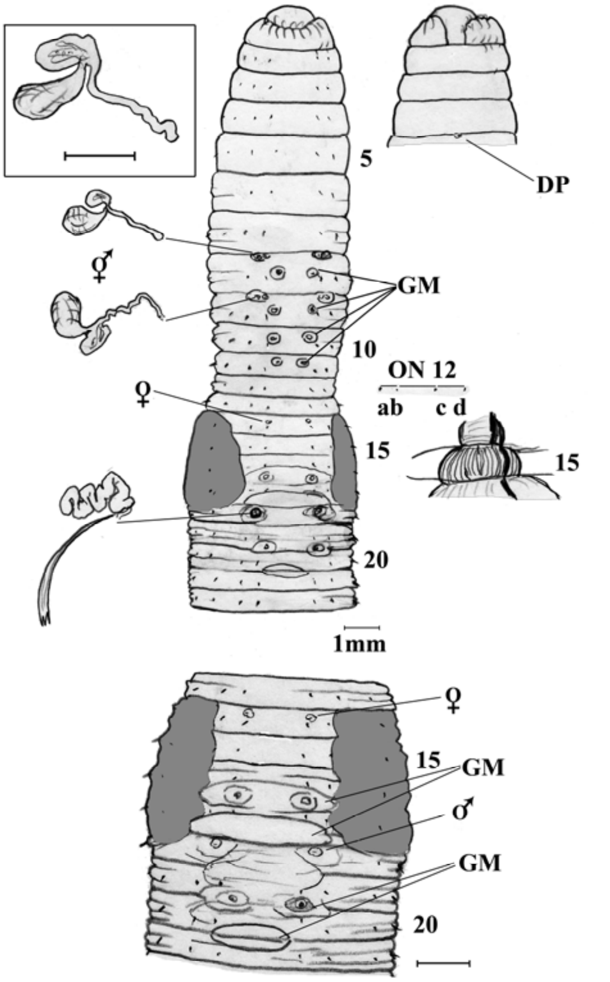

Figure 2. *Graliophilus myara* sp. nov. H with enlargement of male field and 7lhs spermatheca.

18 on short duct with long (ca. 4.5 mm) penial setae. Nephridia avesiculate, holoic. Gut contains fine, yellow soil (geophagy); no typhlosole found.

Distribution. South and east of Jarrahdale, Western Australia.

Etymology. Non-declining noun in apposition derived from type-locality name.

Remarks. This species is close to the previous one differentiated on its distinctive spermathecal pores (possibly doubled or accompanied by gland pore or related to intromission of partner's penial setae), spermathecae with their long duct, the presence of curved penial setae (near concomitant length to the duct plus diverticulum) and on the arrangement of its GMs (paired mid-ventrally in 8–11, 16/17 & 19/20 with pads in intersegments adjacent to male pores and in 19/20). It differs from *G. mendilai* (Michaelsen, 1907: 177) from Eradu and *G. candidus* (Jackson, 1931) that have spermathecal pores in *b*-lines plus GM discs paired in 11/12/13 & 20/21/22 or 16/17 & 18/19, respectively. *G. murrayensis* or *G. carneus* (Michaelsen, 1907: 182) from Albany have spermathecal pores in *a*-lines and GMs unpaired in 8, 9 & 19/21/22 or paired in 10/11 & 16/17/18/19, respectively. The current species has an annular calciferous gland in 15, unlike in *G. mendilai* and *G. candidus* in 16 or *G. strelitzi* where they are paired, sessile in 17.

Genus ***Notoscolex*** Fletcher, 1886

Notoscolex ajax **sp. nov.**

(Figure 3)

Material Examined. H, holotype BMNH Accession No. 419–3 an aclitellate mature (here dissected and figured) from "*Chandlers block Chandler Rd 8/8/83*", "*Species B*"; P, paratype, 419–4, also an aclitellate specimen with same details; other two specimens in the jar are listed under the previous species.

Description. Pale colour. Body length 75 mm. Prostomium tanylobous. Setae lumbricine. First dorsal pore 4/5. Nephropores not found. Clitellum not formed. Spermathecal pores appear in 7/8 & 8/9 in *ab*-lines. Female pores on 14 just anterior to setae *a*. GMs single, mid-ventral in 7 & 8 and elongate pads in *b-b*-lines in 17/18 & 18/19. Male pores on small papillae slightly lateral to *b*-lines but setae *ab* deleted on 18 (penial setae not found).

Spermathecae vestigial in 8 and paired in 9 with short duct leading to multi-lobed spermatheca with diverticulum closest to the duct and iridescent and ampulla largest of other appendages. Oesophagus dilated in 12–16 but not calciferous, narrow in 17–18. Intestinal origin 19. Male organs holandric, seminal vesicles in 9, 11 & 12; testes (iridescent)

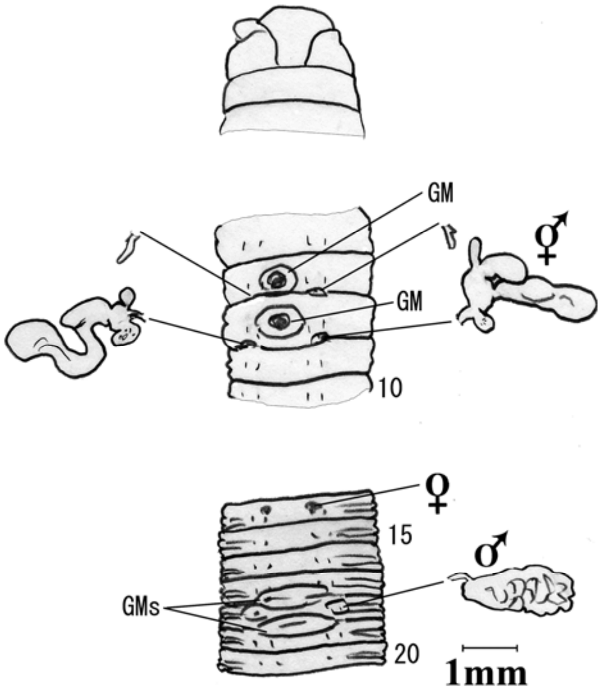

Figure 3. *Notoscolex ajax* sp**.** nov. H, prostomium, spermathecal and male fields.

free in 10 & 11. Last hearts in 12. Ovaries in 13; ovisacs absent. Prostates tubuloracemose in 18 on short ducts; penial setae absent (even though setae deleted). Nephridia avesiculate meroic, but some enlarged in anterior; in posterior three or four 'fatty bodies' per segment indicate location of nephridia. No trace of parasitism noted.

Distribution. Jarrahdale, Western Australia.

Etymology. For nickname of Ada Acraman Jackson (aka Mrs. William Fawcett) of Perth.

Remarks. This is a species 'in transition' losing its anterior pair of spermathecae. Michaelsen (1907) described six species of *Notoscolex* from WA, *viz*.:- *N. maecenatis*, *N. hortensis* (also found at and around Jarrahdale), *N. prestonianus*, *N. modestus*, *N. rubescens* and *N. suctorius*, plus Jackon (1931) described *N. leios* (specimens also aclitellate). All have spermathecal pores in 7/8/9 without vestigial spermathecae in 7/8 and their GMs differ from the current species although *N. leios* lacked markings. The description is brief but the current species is distinct in the shape of its single pair of functional spermathecae. It is perhaps closest nonetheless to *N. modestus* from Yarloop and York or *N. rubescens* from Pickering Brook that also have elongate GM pads, respectively, in 7/8–9/10 plus 17/18–20/21 or in 15/16,16/17–19/20; neither has mid-ventral GM discs in 7 & 8 of the current species.

Notoscolex michaelseni sp. nov.

(Figure 4)

Material Examined. H, holotype BMNH Accession No. 420 mature (here dissected and figured) from "*Chandlers block 4 Burnt 1976*", "*Species C*", "*Plutellus ? sp 7/8/9*"; paratypes P1–2, two matures 421–422, and P 3–4 two immatures 423, with same details. [Note sample jar labelled "*Chandler block 3 burnt 19??*", "*Species D*" contained seven specimens (424) possibly similar but smaller and seem to have dried out during storage].

Description. Pale unpigmented in alcohol. Length H 36 mm with 105 segments; P1 35 mm; P2 38 mm. Prostomium Y-shaped tanylobous (possibly interpreted as cleft epilobous), ventral peristomium also cleft. Setae lumbricine widely spaced laterally. First dorsal pore in 5/6. Nephropores not found. Clitellum saddle-shaped 14–17. Spermathecal pores in 7/8 in *a*-lines and in 8/9 just lateral of *a*-lines. Female pores on 14 just anterior to setae *a*. GMs paired, elliptic pads lateral in *ab*-lines in 10/11/12/13, in *b*-lines in 15/15/1/6/17 and in *ab*-lines in 19/20; P1 the same except not in 12/13 nor 14/15 but present in all of 15/16–20/21 the latter pair conjoined midventrally; P2 has the same arrangement as H. Male pores in small slits in position of deleted setae ab on 18 (penial setae not found).

Septa all thin. Gizzard in 5 but displaced to 6 with septum 5/6 traced to below its midriff. Spermathecae in 8 & 9 with particularly wide duct and small, clavate diverticulum (iridescent) at junction with saccular ampulla. Holandric seminal vesicles in 10, 11 & 12; testis (iridescent) in 10 & 11. Ovaries in 13 with largish eggs visible; no ovisacs found. Dorsal blood vessel single; last hearts in 12. Oesophagus moniliform dilations in 11–14 (not calciferous), valvular in 15 with intestine from 16. Prostates circular racemose with short duct and no

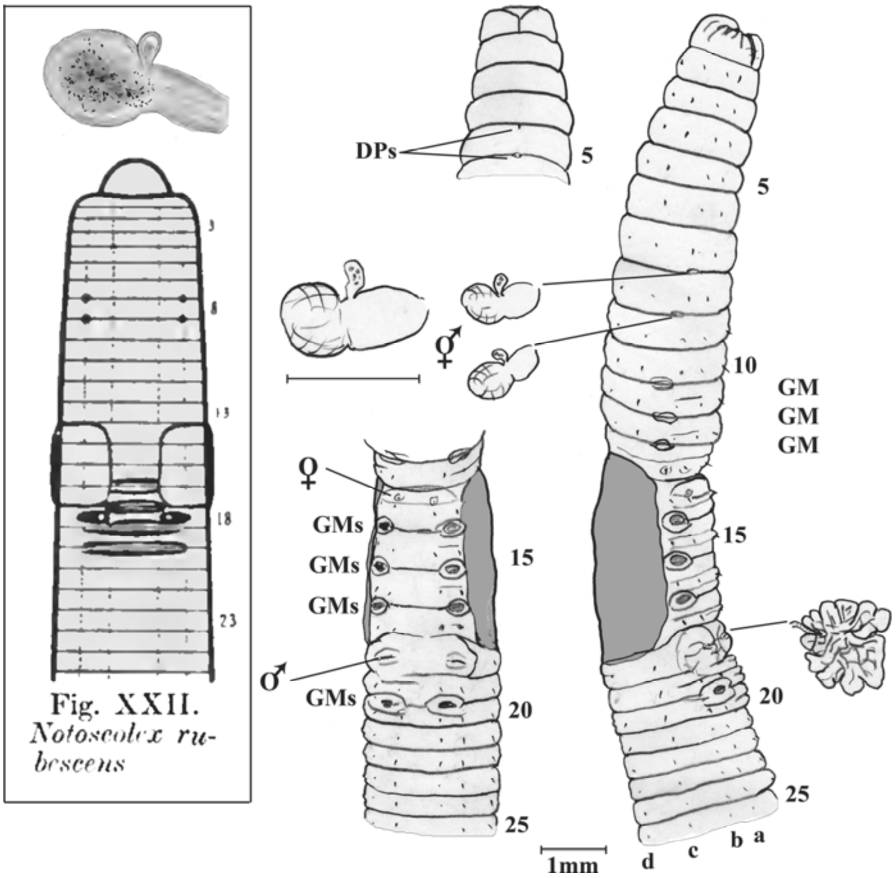

Figure 4. *Notoscolex michaelseni* sp**.** nov. H lateral views with 8lhs spermatheca enlarged and boxed sketch comparison of *N. rubescens* from Michaelsen's (1907) original figures (its GMs stated in 15/16–19/20 but shown in 16/17–19/20).

penial setae in 18. Nephridia avesiculate meroic. No typhlosole found to 30. Gut contains yellow soil with charcoal and coarse organic matter (from soil A-horizon?).

Distribution. Jarrahdale, Western Australia.

Etymology. Named after Professor Wilhelm Michaelsen of Hamburg.

Remarks. This species is perhaps most similar to *Notoscolex rubescens* Michaelsen, 1907 that has similar shaped spermathecae opening in *b*-lines and elongate GM pads only in 15/16–19/20, (described) or 16/17–19/20 (figured) amongst other differences. *N. suctorius* Michaelsen, 1907 from Bridgetown has spermathecal pores paired mid-ventrally with paired markings only in 15/16/17, while *N. prestonianus* Michaelsen, 1907 from Donnybrook has spermathecal and male pores lateral to *b*-lines and widely-paired markings in 15/16/17 & 19/20/21 (described) or 20/21/22 (figured). Spermathecae of both the latter species are also quite different. *Notoscolex leios* Jackson, 1931, its description based on a single immature worm from Murchison, has three pairs of vesicles in 10, 11 & 12 too, but shares few other characteristics with the current species.

Genus ***Woodwardiella*** **Stephenson, 1925**
nom. nov. pro Woodwardia Michaelsen, 1907
(praeocc.)

Woodwardiella michaelseni **sp. nov.**

(Figure 5)

Material Examined. H, holotype BMNH Accession No. 425 mature (dissected and figured) from

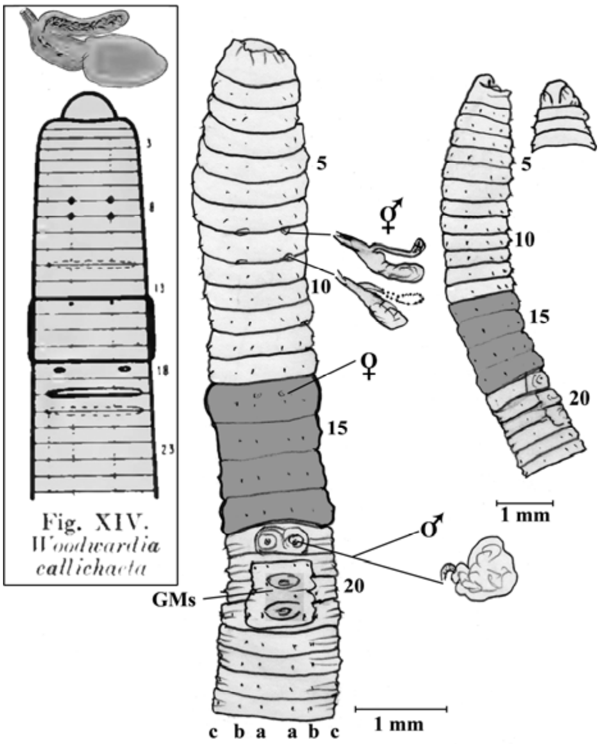

Figure 5. *Woodwardiella michaelseni* sp. nov. H ventral and lateral views (9lhs spermathecal diverticulum accidentally sectioned) and boxed sketch comparison of *W. callichaeta* from Michaelsen's (1907) original figures.

“*Chandlers block 4 Burnt 1937 1*”, “*Species E*”; P1–3, paratypes 426, one mature and two subadults with same details.

Description. Pale colour. Length 28 mm with 105 segments; P1 27 mm. Prostomium essentially tanylobous. Sete lumbricine widely spaced laterally. First dorsal pore 5/6. Nephropores not found. Clitellum annular 14–17. Spermathecal pores in 7/8/9 just lateral of *a*-lines. Female pores on 14 just anterior to setae a. Male pores on small porophores in *a*-lines on 18; setae *ab* deleted but penial setae not found. GMs in H single, mid-ventral papillae in 19/20 & 20/21 in common tumid pads in ½19–½21 as wide as *b*-lines; in P1–3 only in 19/20.

Septa all thin. Gizzard muscular in 5. Spermathecae in 8 & 9 with short duct to branch of elongate diverticulum (terminal bulb iridescent) after which there is slight bulge before saccular ampulla. Holandric seminal vesicles weak in 9 & 12; testis (iridescent) in 10 & 11. Ovaries in 13; no ovisacs found. Last hearts in 12. Oesophagus dilated in 15 & 16, striated but not necessarily calciferous; intestine from 17. Prostates circular racemose with short duct and no penial setae in 18. Nephridia avesiculate holoic. No typhlosole. Gut contains yellow soil with charcoal flakes (from soil A-horizon?).

