

Unraveling some Kinki worms (Annelida: Oligochaeta: Megadrili: Moniligastridae) - Part I

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Abstract. A new species, *Drawida eda* Blakemore, is proposed for an earthworm from rice paddy near Lake Biwa in central Japan. It is compared with both *Drawida barwelli* (Beddard, 1886) – the cosmopolitan type of the genus – and with sympatric *D. japonica* (Michaelsen, 1892) for which a new synonym, *D. propatula* Gates, 1935, is added. Parasitic origin theory of diagnostic ‘genital markings’ in *D. japonica* is extended to other taxa and their conspecificity is mooted. Definitive resolution of the taxonomic complexities within *Drawida* via DNA analysis is pending, although the COI barcode for the type of *D. eda* is initially provided, the first time for a new earthworm species. Polygiceriate similarity of Oriental ‘exquisititellate’ *Drawida* to megascolecoid genera like *Nexogaster* Blakemore, 1997 (type *Nexogaster sexies* Blakemore, 1997) is briefly noted. Using this opportunity, replacement names are given for two preoccupied Tasmanian Lake Pedder taxa as a normal part of taxonomic ‘housekeeping’, viz. *Anisogogaster* for *Anisogaster* Blakemore, 2000 (non Deyrolle, 1862, nec Looss, 1901) and *Perionchella variegata* for *Perionchella variegata* Blakemore, 2000 (non Michaelsen, 1907).

INTRODUCTION

Taxonomy of the large Indo-Oriental family Moniligastridae is beset by many small and apparently similar-looking taxa. Moreover, several key features are often ambiguous. New consideration of possible parasitic origin of characteristic yet highly variable ‘genital markings’ is an additional complication (see Blakemore *et al.* 2010 and *vide infra*).

In Japan, moniligastrid taxonomy is no less confused than for its other megadrile groups, thus the first and only comprehensive review by Easton (1981: 37, tab. 1) stated: “None of the eight [*Drawida*] species considered here is particularly well known and the specific status of each requires closer investigation”. In fact, only two of the eight have been encountered since their contrivance by other than their original authors,

viz. *Drawida hattamimizu* Hatai, 1930, which was dealt with by Blakemore *et al.* (2010), and *D. japonica* (Michaelsen, 1892) – the extent of which is reconsidered based upon historical types and recently re-surveyed material.

As with other taxonomic problems, a possible solution to *Drawida* quandaries is to employ DNA barcoding, for example using the mtDNA COI marker, and ideally this will initially be from primary types. The current paper aims to investigate taxonomic resolution via DNA extraction in compliance with ICZN (1999) Principle of Typification. Types are mostly unknown for earlier Japanese described taxa and most Japanese *Drawida* species are omitted completely from the register of Reynolds and Cook (1976). Reference barcoding of types in Japan, as with other regions, has the following contingency outcomes:

Contingency chart of molecular barcoding from primary types of a species (Sp)

Morphological Sp	Types	Sample DNA	Molecular Result
Known (valid name)	Present (old?)	Holotype/Lectotype (from Syntypes)/Hapanotype, etc.	Confirm species and/or synonymy
Known (valid name)	Absent or lost	Neotype (preferably from amongst topotypes)	Confirm a ‘good’ species or ‘kidnap’ and/or sink a poor one
New and valid name	New	Holotype (Paratype)	Compare taxa/morphs

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Multiple intestinal gizzards in series that characterize *Drawida* occur in some Eudrilidae (e.g., *Hyperiodrilus* Beddard, 1890) and are also remarkably prevalent analogs convergently evolved in Tasmanian megascolecids, particularly those from the Lake Pedder area of the Western Tasmanian Wilderness, perhaps relating to a mutual tendency to geophagy. Whereas *Provescus* and *Hypolimnus*, both described by Blakemore (2000), have doubled or multiple oesophageal gizzards, exemplars of multiple intestinal gizzards are: *Nexogaster* Blakemore, 1997 (type *Nexogaster sexies* Blakemore, 1997), *Retrovescus* Blakemore, 1998 (type *Retrovescus plomleyi* Blakemore, 1998), *Tassiedrilus* Blakemore, 2000 (type *Tassiedrilus griffithae* Blakemore, 2000), *Gastrodrilus* Blakemore, 2000 (type *Gastrodrilus driesseni* Blakemore, 2000), and *Anisogaster* (type *Anisogaster quini* Blakemore, 2000).

This latter genus is a homonym [non *Anisogaster* Deyrolle, 1862 (Coleoptera) nec Looss, 1910 (Trematoda)]. Tasmanian *Perionychella variegata* Blakemore, 2000 is also a junior homonym of Himalayan *Perionychella variegata* Michaelsen, 1907 that is now, at least following Stephenson (1923, 1930), held as *Perionyx variegatus* (Michaelsen, 1907). The opportunity is taken herein to provide replacement names to these two preoccupied taxa as required under the rules of ICZN (1999) and as a part of routine taxonomic ‘house-keeping’.

MATERIALS AND METHODS

Classification follows the convention and methodology style of Blakemore (2000, 2008) that allows for organic variability in natural members of a taxonomic entity.

DNA extraction, amplification and sequencing methodology follows that given in Blakemore *et al.* (2010), and these new data as presented in an Appendix will be submitted simultaneously to the GenBank online facility [<http://www.ncbi.nlm.nih.gov/genbank/>].

RESULTS

Systematics Results

The preoccupied genus name *Anisogaster* Blakemore, 2000 [non *Anisogaster* Deyrolle, 1862 (Coleoptera), nec Looss, 1901 (Trematoda)] is herein replaced by ***Anisogaster*** Blakemore **nom. nov.** [etymology: genus name with “-go-” added for euphony yet, as stated by ICZN (1999: Art. 30.1.2.): a genus name ending in *-gaster* should be treated as Latinized feminine]. The preoccupied species name *Perionychella variegata* Blakemore, 2000 [non *Perionychella variegata* Michaelsen, 1907b: 158] is here replaced with ***Perionychella variegata*** Blakemore **nom. nov.** (etymology: noun in apposition with “-go-” added for euphony and to remove homonymy as required by ICZN (1999: Arts. 23.3.5, 23.9.5, 31.2.1, 39, 52, 53.3 and 60).

Genus ***Drawida*** Michaelsen, 1900: 114 as per Stephenson (1923, 1930) and as recently re-defined in Blakemore *et al.* (2010).

Type species. *Moniligaster barwelli* Beddard, 1886: 94, figs. 4-6 by original designation.

Type locality. Manila, Luzon, P.I.; types in British Museum (BMNH 1904:10:5:522-3 according to Reynolds & Cook, 1976) were disputed by Easton (1984: 112) who stated: “*examination of the specimen (BMNH: 1904:10.5.2-3) [sic], and the associated slide of the body wall, produced no useful data. The specimen is a posterior fragment about 66 mm long. As this is considerably larger than the dimensions provided by Beddard, it is doubtful whether this individual belongs to the type series.*”

Easton then redescribed *Drawida barwelli* on new material from the Pacific Isles and from Jamaica. It is nevertheless possible that the type series retains extractable DNA, and this will be investigated in a later publication.

Species descriptions

***Drawida barwelli* (Beddard, 1886)**

(Figs 1.1–1.4)

Moniligaster barwelli Beddard, 1886: 94, figs. 4–6.

Drawida barwelli: Blakemore 2002: 69, 2008: 119 (for complete synonymy).