Distribution. Jarrahdale, Western Australia.

Etymology. Named after Professor Wilhelm Michaelsen of Hamburg.

Remarks. Michaelsen (1907) described four WA *Woodwardia* species (here *Woodwardiella*), *viz.*:- *W. affinis*, *W. callichaeta*, *W. libferti* and *W. molaeleonis*, all similar in having spermathecal and male pores near *a*-lines and GMs anteriorly and in some of 19–20,21. The current species differs from *Woodwardiella affinis* (Michaelsen, 1907) from Jarrahdale (with possibly synonyms *W. libferti* from Subiaco and *W. magna* Jackson, 1931 from Lesmurdie) as it lacks the distinctive GM pad mid-ventrally in 11/12, or *W. molaeleonis* (Michalesen, 1907) from Lion Mill with GM pad in 10/11. *W. callichaeta* (Michaelsen, 1907), the type of the genus, also from Jarrahdale is perhaps closest although it too has markings in 11/12 (sometimes) as well as in 19/20 and (sometimes) 20/21. In Michaelsen's fig. 14 the pores and markings appear much broader but this may relate more to state of preservation and drawing style. Its main morphological differences being an epilobous prostomium, paired oesophageal dilations in 13 and the form of the spermathecae. Michaelsen gave setal ratios as (aa:ab:bc:dd = 5:3:5:4:10) but dorsal pores were found only after the clitellum in *W. callichaeta*, moreover it has distinct penial setae 1.2 mm long that were absent from the present species. None of the previous species have such long spermathecal diverticula approaching the tip of the ampulla.

Acknowledgements – Thanks to friends and colleagues for moral support: especially to Emma Sherlock, curator of free-living worms of the “Aquatic Invertebrates Division” (sic) of the Natural History Museum, Kensington and to Dr Csaba Csuzdi (Eötvös Loránd University, Budapest) for their help in accessing the collection and publication of the results. Dr Ian Abbott, Senior Principal Research Scientist of Dept. of Environment and Conservation, Kensington, WA and Allan Wills a Senior Technical Officer there are thanked for providing some information on collection history and locality for the samples of our concern.

REFERENCES

ABBOTT, I. (1985): Influence of some environmental factors on indigenous earthworms in the northern jarrah forest of Western Australia. *Australian Journal of Soil Research*, 23: 271–290.

BLAKEMORE, R.J. (2000): *Tasmanian Earthworms*. ICZN compliant CD-ROM. VermEcology, Kippax 2615. Canberra, December, 2000, 800 pp.

BLAKEMORE, R.J. (2005): *A Series of Searchable Texts on Earthworm Biodiversity, Ecology and Systematics from Various Regions of the World.* ITO, M.T. KANEKO, N. (Eds) ICZN compliant CD-ROM publication, Yokohama National University, Yokohama. [Especially Chapter 23 "*A definitive checklist of Australian earthworms*" online here: http://bio-eco.eis.ynu.ac.jp/eng/database/earthworm/ June, 2005].

BLAKEMORE, R.J. (2008): *A definitive checklist of Australian earthworms* (Annelida, Oligochaeta: Moniligastridae, Ocnerodrilidae, Acanthodrilidae, Octochaetidae, Benhamiinae, Exxidae?, Megascolecidae, Glossoscolecidae, Lumbricidae, Eudrilidae). ICZN compliant CD-ROM, available online www.annelida.net/earthworm/Australasian%20Earthworms/Aussie%20Earthworms.pdf.

BLAKEMORE, R.J. (2012): On Schmarda's lost worm and some newly found New Zealand species. *Journal of Species Research*, 1(2): 105–132.

JACKSON, A. (1931): The Oligochaeta of south-western Australia. *Journal of the Royal Society of Western Australia*, 17: 71-136.

MICHAELSEN, W. (1907): Oligochaeta. *Die Fauna Südwest-Australiens*, *Gustav Fischer, Jena,* 1(2): 117–232.

Opusc. Zool. Budapest, 2014, 45(2): 165–180

The diversity of Indian Brachionidae (Rotifera: Eurotatoria: Monogononta) and their distribution

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Abstract. We evaluate diversity status of the Brachionidae of India and present an annotated checklist of 46 species excluding dubious and unconfirmed reports. These merit biodiversity value as ~27% of the global diversity of the taxon and ~81% of its Oriental species. We observed two Australasian elements, two Oriental endemics, one Indian endemic, one paleotropical and one cosmo (sub) tropical species. The cold-water *Keratella serrulata* and *Notholca squamula* are new records from eastern Himalayas. Maximum brachionid diversity (32 species) from Assam state of northeast India (NEI) is followed by the reports of 27 and 26 species from Tamil Nadu and West Bengal, respectively; 25 species each from Tripura and Maharashtra; and 24 species from Jammu & Kashmir. *Brachionus,* the most diverse brachionid genus, is widely distributed in India with low richness in hill states of NEI and coastal waters in particular. The Indian brachionid taxonomy is confounded with unconfirmed reports, misidentifications, invalid taxa, and inconsistent treatment of morphological variants, while analysis of cryptic diversity in *Brachionus calyciflorus, B. caudatus, B. forficula, B. plicatilis, B. quadridentatus, B. urceolaris*, *Keratella cochlearis* and *K. quadrata* species-groups awaits attention.

Keywords. Brachionids, biodiversity, dubious report, interesting taxa, misidentification, taxonomic status.

INTRODUCTION

Brachionidae, an important family of monogonont Rotifera and of the rotifer fauna of India (Sharma 1996, 1998a, Sharma & Sharma 2008) has received relatively more attention of the Indian workers relying on limnetic collections. The *rotiferologist effect* (Fontaneto *et al.* 2012) resulted in reasonably good number of regional reports including those primarily on the family (Sharma 1979, 1981, Sharma & Sharma 1990) while Sharma (1983, 1987) dealt with the diversity of *Brachionus* and the Brachionidae of the country, respectively. A resurgence of interest on the family, during more than last two and half decades, added interesting brachionids to the Indian Rotifera but indiscriminate listing of unconfirmed reports of dubious and ambiguous taxa, and misidentifications nevertheless confounded brachionid taxonomy necessitating its critical evaluation.

We assess diversity status of the Indian Brachionidae and provide an annotated checklist of valid species with comments on their richness and composition known till date from different states / union territories (UT) of India, biogeographically important elements, distribution of interesting taxa and on anomalous reports.

MATERIALS AND METHODS

This review is based on analysis of our extensive samples collected, during the last two and half decades, from Northeast India (NEI) and collections from scattered localities from different states of Northern, Eastern, and Southern India; our earlier reports; and evaluation of various published Indian reports. The plankton and littoral periphytic samples were collected from the littoral, semi-limnetic and limnetic regions of diverse aquatic ecosystems by towing a plankton net (# 50 µm) and were preserved in 5% formalin. All of the collections were screened, different brachionids were isolated and mounted in Polyvinyl alcohol-lactophenol mixture, and were observed with Leica (DM 1000) stereoscopic phase

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urn:lsid:zoobank.org:pub:2B73B6A9-96F1-4560-B948-CB300C8B1BB8
HU ISSN 2063-1588 (online), HU ISSN 0237-5419 (print)

contrast microscope fitted with an image analyzer. The different taxa were identified following Koste (1978), Sharma (1983, 1998b), Koste & Shiel (1987), and Sharma & Sharma (1999, 2000, 2008, 2013). The remarks on biogeography were made following Segers (2007). The community similarities between the rotifer assemblages of different states and union territories (UT) of India were calculated *vide* Sørensen's index and SPSS (version 20) was used for the hierarchical cluster analysis.

RESULTS

We present, hereunder, an annotated checklist of 46 valid species of the Brachionidae of India:

Phylum: **Rotifera Cuvier, 1817**
Class: **Eurotatoria De Ridder, 1957**
Subclass: **Monogononta Plate, 1889**
Order: **Ploima Hudson & Gosse, 1886**
Family: **Brachionidae Ehrenberg, 1838**

1. *Anuraeopsis coelata* De Beauchamp, 1932
2. *A. fissa* Gosse, 1851
3. *A. navicula* Rousselet, 1911
4. *Brachionus ahlstromi* Lindeman, 1939
   - Syn. *B. caudatus* var. *personatus* Ahlstrom, 1940
     B. caudatus var. *indica* Novotoná-Dvořáková, 1963
5. *B. angularis* Gosse, 1851
   - *B. angularis bidens* Plate, 1886
6. *B. bennini* Leissling, 1924
7. *B. bidentatus* Anderson, 1889
   - *B. bidentatus* f. *adornus* Wulfert, 1966
   - *B. bidentatus* f. *crassispineus* Hauer, 1963
   - *B. bidentatus* f. *inermis* Rousselet, 1906
   - *B. bidentatus* f. *jirovci* Bartoš, 1946
   - *B. bidentatus* f. *testudinarius* Jakubski, 1912
8. *B. budapestinensis* Daday, 1885
9. *B. calyciflorus* Pallas, 1766
   - *B. calyciflorus* f. *anuraeiformis* Brehm, 1909
   - *B. calyciflorus* f. *amphiceros* Ehrenberg, 1838
   - *B. calyciflorus* f. *dorcas* Gosse, 1851
   - *B. calyciflorus borgerti* Apstein, 1907
   - Syn. *B. calyciflorus* var. *hymani* Dhanapathi, 1974
10. *B. caudatus* Barrois & Daday, 1894
    - *B. caudatus* var. *aculeatus* Hauer, 1937 (including f. *lateralis* Hauer, 1937)
    - *B. caudatus* f. *apsteini* Fadeev, 1925
    - *B. caudatus* f. *majusculus* Ahlstrom, 1940
    - *B. caudatus* f. *vulgatus* Ahlstrom, 1940
11. *B. dichotomus reductus* Koste & Shiel, 1980
12. *B. dimidiatus* Bryce, 1931
13. *B. diversicornis* (Daday, 1883)
14. *B. donneri* Brehm, 1951
15. *B. durgae* Dhanapathi, 1974
16. *B. falcatus* Zacharias, 1898
17. *B. forficula* Wierzejski, 1891
    - Syn. *B. forficula* var. *keralensis* Nayar & Nair, 1969
      B. forficula f. *minor* (Voronkov, 1913)
18. *B. kostei* Shiel, 1983
19. *B. leydigii* Cohn, 1862
20. *B. mirabilis* Daday, 1897
21. *B. plicatilis* O.F. Müller, 1786 *s. lato*
    - *B. plicatilis murrayi* Fadeev, 1925
22. *B. pterodinoides* Rousselet, 1913
23. *B. quadridentatus* Hermann, 1783
    - *B. quadridentatus* f. *melhemi* Barrois & Daday, 1894
    - *B. quadridentatus* f. *brevispinus* Ehrenberg, 1832
    - *B. quadridentatus* f. *cluniorbicularis* Skorikov, 1894
    - *B. quadridentatus* f. *rhenanus* Lauterborn, 1893
24. *B. rotundiformis* Tschugunoff, 1921
25. *B. rubens* Ehrenberg, 1838
26. *B. sessilis* Varga, 1951
27. *B. urceolaris* O. F. Müller, 1773
28. *Kellicottia longispina* (Kellicott, 1879)
29. *Keratella cochlearis* (Gosse, 1851)
30. *K. edmondsoni* Ahlstrom, 1943
31. *K. javana* Hauer, 1937
32. *K. hiemalis* Carlin, 1943
33. *K. lenzi* Hauer, 1953
34. *K. procurva* (Thorpe, 1891)
35. *K. quadrata* (O. F. Müller, 1786)
36. *K. serrulata* (Ehrenberg, 1838)

37. *K. tecta* (Gosse, 1851)
38. *K. ticinensis* (Callerio, 1921)
39. *K. tropica* (Apstein, 1907)
40. *Notholca acuminata* (Ehrenberg, 1832)
41. *N. labis* Gosse, 1887
42. *N. squamula* (O.F. Műller, 1786)*
43. *N. striata* (O. F. Müller, 1786)
44. *Plationus patulus* (O.F. Müller, 1786)
    P. patulus macracanthus (Daday, 1905)
45. *Platyias leloupi* (Gillard, 1967)
    Syn. *P. longispinosus* Arora, 1966
46. *P. quadricornis* (Ehrenberg, 1832)
    P. quadricornis andhraensis Dhanapathi, 1974

* New record from NEI.

Infrasubspecific categories indicated above have no nomenclatural validity as per ICZN; these are invariably cited in the Indian literature and, hence, require cautious use by amateur workers.

Brachionus includes 24 species; 11 species belong to *Keratella*; *Notholca, Anuraeopsis* and *Platyias* are represented by four, three and two species respectively, and *Plationus* and *Kellicottia* include one species each. Our collections particularly from NEI indicate several interesting taxa namely *Brachionus dichotomus reductus* (Fig. 1), *B. donneri* (Fig. 2), *B. durgae* (Fig. 3), *B. kostei* (Fig. 4), *Keratella edmondsoni* (Fig. 5) and *K. javana* (Fig. 6). *Notholca squamula* (Fig. 7) and *Keratella serrulata* (Fig. 8), observed in our recent samples from Arunachal Pradesh, are new records from NEI. *Platyias quadricornis andhraensis* is the sole Indian endemic.

The richness of Brachionidae and *Brachionus* from different parts of India varies between 7–32 (19±6) species and 5–18 (11±4) species, respecttively. The community similarities (vide Sørensen's index) and dendrogram depicting the hierarchical cluster analysis of the Brachionidae occurring in different states / Union territories of this country are indicated in Table 1 and Figure 9, respectively. Their community similarities range between 22.2–96.7%. We observed 32, 27, 26 species from Assam, Tamil Nadu and West Bengal, respectively; Tripura and Mahrashtra recorded 25 species each; Jammu & Kashmir showed 24 species; 23 species each are observed from Delhi and Kerala, and 22 species each are listed from Andhra Pradesh, Meghalaya, Orissa and Punjab. On the other hand, only seven species are known from Andaman and 11 species each are documented from the states of Arunachal Pradesh, Himachal Pradesh, Mizoram and Nagaland.

DISCUSSION

Richness and composition

We recognize a total of 46 valid species (53 taxa, including subspecies) of Brachionidae from India. These are of biodiversity value as ~27% of the global diversity and ~81% of Oriental species (Segers 2008) of the taxon. *Notholca squamula* and *Keratella serrulata,* from Arunachal Pradesh, are new records from NEI. The former is known from Kashmir Himalayas (Shah *et al.* 2014) while the latter is known by its un-validated reports from Kashmir and elsewhere from India (BKS unpublished). This report is the first validation of *K. serrulata* from India and extends the distribution of both species to eastern Himalayas; it is incidentally the first report of genus *Notholca* from NEI. Our inventory provides a notable update (~48.0%) to earlier Indian reports of 31 species of the Brachionidae (Sharma & Michael 1980, Sharma 1987). All seven genera of the family (Segers 2007, 2008) are represented in the rotifer fauna of India.

The richness of the Indian Brachionidae is higher than 41 species known from Thailand (Sa-Ardrit *et al.* 2013); their composition compares well with the latter (~73.0% similarity *vide* Sørensen's index) but differs in the absence of *Notholca* and *Kellicottia* in Thai fauna in particular. The cosmopolitan species form main component (~48.0%) of the brachionids known from India while the pantropical (~24.0%) and the biogeographically important (~15.5%) species form important fractions. Five species (~11.0%) are characterized by restricted distribution and *Brachionus mirabilis* and *Platyias leloupi* are tropicopolitan elements.