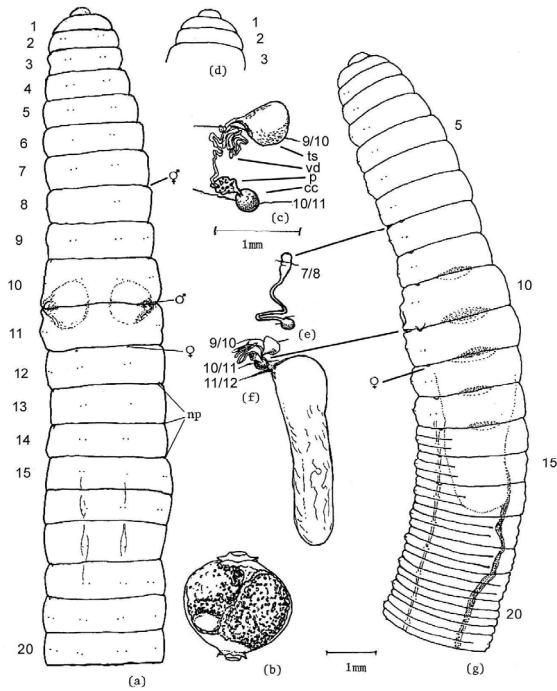


Figure 1.1. *Drawida barwelli*, ex Samford (Qld, Australia) specimens anaesthetized in alcohol, sketched then dissected: a = ventral view, b = cocoon, c = enlargement of testis sac on septum with convoluted vas deferens to 'prostate' on copulatory chamber, d = dorsal view of prostomium, e = spermatheca and f = male organs and distended, gravid egg sac shown in relative position, g = lateral view (dorsal blood vessel and eggs sac visible through cuticle)

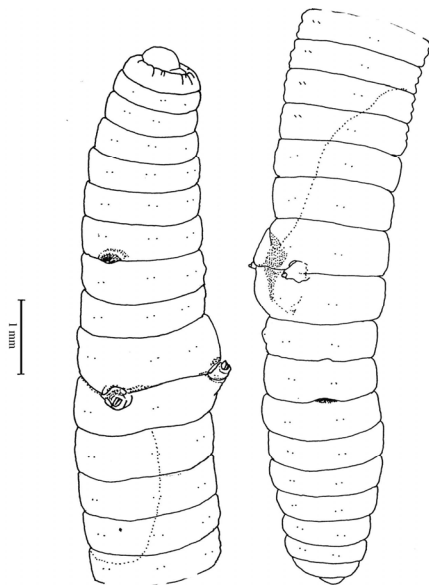


Figure 1.2. *D. barwelli*, two amphimictic Samford specimens captured 'in flagrante delicto'

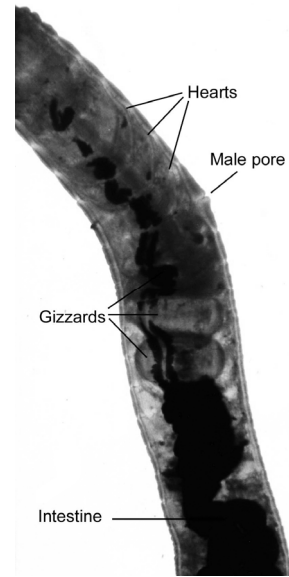


Figure 1.3. *D. barwelli*, live specimen gently compressed under glass slides (photo by RJB)

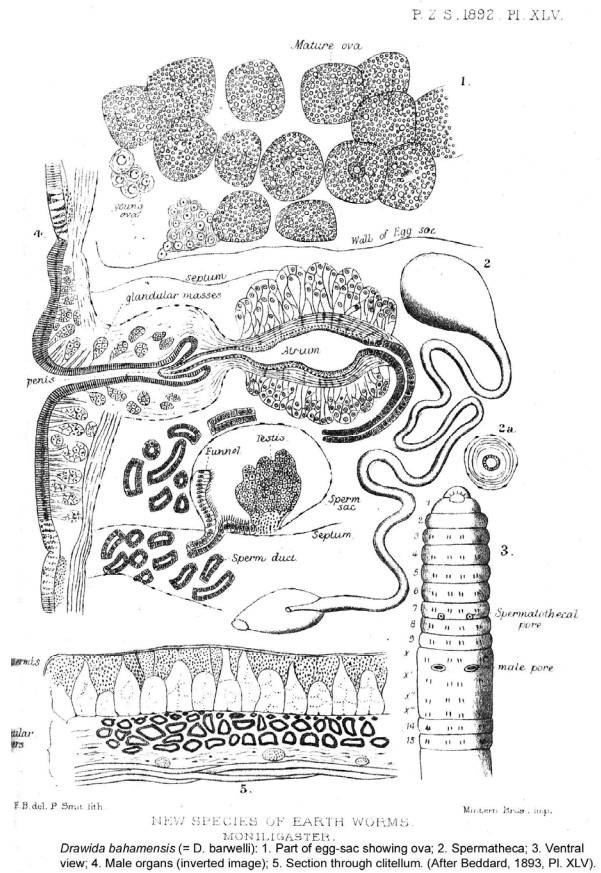


Figure 1.4. *Drawida barwelli* synonym *D. bahamensis* after Beddard (1893, Pl. XLV)

Material examined. *Drawida barwelli* 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, which he labeled “(BMNH: 1904:10.5.2-3)”, comprised a posterior portion and an associated slide that produced no useful data (although DNA is possibly retained?); Australian material: Canberra ANIC: RB.95.4.1, numerous specimens collected at Samford, Qld (27°22'S, 152°53'E) by RJB in 1992 (Blakemore 1994).

Remarks. Description is restricted to figures and comparative Tables 2 and 3 below. *Drawida barwelli* is fully described, figured, photographed, and its synonymy, world distribution and historical records accounted for in Blakemore (1994, 1999, 2002, 2008) with this species as the first record of a moniligastrid from Australasia, and of *D. barwelli* from Thailand (as *D. beddardi* synonym) and Hainan, China for *D. gabella* Chen, 1938 **syn. nov.** Specimens of similarly small and unpigmented species may be easily confused superficially, not least *D. japonica* and *D. eda* as described next.

***Drawida eda* Blakemore sp. nov.**

(Fig. 2)

Type material. Rice paddy survey, Tanakami region nr. Kurotsu, southern Otsu-shi, Shiga-ken, Kinki, Japan - ca. 35°1'N, 135°51'E, elev. ~80 m, 17.VI.2009 sample stations #4-6, leg. RJB, all deposited with initial Accession No.: Misc. Invert. FY2009-13 in Lake Biwa Museum (hereafter, LBM), Kusatsu-shi, Shiga-ken. *Holotype* (H) ex sample #6 from Eda 1-chôme (type locality), Otsu-shi, slightly larger of two mature specimens that are now separated off, sketched and dissected dorsally with a small tissue sample taken from posterior region for DNA diagnosis. *Holotype* Reg. No. LBM1380000097. *Paratypes* (P1) ex sample #5 with same collection data except from Inazu 4-chôme, Otsu-shi, mature, initially labelled as “*Drawida* cf. *barwelli*”, dissected, LBM 1380000101; (P2) the slightly smaller specimen with same data as H, undissected, LBM 1380000100; (P3-7) five specimens ex sample #4

with same collection data but from Kurotsu 5-chôme, Otsu-shi, inspected but undissected, LBM 1380000102.

Etymology. The specific name “*eda*” is a noun in apposition meaning “*branch*” in Japanese referring to type locality and alluding to phylogenetic branching off of species throughout the Darwinian Tree-of-Life.

Diagnosis. Small, unpigmented *Drawida* lacking genital markings, with male pores in 10/11 on tips of ‘comma-shaped’ eversible organs (penes) and spermathecae median of *c* lines in 7/8. Spermathecal atria are elongate and accompanied ventrally by a small, distinctive accessory gland. Prostates are glandular overlaying male atrium. Gizzards number five in 13–17 (but first one may be weaker). Apparent feature on preservation is male organ extrusion only from 10/11 lhs (from the observer’s point of view), seen consistently in all specimens that is probably a product of preservation.

Distribution. Known only from the type locality which is not unusual for such small species that are often overlooked or mistaken for other taxa, e.g. *D. barwelli* or *D. japonica*. Its restricted distribution may also be indicative of an exotic introduction.