Figure 1. *Brachionus dichotomus reductus* Koste & Shiel, after Sharma (2014)

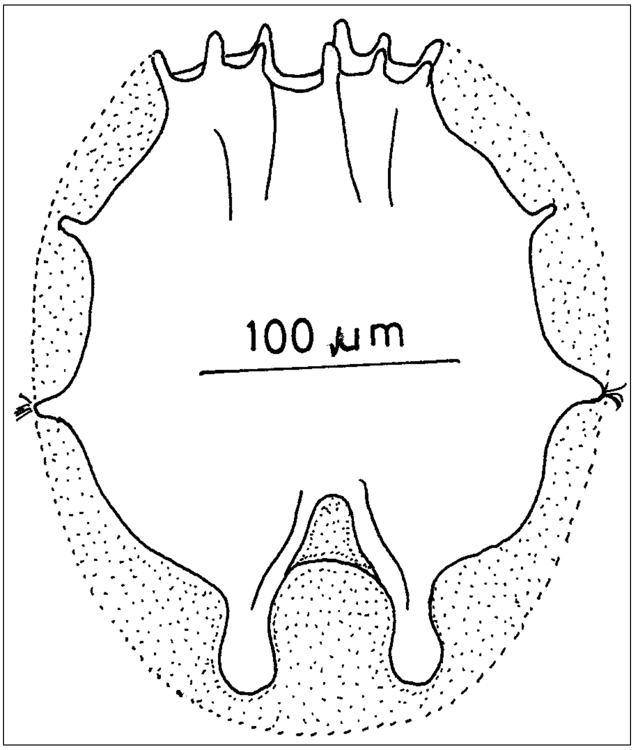

Figure 2. *Brachionus donneri* Brehm, after Sharma & Sharma (2008)

Figure 3. *Brachionus durgae* Dhanapathi (from Mizoram state, NEI)

Figure 4. *Brachionus kostei* Shiel after Sharma (2014)

Figure 5. *Keratella edmondsoni* Ahlstrom , after Sharma (2014)

Figure 6. *Keratella javana* Hauer (from Mizoran state, NEI)

Figure 7. *Notholca squamula* (O.F. Müller) (from Arunachal Pradesh, NEI)

Figure 8. *Keratella serrulata* (Ehrenberg) (from Arunachal Pradesh, NEI)

Our analysis of distinct variations in composition of the Brachionidae of different States / UT of India (7–32, 19±6 species) is supported by wide range of community similarities (22.2–96.7% *vide* Sørensen's index). The lowest similarity between species occurring in Andaman and Meghalaya is hypothesized to contrasting ecological conditions. The geographical proximity, however, explains maximum affinity between Delhi *vs.* Haryana and again between Delhi *vs.* Jammu & Kashmir, and is followed by 93.3% similarity between Haryana *vs.* Jammu & Kashmir. Ten more instances in the matrix register higher values of ~ or < 90.0% similarity. The cluster analysis reiterates distinctness of brachionids of Andaman followed by certain degrees of distinctness in their composition from Assam, Jammu & Kashmir, Nagaland and Manipur as well as Meghalaya, Himachal Pradesh and Sikkim in particular. The affinities in their composition, result in main cluster groupings between Haryana, Jharkhand, Chandigarh, Rajasthan, Karnataka, Uttrakhand; Tamil Nadu, West Bengal, Orissa, Kerala, Tripura; and Madhya Pradesh, Uttar Pradesh, Bihar, Goa, Andhra Pradesh, Maharashtra, Delhi while homology is indicated between species known from Gujarat and Punjab; Assam and Meghalaya; and Nagaland, Himachal Pradesh and Sikkim.

Our collections from Assam record the richest diversity (~71.0% of the Indian Brachionidae) and represent total richness of the taxon known from NEI. This salient feature is hypothesized to environmental heterogeneity of sampled aquatic ecosystems as well as to our intensive sampling. Our reports of 30 species from the floodplains of the Brahmaputra basin (BKS unpublished) and 26 species (Sharma & Sharma 2013) from Deepor Beel (a Ramsar site) in particular support the former hypothesis. In addition, the reports of 27 and 26 species from Tamil Nadu (Sharma & Sharma 2009) and West Bengal (Sharma 1998b) respectively, 25 species each Tripura (Sharma & Sharma 2000) and Maharashtra (BKS unpublished); 24 species from Jammu & Kashmir, and 23 species (BKS unpublished) from Delhi and Kerala exhibit rich diversity in these states of India.

The brachionid paucity from the greater Andaman (George *et al.* 2011) and from certain coastal ecosystems and backwaters of India (Varghese 2006, 2011, Varghese & Krishnan 2008, Manikannan *et al.* 2011, Prabhahar *et al.* 2011, Janakiraman *et al.*, 2012, Mohapatra & Patra 2012, 2013) is attributed to influence of salinity on the rotifers in general (Sladecek 1983, Attayde and Bozelli 1998) and Brachionidae in particular (Athibai *et al.*, 2013). Low richness in Arunachal Pradesh, Mizoram and Nagaland of NEI (Sharma & Sharma 2014a) and Sikkim (BKS, unpublished) is attributed to slightly acidic waters of hilly areas of NEI (Sharma & Sharma 2005, 2014a) and is also hypothesized to lack of permanent limnetic habitats (BKS, unpublished).

The predominantly 'tropic-centered' and most diverse genus *Brachionus* (Segers 2007, 2008) registers rich diversity in India (24 species) representing ~37.0% and ~72.0% of its global and Oriental species, respectively. It shows considerable richness variations in different states / UT (5–18, 11±4 species) with the reports of 18 and 17 species from Assam and Tripura, respectively; 16 species each from Maharashtra, Tamil Nadu and West Bengal, and 15 species each from Andhra Pradesh, Delhi and Kerala. Low *Brachionus* richness in brackish waters of Andaman (George *et al.* 2011) and coastal ecosystems (Varghese & Krishnan 2008, Manikannan *et al.* 2011, Prabhahar *et al.* 2011, Varghese 2011, Janakiraman *et al.* 2012) is attributed to influence of salinity. A paucity of *Brachionus* spp. in several hill states of India namely Arunachal Pradesh, Himachal Pradesh, Manipur, Mizoram, Nagaland, Uttrakhand and Sikkim is hypothesized to lack of permanent limnetic habitats as well as to slightly acidic waters of certain states of NEI.

The 'temperate centered' *Keratella* (11 species) ranks second with ~22.0% its global diversity and ~92.0% of the Oriental richness. Its richness in India is to be considered with caution as we observed more richness only from Assam, and Tamil Nadu. *Notholca, Anuraeopsis* and *Platyias* include four, three, and two species, respectively.

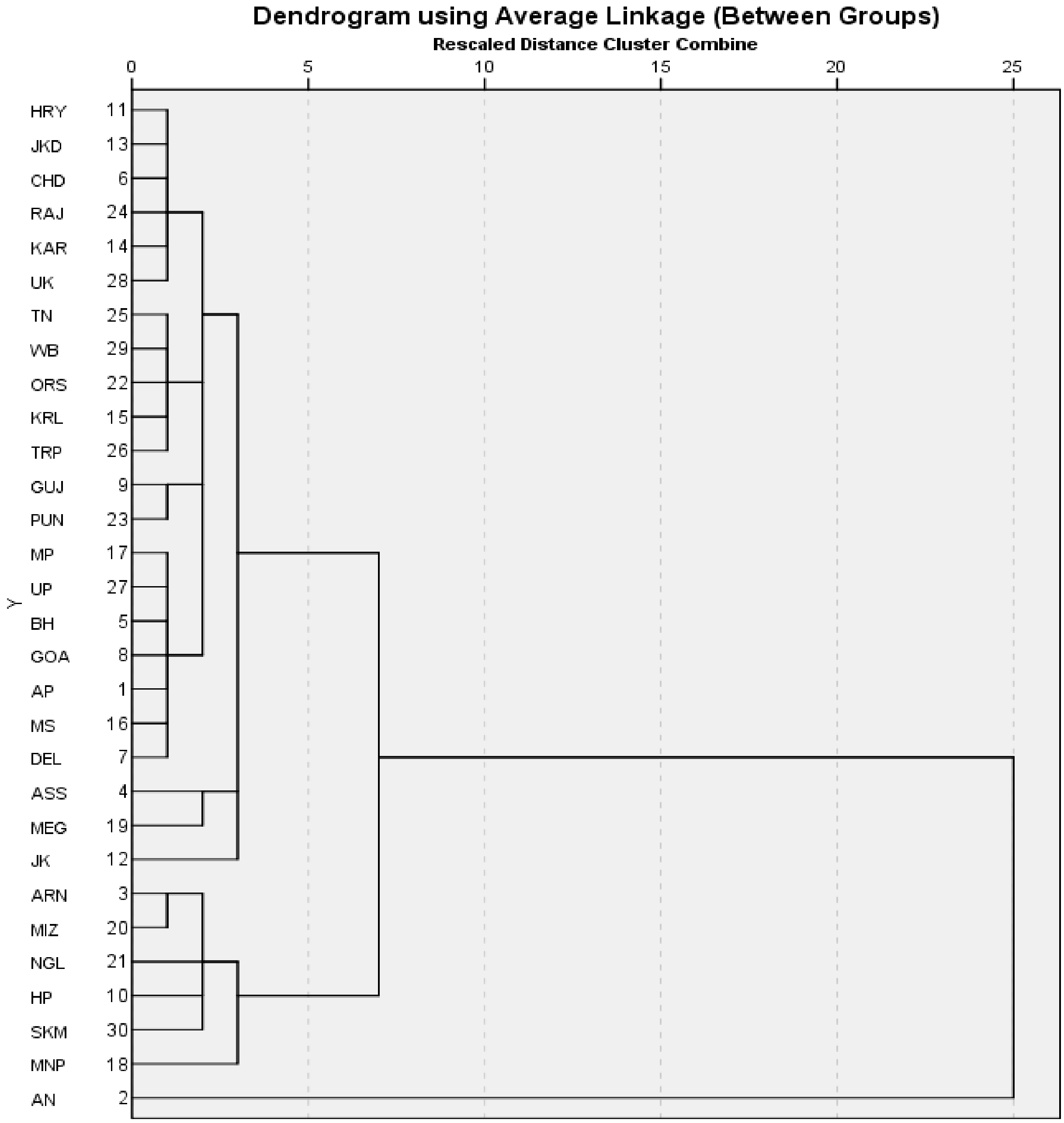

Figure 9: The hierarchical cluster analysis of Brachionidae known from different states/Union territories of India

Abbreviations. 1. AP-Andhra Pradesh; 2. AN-Andamans (UT); 3. ARN-Arunachal Pradesh; 4. ASS-Assam; 5. BH-Bihar; 6. CHD-Chandigarh (UT); 7. DEL-Delhi; 8. GOA-Goa(UT); 9. GUJ-Gujarat; 10. HP-Himachal Pradesh; 11. HRY- Haryana; 12. JK-Jammu & Kashmir; 13. JKD-Jharkhand; 14. KAR-Karnataka; 15. KRL-Kerala; 16. MS-Maharashtra; 17. MP-Madhya Pradesh; 18. MNP-Manipur; 19. MEG-Meghalaya; 20. MIZ-Mizoram; 21. NGL-Nagaland; 22. ORS-Orissa; 23. PUN-Punjb; 24. RAJ-Rajasthan; 25. TN-Tamil Nadu; 26. TRP-Tripura; 27. UP-Uttar Pradesh; 28. UK-Uttarakhand; 29.WB-West Bengal; 30. SKM-Sikkim (not included Chhattisgarh-insufficient information)

Table 1: Percentage similarities (*vide* Sørensen's index) between Brachionidae assemblage in different states / union territories of India

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	-	41.3	54.5	77.7	85.7	78.9	80.8	90.4	82.0	66.7	75.7	78.2	75.7	80.0	80.0	89.4	85.7	64.9	72.7	54.6	54.6	81.8	77.3	80.9	81.6	76.6	90.5	72.2	79.2	62.9
2		-	33.3	25.6	44.4	43.5	40.0	44.4	41.7	44.4	45.5	32.2	36.4	48.0	46.7	37.5	37.0	36.4	27.6	22.2	33.3	35.7	42.9	37.0	35.3	43.8	37.0	38.1	36.4	40.0
3			-	46.5	64.5	66.6	58.8	64.5	64.2	81.8	69.2	57.1	69.2	68.9	58.8	55.5	64.5	76.9	60.6	81.8	81.8	54.5	60.6	64.5	52.6	55.5	64.5	72.0	54.0	66.6
4				-	69.2	66.7	69.1	90.5	65.3	51.1	63.8	64.2	63.8	64.0	76.4	73.7	73.1	63.8	77.8	46.5	52.4	81.5	70.4	73.1	84.8	80.7	73.1	60.9	82.8	57.7
5					-	83.3	83.7	90.0	86.5	70.9	85.7	72.7	80.0	89.5	88.4	84.4	85.0	80.0	76.2	58.1	64.5	85.7	85.7	85.0	85.1	80.0	90.0	82.4	86.9	60.6
6						-	76.9	83.3	78.7	74.0	96.7	75.0	95.7	82.3	76.9	73.1	88.8	70.9	63.1	59.2	59.2	84.2	84.2	88.8	69.7	73.1	88.8	80.0	76.1	62.0
7							-	88.3	80.0	64.7	73.6	68.0	73.6	82.9	73.9	79.1	74.4	68.4	71.1	52.9	52.9	71.1	80.0	83.7	76.0	75.0	83.7	75.6	77.5	55.5
8								-	81.0	70.9	80.0	72.7	80.0	89.4	83.7	88.8	85.0	74.2	76.1	58.0	58.0	85.7	80.9	85.0	85.1	80.0	90.0	82.3	82.6	66.6
9									-	78.5	81.2	68.2	81.2	80.0	80.0	76.1	75.6	75.0	71.7	64.2	71.4	76.9	82.0	75.6	77.2	76.1	81.0	77.4	79.0	73.3
10										-	76.9	62.8	76.9	75.6	64.7	61.1	70.9	76.9	60.6	81.8	81.8	60.6	66.6	70.9	57.8	61.1	70.9	80.0	59.4	83.3
11											-	71.7	93.3	84.8	78.9	75.0	85.7	73.3	70.2	61.5	61.5	81.0	81.0	85.7	71.4	70.0	85.7	82.7	73.1	64.2
12												-	71.7	71.4	63.8	77.5	81.8	56.4	65.2	51.4	51.4	69.5	73.9	77.2	70.5	61.2	77.2	68.4	60.0	54.0
13													-	78.7	73.6	75.0	85.7	73.3	70.2	61.5	61.5	81.0	81.0	85.7	71.4	70.0	85.7	82.7	73.1	64.2
14														-	78.0	83.7	84.2	72.7	60.0	68.9	62.0	75.0	80.0	84.2	71.1	74.4	84.2	87.5	77.2	64.5
15															-	79.1	74.4	73.6	71.1	52.9	50.8	80.0	80.0	74.4	84.0	83.3	79.0	70.2	81.6	61.1
16																-	84.4	65.0	68.0	50.0	50.0	80.0	85.1	80.0	84.6	72.0	84.4	71.7	78.4	57.8
17																	-	68.5	76.1	58.0	58.0	80.9	80.9	90.0	76.5	71.1	90.0	82.3	82.6	66.6
18																		-	75.6	69.2	76.9	75.6	70.2	74.2	71.4	70.0	74.2	75.8	68.2	64.2
19																			-	60.6	66.6	77.2	72.7	71.4	77.5	85.1	76.1	72.2	79.1	57.1
20																				-	81.8	48.4	54.5	58.0	47.3	55.5	58.0	64.0	48.6	66.6
21																					-	60.6	66.6	58.0	57.8	61.1	58.0	47.0	59.4	75.0
22																						-	81.8	85.7	89.7	76.5	85.7	72.2	83.3	62.8
23																							-	80.9	77.5	80.8	80.9	72.2	83.3	62.8
24																								-	80.8	71.1	90.0	82.3	78.2	60.6
25																									-	80.7	80.8	68.2	90.5	60.0
26																										-	80.0	66.6	82.3	57.8
27																											-	82.3	82.6	60.6
28																												-	70.0	66.6
29																													-	61.5
30																														-

Abbreviations: 1.AP-Andhra Pradesh; 2.AN-Andamans (UT); 3.ARN-Arunachal Pradesh; 4.ASS-Assam; 5.BH-Bihar; 6.CHD-Chandigarh (UT); 7.DEL-Delhi; 8.GOA-Goa(UT); 9.GUJ-Gujarat; 10.HP-Himachal Pradesh; 11.HRY-Haryana; 12.JK-Jammu & Kashmir; 13.JKD-Jharkhand; 14.KAR-Karnataka; 15.KRL-Kerala; 16.MS-Maharashtra; 17.MP-Madhya Pradesh; 18.MNP-Manipur; 19.MEG-Meghalaya; 20. MIZ-Mizoram; 21.NGL-Nagaland; 22.ORS-Orissa; 23.PUN-Punjb; 24.RAJ-Rajasthan; 25.TN-Tamil Nadu; 26.TRP-Tripura; 27.UP-Uttar Pradesh; 28-UK-Uttarakhand; 29.WB-West Bengal; 30.SKM-Sikkim

Kellicottia and *Plationus* are known by one species; the latter is invariably identified as *Platyias* or *Brachionus* from this country indicating a casual approach on its nomenclatural change. We are yet to confirm the reports of *Kellicottia longispina* and *Notholca striata* from Kashmir Himalayas in particular notwithstanding their 'dubious records' elsewhere from India. The Indian literature shows notorious reports of *Notholca* species. We seek re-examination of *Plationus patulus macracanthus* as earlier reports indicate specimens with longer posterior species but not confirming to this taxon *sensu stricto*.

Morphological plasticity inherent in certain Brachionidae infrequently resulted in designation of infra-subspecific categories from India as already commented earlier by Sharma (1983). This trend has continued unabated in recent reports, by amateur workers, without recourse even to standard taxonomic works (Segers 2007, Jersabek *et al* 2012, Jersabek & Leitner 2013) thus confounding the Indian literature with records without any nomenclatural validity.

Analysis of cryptic diversity in the Indian populations of *Brachionus calyciflorus, B. caudatus, B. forficula, B. plicatilis, B. quadridentatus, B. urceolaris*, *Keratella cochlearis* and *K. quadrata* species-groups awaits attention concurrent with such global initiatives particularly on the *B. plicatilis* complex (Ciros-Perez *et al.* 2001, Suatoni *et al.* 2006). Anitha & George (2008) analyzed the latter complex and classified its variants into *B. plicatilis*, *B. rotundiformis* and *B. murrayi* describing new infrasubspecific variants with no taxonomic validity *i.e*., *B. plicatilis* f. *ovalis* f. nov. and B. *murrayi* f. *divergispinus* f. nov. Of these, *B. murrayi* itself is a junior synonym of *B. plicatilis murrayi* and *B. rotundiformis* is a distinct taxon. A global rotifer community initiative on "Cryptic speciation in *B. plicatilis*" launched at Rotifera XIII held at Shillong in 2012 is likely to resolve status of this species-complex. We allocated *Brachionus caudatus* var. *personatus* to *B. ahlstromi* following Giri & Jose De Paggi (2006).

Interesting taxa

Brachionidae contains taxa with well-documented ranges (Pejler 1977, Dumont 1983). Likewise, various interesting taxa known from India including the Australasian *Brachionus dichotomus reductus* and *B. kostei*, two Oriental endemics *B. donneri* and *Keratella edmondsoni*, and the sole known Indian endemic: *Platyias quadricornis andhraensis*. The paucity of endemics from this country concurs with low endemicity model of the Oriental Brachionidae (Segers 2008) in particular and also with their paucity in well studied Thai Rotifera (Sa-Ardrit *et al.* 2013).

We support the hypothesis of Segers (2001) on possible Australian origin of *Brachionus dichotomus reductus* by its relation with the Australian *B. dichotomus dichotomus* with recent expansions of populations of the former to the Indian subregion (Sharma 2004, Sharma & Sharma 2005, 2014a). Contrastingly, Sa-Ardrit *et al.* (2013) indicated occurrence of names of both taxa in literature on Thai Rotifera with comments on need for confirmation of the latter.

Brachionus kostei, the second Australasian species, is known elsewhere from Australia, Papua Guinea and Thailand while its unpublished report from northeast China is a possible example of introduction (Sa-Ardrit *et al.* 2013). Jersabek & Leitner (2013) indicated verification of conspecifity of the forms of *B. kostei* known from SE Asia and northeast India with the 'typical form' from Australia.

The Oriental *Keratella edmondsoni*, described from Tamil Nadu (Ahlstrom 1943) as *K. quadrata* var. *edmondsoni,* was raised to the status of a distinct species by Nayar (1965). It is reported elsewhere from Northeast Thailand (Sanoamuang *et al.* 1995, Sa-Ardrit *et al.* 2013). *Brachionus* ***donneri***, another Oriental species described by Brehm (1951), was erroneously listed as pantropical species (Sharma & Sharma 2001, 2005). Its unconfirmed report from Panama Canal *i.e.* beyond the classical distribution limit is a possible example of its introduction (Segers 2007).

The sole Indian endemic *Platyias quadricornis andhraensis*, described by Dhanapathi (1974a) from Hussain Sagar reservoir, Hyderabad, Andhra Pradesh, is known only from its 'type-locality'. The other interesting brachionids include *Keratella javana* and *Brachionus durgae*. The latter was described from Andhra Pradesh (Dhanapathi 1974b) and its distribution now extends to the African, Neotropical, Oriental and Palearctic regions (Segers 2007).

Distribution

The distribution of Brachionidae merits interest for its relative paucity in various hill states of India and in coastal waters. We allocate brachionids known from this country into three categories:

(a) **Species with restricted distribution:** *Keratella javana, Brachionus dichotomus reductus* and *B. kostei* are examples with distribution restricted to NEI. The occurrence of the Australasian *B. dichotomus reductus* and *B. kostei* impart special affinity of Rotifera of NEI with those of the Oriental region and Australia (Sharma & Sharma 2005, 2008, 2012, 2014a, Sharma 2014). We also assign *Keratella hiemalis, K. ticinensis, Kellicottia longispina* and *Notholca striata* to this category because of restricted distribution to Kashmir Himalayas notwithstanding their unconfirmed reports elsewhere from India. The halobiont *Brachionus rotundiformis* is restricted to coastal brackish-waters of South India extending up to Andaman.

(b) **Species with disjunct distribution:** Eighteen species *i.e. Anuraeopsis coelata, A. navicula, Brachionus bennini, B. dimidiatus, B. donneri, B. durgae, B. pterodinoides, B. urceolaris, Keratella edmondsoni, K. lenzi, K. procurva, K quadrata, K. serrulata, K. tecta, Notholca acuminata, N. squamula, N. labis* and *Platyias leloupi* show disjunct populations in India.

(c) **Widely distributed:** Fourteen species namely *Anuraeopsis fissa, Brachionus angularis, B. bidentatus, B. budapestinensis, B. caudatus, B. calyciflorus, B. falcatus, B. forficula, B. plicatilis, B. quadridentata, Keratella cochlearis, K. tropica, Plationus patulus* and *Platyias quadricornis* are widely or nearly widely distributed in India.

Indeterminate species: Segers & Babu (1999, Figs 1–2) examined single specimen of *Keratella* species which appeared close to *K. tropica*. It is differentiated by peculiar antero-median facet. Insufficient material did not allow for a description of this taxon (Segers & Babu 1999).

Anomalous reports: Various recent publications spurted from amateur workers without adequate taxonomic expertise, in several online journals / even regular journals without expert peer-review, are an alarming impediment to Rotifera biodiversity in India (Sharma & Sharma 2014b, 2014c). This generalization holds true to anomalous Brachionidae reports categorized as follows:

Misidentifications

1. *Brachionus havanaensis* Rousselet, 1911: It is known from Nearctic and Neotropical regions with possible introduction to Oriental and Palearctic regions (Segers 2008). Its notorious Indian reports from Tamil Nadu (Francis *et al.* 2003), Maharashtra (Ekhande *et al.* 2013), Rajasthan (Paulose & Maheshwari 2008) and Uttar Pradesh (Khan *et al.* 1986, Haque *et al.* 1988, Ali *et al.* 1990) are considered as examples of misidentifications of its vicariant – *B. diversicornis*.
2. *Keratella valga* (Ehrenberg, 1834): We agree with Sa-Ardrit *et al.* (2013) considering that the distinction between the cold-water, acidophilic *K. valga* and the warm-water, euryoecious *K. tropica* has long remained problematic. *K. valga* is indiscriminately listed, without any validation from India, from Bihar (Pandey *et al.* 2013), Jammu & Kashmir (Sharma J.P. & Srivastava 1986, Ahangar *et al.* 2012), Gujarat (Nirmal Kumar *et al.* 2011), Madhya Pradesh (Adohlia 1979), Maharashtra

(Tayade & Dabhade 2011), Punjab (Bath & Kaur 1998, Kaur *et al.* 1999), Rajasthan (Saxena 2001, Sharma V. *et al*. 2008, Sharma R. *et al.* 2011), Tamil Nadu (Raghunathan & Suresh Kumar 2006, Sonia & Ramanibai 2012). We consider all of the stated records as misidentifications apparently of *K. tropica* unless authenticated otherwise.

3. *Brachionus urceus* Linneaus, 1758: Ahlstrom (1940) indicated the early descriptions of the taxon as being inadequate. Jersabek & Leitner (2013) considered *B. urceus* as a 'doubtful species' and "recommended the name *urceolaris*, associated for many years with the species under consideration." The sole un-validated report of this brachionid from Madhya Pradesh (Bhat *et al.* 2012) lacking 'author citation' refers to misidentified *B. urceolaris*.
4. *Keratella canadensis* Berzinš, 1954: Un-validated reports of this Nearctic species from Uttar Pradesh (Khan *et al.* 1986, Ali *et al.* 1990) and without 'author citation' are misidentifications.
5. *Keratella earlinae* Ahlstrom, 1943: An un-validated report from Tripura (Banik & Chakraborty 1998) represents misidentification.
6. *Notholca caudata* Carlin, 1943: The sole un-validated report from Wular Lake, Kashmir (Mir *et al.* 2008) perhaps refers to misidentified *N. acuminata* (BKS unpublished).
7. *Kellicottia* sp.: The report from Andaman (George *et al.* 2011, Fig. 2H) does not show this taxon.

Reports warranting confirmations

Un-validated reports of the following taxa warrant confirmations to ascertain their validity:

1. *Keratella serrulata* (Ehrenberg, 1838): Jammu & Kashmir (Balkhi *et al.*1987, Ticku & Zutshi 1993, Mir *et al.* (2008), Punjab (Bath & Kaur, 1998) and Uttar Pradesh (Tare 2012).
2. *Kellicottia* sp.: Punjab (Bath & Kaur 1998).
3. *Notholca laurentiae* Stemberger, 1976: Kashmir (Raina & Vass 1993).
4. *Plationus polyacanthus* (Ehrenberg, 1834): Kashmir (Balkhi *et al.* 1987, Pandit & Yousuf 2003; Shah *et al.* 2014) and Punjab (Bath & Kaur 1998).

Dubious reports

Sharma and Sharma (2014b) commented on dubious reports lacking validation without voucher specimens – a recurrent problem with rotifer records from India. We categorize the following brachionid taxa, reported in *ad hoc* ecological studies, as 'dubious':

a. The most notorious report (Adholia 1979) is of five *Notholca* spp. from Madhya Pradesh: *Notholca acuminata, N. squamula, N. striata, N. carinata* and *N. foliaacea* (misspelled!).
b. *Keratella ticinensis* (Callerio, 1921): Madhya Pradesh (Chourasia & Adoni 1986), Maharashtra (Tayade & Dabhade 2011) and Tamil Nadu (Raghunathan & Suresh Kumar 2006). Misspelled as '*K. ticinessis* (Carlin)' from Tamil Nadu.
c. *Keratella hiemalis* Carlin, 1943: Maharashtra (Tayade & Dabhade 2011) and Rajasthan (Sharma V. *et al*. 2008).
d. *Kellicottia longispina* (Kellicott, 1879): Madhya Pradesh (Adholia 1979).
e. *Notholca acuminata* (Ehrenberg, 1832): Bihar (Ahmed & Singh, 1988, Kumar *et al*. 2011), Madhya Pradesh (Chourasia & Adoni 1986), Orissa (Mohapatra & Patra 2012), Punjab (Bath & Kaur 1998, Kaur *et al.* 1999) and West Bengal (Moharana *et al.* 2012).
f. *Notholca labis* Gosse, 1887: Tamil Nadu (Dheenadayalamoorthy & Sultana 2011) and West Bengal (Chattopadhyay & Barik 2009).
g. *Notholca priodonta*: Uttar Pradesh (Haque *et al.* 1988).
h. *Notholca* sp.: Bihar (Ahmed & Singh 1988, Kumar et al (2011).
i. *Notholca accuminata* Gosse (Misspelled!): Puri coast, Orissa (Mohapatra & Patra (2012).
j. *Notholca accuminata* Gosse (Misspelled!): Digha coast, West Bengal (Moharana *et al.* 2012, Moharana & Patra 2013).

Invalid reports

The followings are categorized as 'invalid reports' from India:

Anuraeopsis sp.: (Lauterborn 1990). Haryana (Chopra *et al.* 2014).
Brachionus longiceps: Rajasthan (Sharma V. *et al.* 2008).
Brachionus terminalis: Bihar (Kumar *et al.* 2011).
Brachionus tropica Apstein: Orissa (Patra *et al.* 2011).
Brachionus sp. (Pallas, 1776): Haryana (Chopra *et al.* 2014).
Brachionus patulus (Attwood, 1881): Haryana (Chopra et al 2014).
Platyias trgonellus: West Bengal (Datta 2011).

To sum up, Indian Brachionidae is speciose by its relation to the Oriental diversity of the taxon. In spite of its low endemicity model in India, it reveals certain globally interesting elements and species of regional biogeography interest. The *rotiferologist effect* resulted in its documentation from certain parts of India but casual approach by several amateur workers invariably culminated in *ad hoc* inventories riddled with misidentifications, unconfirmed dubious and invalid reports. The diversity of Brachionidae of India is likely to increase following studies from biodiversity hotspots namely the Himalayan region and Western Ghats in particular; analysis of cryptic diversity in certain species groups; and validation / confirmation of questionable reports.

Acknowledgements – The senior author is grateful to the Ministry of Environment & Forests (Govt. of India) for sanction of a research project No. 22018-09/2010-CS (Tax) under its AICOPTAX program under which the samples were collected from NEI during 2010-2013. Thanks are due to the Head, Department of Zoology, NEHU, Shillong, for laboratory facilities. We thank collectively all those who helped us in our field collections. We thank our three anonymous reviewers for their useful comments. The authors have no conflict of interests.

REFERENCES

ADHOLIA, D. H. (1979): Zooplankton of the river Betwa (India). *Geo–Eco–Tropics,* 3: 267–271.

AHANGAR, I.A., SAKSENA, D.N. & MIR, F.M. (2012): Seasonal variation in zooplankton community of Anchar lake, Kashmir. *Universal Journal of Environmental Research & Technology,* 2(4): 305–310.

AHLSTROM, E.H. (1940): A revision of the Rotatorian genera *Brachionus* and *Platyias* with descriptions of one new species and two new varieties. *Bulletin of the American Museum of Natural History,* 77: 148–184.

AHLSTROM, E.H. (1943): A revision of the Rotatorian genus *Keratella* with description of three new species and five new varieties. *Bulletin of the American Museum of Natural History,* 80: 411–457.

AHMED, S.H. & SINGH, A.K. (1988): Zooplankters in lentic and lotic water bodies in and around Patna (Bihar) and their similarity index. *Indian Journal of Animal Sciences,* 58(3): 406–409.

ALI, M., KHAN, A.A. & HAQUE, N. (1990): Population dynamics of rotifer fauna from two tropical ponds of Aligarh, India. *Proceedings of the National Academy of Science, India,* 60(B):13–19.

ANITHA, P.S. & GEORGE, R.M. (2008): The taxonomy of *Brachionus plicatilis* species complex (Rotifera: Monogononta) from the Southern Kerala (India) with a note on their reproductive preferences. *Journal of Marine Biological Association of India,* 48 (1): 6–13.

ATHIBAI, S., SEGERS, H. & SANOAMUANG, L. (2013): Diversity and distribution of Brachionidae (Rotifera) in Thailand, with a key to the species. *Journal of Limnology,* 72(2): 345–360.

ATTAYDE, J.L. & BOZELLI, R.L. (1998): Assessing the indicator properties of zooplankton assemblages to disturbance gradients by canonical correspondence analysis. *Canadian Journal of Fisheries & Aquatic Sciences,* 55: 1789–1797.

BALKHI, M.H., YOUSUF, A.R. & QADRI, M.Y. (1987): Hydrobiology of Anchar Lake. *Journal of Comparative Physiology & Ecology,* 12: 131–139

BANIK, S. & CHAKRABORTI, M. (1998): Limnological studies of a freshwater river (Gomti) in Tripura with reference to periphyton. *ENVIS Bulletin of Himalayan Ecology,* 6(2):1–2.

BATH, K.S. & KAUR, H. (1998): Seasonal distribution and population dynamics of rotifers in Harike reservoir (Punjab-India). *Journal of Environment & Pollution,* 5(4): 249–252.

BHAT, N.A., WANGANEO, A. & WANGANEO, R. (2012): Composition and dynamics of Rotifera fauna from Upper Basin (Bhoj wetland) as parameter of water quality. *International Journal of Applied Biology & Pharmaceutical Technology,* 3(3):1109–113.

BREHM, V. (1951): Einer neuer *Brachionus* aus Indien (*Brachionus donneri*). *Zoologischer Anzeiger,* 146: 54–55.

CHATTOPADHYAY, C. & BARIK, A. (2009): The composition and diversity of net zooplankton species in a tropical freshwater lake. *International Journal of Lakes & River,* 2(1): 21–30.

CHOPRA, G., TYOR, K. & KUMARI, S. (2014): Diversity of rotifers in shallow lake of Sultanpur national park, Gurgaon (Haryana). *Proceedings of the Zoological Society,* DOI 10.1007/s12595–013–0094–z.

CHOURASIA, S. K. & ADONI, A. D. (1986): *Seasonal variation of rotifers in an eutrophic lake*. In. K. S. UNNI (Ed) Proceedings of the all Indian Seminar on water quality around urban Environments, p. 107–116.