External features. Holotype and paratypes all appear mature although clitella are not particularly distinct. Biometry: lengths (mm) range 40–86; H 86, P1 66+ (posterior amputee regenerate), P2 85, P3 50, P4–6 40, P7 40+ (posterior regenerate); width about 2 mm. Segments: H 154, P1 116 with the last 16 regenerated. Body circular but slightly quadrangular in posterior section. Unpigmented/pale in ethanol. Prostomium prolobous. Dorsal pores absent although thinning and imperforate dark spots seen in some specimens. Setae lumbricine with ratio figured for segment 12. Clitellum in ½9–13 or less for H. Nephropores seen on clitellar segments approximately in *d* lines, but closer to *c* lines further posteriorly. Spermathecal pores in 7/8 in *cd* but just closer to *c* lines, quite deep with possibly minute pore

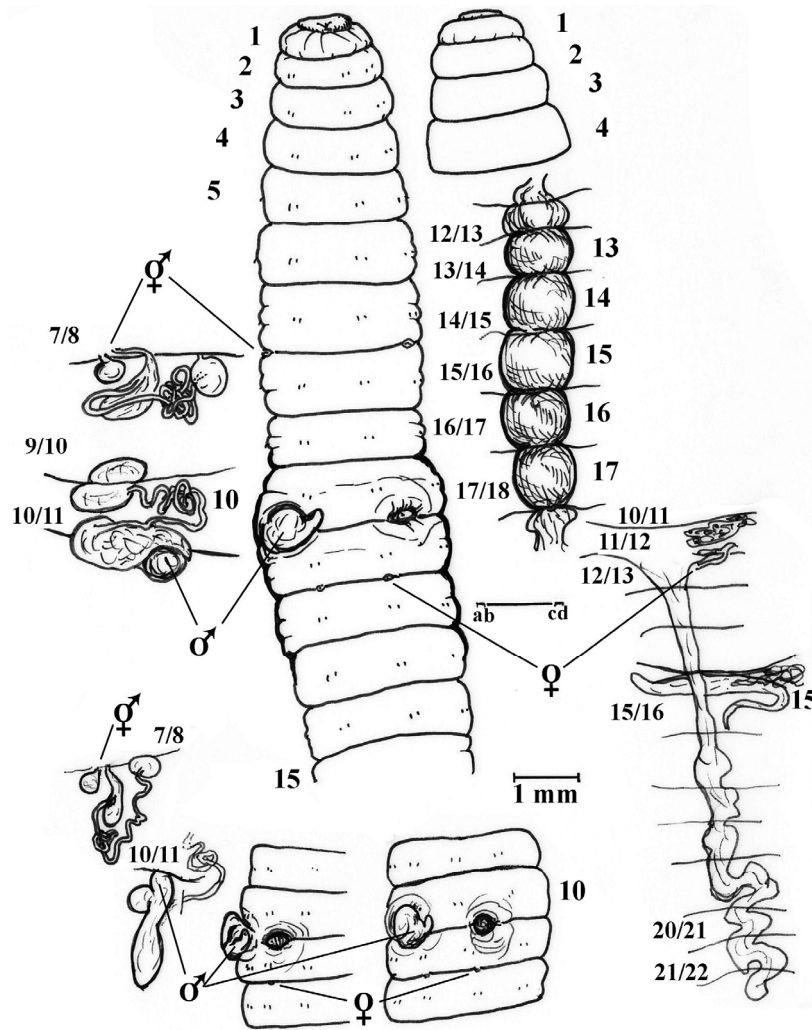


Figure 2. *Drawida eda* Holotype and P1 showing ventral view of H with its spermathecal, male and female organs marked as they appear *in situ*; its gizzards in the region of 13–17 and a single nephridium for shown example in segment 15; genital region of P1 in ventral and ventro-lateral view with similar arrangement of genital organs – see text for details

adjacent to spermathecal opening intramurally. Male pores in all specimens have lhs male pore extruded and appearing as inward-facing flat comma-shape with primary pore median-most on comma's tail; the rhs pore is invaginated and wide just lateral to *b* lines, sometimes with only the penial tip extruding. Female pores minute in 11/12 in *ab* slightly closer to *b* lines.

Internal anatomy. Septa converged around ovarian segment as usual. Nephridia holoic with large sausage-shaped bladders seen from 6 (at

least) and retained in segment 10. Hearts in 6–9 and dorsal blood vessel single. Spermathecal ampulla attached to posterior face of septum 7/8 with long, convoluted duct to wall of large thumb-shaped atrium (apparently entering about mid-length). Adjacent on the outboard side to where the narrowing atrium exits is a small sessile but solid accessory gland (seen in both dissected specimens). Testes in sacs that transgress septum 9/10 with elongate and convoluted vas deferens appearing to enter apex of large elongate and glandular prostate that is S-shaped overlaying

spherical male chamber (male atrium) in 10/11. Ovaries are large on posterior face of septum 10/11 with oviducts opposite and lateral to ovisac entrances from septum 11/12 that extend back through to 21/22 in H or to just 13/15 in P1. Oesophagus widens in 12 and gizzards are muscular spheres in 13–17 (five of in H and P1) but perhaps weaker in 13; intestine proper commences behind gizzards in 18.

Ingesta. Not noted but assumed to be geophagous based on the muddy habitat.

Behaviour. Apart from the extrusion of the lhs male pores on preservation, no ethological characters were recorded.

Genetics. A small tissue sample was taken from non-essential posterior segments of H for DNA extraction and sequencing to provide COI barcode (data in supporting online material).

Parasites and predators. None noted.

Ecology. Nothing is yet known of its ecology except that it appears to survive in cultivated and/or waterlogged paddy soils. Other species found on the same collecting trip with H and P2 in sample #6 were *Amyntas corticis* (Kinberg, 1867) and from other samples #4–5 were several pheretimoid megascolecid plus the ocerodrilid *Eukeria saltensis* (Beddard, 1895) and several lumbricids (see Part II accompanying paper).

Remarks. *Drawida eda* is similar in superficial appearance and biometry to *D. barwelli* and to specimens of *D. japonica* that lack markings. Features that distinguish these entities are the eversible male pore structures in *D. eda* that are developed rather more than simple penes or mounds, and the gizzards that are more numerous and posteriorly placed being five in 13–17 in *D. eda* (Tables 2, 3). Nephridial details may also differ. Accessory glands outboard of each spermathecal atrium appears distinctive in *D. eda* although a similar feature occurs in *Drawida nemora* Kobayashi, 1936, *D. keikiensis* Kobayashi, 1938, *D. tairaensis* Ohfuchi, 1938 and *D. jeholensis* Kobayashi, 1940. These may thus be the nearest taxa, however they all have fewer gizzards (Table

3). *Drawida nemora*, as redescribed by Kobayashi (1938, 1940), has three to five gizzards in some of 12–16; *D. keikiensis* has gizzards in only 12, 13–15; *D. tairaensis* has four from 13 (i.e., in 13–16?). Chinese *Drawida jeholensis* has two or three gizzards in 11, 12–13. In some of these species a further difference is irregular genital markings (when present!).

The key in Michaelsen (1900: 114) points the current specimens to Indian and Aru Island *D. parva* (Bourne, 1894) *sp. dub.* that differs not least by fewer gizzards in 14–16, 17.

An interesting feature of the Lake Biwa worms is that specimens had the lhs male apparatus everted consistently, whereas the rhs organ was either invaginate or only the tip of the penis was visible. This is similar to one specimen from the Juan Fernandez Isles described as *D. bahamensis* (Beddard, 1892) by Gates (1969) with only their rhs male pores extruded, this taxon is now in synonymy of *D. barwelli*, nevertheless it may be a characteristic of worms within this species group.

The mtDNA-COI barcode should help to definitively differentiate *D. eda* from any sympatric or exotic congeners (data in Appendix). Morphological comparison with *Drawida barwelli* is touched on above; *D. japonica* is described and compared next below.