CIROS-PÉREZ, J., GÓMEZ, A. & SERRA, M. (2001): On the taxonomy of three sympatric sibling species of *Brachionus plicatilis* (Rotifera) complex from Spain, with the description of *Brachionus ibericus* n. sp. *Journal of Plankton Research,* 23 (12):1311–1323.

DATTA, T. (2011): Zooplankton diversity and physico–chemical conditions of two wetlands of Jalpaiguri district, India. *International Journal of Applied Biology & Pharmaceutical Technology,* 2(3): 575–583.

DHANAPATHI, M.V.S.S.S. (1974a): A new brachionid rotifer *Platyias quadricornis andhraensis* subsp. nov. from India. *Current Science,* 43:358.

DHANAPATHI, M.V.S.S.S. (1974b): Rotifers from Andhra Pradesh, India I. *Hydrobiologia,* 45: 357–372.

DHEENDAYAMOORTHY. G. &, SULTANA, M. (2011): Identification of zooplankton species collected from different ponds of Arakkonam town, Vellore district, Tamil Nadu. *Journal of Biosciences Research,* 2(2): 72–75.

DUMONT, H.J. (1983): Biogeography of rotifers. *Hydrobiologia,* 104: 19–30.

EKHANDE, A.P., PATIL, J.V., PAUL, R.D. & PADATE, G.S. (2013): Water quality monitoring–study of seasonal variation of rotifers and their correlation with physicochemical parameters of Yashwant Lake, Toranmal (M.S.) India. *Archives of Applied Scientific Research,* 5 (1): 177–181.

FONTANETO, D., MÁRCIA BARBOSA, A., SEGERS, H. & PAUTASSO, M. (2012): The 'rotiferologist' effect and the other global correlates of species richness in rotifers. *Ecography,* 35: 174–182.

FRANCIS, T., RAMANATHAN, N., ATHITHAN, P., ROSALIND, D. I. & PADMAVATHY, P. (2003): Rotifer diversity of fish ponds manured with live–stock waste. *Indian Journal of Fisheries,* 50(2): 203–208.

GEORGE, G., SREERAJ, C. R. & DAM ROY, S. (2011): Brachionid rotifer diversity in Andaman waters. *Indian Journal of Geo–Marine Sciences,* 40(3): 454–459.

GIRI, F. & JOSÉ DE PAGGI, S. (2006): Geometric morphometric and biometric analysis for the systematic elucidation of *Brachionus caudatus* Barrois and Daday, 1894 (Rotifera Monogononta Brachionidae) forms. *Zoologischer Anzeiger,* 244: 171–180.

HAQUE, N., KHAN, A.A., FATIMA, H. & BARBHUYAN, S.I. (1988): Impact of some ecological parameters on rotifer population in a tropical perennial pond. *Environmental & Ecology,* 6(4): 998–1001.

JANAKIRAMAN, A., NAVEED, M.S. & ALTAFF, K. (2012): Impact of domestic sewage pollution on rotifer abundance in Adyar estuary. *International Journal of Environmental Sciences,* 3(1): 689–696.

JERSABEK, C.D., DE SMET, W.H., FISCHER, C., FONTANETO, D., MICHALOUDI, E., WALLACE, R.L. & SEGERS, H. (2012): *List of available names in zoology, part phylum Rotifera, species–group names established before 1 January 2000*. Available from: http://www.ansp.org/~/media/Files/ans/research/sys–rotifera/LAN_CandidatePart–Rotifera–2012–03–22.ashx

JERSABEK, C.D & LEITNER, M.F. (2013): *The Rotifer World Catalog*. World Wide Web electronic publication. http://www.rotifera.hausdernatur.at/ accessed {03.12.2013}.

KAUR, H., BATH, K.S., MANDER, G. & DHILLON, S.S. (1999): Aquatic invertebrate diversity of Kanjli Lake, Punjab. *Indian Journal of Environment & Ecoplanning,* 2(1):37–41.

KHAN, A.A., ALI, M., HAQUE, H. (1986): *Population ecology of zooplankton in polluted ponds at Aligarh.* In. Environmental Biology – Coastal Ecosystems, The Academy of Environmental Biology, India, p. 75–82.

KOSTE, W. (1978): Rotatoria. Die Rädertiere Mitteleuropas, begründet von Max Voigt. Überordnung Monogononta. Gebrüder Borntraeger, Berlin, Stuttgart. I. Text (673 pp.) U. II. Tafelbd. (T. 234).

KOSTE, W. & SHIEL, R.J. (1987): Rotifera from Australian inland waters. II. Epiphanidae and Brachionidae (Rotifera: Monogononta). *Invertebrate Taxonomy,* **7**: 949–1021.

KUMAR, P., WANGANEO, A., WANGANEO, R. & SONAULLAH, F. (2011): Seasonal variations in zooplankton diversity of railway pond, Sasaram, Bihar. *International Journal of Environmental Sciences,* 2(2): 1007–1016.

MANIKANNAN, R., ASOKAN, S. & SAMSOOR ALI, A.H.M. (2011): Studies on species composition of plankton in the great Vedaranyam swamp of the Pont Calimore Wildlife sanctuary, Tamil Nadu, India. *World Journal of Fish & Marine Sciences,* 3(4): 283–389.

MIR, A.R., WANGANEO, A., YOUSUF, A.R. & WANGANEO, W. (2008): Zooplankton community in a through flow system of Kashmir Himalayan wetland. *Nature Environment & Pollution Technology,* 7(4): 627–634.

MOHAPATRA, S. & PATRA, A. K. (2012): Studies on zooplankton diversity of Bay of Bengal at Puri sea–shore in Orissa. *International Journal of Advanced Scientific & Technical Research,* 2(5): 532–540.

MOHAPATRA, S. & PATRA, A.K. (2013): Spatial distribution and seasonal abundance of plankton population of Bay of Bengal at Gigha sea–shore in West Bengal. *Indian Journal of Science Research,* 4(2): 93–97.

MOHARANA, P., PATRA, A.K. & PRADHAN, S.C. (2012): Spatial distribution and seasonal abundance of plankton population of Bay of Bengal at Digha sea–shore in West Bengal. *International Journal of Sustainable Development & Green Revolution,* 1(1): 47–52.

NAYAR, C.K.G. (1965): Taxonomic notes on Indian species of *Keratella* (Rotifera). *Hydrobiologia,* 26: 457–462.

NIRMAL KUMAR, J.L., VERMA, Y. & KUMAR, R.N. (2011): Spatial analysis of composition and species interactions with temporal variation of zooplankton community of shallow tropical lake: Thoi Bird Sanctuary, India. *Universal Journal of Environmental Research & Technology,* 1(2):151–159.

PANDEY, B.N., SIDDHARTHA, R., TANTI, K.D. & THAKUR, A.K. (2013): Seasonal variation of zooplanktonic community in swamp of Purnia (Bihar), India. *Aquatic Biology Research,* 1(1): 1–9.

PANDIT, A.K. & YOUSUF, A.R. (2003): Rotifer community in some Kashmir Himalayan lakes of varied trophic status. *Journal of Research and Development,* 2: 1–12

PATRA, A., SANTRA, K.B. & MANNA, C.K. (2011): Ecology and diversity of zooplankton in relation to physico–chemical characteristics of water of Santragachi Jheel, West Bengal, India. *Journal of Wetlands Ecology,* 5:20–39.

PAULOSE, P.V. & MAHESHWARI, K. (2008): *Seasonal variation in zooplankton community structure of Ramgarh Lake, Jaipur, Rajasthan.* In. SENGUPTA, M. & DALWANI, R. (Eds) Proceedings of Taal 2007. The 12th World Lake Conference, Jaipur, India, p. 82–87.

PEJLER, B. (1977): On the global distribution of the family Brachionidae (Rotatoria). *Archiv für Hydrobiology, supplement,* 53: 255–306.

PRABHAHAR, C., SALESHRANI, K. & THERMARAJ, K. (2011): Hydrobiological investigations on the plankton diversity of Vellar eiver, Vellar estuary and Portonovo coastal waters, South East coast of India. *International Journal of Pharmaceutical & Biological Archives,* 2(6): 1699–1704.

RAGHUNATHAN, M.B. & SURESH KUMAR, R. (2006): Diversity of rotifers of Tamil Nadu. *Records of the Zoological Survey of India,* 106: 67–78.

RAINA, H.S. & VASS, K.K. (1993): Distribution and species composition of zooplankton in Himalayan ecosystems. *Internationale Revue der gesamten Hydrobiologie,* 78(2): 295–307.

SA-ARDRIT, P., PHOLPUNTHIN, P. & SEGERS, H. (2013): A checklist of the freshwater rotifer fauna of Thailand (Rotifera, Monogononta, Bdelloidea). *Journal of Limnology,* 72(2): 361–375.

SANOAMUANG, L., SEGERS, H. & DUMONT, H.J. (1995): Additions to the rotifer fauna of south-east Asia: new and rare species from north-east Thailand. *Hydrobiologia,* 313/314: 35–45.

SAXENA, M.M. (2001): Rotifer fauna of the Indian desert. *Bionotes,* 3 (4): 80–81.

SEGERS, H. (2001): Zoogeography of the Southeast Asian Rotifera. *Hydrobiologia,* 446/447: 233–246.

SEGERS, H. (2007): Annotated checklist of the rotifers (Phylum Rotifera), with notes on nomenclature, taxonomy and distribution. *Zootaxa,* 1564: 1–104.

SEGERS, H. (2008): Global diversity of rotifers (Rotifera) in freshwater. *Hydrobiologia,* 595: 49–59.

SEGERS, H. & BABU, S. (1999): Rotifera from a high–altitude Lake in Southern India, with a note on the taxonomy of *Polyarthra* Ehrenberg, 1834. *Hydrobiologia,* 405:89–93

SHAH, J.A., PANDIT, A. K. & SHAH, G.M. (2014): A research on rotifers of aquatic ecosystems of Kashmir Himalayas for documentation and authenticcation. *Proceedings of the National Academy of Sciences, Section B, Biological Sciences*, DOI 10.1007/s40011–014–0334–7.

SHARMA, B.K. (1979): Rotifers from West Bengal. III. Further studies on the Eurotatoria. *Hydrobiologia,* 64(3): 239–250.

SHARMA, B.K. (1981): Contributions to the rotifer fauna of Panjab State, India. I. Family Brachionidae. *Hydrobiologia,* 76: 249–253.

SHARMA, B.K.(1983): The Indian species of the genus *Brachionus* (Eurotatoria: Monogononta: Brachionidae). *Hydrobiologia,* 104: 31– 39

SHARMA, B.K. (1987): Indian Brachionidae (Eurotatoria: Monogononta) and their distribution. *Hydrobiologia,* 144: 269–275.

SHARMA, B.K. (1996): Biodiversity of Freshwater Rotifera in India - a status report. *Proceedings of the Zoological Society, Calcutta,* 49:73–85.

SHARMA, B.K. (1998a): *Faunal diversity in India: Rotifera*. In. ALFRED, J.R.B., DAS, A.K. & SANYAL, A.K. (Eds) Faunal diversity of India. ENVIS Centre, Zoological Survey of India, Calcutta, p. 57–70.

SHARMA, B.K. (1998b): Freshwater rotifers (Rotifera: Eurotatoria). *State Fauna Series: Fauna of West Bengal, Zoological Survey of India, Calcutta*. 3(11): 341–461.

SHARMA, B.K. (2004): Rare and interesting monogonont rotifers (Rotifera, Eurotatoria) from North–Eastern India. *Mitteilungen aus dem Museum für Naturkunde Berlin, Zoologische Reihe,* 80(1): 33–40.

SHARMA, B.K. (2014): Rotifers (Rotifera: Eurotatoria) from wetlands of Majuli – the largest river island, the Brahmaputra river basin of upper Assam, northeast India. *Check List,* 10(2): 292–298

SHARMA, B.K. & MICHAEL, R.G. (1980): Synopsis of taxonomic studies on Indian Rotatoria. *Hydrobiologia,* 73: 229–236.

SHARMA, B.K. & SHARMA, S. (1990): *On the distribution of brachionid rotifers (Eurotatoria: Brachionidae) in North-Eastern India.* In. MISHRA, R.R., CHATTERJEE, K. (Eds) Current Trends in Environmental Biology, Wiley Eastern Limited, p. 189–196.

SHARMA, B.K. & SHARMA, S. (1999): Freshwater rotifers (Rotifera: Eurotatoria). *State Fauna Series: Fauna of Meghalaya, Zoological Survey of India, Calcutta,* 4(9):11–161.

SHARMA, B.K. & SHARMA, S. (2000): Freshwater rotifers (Rotifera: Eurotatoria). *State Fauna Series: Fauna of Tripura, Zoological Survey of India, Calcutta*, 7(4): 163–224.

SHARMA, B K. & SHARMA, S. (2001): Biodiversity of Rotifera in some tropical floodplain lakes of the Brahmaputra river basin, Assam (N.E. India). *Hydrobiologia,* 446–447: 305–313.

SHARMA, B.K. & SHARMA, S. (2005): Biodiversity of freshwater rotifers (Rotifera: Eurotatoria) from North-Eastern India. *Mitteilungen aus dem Museum für Naturkunde Berlin, Zoologische Reihe,* 81: 81–88.

SHARMA, B.K.& SHARMA, S. (2009): Biodiversity and distribution of freshwater rotifers (Rotifera, Eurotatoria) of Tamil Nadu. *Records of the Zoological Survey of India,* 109(3):41–60.

SHARMA, B.K. & SHARMA, S. (2012): Deepor Beel – a Ramsar site of India: An interesting hot-spot with its rich Rotifera biodiversity. *Acta Zoologica Academiae Scientiarum Hungaricae,* 58(2): 105–120.

SHARMA, B.K. & Sharma, S. (2014a) Northeast India – An important region with a rich biodiversity of Rotifera, In. SHARMA, B.K., DUMONT, H.J., WALLACE, R.L. (Eds) Rotifera XIII. Rotifer Biology – A structural and functional Approach. *International Review of Hydrobiology,* 99(1–2): 20–37. DOI 10.1002/iroh.201301701

SHARMA, B.K. & SHARMA, S. (2014b): Indian Lecanidae (Rotifera: Eurotatoria: Monogononta) and its distribution. In. SHARMA, B.K., DUMONT, H.J., WAL-

LACE, R.L. (Eds) Rotifera XIII. Rotifer Biology – A structural and functional Approach. *International Review of Hydrobiology,* 99 (1–2): 38–47. DOI 10.1002/iroh.201301702.

SHARMA, B.K. & SHARMA, S. (2014c): Remarks on ‘A report on Lecanidae (Rotifera: Monogononta) from Andhra Pradesh, India’: misidentifications and status. *Journal of Threatened Taxa,* 6(3): 5990–5992.

SHARMA, J.P. & SRIVASTAVA, J.B. (1986): Ecological observations on rotifer fauna of some freshwater ponds of Jammu (J&K). *Geobios New Reports,* 5(11): 6–10.

SHARMA R., SHARMA, V., SHARMA, M.S., VERMA, B. K., MODI, R. &, GAUR, K.S. (2011): Studies on limnological characteristic, plankton diversity and fishes (species) in Lake Pichhola, Udaipur, Rajasthan (India). *Universal Journal of Environmental Research & Technology,* 1(3): 274–285.

SHARMA, S. & SHARMA, B.K. (2008): Zooplankton diversity in floodplain lakes of Assam. *Records of the Zoological Survey of India, Occasional Paper, No.* 290: 1–307+28 plates.

SHARMA, S. & SHARMA, B.K. (2013): Faunal Diversity of Aquatic Invertebrates of Deepor Beel (a Ramsar site), Assam, northeast India. *Wetland Ecosystem Series, Zoological Survey of India, Kolkata,* 17: 1–226.

SHARMA V., SHARMA, S., MALARA, H., SHARMA, R. & BAGHELA, B.S. (2008): *Trophic status and zooplankton diversity of Lake Jaisamand in relation to its physico-chemical characteristics*. In. SENGUPTA, M. & DALWANI, R. (Eds). Proceedings of Taal 2007. The 12th World Lake Conference, Jaipur, India, p. 490–495.

SLADECEK, V. (1983): Rotifera as indicators of water quality. *Hydrobiologia,* 100: 169–201.

SONIA, R. & RAMANIBAI, R. (2012): Diversity of rotifer fauna of Kolavari Lake, Chingleput district, Tamil Nadu. *Journal of Research in Biology,* 1: 28–31

SUATONI, E., VICARIO, S., RICE, S., SNELL, T. & CACCONE, A. (2006): An analysis of species boundaries and biogeographic patterns in a cryptic species complex: the rotifer – *Brachionus plicatilis*. *Molecular Phylogenetic Evolution,* 41: 86–98.

TARE, V. (2012): *Floral and faunal diversity in Yamuna River (Yamnotri- Allahabad).* Ganga River Basin Environment Management Plan. Indian Institute of Technology. Report: 034_GBP_IIT _ENB _DAT_12_Ver1_Jun 2012, 48 pp.

TAYADE, S.N. & DABHADE, D.S. (2011): Checklist of rotifers in Wasim district of Maharashtra, India. *International Journal of Innovations in Bio–Sciences,* 1: 27–31.

TICKU, A. & ZUTSHI, D.P. (1993) The distribution and abundance of epiphytic rotifers populations on submerged macrophytes in Dal Lake, Srinagar. *Journal of the Indian Institute of Sciences,* 73: 237–245.

VARGHESE, M. (2006): *Studies on taxonomy, distribution, ecology and reproductive potentials of rotifers from selected centres in Cochin backwater system, Kerala*. Ph. D thesis, Central Marine Fisheries Research Institute, Kochi, Kerala, 344 pp.

VARGHESE, M. (2011): Distribution of *Brachionus* species (Phylum Rotifera) in Cochin backwaters. Kerala, India. *Journal of Marine Biological Association, India,* 53 (1):130 – 134.

VARGHESE, M. & KRISHNAN, L. (2008): *Biodiversity of rotifers in selected centres of Cochin backwater system, Kerala*. In. Glimpses of Aquatic Biodiversity NATRAJAN, P., JAYACHANDRAN, R.V., KENNAIYAN, S., AMBAI, B., AUGUSTINE, A. (Eds) Rajiv Gandhi Chair Special Publication, 7: 193–204.

Opusc. Zool. Budapest, 2014, 45(2): 181–188

Remarks on the earthworm genus *Helodrilus* Hoffmeister, 1845 with new epigean and subterranean records (Oligochaeta, Lumbricidae)

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Abstract. The earthworm genus *Helodrilus* Hoffmeister, 1845 is shortly reviewed. Its special semi-aquatic and subterranean way of life and its consequences to the taxonomy of the genus is discussed. Several new occurrences of some little-known *Helodrilus* species are given including new country records of *H. oculatus* for Hungary and *H. putricola putricola* for Portugal. Examining a topotype of *H. hachiojii* revealed presence of saccular nephridial bladders consequently, here we propose its transposal to the genus *Eisenia* as *E. hachiojii* (Blakemore, 2007) comb. nov.

Keywords. *Helodrilus*, new records, nephridial system, distribution, phylogeny

INTRODUCTION

The genus *Helodrilus* was described by Hoffmeister (1845) with the type species *Helodrilus oculatus* Hoffmeister, 1845 and defined by characters such as a thin body, strong setae, and the absence of a clitellum which clearly indicates that the specimens examined by Hoffmeister were either juvenile or aclitellate adults. Later Michaelsen (1900) created a large catch-all genus from the original *Helodrilus* by merging the genera *Allolobophora* Eisen, 1873, *Dendrobaena* Eisen, 1873, and *Bimastos* Moore, 1893 into it as independent subgenera. Pop (1941) in his revision of the family Lumbricidae transposed all unpigmented species with closely paired setae, from *Helodrilus* to the genus *Allolobophora* and furthermore elevated *Dendrobaena* to genus rank resulting in exterminating the former genus *Helodrilus*.

Omodeo (1953) resurrected the genus *Helodrilus* with the following characteristics: setae strictly paired, calciferous glands without lateral diverticula, pigmentation lacking, two pairs of seminal vesicles in segment 11, 12, spermathecal pores in setal line cd, small or medium size, medium number of segments. It is worth mentioning that the *Helodrilus* species usually possess lateral calciferous diverticula in segment 10, but these are sometimes hardly recognizable (Csuzdi & Zicsi 2003).

Perel (1976a) was among the first earthworm taxonomists who thoroughly examined the morphology of the nephridial bladders in the family Lumbricidae and highlighted the absence of nephridial bladders in case of the *Helodrilus* species, as an important distinguishing character. Following a similar train of thought Zicsi (1985) separated the genus *Proctodrilus* from *Helodrilus* by differences in the excretory system. The nephridial bladders are lacking in both cases, but in the genus *Helodrilus* each nephridium opens in its own segment (exonephric system). In the *Proc-*

urn:lsid:zoobank.org:pub:DA9BE981-09D8-4DEE-A4CA-6837B64D039F
HU ISSN 2063-1588 (online), HU ISSN 0237-5419 (print)

todrilus species each nephridium discharges in a collecting canal (enteronephric system).

Up to now the genus *Helodrilus* comprises ca. 20 species and subspecies (Appendix 1) showing holarctic distribution, from the Iberian Peninsula (Trigo *et al.* 1988) to Anatolia (Csuzdi *et al.* 2006), Levant (Pavlícek *et al.* 2003) and the Caucasus (Kvavadze 1985).

The species have special habitat preferences; most of them prefer highly moist soils or can be found in the banks of streams, swamps and caves, and because of their narrow range many species are considered as endangered or critically endangered (Stojanović & Karaman 2006). However, this conservation status may also be attributed to undersampling in these habitats and more research should be carried out in these areas to accurately assess their conservation status and distribution.

A typical example for this is the first records of *Helodrilus oculatus* Hoffmeister, 1845 from Hungary and *Helodrilus putricola putricola* (Bouché, 1972) from Portugal presented here.

MATERIAL AND METHODS

Earthworms were collected by digging and hand-sorting. 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). For later molecular studies, tail parts of specimens of taxonomic importance were placed into 96% ethanol.

RESULTS

Helodrilus cernosvitovianus (Zicsi, 1967)

Allolobophora cernosvitoviana Zicsi, 1967: 248.
Helodrius cernosvitovianus: Zicsi 1985: 282., Mršić 1991: 115., Csuzdi & Zicsi 2003: 170.

Material examined. HNHM/16511, 1 ex., Hungary, Kömörő, leg. Cs. Csuzdi, 16.04.2007.

Remarks. This species was described from Hungary (Zicsi 1967) and later was found in Ukraine (Perel 1976b), Poland (Rosen & Kostecka 1988), Serbia (Mršić 1991, Karaman & Stojanović 2002, Stojanović & Karaman 2005) and Greece (Zicsi & Michalis 1981). The real distribution of this species is still unknown (Csuzdi *et al.* 2011).

Helodrilus deficiens Zicsi, 1985

Helodrilus deficiens Zicsi, 1985: 282., Mršić 1991: 126., Csuzdi & Zicsi 2003: 172.

Material examined. HNHM/14880, 1 ex., Hungary, Püski, Salamon Isle, leg. S. Mahunka, 23.06.2004.

Remark. This species is known only from Hungary and Austria (Zicsi 1994) from a narrow area, and all the specimens were collected from the bank of the Danube.

Helodrilus kratochvili (Černosvitov, 1937)

Eophila kratochvili Černosvitov, 1937: 130.
Helodrilus kratochvili: Zicsi 12985: 280., Mršić 1991: 114.

Material examined. HNHM/16960, 2 ex., Bosnia-Herzegovina, Žira Cave, leg. G. Balázs, 01. 08.2014.

Remarks. Zicsi (1985) examining the type material recognized that it contains only a single adult specimen, the other four specimens in the vial were praeadult or juvenile. Our specimens are also juvenile with only developing tubercles present on 29–31.

This troglobiont species lives solely in the Žira Cave and was found only two times after the original description. The samples were collected in the terminal siphon of the cave. The siphon is filled with fine mud. The cave is considered as a fossil sinkhole. Its morphology suggests that it used to consume huge quantities of water, but now the entrance is situated 7–8 meters higher than the present polje level, therefore normally it collects only percolating water from the surface which is just enough to keep the mud wet throughout the year, and floods can only occur in the cave when the water level on Popovo polje is high. Although this area of the Dinaric Karst is well researched due to the close position of Vjetrenica Cave, *H. kratochvili* has only been found in this single cave. The unique hidrology of the locality might serve as explanation for this phenolmenon.

Helodrilus mozsaryorum (Zicsi, 1974)

Allolobophora mozsaryorum Zicsi, 1974: 230.
Helodrilus mozsaryorum: Zicsi 1985: 282., Mršić 1991: 125., Csuzdi & Zicsi 2003: 173.

Material examined. HNHM/16134, 2 ex., Hungary, Jósvafő, Baradla Rövid-Alsó Cave, siphon 4, leg. G. Balázs, 07.07.2011.

Remarks. This troglobiont species is endemic to Hungary, found only in the Baradla Rövid-Alsó Cave, NE Hungary, where it lives under water in the mud of siphons and secures its oxygen needs by the circular moves of its tail (Csuzdi & Zicsi 2003).

The cave is one of the active lower spring caves of the Baradla-Domica Cave System. Since the siphons, where these animals lived, were dried up by intensive pumping, this species was thought to be extinct (Zicsi *et al.* 1999).

New research in the Baradla-Domica Cave System proved that *H. mozsaryorum* specimens are still found in their type locality and they occur not only in the siphons but probably along the whole cave stream, as they were observed in the water of the artificial tunnel at the beginning of the cave, in a distance of about 30–40 meters from the entrance.

It worth noting, that the species have been found only in this branch of the Baradla-Domica Cave System although, since its discovery, numerous attempts were made to find it in other parts of the cave with similar conditions, as well as in surrounding caves.

Helodrilus oculatus Hoffmeister, 1845

Helodrilus oculatus Hoffmeister, 1845: 39., Zicsi 1985: 279., Mršić 1991: 118., Zicsi 1994: 43., Zicsi & Csuzdi 1999: 991.

Material examined. HNHM/11855, 1 ex., Germany, Rolfshagen, leg. A. Zicsi, 17.06.1963. HNHM/16133, 1 ex., Hungary, Mecsek, Abaliget Cave, leg. D. Angyal, L. Dányi, 14.01.2012. HNHM/16961, 1 ex., Hungary, Mecsek, Spirál Sinkhole, beginning of streamy branch, leg. D. Angyal, 23.02.2013.

Remarks. *H. oculatus* is the most widely distributed *Helodrilus* species. It is recorded from the Iberian peninsula (Trigo *et al.* 1998) to the Caucasus (Perel 1979, Kvavadze 1985). Consequently it shows a rather large morphological variability which resulted in describing many synonym names (Csuzdi 2012).

Our specimens with the clitellum on 22–31 and tubercles on 29–1/2 31 agrees well with the modern concept of the species (Michaelsen 1900: 497.).

Both the Abaliget Cave and the Spirál Sinkhole are situated in the Mecsek Mts. in SW Hungary. The former is the longest (about 2000 meters) and the later is the deepest (with 86 vertical metres extension and 1600 metres length) cave in that karstic region. Both caves have been developed in Triassic limestone and provide various microhabitats for some eutroglophile and troglobiont macroinvertebrate species. The collected *H. oculatus* specimens were found on clay in a wet environment approximately 70 meters deep in the Spirál Sinkhole and in a small puddle on the top of a large rock about 470 meters deep in the Abaliget Cave.

Helodrilus oculatus is new to the fauna of Hungary. As it was found in Slovenia (Mršić 1991) and Austria (Zicsi 1994) its presence in

Hungary was to be expected. The fact that it could have remain undiscovered till now in one of the biologically best investigated Hungarian caves– the Abaliget Cave – may indicates the rarity of the species.

Helodrilus patriarchalis **(Rosa, 1893)**

Allolobophora patriarchalis Rosa, 1893: 9.
Helodrilus patriarchalis: Zicsi 1985: 280., Csuzdi & Pavlíček 2005: 92., Szederjesi *et al.* 2013: 398., 2014: 566.

Material examined. HNHM/16624, 6 ex., Greece, Crete, Chania regional unit, Georgioupoli, swamp E of the village, 5m, N35°21.112’ E24°17.442’, leg. J. Kontschán, D. Murányi, T. Szederjesi, 01.04.2013. HNHM/16667, 2 ex., Jordan, Wadi Hassa, leg. T. Pavlíček, 14.05.1996. HNHM/16925, 2 ex., Turkey, Akyaka Mts. region, near stream, pine forest, leg. P. Cardet, T. Pavlíček, 13.04.2014. HNHM/16931, 3 ex., Turkey, Akyaka, mount slopes, pine forest, leg. P. Cardet, T. Pavlíček, 15.04.2014.

Remarks. *H. patriarchalis* shows a typical East Mediterranean distribution with its range stretching from Crete through Anatolia and the Levant (Csuzdi *et al.* 2006, Pavlíček *et al.* 2003) to the Transcaucasus (Perel 1967, Kvavadze 1985). It becomes completely adult only for a short period in the year which results in high variability of the clitellar and tubercular positions. In case of full development, the tubercles stretch from the hind end of segment 30 to the beginning of segment 34. Between this maximal extension large variations can be seen during development which have resulted in the description of several synonymised names such as *Helodrilus colchicus* Kvavadze, 2000 and *Helodrilus zicsianus* Kvavadze 2000 with data cl: 21,22–33,34 tb: ¼30,31–¼33,½34 and cl: 23–33,34 tb: ¼30,31–32,¼33 respectively.

Helodrilus putricola putricola **(Bouché, 1972)**

Allolobophora putricola Bouché, 1972: 442.
Helodrilus putricola putricola: Zicsi 1985: 282., Zicsi & Csuzdi 1999: 991.

Material examined. HNHM/16414, 1 ex., Portugal, Cal de Bois, N41°21.53 W7°29.219, leg. T. Pavlíček, 05.09.2011. HNHM/16428, 1 ex., Portugal, Palmeira de Faro, stream in a farm, 89 m, leg. T. Pavlíček, 01–05.09.2011. HNHM/16470, 1 ex., France, Midi-Pyrénées, after Paréac, forest, 404 m, N43°06.736’ E00°00.736’, leg. Cs. Csuzdi, 07.07.2004.

Remarks. Our specimen with a clitellum on 23– 29, tubercula on 23–28, four pairs of vesicles in 9–12 and spermatheca in 9/10, 10/11 *cd* agrees well with the original description. *H. putricola putricola* was previously known only from France and it is new to the fauna of Portugal.

Helodrilus putricola orionense **(Zicsi, 1977)**

Allolobophora orionense Zicsi, 1977: 682.
Helodrilus putricola orionensis: Zicsi & Csuzdi 1999: 991.

Material examined. HNHM/16413, 1 ex., France, Aquitaine, Pyrenees Mts., 21 km after Combo les Bains, before St. James Pied de Port, forest, stream bank, 63 m, N43°19.517’ W01°22.963’, leg. Cs. Csuzdi, 06.07.2004.

Remark. This subspecies is only known from the French part of the Pyrenees.

Eisenia hachiojii **(Blakemore 2007) comb. nov.**

Helodrilus hachiojii Blakemore, 2007: 17., Blakemore & Grygier 2011: 276.

Material examined. HNHM/15531, 1 ex., Japan, Komiga Park, Hachioji, West Tokyo, leg. R.J. Blakemore, 05.09.2010.

Remarks. Blakemore (2007) noted that he observed simple, flask-shaped nephridial bladders in certain segments of a few of the specimens. Examining a topotype we found small, simple, saccular nephridial bladders in all segments which makes it clear that the species *hachiojii* belongs to the genus *Eisenia*. Similar shaped bladders are found in other limicolous *Eisenia* species such as the Inner Asian *Eisenia colchidica* (Perel, 1967) and the Central European *E. balatonica* (Pop, 1943).

DISCUSSION

As the *Helodrilus* species live mostly in stream banks and caves where earthworm sampling is usually not focused, we still have little information both on the species and also their exact distribution. This might be the reason that, except the two most common species (*H. oculatus* and *H. patriarchalis*), the current known species' ranges for the other *Heliodrilus* taxa are quite limited. Except the truly troglobiont taxa (such as *H. kratochvili* and *H. mozsaryorum*) the other species are likely to have much larger distribution ranges than we currently know. This is highlighted by the recent discovery of *Helodrilus vagneri* Mršić, 1991 in Greece (Szederjesi *et al*. 2012) and also the record of *H. oculatus* in the quite well explored Hungary.

Another problem is that many *Helodrilus* specimens recorded in the literature (including the type specimens of *H. oculatus,* the generotype) are not fully adult because the maturity of these species lasts only for a short period of time in the year. This can lead to misidentifications and also recording high morphological variability which questions the validity of certain species (Omodeo & Rota 2008).

The genus *Helodrilus* is problematic also from phylogenetic point of view. Its most specific character is the lack of nephridial bladders which is the plesiomorphic character state according to Perel (1976a). If we accept this assumption, then *Helodrilus* is considered to be an ancient group of earthworms. The range of this genus totally covers the whole Lumbricidae domain (except North America) which could also imply an ancient origin. However, if we examine the plesiomorphic sister groups of Lumbricidae, e.g. Hormogastridae (James & Davidson 2012), we found nephridial bladders present in all cases. Therefore the absence of bladders seems to be a derived character (Csuzdi 2004) and can be related to the limicolous way of life. Further molecular studies are needed to determine the true phylogenetic position (or even monophyly) of this highly special earthworm taxon.