***Drawida japonica japonica* (Michaelsen, 1892)**

(Figs 3.1–3.7)

Moniligaster japonicus Michaelsen, 1892: 232–233. [From Japan. Syntype in Hamburg Museum: 403 (Reynolds & Cook 1976), but originally stated by Michaelsen as in Zoological Museum, Berlin: Verm. 2122 and this syntype is also listed by Hartwich & Kilius (1989: 268 as “*Japan; HILGENDORF leg.*” just after *Allolobophora japonica* (Verm. 2117). Both were collected by Herr Dr Franz Hilgendorf, the latter definitely at Enoshima on 29.III. 1875 – thus this is possibly a type locality of the *D. japonica* syntype although my searches of the island have thus far proved fruitless for this species. Gates (1939: 411–413) did not mention #403 but he inspected three specimens from Hamburg labeled “*V 1194. Drawida japonicus Mich. f. Typ. Dr Chen F. Wu c. Dr Michaelsen a. Nanking, China*” and other materials none of which were types, saying (incorrectly) on page 413 that the original two types – described by Michaelsen as “*Diese*

Art ist durch ein geschlechtstreffes und ein unreifes Exemplar vertreten” – were sectioned and are no longer available for study. Note the “Typ.” in the China label refers to *D. japonicus* f. *TYPica* not to a true type specimen].

[? *Moniligaster bahamensis* Beddard, 1893: 690, figs 1-5.; Beddard 1895: 202. Type locality Kew Gardens imported with plants from the Bahamas. Types unknown and this confirmed from personal enquiries to NHM, London. Included by Michaelsen (1910: 50) as a *D. japonica* subspecies, it is now held in *D. barwelli* synonymy]

Drawida japonica: Michaelsen 1900: 115.; 1910: 48.; Stephenson 1922: 119, figs. 1-6.; Chen 1933: 189, fig.?.; Gates 1935: 3 (questioning Chen’s ‘*D. japonica*’); Chen 1936: 291 (syn. *grahami*); Kobayashi 1937, 1938: 94, fig. 1.; Gates 1939: 411 (cf. *grahami*); Kobayashi 1940: 263 (part. + *propatula*); 1941: 458, 515.; Chen 1959: 15, fig. 22.; Ohfuchi 1965: 546 (plus fig. apparently copied from Chen); Easton, 1981: 37 (part. excluding *grahami* and with China not included in distribution range); Blakemore 2003; 2005/2007 (syn. *grahami* from China).

Drawida japonica typica: Michaelsen 1910: 49.; 1927: 85.; Stephenson 1917: 366, fig. 1.; 1922: 126.; 1923: 142, fig. 52 (part. syn. *bahamensis* and explaining Michaelsen’s initial incomplete description).

Drawida japonicus typicus: Michaelsen 1931: 7.

Drawida japonicus: Michaelsen 1931: 523 (part. syn. *siemseni*).

Drawida grahami Gates 1935: 3.; 1939: 408. [From Suifu, Szechuan. Type(s) USNM: 20093. Said to have more ventral spermathecal pores in mid-bc otherwise cf. *D. japonica*; three gizzards in 12-14 (as in three of Gates’ five subsequent *D. japonica* specimens); one of seven of Gates’ specimens lacked markings].

Drawida propatula Gates 1935: 449. [From China. Types USNM 20179. Said by Kobayashi (1938: 94, 1940: 263) to be similar although Kobayashi (1940: 265) maintained them separately mainly on extent of the ovisacs]. **Syn. nov.**

Drawida japonica japonica: Blakemore 2005/2007 (syn. *grahami*); 2008; Blakemore *et al.* 2010: 1.

Material examined. Berlin Kat. Nr. 2122 (*Drawida japonica* Syntype! Japan. Hilgendorf) a dissected specimen 26mm long with the last 24 of its 95 segments regenerated that, although the internal organs are mostly removed, is nevertheless in good condition; Hamburg #403 syntype label states collected by Hilgendorf in Japan but is only a desiccated posterior portion (ca. 8mm and 25 segments comprising mostly intestinal soil and possibly Michaelsen’s ‘25 segmenten regeneriert Hinterende’- RJB pers. obs. IV.2010). Five specimens, two from “Aichi” [kanji for the prefecture] (one with dorsal pores and GMs and one

without either) plus three from fields at Nagura-shi near Nagoya, Aichi-ken (one with dorsal pores but no GMs, the other two without either) all stored in Hachioji collection (RJB inspected 20.IX.2002); Watarase one specimen without dorsal pores but with GMs in 9lhs posteriorly and 10rhs anteriorly, and male pores in 10/11 on eversible penes with gizzards in 12-14 (coll. IV.2003 by Dr Takafumi Kamitani of YNU and RJB inspected 9.IV.2004); one specimen collected from Kamakura Daibutsu shrine 13.VI. 2004 by RJB (identified tentatively); four specimens from rice fields in Hikone-shi, Shiga-ken (collected 19.VI.2009 by RJB) – one dissected and figured (Fig. 3.5) plus donor for mtDNA COI sample (GenBank GQ-500902); plus three others, all lacking dorsal pores but having GMs as detailed below (these latter specimens’ reg.no.s LBM 1380000085 ex FY2009-13-3).

Original author’s description [Michaelsen (1900: 115)]: “*I. D. japonica* (Michlsn.) 1892 *Moniligaster japonicus*, Michaelsen in: *Arch. Naturg.*, v. 581 p. 232. *Grau. Kopfplatten klein. Borsten eng gepaart, in ventralen und lateralen Paaren; Borstendistanz aa gleich bc. Vor den männlichen Poren am 10. Segm. je 1 Pubertätsgrube. 2 große kugelige Muskelmagen im 12. und 13. Segm. Testikelblasen kugelig; Samenleiter eng gewunden; Prostaten dick schlauchförmig. Ovarien im 11. Eiersäcke dick schlauchförmig, unregelmäßig verdickt und gekrümmt, vom Dissep. 11/12 bis etwa in das 16 Segm. reichend. L. 28, D. 3mm; Segmz. 95 (Hinterende regeneriert). Japan*”.

[*Translation:* Gray. Prostomium small. Setae tightly coupled in ventral and lateral pairs; setal distance *aa* equal to *bc*. Before each male pore on 10 is a puberty pit (= genital papillae). Two large spherical gizzards in 12 and 13. Testes sacs spherical bubbles; vas deferens tightly wound; prostates thickly tubular. Ovaries in 11; ovisacs thickly tubular, irregularly thickened and curved; reaching from 11/12 to around 16. Length 28; width 3 mm; segments 95 (posterior regenerated). Japan.].

External characters. (from synonymy above and pers. obs.): Grey when preserved (Michael

sen, Stephenson and pers. obs. Aichi or, Hikone specimens) or ruddy in field and pale bleached in alcohol. Size ~26–130 mm by 2–4.5 mm although Chen (1933: 194, 1959: 15) says up to 200 mm in specimens that Gates (1935: 4) doubted were conspecific. Segments up to 142 [cf. 126–179 Kobayashi 1938, 1940 (for *D. propatula*); 195, Chen]. Prostomium small and seen with a characteristic ventral cleft in Aichi and Biwa specimens (pers. obs.). Dorsal pores intermittently present (RJB pers. obs. in syntype #2122 where they are small in 8/9 and 10/11 and gaping in 31/32 and irregularly to 58/59; also in some Aichi specimens where they were in 9/10 seen due to ejecta although possibly small in 8/9 too, thereafter intermittent and, although gaping when present, they cease before segment 45) or, more usually, absent. Setae small and closely paired (aa = bc). Nephropores seen in anterior in d lines or above in 3-8, thereafter in cd or c or ab lines on each side from 9; less obvious in posterior. Clitellum 9,10–13,½14. Spermathecal pores 7/8 in bc (but closer to c). Male pore superficial lateral of b on porophore on 10 [according to Stephenson (1923) and Gates (1935)] or in 10/11 [Michaelsen (1892: 232; 1900: 115) who says they are clearly in 10/11 and overhanging segment 11 after a pair (or unilateral) markings in 10, this repeated by Gates, 1939] current specimens have male pores on those protruded ‘flaps’ overhanging 10/11 and just lateral to b lines (pers. obs. as per Michaelsen and Kobayashi) or (doubtfully) as eversible penes in the Watarase specimen]; Hikone specimens have ventral region of segments 10 and 11 flared around the male pores to present a flattened area; ‘Genital Markings’ variously in 7–13 [e.g. Michaelsen has them in 10, Stephenson in 7–9 and 12, Easton in 7–9 and 12-13, Chen in 7–12, and Kobayashi in 7–13 and, for *grahami* and *calebi* they are stated to be in 7–13 thus this is accepted as the extent]; that said, however, it is possible they are all just parasitic artefacts (RJB pers. obs.) – and sometimes they are absent [e.g., Gates, Kobayashi (1938) and RJB pers. obs. of Aichi specimens; cf. *D. barwelli*]. Female pores minute in 11/12 near b lines.