Acknowledgements – This research was supported by a grant from OTKA (No. 100369).

REFERENCES

BARTOLI, P. (1962): *Helodrilus massilensis* Nouvelle Espéce de Lumbricidae (Oligochaeta). *Bulletin de la Société Zoologique de France*, 1962: 458–462.

BLAKEMORE, R. J. (2007): *Helodrilus hachiojii* sp. nov. (Oligochaeta, Lumbricidae) from Japan. *Edaphologia*, 82: 17–23.

BLAKEMORE, R. J. & GRYGIER, M.J. (2011): Unraveling some Kinki worms (Annelida, Oligochaeta, Megadrili, Lumbricidae) – Part III. *Soil Organisms*, 83(2): 265–278.

BOUCHE, M. B. (1972): *Lombriciens de France. Écologie et Systématique.* Institut National de la Recherche Agronomique, Articles de Zoologie-Écologie animale (Numéro hors-série), pp. 671.

QIU, J-P. & BOUCHE, M. B. (2000): Une nouvelle évaluation du genere *Helodrilus* (sensu Zicsi, 1985) (Oligochaeta: Lumbricidae). *Documents Pedozoologiques & Intégrologiques*, 4: 8–16.

ČERNOSVITOV, L. (1931): Zur Kenntnis der Oligochätenfauna des Balkans. III. Oligochäten aus Montenegro und Südserbien. *Zoologischer Anzeiger*, 95: 312–327.

ČERNOSVITOV, L. (1937): Notes sur les Origochaetes cavernicoles. *Mémoires de la Société Zoologique Tchécoslovaque de Prague*, 5: 125–133.

COGNETTI, L. (1914): Nota sugli oligocheti degli Abruzzi. *Bolletino dei Musei di Zoologia ed Anatomia comparata della R. Università di Torino*, 29(689): 1–5.

CSUZDI, CS. (2004): *Towards the phylogenetic system of lumbricid earthworms*. In. MORENO, A. G. & BORGES, S. (Eds.) Advances in Earthworm Taxonomy I. Editorial Complutense, Madrid, p. 333–346.

CSUZDI, CS. (2012): Earthworm species, a searchable database. *Opuscula Zoologica Budapest*, 43(1): 97–99.

CSUZDI, CS. & ZICSI, A. (2003): *Earthworms of Hungary. (Annelida: Oligochaeta, Lumbricidae).* In. CSUZDI, CS. & MAHUNKA, S. (Eds.) Pedozoologica Hungarica 1. Hungarian Natural History Museum, Budapest, pp. 271.

CSUZDI, CS. & PAVLÍČEK, T. (2005): Earthworms from Israel. II. Remarks on the genus *Perelia* Easton, 1983 with descriptions of a new genus and two new species. *Acta Zoologica Academiae Scientiarum Hungaricae*, 51(2): 75–96.

CSUZDI, CS., ZICSI, A. & MISIRLIOĞLU, M. (2006): An annotated checklist of the earthworm fauna of Turkey (Oligochaeta: Lumbricidae). *Zootaxa*, 1175: 1–29.

CSUZDI, CS., POP, V. V. & POP, A. A. (2011): The earthworm fauna of the Carpathian Basin with new records and description of three new species (Oligochaeta: Lumbricidae). *Zoologischer Anzeiger*, 250: 2–18.

HOFFMEISTER, W. (1845): *Übersicht aller bis jetzt bekannten Arten aus der Familie der Regenwürmer*. Friedrich Vieweg & Sohn, Braunschweig, pp. 43.

JAMES, S. W. & DAVIDSON, S. K. (2012): Molecular phylogeny of earthworms (Annelida: Crassiclitellata) based on 28S, 16S and 16S gene sequences. *Invertebrate Systematics*, 26: 213–229.

KARAMAN, S. (1972): Beitrag zur Kenntnis der Art *Eiseniella balcanica* Černosvitov, 1931 (Oligochaeta, Lumbricidae). *Fragmenta Balcanica Skopje*, 9(7): 77–88.

KARAMAN, S. & STOJANOVIĆ, M. (2002): *Treći prilog poznavanja kišnih glista (Oligochaeta, Lumbricidae) južne i jugoistočne Srbije*. Proceeding of 7th. Symposium on Flora of Southeastern Serbia, Dimitrovgrad, Serbia, p. 223–225.

KVAVADZE, E. S. (1985): *The earthworms (Lumbricidae) of the Caucasus*. Metsniereba, Tbilisi, pp. 237. (in Russian)

KVAVADZE, E. S. (2000): New data on earthworms (Oligochaeta, Lumbricidae) systematic. *Proceedings of the institute of Zoology Tbilisi*, 20: 77–84. (in Russian)

MICHAELSEN, W. (1890): Die Lumbriciden Norddeutschlands. *Jahrbuch der Hamburgischen Wissenschaftlichen Anstalten*, 7: 1–19.

MICHAELSEN, W. (1900): *Oligochaeta*. In. Das Tierreich X. Friedländer & Sohn, Berlin, pp. 575.

MRŠIĆ, N. (1991): *Monograph on earthworms (Lumbricidae) of the Balkans I-II.* Slovenska Akademija Znanosti in Umetnosti, Zazred za Naravoslovne Vede Opera. 31. Ljubljana, pp. 757.

OMODEO, P. (1953): Nota su alcuni lombrichi delle Alpi e considerationi sul gen. *Helodrilus* di Hoffmeister. *Memorie del Museo Civico di Storia Naturale di Verona*, 4: 75–85.

OMODEO, P. & ROTA, E. (2008): Earthworm Diversity and Land Evolution in Three Mediterranean Districts. *Proceedings of the California Academy of Sciences*, 59(supplement 1): 65–83.

PAVLÍČEK, T., CSUZDI, CS. & NEVO, E. (2003): Species richness and zoogeographic affinities of earthworms in the Levant. *Pedobiologia*, 47: 452–457.

PEREL, T. S. (1967): Dozdevye cervi reliktovych lesov Zapadnogo Zakavkaz'ja i Talysa. *Pedobiologia*, 7: 93–120.

PEREL, T. S. (1976a): A critical analysis of the Lumbricidae genera system (with key to the USSR fauna genera). *Révue d'Écologie et Biologie du Sol*, 13(4): 635–643.

PEREL, T. S. (1976b): A critical analysis of the system of family Lumbricidae. *Zoologicheski Zhurnal*, 55: 823–836. (in Russian)

PEREL, T. S. (1979): *Range and regularities in the distribution of earthworms of the USSR fauna.* Nauka, Moscow, pp. 272. (in Russian)

POP, V. (1941): Zur phylogenie und Systematik der Lumbriciden. *Zoologische Jahrbücher Abteilung für Systematik, Ökologie und Geographie der Tiere*, 74: 487–522.

POP, V. (1943): Hazai és külföldi Lumbricidák a Magyar Nemzeti Múzeumban. *Annales Historico-Naturales Musei Nationalis Hungarici*, 34: 12–24.

ROSA, D. (1893): Viaggio del Dr. E. Festa in Palestina, nel Libano e regioni vicine. II. Lumbricidi. *Bolletino dei Musei di Zoologia ed Anatomia comparata della R. Università di Torino*, 8(160): 1–14.

ROZEN, A. & KOSTECKA, J. (1988): *Allolobophora cernosvitoviana* (Zicsi, 1967) (Oligochaeta, Lumbricidae), a new species of earthworm in Poland. *Przeglad Zoologiczny*, 32: 199–202.

ŠAPKAREV, J. (1971): Neue Regenwürmer (Oligochaeta: Lumbricidae) aus Mazedonien. *Fragmenta Balcanica Skopje*, 8: 149–164.

ŠAPKAREV, J. (1989): Description of new species of earthworms (Oligochaeta: Lumbricidae) from Yugoslavia. *Macedonian Academia of Sciences and Arts*, 7(1–2): 33–46.

STOJANOVIĆ, M. & KARAMAN, S. (2005): Further contribution to the knowledge of the earthworms of Šumadija (Serbia). *Archives of Biological Sciences Belgrade*, 57(2): 127–132.

STOJANOVIĆ, M. & KARAMAN, S. (2006): Threat status and distribution of the earthworm genus *Helodrilus* Hoffmeister, 1845; sensu Zicsi 1985, on the Balkans and the neighboring regions. *Biodiversity and Conservation*, 15: 4601–4617.

SZEDERJESI, T. & CSUZDI, CS. (2012): New and little known earthworm species from Greece (Oligochaeta: Lumbricidae, Acanthodrilidae). *Zootaxa*, 3304: 25–42.

SZEDERJESI, T., PAVLÍČEK, T. & CSUZDI, CS. (2013): New earthworm species from Jordan (Oligochaeta, Lumbricidae). *Acta Zoologica Academiae Scientiarum Hungaricae*, 59(4): 391–400.

SZEDERJESI, T., PAVLÍČEK, T., COŞKUN, Y. & CSUZDI, CS. (2014): New earthworm records from Turkey, with description of three new species (Oligochaeta: Lumbricidae). *Zootaxa*, 3764(5): 555–570.

TRIGO, D., MASCATO, R., MATO, S. & DIAZ COSIN, D. J. (1988): Biogeographical divisions of continental Portugal as regards earthworm fauna. *Bollettino di Zoologia*, 55: 85–92.

ZICSI, A. (1967): Beiträge zur Kenntnis der ungarischen Lumbricidenfauna, IV. *Opuscula Zoologica Budapest*, 6: 187–190.

ZICSI, A. (1974): Ein neuer Höhlen-Regenwurm (Oligochaeta: Lumbricidae) aus Ungarn. *Acta Zoologica Academiae Scientiarum Hungaricae*, 20: 227–232.

ZICSI, A. (1977): Neue Regenwürmer (Oligochaeta: Lumbricidae) aus den Atlantischen Pyrenäen. *Revue Suisse de Zoologie*, 84: 681–685.

ZICSI, A. (1985): Über die Gettungen *Helodrilus* Hoffmeister, 1845 und *Proctodrilus* gen. n. (Oligochaeta: Lumbricidae). *Acta Zoologica Academiae Scientiarum Hungaricae*, 31: 275–289.

ZICSI, A. (1994): Die Regenwürmer Österreichs (Oligochaeta: Lumbricidae) mit Bestimmungstabellen der Arten. *Verhandlungen der Zoologisch-Botanischen Gesellschaft in Österreich*, 131: 37–74.

ZICSI, A. & MICHALIS, K. (1981): Übersicht der Regenwurm-fauna Griechenlands (Oligochaeta: Lumbricidae). *Acta Zoologica Academiae Scientiarum Hungaricae*, 27: 239–264.

ZICSI, A. & CSUZDI, CS. (1986): Regenwürmer aus Bulgarien (Oligochaeta: Lumbricidae). *Opuscula Zoologica, Budapest*, 22: 113–121.

ZICSI, A. & CSUZDI, CS. (1999): Weitere Angaben zur Regenwurmfauna Frankreichs mit Beschreibung fünf neuer Arten (Oligochaeta: Lumbricidae). *Revue suisse de Zoologie*, 106(4): 983–1003.

ZICSI, A., DOZSA-FARKAS, K. & CSUZDI, CS. (1999): *Terrestrial Oligochaetes of the Aggtelek National Park.* In.: Mahunka, S. (Ed.) The Fauna of the Aggtelek National Park. Hungarian Natural History Museum Budapest, p. 39–43.

Appendix 1.

List of the valid names in the genus *Helodrilus* Hoffmeister, 1845

Helodrilus balcanicus balcanicus (Černosvitov, 1931)

Eiseniella balcanica Černosvitov, 1931: 321.
Allolobophora macedonica Šapkarev, 1971: 150.

Helodrilus balcanicus plavensis (Karaman, 1972)

Eiseniella balcanica plavensis Karaman, 1972: 78.

Helodrilus cernosvitovianus (Zicsi, 1967)

Allolobophora cernosvitoviana Zicsi, 1967: 248.

Helodrilus deficiens Zicsi, 1985

Helodrilus deficiens Zicsi, 1985: 282.

Helodrilus dinaricus Mršić, 1991

Helodrilus dinaricus Mršić, 1991: 108.

Helodrilus duhlinskae Zicsi & Csuzdi, 1986

Helodrilus duhlinshae Zicsi & Csuzdi, 1986: 119.

Helodrilus italicus Zicsi, 1985

Helodrilus italicus Zicsi, 1985: 284.
Helodrilus serbicus Šapkarev, 1989: 33.

Helodrilus jadronensis Šapkarev, 1989

Helodrilus jadronensis Šapkarev, 1989: 36.

Helodrilus kratochvili (Černosvitov, 1937)

Eophila kratochvili Černosvitov, 1937: 130.

Helodrilus mozsaryorum (Zicsi, 1974)

Allolobophora mozsaryorum Zicsi, 1974: 227.

Helodrilus musicus Qiu & Bouché 2000

Helodrilus musicus Qiu & Bouché, 2000: 11.

Helodrilus oculatus Hoffmeister, 1845

Allolobophora hermanni Michaelsen, 1890: 13.
Helodrilus ospensis Mršić, 1991: 113.
Helodrilus cartlicus Kvavadze, 2000: 82.
Helodrilus cortezi Qiu & Bouché, 2000: 9.
Helodrilus phillipei Qiu & Bouché, 2000: 12.
Helodrilus turquini Qiu & Bouché 2000: 10.

Helodrilus patriarchalis (Rosa, 1893)

Allolobophora patriarchalis Rosa, 1893: 9.
Helodrilus colchicus Kvavadze, 2000: 82.
Helodrilus zicsianus Kvavadze, 2000: 83.

Helodrilus putricola putricola (Bouché, 1972)

Allolobophora putricola Bouché, 1972: 442.

Helodrilus putricola orionense (Zicsi, 1977)

Allolobophora orionense Zicsi, 1977: 682.

Helodrilus putricola tebra (Bouché, 1972)

Allolobophora putricola tebra Bouché, 1972: 443.

Helodrilus samniticus (Cognetti, 1914)

Helodrilus (Bimastus) oculatus samnitica Cognetti, 1914: 3.
Allolobophora oculata v. *dudichi* Pop, 1943: 14.
Helodrilus massiliensis Bartoli, 1962: 458.

Helodrilus segalensis (Bouché, 1972)

Allolobophora segalensis Bouché, 1972: 457.

Helodrilus slovenicus Mršić, 1991

Helodrilus slovenicus Mršić, 1991: 124.

Helodrilus vagneri Mršić, 1991

Helodrilus vagneri Mršić, 1991: 116.

Opusc. Zool. Budapest, 2014, 45(2): 189–194

New data on the Pseudoscorpion fauna of the caves of the Bakony Mountains, Hungary

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Abstract. Examining cave samples from the *Bakony Museum of the Hungarian Natural History Museum*, Hungary two pseudoscorpion species were found; *Chthonius ressli* Beier, 1956 and *Neobisium carcinoides* (Hermann, 1804). *C. ressli* is new to the pseudoscorpion fauna of Hungary. The morphological characters of the specimens found are discussed in detail and drawings of the *C. ressli* specimens are given.

Keywords. Pseudoscorpiones, new records, faunistics, Central Europe.

INTRODUCTION

The pseudoscorpion fauna of the Bakony Mts. (Hungary) was studied earlier by Loksa (1960, 1966), Szalay (1968), and Novák (2011). As a result of these investigations eleven pseudoscorpion species belonging to six families were reported as follows: *Chthonius tetrachelatus* (Preyssler, 1790), *Neobisium carcinoides* (Hermann, 1804), *Neobisium erythrodactilum* (L. Koch, 1873), *Neobisium simile* (L. Koch, 1873), *Neobisium sylvaticum* (C. L. Koch, 1835), *Roncus lubricus* L. Koch, 1873, *Atemnus politus* (Simon, 1878), *Chelifer cancroides* (Linné, 1758), *Rhacochelifer peculiaris* (L. Koch, 1873), *Pselaphocernes scorpioides* (Hermann, 1804) and *Withius piger* (Simon, 1878). This seems to be quite large number in comparison with many other Hungarian middle ranges (Kárpáthegyi 2007); however, the pseudoscorpion fauna of the Bakony Mts. is still understudied.

The zoological research on the Hungarian caves has a great tradition (Csiki & Mihók 1914); however, in the last decades only a few investigations have been carried out. In 2009 the Natural History Museum of Bakony Mountains and the local caving clubs started to investigate the cave fauna of the Bakony Mts. Some of these caves, like the Csodabogyós Cave (discovered only recently in 1990) were never studied zoologically before.

More than 50 years ago Imre Loksa collected material using pitfall traps in the Lóczy Cave; some of his results were published, including the presence of *Chthonius tetrachelatus* (Preyssler, 1790) in the cave (Loksa 1960).