Internal anatomy. Septa 5/6–8/9 thickened; septum 10/11 weak and displaced to enclose ovaries and egg-sacs in 11. Large tendons pass on

either side from dorsum at 10/11 to the *ab* ventrally in 11 which may assist bowing of the male pores during copulation. Hearts 6–9. Nephridia holoic and vesiculate (always?). Spermathecae with ampulla from septum 7/8, mostly pear-shaped or spherical but sometimes with elongate extension to duct that is convoluted to small atrium. Testis sacs spherical, bulging from 9/10, vasa deferentia tightly wound. Prostates described by Michaelsen (1900: 114) as thickly tubular and by Gates (1939: 410, 412) as round, sessile discs (*grahami*) or club-shaped and erect (*japonica*); here described as ‘blunt’. Ovaries in 11 with long ovisacs from 11/12 as far back as 16 [or 43 according to Gates (1935: 3) who, rather condescendingly, said that “*These appendices were overlooked by both Michaelsen and Stephenson*” but he failed to account that extent is dependent on stage of maturity]. Gizzards usually two in 12–13 (Michaelsen, Stephenson and pers. obs.) or there may be three in 11–13 (Stephenson) or 12–14 (Chen, Kobayashi and seen in Watarase and Hikone specimens) or in some of 11,12–13,14 (Gates cf. *D. barwelli*); intestinal origin in 15–18 after gizzards. Corresponding to the external ‘markings’ are small, white spherical bodies that are buried in body wall and appear to duct to exterior – however, these may be parasitic artefacts of gregarine sporozoites (pers. obs. and see Blakemore 2008).

Species associations. Michaelsen (1892) recorded these taxa at the same time as *Drawida japonica* (No. 2122. Hilgendorf rp.): *Eisenia fetida* (Japan; o. 2121, Hilgendorf); *Aporrectodea trapezoides* (Japan; No. 2119, Hilgendorf); *Eisenia japonica* (Japan, Enosima; No. 2117, - Hilgendorf rp. 29,III,1875); *Duplodicrodrilus schmaridae* (Japan; No. 2120. Hilgendorf rp.), *Metaphire sieboldi* (Japan; No. 2133. Langegg rp., Hilgendorfi leg.), and *Metaphire hilgendorfi* [Japan, Hakodate; No. 2123, Hilgendorf rp. (Typische Exempl. α und Exempl. γ und δ); Japan, No. 2144, Hilgendorf rp. (Exempl. ϵ); Japan, Yokohama; No. 2149, v. Martens rp. (Exempl. β)] plus *Amyntas corticis* [as *Perichaeta indica* Horst. (Japan; No. 2188. Hilgendorf. rp.) and as *Perichaeta divergens* (Japan; No. 2116. Hilgendorf rp.)]. Which, if any, of these were co-incident is unknown.

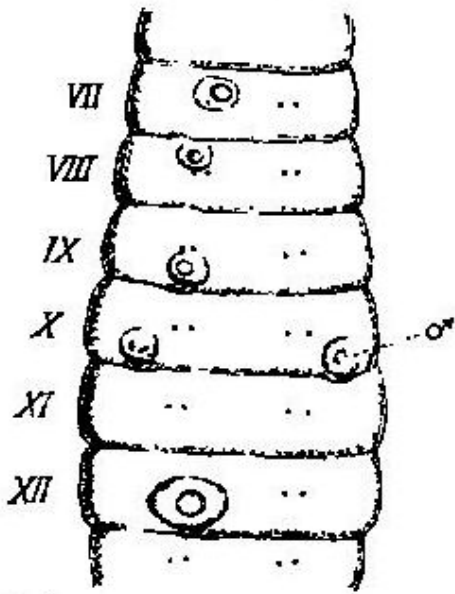


Figure 3.1. *Drawida japonica* from Stephenson (1923: fig. 52 seemingly mislabeling 'marking' on 10 as male pore)

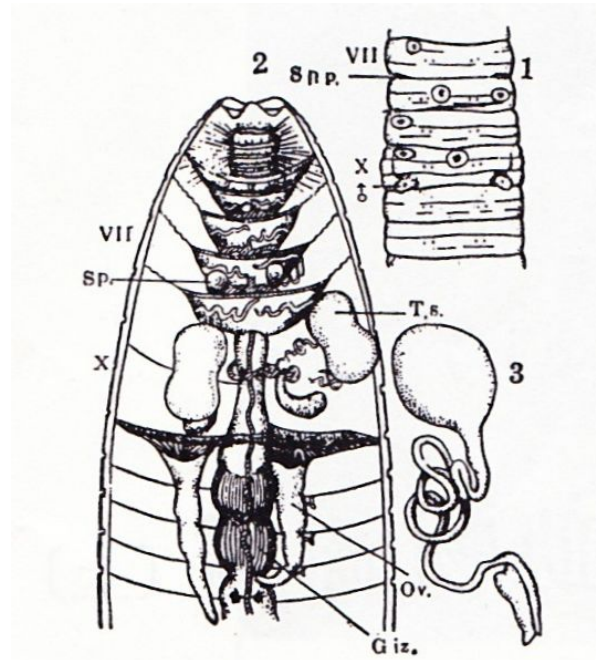


Figure 3.3. from Ohfuchi (1965?): #1 external, #2 internal, #3 a spermatheca; note: Ohfuchi's #2 has miscounted the internal segments – a quite common mistake – cf. Chen's original)

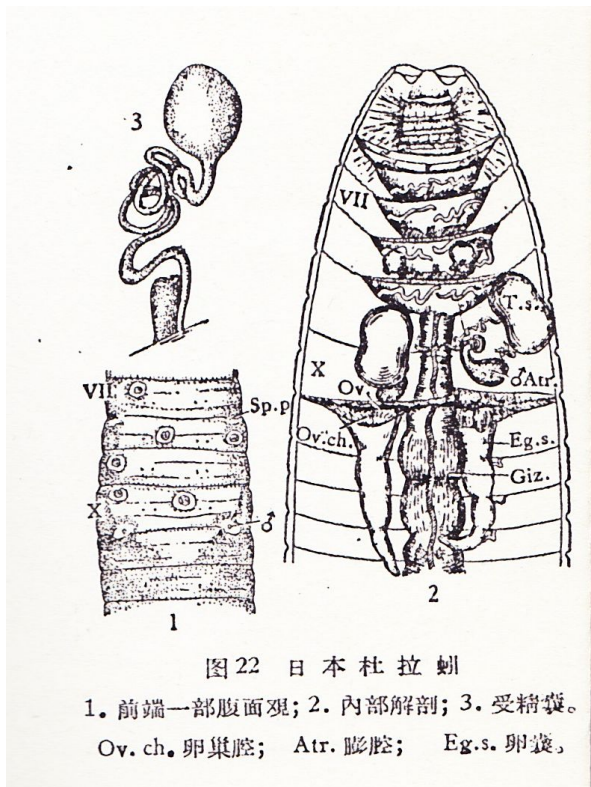


Figure 3.2. From Chen (1959?: fig. 22)

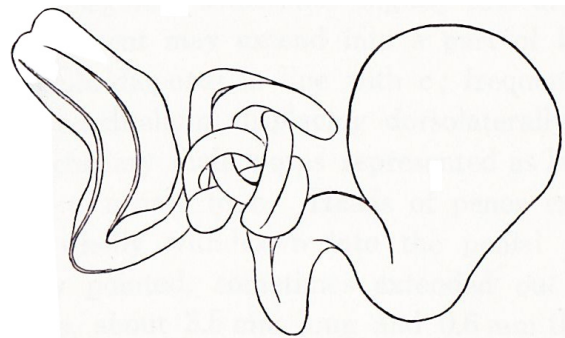


Figure 3.4. from Kobayashi (1938: fig. 1 of a spermatheca being exactly similar to current sketch)

Distribution. Japan, from around Tokyo, Honshu to Nagasaki, Kyushu, *Drawida japonica* is probably not wholly endemic to Japan as its distribution includes southern China, Taiwan, the Ryukyu Islands, Japan (Honshu, Shikoku, Kyushu), Korea (including Quelpart/Jeju-do), and south-east Asia. Inclusion of *D. propatula* adds central and northeast China. Stephenson (1923: 143), Gates (1939: 413 six specimens from Mur-

ree) and Paliwal & Julka (2005) list it outside the normal *Drawida* domain from the western Himalayas, India; and it is reported (as “*Drawida japonica* Michaelsen 1917”) from the famous Punjab beer-district of Solan, Himachal Pradesh (Dhiman & Battish 2005). [Note: Stephenson’s (1923) description included *bahamensis* that is now included in *barwelli* as it typically lacks ‘genital markings’; cf. Japanese *D. eda* specimens lacking markings that have a male pore on extractible penis rather than external and ‘flap-like’].

Ecological and Economic Importance. Apart from contributing to soil fertility and a basis for food-webs – as with all other earthworms – this species has been utilized as a bioindicator for soils in China (Fang *et al.* 1999), assuming their identification is correct.

Remarks. In summary, the problem of integrity of *Drawida japonica* is that it was soon confused with *D. bahamensis* and this possibly introduced new characteristics into the definition. Subsequently, *D. bahamensis* was either included in *D. japonica* or transferred as a junior synonym of *D. barwelli*. Perhaps this is indicative of entities such as *D. bahamensis* being intermediate between these two earlier described taxa, thereby eroding validity of either. Moreover, the only substantial characters differentiating *D. japonica* from prior *D. barwelli* are the flap-like male poropores (cf. Watarase specimens) and possibly its cleft prostomium. Markings vary and, on current interpretation so far, may actually be parasitic artefacts. Whether these are truly characteristic of *D. japonica* is currently uncertain. Kobayashi (1938: 94) remarked how similar Chinese *D. propatula* Gates, 1935 is, but the latter is supposedly larger and has longer egg-sacs although these features are not now of much significance, thus it is placed in synonymy.

Michaelsen (1910: 48–52; 1931: 523) recorded subspecies for this taxon, *Drawida japonica siemsseni* (Michaelsen 1910) from Fuchow, China that Michaelsen (1931b: 7) later said “*seems somewhat questionable*” and which Gates (1939: 414) redescribed from the Hamburg type [labeled

as “V 6333 *Drawida japonicus* Mich. f. *siemsseni*. Tiensin, Futschau” that he said was inadequate as the internal organs had been removed in course of the original dissection and lost, and for which there is also a discrepancy as Reynolds & Cook (1976: 170) list type as “6233”] as a clearly separate species having 6 gizzards (cf. Gates 1935: 3); and *Drawida japonica bahamensis* (Beddard, 1893), for which types are listed as missing in Reynolds & Cook (1976: 75), and that was subsequently placed, at least by Easton (1984: 112) and Blakemore (2002, 2008), in synonymy of *Drawida barwelli* (Beddard, 1886).

Other similar species are *Drawida minuta* (Bourne, 1887) with male and spermathecal pores in *ab*, and *Drawida willsi* Michaelsen, 1907 that differs, at least, by being a bluish grey or reddish grey colour and it may have an additional pair of rudimentary male pores in 9/10 corresponding to those in 10/11, as is more usual. A specimen of ‘*D. willsi*’ that Michaelsen (1907 or 1909?) described from Western Himalayas, was thought by Stephenson (1923) to be *D. japonica*.

Kobayashi (1940b) had proposed a dispersal of *D. japonica* from China to Japan, possibly via Taiwan and questioned the identification of some earlier records from outside the Japan/Korea area. Although, Gates (1972: 244) was of the opinion that this species came originally from the Indian Himalayas, from whence it was recorded by Stephenson (1923), and from Yunnan and Szechuan, Stephenson (1923: 143) had earlier said its occurrence at Murree and probably Simla (by Michaelsen 1909) in the western Himalayas was “*far from the proper Drawida region*”. This domain he regarded as in southern India and the eastern Himalayas and so Stephenson classed *D. japonica* as “*a wanderer [i.e., a peregrine] of a pronounced type*”. Easton (1981: 37) included only Japanese and Korean records in his distribution range for this taxon.

Identification now confirmed and augmented from inspection of original syntypes and new material. Major differences from some earlier accounts (in synonymy above) are that markings

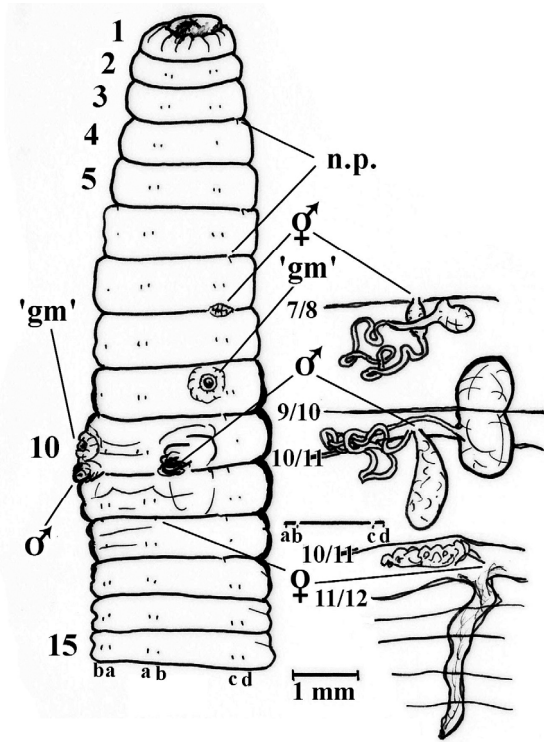


Figure 3.5. Shiga specimen (LBM1380000085 that provided DNA sample for Genbank)

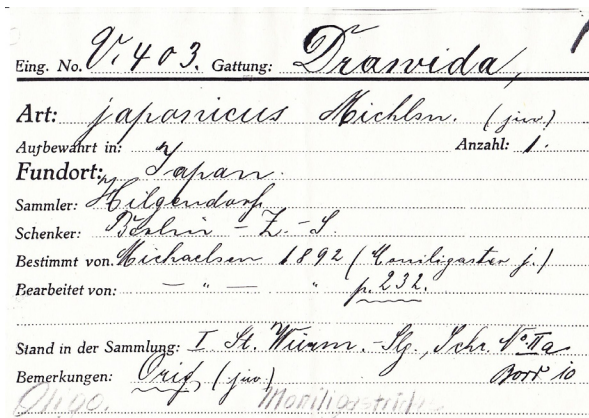


Figure 3.6. Copy of the label for Hamburg Syntype #403.

may be present only in 10 (just ventral of c) as per Michaelsen's original account or absent; Stephenson (1923: 142) has them in “vii–ix and xii” and Kobayashi (1938: 95) from “about a thousand specimens from about a hundred localities” allows either in 7–13 or totally absent, while Easton gives them in 7–9, 12 and 13 [actually Easton (1981) states “vii–ix, occ. xii & xiii” which may

be a mistake for “vii–xi, occ. xii & xiii”, or not] and, for *D. grahami* synonym, Gates (1939) has them in 7–13 or absent in at least one of his Suifu specimens. Present specimens either lack them entirely or have them unilaterally or paired on posterior or anterior of some of 7–9 and anteriorly in 10 or 13. It appears Stephenson (1923: 142, fig. 52 – herein Fig. 3.1) mistook the paired genital markings posteriorly in 10 for male pores that he himself (p 124) describes as intersegmental in 10/11. Moreover, in the present specimens, dorsal pores may be absent or intermittent: e.g., the Berlin syntype and one Aichi specimen had them from 8/9/10 but thereafter, although gaping, they became intermittent and were not present after segment 60. Earlier authors overlooked the intermittent and variable dorsal pores.