Both of the recently studied caves belong to the authority of the Balaton-felvidéki National Park and are partly open to the public.

The Csodabogyós Cave is situated at Balatonederics, in the Keszthelyi Mts. which is part of the Bakony Mts. The cave was formed in the Late Triassic period in the Ederics Limestone formation, and represents a 5200 m long and 121 m deep multi level system of fissures. The cave chambers are decorated with various dripstone formations, making it highly protected since 1992 (Kárpát 2003).

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HU ISSN 2063-1588 (online), HU ISSN 0237-5419 (print)

The Lóczy Cave of Balatonfüred was discovered in 1882 and open to the public in 1934. The 154 m long and 15 m deep cave was formed by upwelling thermal water in the Füred Limstone formation during the Late Triassic period, and it is highly protected since 1982 (Hazslinszky 2003).

The aim of our present study is to report on the pseudoscorpion fauna of the two above mentioned caves of the Bakony Mts.

MATERIAL AND METHODS

The specimens were collected in 250 cm³ volume pitfall traps filled with ethylene glycol in both caves. In addition, during the winter sterilized straw was placed in the Csodabogyós Cave, two months later the arthropods were collected from this substrate using simple Tullgren funnels.

The specimens were cleared in lactic acid and examined by stereo and compound light microscopy. Drawings were made with the aid of a Zeiss Axioskop 2 microscope. Measurements were taken with the Olympus Soft Imaging analySIS work 5.0 software. The specimens were identified using the publications of Beier (1956, 1963) and Judson (1990).

The identified material is deposited at the HNHM Bakony Museum, in 70% ethanol. Each item is accompanied with an inventory number („NHMB Pseud-Nr.”).

GPS coordinates of the investigated caves are as follows: Lóczy Cave, Balatonfüred: 46° 58.140’ N; 17° 52.409’ E; 248 m asl. Csodabogyós Cave, Balatonederics: 46° 47.822’ N; 17° 21.873’ E; 396 m asl.

RESULTS

Neobisium carcinoides (Hermann, 1804)

Material examined. NHMB Pseud-0035: 1♂, Balatonederics, Csodabogyós Cave, Lián chamber, 70 m from the entrance, 30 m under the surface, from straw, 17.12.2009-27.02.2010. Leg.: Lajos Tamás Katona & Csaba Kutasi; NHMB Pseud-0036: 1♀ Balatonederics, Csodabogyós Cave, Bezengő, 50 m from the entrance, 30 m under the surface, pitfall traps, 19.10.2010–13.01.2011. Leg.: Lajos Tamás Katona & Csaba Kutasi & Zsolt Csermák; NHMB Pseud-0037: 1♂ 1♀ Balatonederics, Csodabogyós Cave, Óriás chamber, 40 m from the entrance, 30 m under the surface, pitfall traps, 27.02.2010–06.05.2010. Leg.: Lajos Tamás Katona; NHMB Pseud-0038: 1♀ Balatonederics, Csodabogyós Cave, Chamber no. 5, 60 m from the entrance, 30 m under the surface, pitfall traps, 19.10.2010–13.01.2011. Leg.: Lajos Tamás Katona & Csaba Kutasi & Zsolt Csermák.

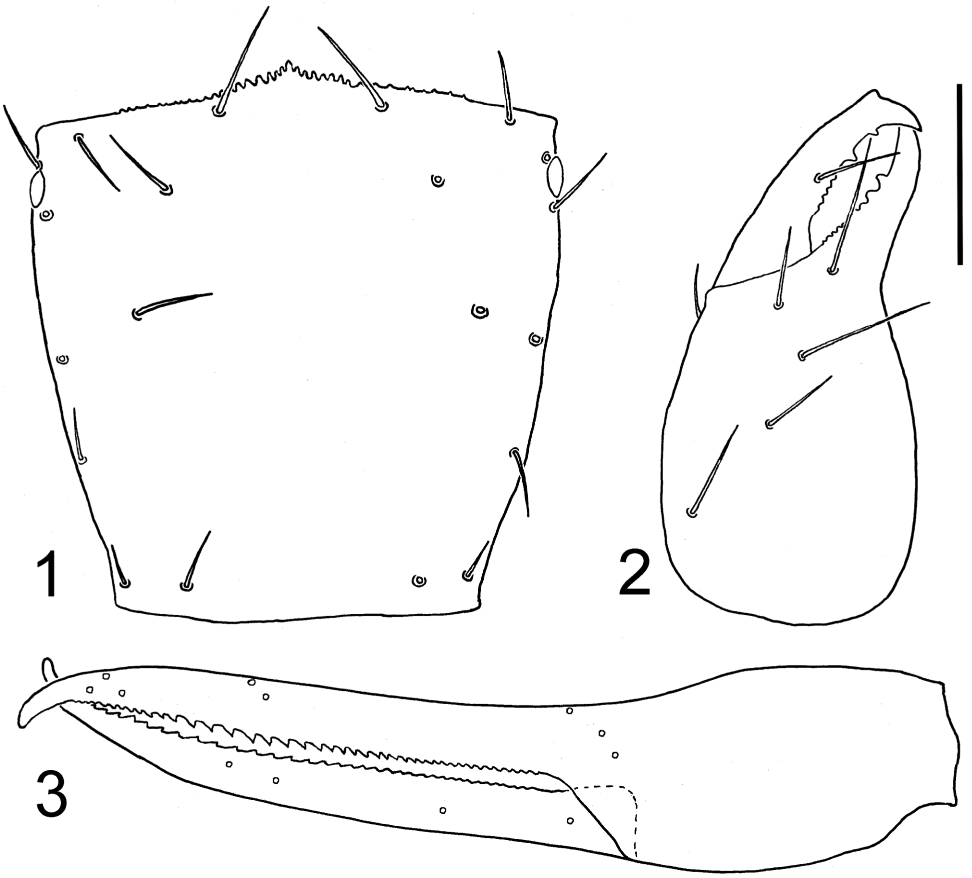
Chthonius ressli Beier, 1956

(Figures 1–3)

Material examined. NHMB Pseud-0033: 1 ♂, Balatonfüred, Lóczy Cave, Hátsó-kar, 50 m from the entrance and 1–2 m under the surface, pitfall traps, 25.09.2011-26.03.2012. Leg.: Lajos Tamás Katona & Csaba Kutasi & Zsolt Csermák; NHMB Pseud-0034: 1 ♂, Balatonfüred, Lóczy Cave, Középső-kar, 50 m from the entrance and 1-2 m under the surface, pitfall traps, 28.06.2011–25.09.2011. Leg.: Lajos Tamás Katona & Csaba Kutasi.

Short description. *Measurements* (in mm). Body length 1.00–1.12. Carapace length 0.30–0.32. Carapace breadth, anterior margin 0.30. Carapace breadth, posterior margin 0.22–0.24. Length of chelicer: 0.30–0.32. Breadth of chelicera 0.14–0.15. Movable cheliceral finger length 0.14–0.17. Palpal femur length 0.33–0.36. Palpal femur breadth 0.07. Palpal tibia length 0.14–0.15. Palpal tibia breadth 0.09. Palpal chela length 0.52. Movable chelal finger length 0.32–0.35. Chelal hand length 0.17–0.20. Chelal hand breadth 0.11.

Carapace (Fig. 1). Approximately as long as broad, the posterior margin narrower than the anterior. Epistome prominent and dentate, the



Figures 1–3. *Chthonius ressli* Beier, 1956. 1 = Carapace, 2 = Chelicera, 3 = Pedipalp. Scale bar = 0.1 mm.

dentition is weakly continuous along the anterior margin. A pair of anterior eyes with weak lenses is present. The carapace bears 20 setae, with two long and two short on the posterior margin. Setal formula: 4:6:4:2:4.

Chelicera (Fig. 2). Six setae on the cheliceral hand, and one on the movable finger. Fixed cheliceral finger with 8 small and 2 large teeth; movable finger with one large and 6 small teeth and one isolated apical tooth. Spinneret low and rounded.

Chela. Chelal finger somewhat less than twice as long as the hand. Fixed finger with 38–42, movable with 35–37 triangular and pointed teeth (Fig. 3). Teeth of the movable finger and the proximal and distal third of the fixed teeth are close-set. At the medial third of the fixed finger the teeth are separated, but the distance between them is less than their basal length.

Opisthosoma. Tergal chaetotaxy from tergite I. to X: 4:4:4:4:6:6:6:6:6:8. Sternal chaetotaxy from sternite IV. to X: 10:7:6:6:6:6:6. The anal cone bears 2 setae.

Male genital region. Sternite II. with 10, sternite III. with 8 microsetae.

Coxal area. coxa II. with 7, coxa III. with 4 spines.

DISCUSSION

Before the present investigation only three pseudoscorpion species were known from cavernicolous habitats in Hungary, *Chthonius tetra-*

chelatus (Preyssler, 1790) from the Lóczy Cave (Loksa 1960), *Neobisium (Blothrus) slovacum* Gulicka, 1977 from the Meteor Cave (Aggtelek Karst) (Duchác & Mlejnek 2000) and *Neobisium (Neobisium) biharicum* Beier 1939 from the Imre Cave (Pilis Mts) (Novák 2013). It is also worth noting that during the investigations of the Csodabogyós cave a new mesostigmatid mite species for the Hungarian fauna, *Hypoaspis fishtowni* Ruf & Koehler 1993, was also reported (Szabó *et al.* 2013).

N. carcinoides was recently reported from the Bakony Mts. (Novák 2011), and occurs all over Europe (Harvey 2013).

C. ressli, according to the list of Harvey (2013) is new to the fauna of Hungary. This species was originally described from Austria by Beier (1956), later it was reported from France (Judson 1990), Slovakia (Mock *et al.* 2004; 2005) and the Czech Republic (Šťáhlavský 2006). Judson concluded that *Chthonius parvulus* Inzaghi, 1981 is a junior synonym of *C. ressli* therefore it occurs in Italy as well (Judson 1990) (Fig. 4).

The morphological and morphometrical characters of the specimens found correspond well with Beier's original description (Beier 1956) and with Judson's redescription (Judson 1990). However, a greater variability was observed in the number of chelal teeth, the number of spines of coxae II and in the measurement data. With respect to our present knowledge, after its recording from Slovakia, this is the second report of this species from the Carpathian Basin.

Figure 4. Distribution of *Chthonius ressli* in Europe.

Both species reported here are originally epigean, their presence in caves should be regarded as occasional occurrences, which means that they are trogloxene species (Sket 2008). Cave occurrence of *C. tetrachelatus* and *N. carcinoides* is already known in the literature (Mahnert 2013).

With *N. carcinoides* and *C. ressli* the number of pseudoscorpion species occurring in caves in Hungary is increased from three to five. Further records of *C. ressli* from Hungary are also expected.

Acknowledgements – The authors would like to thank Lajos Tamás Katona, Zsolt Csermák, Attila Piri and Szilárd John for their help in the cave collecting work, and Gergely Balázs for his help in the translation of the cave terms. We are especially grateful to Dr. Gerald Legg for his linguistic help and his comments and advices and to Dr Giulio Gardini for confirming the Italian locations of *Chthonius ressli*. Special thank to the prominently public benefit organization of the Bakonyi Természettudományi Múzeum Baráti Köre for supporting financially the project. The valuable comments of the two anonymous reviewers are also acknowledged.

REFERENCES

BEIER, M. (1956): Bemerkenswerte Pseudoscorpioniden-Funde aus Niederösterreich. *Entomologisches Nachrichtenblatt Wien*, 8: 24–25.

BEIER, M. (1963): *Ordnung Pseudoscorpionidae (Afterscorpione).* In. D'AGUILAR, J. & BEIER, M. & FRANZ, H. & RAW, F. (Eds.) Bestimmungsbücher zur Bodenfauna Europas. Lieferung 1., Akademie-Verlag, Berlin, pp. 313.

CSIKI, E. & MIHÓK, O. (1914): *A hazai barlangok állatvilágának irodalma, különös tekintettel a barlangi bogarakra. 1850–1913.* In. SIEGMETH, K. & HORUSITZKY, H. (Eds.) A magyarországi barlangok és az ezekre vonatkozó adatok irodalmi jegyzéke 1549–1913. A Magyar Királyi Földtani Intézet Kiadványa, Budapest, p. 69–74.

DUCHÁČ, V. & MLEJNEK, R. (2000): *Records of the pseudoscorpion Neobisium (Blothrus) slovacum (Neobisiidae) in caves and chasms of the slovak karst.* In. MOCK, A., KOVÁČ, L. & FULÍN, M. (Eds.) Fauna jaskýň (Cave fauna). [Proceedings of theworkshop 20–21 October, 1999 East Slovakian Museum in Košice] East Slovakian Museum, Košice, p. 15–20.

HARVEY, M.S. (2013): *Pseudoscorpions of the World.* version 3.0. Western Australian Museum, Perth. Available from: http://museum.wa.gov.au/catalogues-beta/pseudoscorpions (accessed 9 April 2014).

HAZSLINSZKY, T. (2003): *Lóczy-barlang.* In. SZÉKELY, K. (Ed.) Magyarország fokozottan védett barlangjai. Mezőgazda Kiadó, Budapest p. 365–367.

JUDSON, M.L.I. (1990): On the presence of *Chthonius (C.) halberti* Kew and *Chthonius (C.) ressli* Beier in France with remarks on the status of *Kewochthonius* Chamberlin and *Neochthonius* Chamberlin (Arachnida, Chelonethida, Chthoniidae). *Bulletin du Muséum National d'Histoire Naturelle Paris,* (4) 11: 593–603.

KÁRPÁT, J. (2003): *Csodabogyós-barlang.* In. SZÉKELY, K. (Ed.) Magyarország fokozottan védett barlangjai. Mezőgazda Kiadó, Budapest, p. 375–378.

KÁRPÁTHEGYI, P. (2007): Pseudoscorpions of Hungary. *Folia Historico Naturalia Musei Matraensis*, 31: 81–90.

LOKSA, I. (1960): Faunistisch-systematische und ökologische Untersuchungen in der Lóczy-höhle bei Balatonfüred. *Annales Universitatis Scientiarum Budapestiensis de Rolando Eötvös Nominatae: Sectio Biologica*, 3: 253–266.

LOKSA, I. (1966): *Die bodenzoozönologischen Verhältnisse der Flaumeichen-Buschwälder Südostmitteleuropas*. Akadémiai Kiadó, Budapest, pp. 437.

MAHNERT, V. (2013): Pseudoskorpione (Arachnida, pseudoscorpiones) aus Höhlen des Großherzogtums Luxemburg. *Ferrantia*, 69: 108–114.

MOCK, A., ĽUPTÁČIK, P., FENĎA, P. & PAPÁČ, V. (2004): Biologická charakteristika jaskýň Bujanovských vrchov (Čierna hora). *Aragonit*, 9: 35–40.

MOCK, A., ĽUPTÁČIK, P., FENĎA, P., SVATOŇ, J., ORSZÁGH, I. & KRUMPÁL, M. (2005): *Terrestrial arthropods inhabiting caves near Veľký Folkmar (Čierna hora Mts., Slovakia).* In. TAJOVSKÝ, K., SCHLAGHAMERSKÝ, J. & PIŽL, V. (Eds.) Contributions to Soil Zoology in Central Europe I. Institute of Soil Biology, Academy of Sciences of the Czech Republic, České Budějovice, pp. 95–101.

NOVÁK, J. (2011): Adatok a Bakony álskorpió-faunájához (Arachnida: Pseudoscorpiones). *Folia Musei Historico-Naturalis Bakonyiensis*, 28: 67–70.

NOVÁK, J. (2013): First records of *Larca lata* (Hansen 1884) and *Neobisium biharicum* Beier 1939 from

Hungary. *Opuscula Zoologica Budapest*, 44(2): 161–166.

SKET, B. (2008): Can we agree on an ecological classification of subterranean animals? *Journal of Natural History*, 42 (21–22): 1549–1563.

ŠŤÁHLAVSKÝ, F. (2006): Štírci (Arachnida: Pseudoscorpiones) Národního parku Podyjí. *Klapalekiana*, 42: 167–178.

SZABÓ, Á. & RIPKA, G. & HAJDU, ZS. & TEMPFLI, B. & VARGA, M. & MÉSZÁROS, I. & KUTASI, CS. & NÉMETH, T. & PÉNZES, B. (2013): New data on the mesostigmatid mite fauna of Hungary (Acari: Mesostigmata). *Acta Phytopathologica et Entomologica Hungarica*, 48(1): 149–154.

SZALAY, L. (1968): *Pókszabásúak I.* In. Magyarország Állatvilága (Fauna Hungariae) LXXXIX., 18., Akadémiai Kiadó, Budapest, pp. 122.