As remarked by Blakemore *et al.* (2010), recent inclusion in COI barcode analyses (by Huang *et al.* 2007 and Chang *et al.* 2008) from Chinese source material differed by ~17% from a Lake Biwa sample and conspecificity of these Chinese

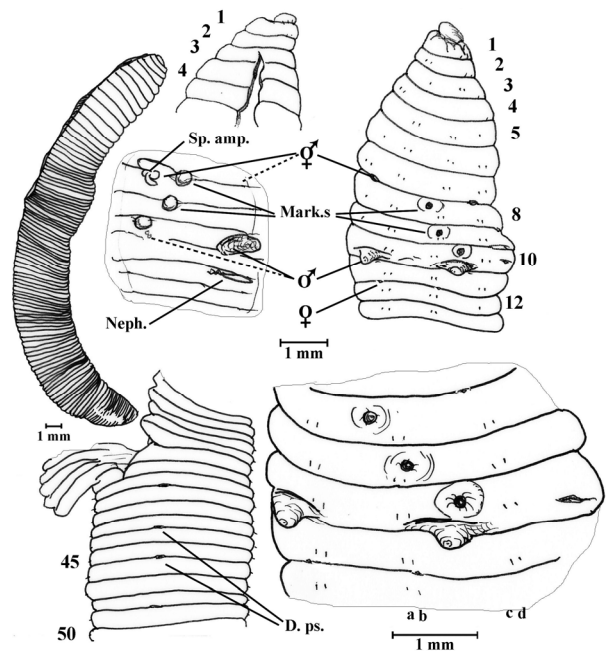


Figure 3.7. Sketch of Berlin Syntype #2122 showing habitus at low scale; anterior, externally and internally (with remnant lhs ampulla, rhs prostate and vesiculate nephridium in 12), and mid-body showing dorsal pores; plus an enlargement of genital field

specimens, at least, require comparison with synonymic *Drawida grahami* Gates, 1935 types (Smithsonian #20093), also with types of erstwhile sub-species *Moniligaster bahamensis* Beddard, 1893 and *Drawida japonica siemsseni* (Michaelsen, 1910) (Hamburg #6233), plus its likely new synonym, Chinese *D. propatula* Gates, 1935.

Drawida nepalensis (Michaelsen, 1907) with gizzards in 13–20 and *D. ramdadana* (Michaelsen, 1907) are also closely reminiscent taxa. It may be noted that *D. gracilis*, *rangoonensis*, and *rara* by Gates, 1925, and *D. flexa* Gates, 1929 plus similar taxa from Myanmar appear to differ only in their two to five gizzards in 12–23 – see Gates (1962: 320–351). Another potential synonym is *D. vulgaris* Gates, 1930, unless it is a synonym of *D. bullata* Gates, 1933: 424 (with its synonym *D. fucosa* Gates, 1933: 439) – see Gates (1962: 313).

DISCUSSION

Regarding *Drawida* nomenclature, two substitute names for Chinese *Drawida* seem to have been omitted in a recent website (i.e., insects.tamu.edu/research/collection/hallan/test/Ann-elida/Family/Moniligasteridae.txt accessed 13.III.2010). As a reminder, the new replacement names were: *Drawida zhangetalia* Blakemore, 2006 for *Drawida cheni* Zhang *et al.*, 2006 (non *Drawida cheni* Gates, 1935), and *Drawida zhongi* Blakemore, 2006 for *Drawida sulcata* Zhong, 1986: 28 (non *Drawida sulcata* Michaelsen, 1907: 144 from South India), published under provisions of ICZN (1999: Art. 8) for permanently invalid primary homonyms, and both new names formed with approval of their original authorities. The same website has further catalogued several other invalid names making them searchable on the Net and giving the false impression they are valid taxa. Whereas Oishi (1932: 18) listed as new several Japanese species names, viz.: “*Drawida toriui*” sometimes misspelt “*Drawida torini*”, “*Drawida kamakuraensis*”, “*Drawida tosaensis*”, “*Drawida hataii*” sometimes misspelt “*Drawida hatai*”, and “*Drawida kambarai*”, none of these was supported by description and all are therefore

nomina nuda outside of ICZN nomenclature (Easton, 1981). Current earthworm species from mainland China are checklisted by Blakemore (2007 - <http://bio-eco.eis.ynu.ac.jp/eng/database/earthworm/China.pdf>); and similar checklists are freely provided for India, Taiwan, Korea, Japan and all SE Asia faunas as hosted on the same YNU server site and mirrored on <http://www.annelida.net/earthworm/> (accessed 10. V. 2010)

Taxonomically key characteristics are often ambiguous for small *Drawida* species. Moreover, size range and colouration are generally variable in most earthworms. As the moniligastrid clitellum is only one-cell thick (i.e., ‘exquisiticitellate’ rather than ‘crassiclitellate’ as with other megadriles) its extent is often incalculable and, because its nutritive function is replaced by copious yolky (i.e., macrolecithal) eggs, the ovisacs can be either highly gravid and extensive, or evacuated and flimsy. Thus morphology is especially variable naturally due to the state of maturity and reproductive activity of the specimen. Moreover, diagnostic intestinal gizzards frequently vary intraspecifically in both exact number and in relative position (or on an author’s determination of muscularity). First and second segments are weakly divided externally in some species confounding counts as does convergence of weak internal septa. Septa are increasingly displaced around the ovaries which themselves are translocated two segment to 11 rather than occurring in 13 as is usual for other megadriles (thereby rather obviously accounting for the reduction of moniligastrid ancestral male segments in anteriorly in 10 and 11 to a pair of ‘intraseptal’ testis sacs now observable in 9/10). In many earlier diagnoses “atrium” refers to the spermathecal opening but it may equally apply to the male chamber. Hence diagnoses of species are particularly reliant upon the skill of the original author and, from the classical texts of Michaelsen (1900) and Stephenson (1930) onwards, confusion has tended to be compounded. New consideration of possible parasitic origin of definitive ‘genital markings’ is an additional complication (see Blakemore *et al.*, 2010).

Table 1. Variations in genital markings (GM) & dorsal pores (DP) in *D. japonica*

Contingencies Found	GM Present (but variable)	GM Absent
DP Present (intermittent)	Yes	No
DP Absent	No	Yes

Table 2. Characters of *D. japonica* found in Japan, cf. *D. barwelli*

Character/ <i>Drawida</i> cf. spp.	<i>barwelli</i> summary as here	<i>japonica</i> summary as here	<i>japonica</i> Aichi spec A	<i>japonica</i> Aichi spex B	<i>japonica</i> Biwa spex	<i>japonica</i> Watarase spec
Colour	pale/unpig.	grey/pale	?	?	pink/pale	?
Size (mm)	30-65	28-130	50	30-40	50-70	55
GMs	None	7-13 or none	9 & 10	None	8-10	9 & 10
Dorsal pores	Yes/No	Yes/No	No	Yes/No	No	No
Form of MP	penis in pouch	flap or mound	flap or mound	?	flap or mound	penis in pouch
Gizzards	2-4	2-3	2	2	3	3
Gizzard Segs.	12,13- 14,15,(16)	(11,)12-13,14	12-13	12-13	12-14	12-14

Spec. – specimen; Spex. – specimens; Segs. – segments.

Table 3. Key characters of prioritized *Drawida* listed in Japan modified from Easton (1981: tab. 1) cf. *D. barwelli* ‘proper’

<i>Drawida</i> spp. / Character	<i>barwelli</i> (Beddard, 1886)	<i>japonica</i> (Michaesen, 1892)	<i>nemora</i> Kobay., 1936	<i>koreana</i> Kobay., 1938	<i>keikiensis</i> Kobay., 1938	<i>ofunato-</i> <i>ensis</i> * O., 1938	<i>taira-</i> <i>ensis</i> O., 1938	<i>morioka-</i> <i>ensis</i> O., 1938
Colour	pale/unpig- mented	grey/pale	dark blue	dark blue	yellow/ grey	dark yellow	flesh red	dark lead grey
Size (mm)	30-65	28-130(200)	65-185	63-100	40-54	228-283	59-92	65-100
GMs	None	7-13 I	6-13 (I)	7-12 I	None	7-13	8 I	None
DPs	Yes/No	Yes/No	No	No	No	No	?	?
Gland in 7	No	No	Yes	No	Yes	No	Yes	No
Form of Male Pores	penis in pouch	flap or porophore	penis in pouch	flap or porophore	penis in pouch	penis in pouch	penis in pouch	penis in pouch
Gizzards	2-4	2-3	3-5	2-3	3-4	4+ (?)	4	2-3
Gizzard Segs.	12,13- 14,15,(16)	(11,)12- 13,14	12,13- 15,16	12-13,14	12,13-15	12-15,16?	13-16?	10,11-12

Kobay. – Kobayashi; O. – Ohfuchi; GM – genital marks; I – irregular ‘markings’ that may be absent or artefactual. **Bold** options distinguish taxa. ? – data not provided, ambiguous/inconsistent by original author or from Easton’s table.

*Misspelt “onfunatoensis” by Easton (1981: 35). [Note: *D. hattamimizu* as dealt with by Blakemore *et al.* 2010].

If the supposedly distinguishing but uneven ‘genital markings’ of *D. japonica* eventually prove to be parasitic artefacts, as they appear at least in the Japanese material with the disc-like markings internally resembling spherical *Monocystis* cysts (RJB, pers. obs.), then *D. japonica* confusion in the past with prior *D. barwelli* seems possible, although the flap-like male pores now serve to separate it. Further testing of *Drawida* relationships without consideration of the *D. barwelli* (Beddard, 1896) type-species’s types (in London, BMNH:1904:10:5:522-3, 582? - cf.

“(BMNH: 1904:10.5.2-3)” Easton 1984: 112), and those of its ten synonyms, is pending.

Arguments against the ‘markings’ being parasiticw are that externally they look like typical sucker-like discs and they only appear in the anterior region where GMs usually occur. Arguments for them being parasitic in origin are their internal resemblance to *Monocystis* gregarine sporozoite cysts, their unevenness, and that by occurring just where worms attach when breeding they may infect new hosts whilst in

intimate contact. Moreover, they are absent and therefore ‘un-necessary’ in some specimens. In the case of some *Drawida* specimens having ventral parasites, these may be likened to a venereal ‘kissing-disease’. It is easy to envisage how the setae of copulating individuals may pierce the cuticle of their partner thus facilitating exchange and entry of sporozoite infective agents, and the locations would be exactly where the ‘genital markings’ are found in specimens of *Drawida japonica* – in or adjacent to setal lines in the anterior segments which closely attach during copulation.

Drawida gisti gisti Michaelsen, 1931 (from China and Korea), *D. nemora* Kobayashi, 1936 (from Korea, Japan and China), *D. koreana* Kobayashi, 1938 (from Korea and China), Japanese *D. tairaensis* Ohfuchi, 1938, Chinese *D. jeholensis* Kobayashi, 1940 and Indian *D. calebi* Gates, 1945 all have the same irregularity of markings (when present!) that may also be parasitic artefacts as for *D. japonica*; species that are sympatric are distinguished in Table 3.

If the parasitic artefact theory (Blakemore in Blakemore *et al.*, 2010) is correct, then species separated only on the strength of their (irregular) ‘genital markings’ may require wider re-assessment. For example, Indian *Drawida pomella* Gates, 1934: 250 may re-join *D. papillifer* Stephenson, 1917: 370 in synonymy of *D. hodgarti* Stephenson, 1917: 366; and *D. gisti* Michaelsen, 1931 may also require re-evaluation along with its subspecies *D. g. nanchangiana* Chen, 1933: 200 and *D. g. anchingiana* Chen, 1933: 202 (cf. Gates, 1935: 2; 1939: 408) and cf. *D. calebi* Gates, 1945. *Drawida gisti* as redescribed by Gates (1935: 2, 1939: 406), Kobayashi (1938) and Chen (1959: 16) from China and Korea was said to have an “urn-shaped” gland within the atrial wall of each spermatheca, irregular ‘genital markings’ (sometimes absent, e.g. Kobayashi 1938, 1940), small penes, and gizzards in 12–14 only. It is almost identically with *D. calebi* Gates, 1945: 211 from Jubbulpore and widely spread in Central India with types listed as missing in Reynolds & Cook (1976) but which is probably a new synonym of *D. gisti* Michaelsen,

1931, and both are now comparable to prior *D. hehoensis* Stephenson, 1924.

The parasitic theory of ‘genital markings’ as newly extended in *Drawida* species may at least partly account for differences in pheretimoid *Amyntas songnisanensis* Hong & Lee, 2001: 284 and its likely synonym *A. multimaculatus* Hong & Lee, 2001: 288 from Korea (that both may be synonyms of some other taxon lacking such artifacts). A similar parasitic cause probably also explains the irregular spots dorsally on *Archipheretima ophiodes* Michaelsen, 1929 and similarly on *Archipheretima middletoni* James, 2009 from the Philippines. In fact it is quite usual to see abundant sporozoan *Monocystis* parasites through the body walls of certain specimens and for these to mistakenly be given taxonomic significance, e.g., those reported for *Amyntas maculosus* (Hatai 1930) (RJB pers. obs.). As with some other invertebrates, a species may yet have its own unique host-specific complement of parasitic species that often bear the host’s name.

Key characters of current and available Japanese *Drawida* species are given in Table 3. From this character data it appears that:

- *D. japonica* differs from *D. barwelli* mostly in the form of the male pores
- *D. koreana* differs from *D. japonica* mostly in its blue colour
- *D. keikiensis* differs from *D. barwelli* by its glands in 7
- *D. moriakaensis* differs from *D. japonica* mostly in the form of the male pores

The newly described species from Lake Biwa, *D. eda* Blakemore, differs by having eversible male pores on penes, five gizzards in 13–17, in lacking both pigment and genital markings, and in having an accessory genital gland near spermathecal atria internally in 7. The same sort of gland is also reported for *D. nemora*, *D. keikiensis*, *D. tairaensis* and *D. jeholensis*. Chinese *Drawida jeholensis* Kobayashi, 1940 is unpigmented, has irregular markings in 7–11, male pores on poropore ‘flaps’ overhanging 10/11, and two or three gizzards in 11,12-13. Thus, the only major difference of *D. jeholensis* from prior *D. japonica* is (consistent?)

presence of this accessory gland in 7 near its spermathecal atrium.

Atrial structure of poorly-known *Drawida jalpaigurensis* Stephenson, 1916: 306, which is otherwise quite similar to *D. japonica*, appears to be substantially different to the accessory gland arrangement noted herein (see Stephenson, 1923: 141, fig. 51)

DNA barcoding, such as using a fragment of mtDNA COI marker gene, ideally from primary types (Blakemore *et al.* 2010), offers a possible solution to taxonomic confusion within *Drawida* in Asia and further abroad, as has been initially attempted herein.

An ancillary considerations in this, the first of a short series of pragmatic works on earthworms from the Kinki region of central Japan, is the “Clarity of vision and courage of purpose” (Wheeler 2004) needed from individual taxonomists and natural history museums to bring about the (r)evolution of taxonomy into the Bio-Info-Tech Age (see Blakemore 2000, 2007, 2008, Blakemore *et al.* 2010), especially in this UNO-designated International Year of Biodiversity.

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Appendix

Preliminary mtDNA COI sequences for *Drawida eda* Holotype cf. BLAST comparisons

LK 186-187 W4 (*D. eda* Holotype) COI (small letters = single strands, caps = double strands):-

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atCataaagatatgggaacaCTATATTTTATTTTGGGTGTCTGGGCAGGCATAGTTGGAGCCGGCATAAGGATATTAATTCGTA
TTGAGCTTAGGCAACCCGGCACATTTTGGGAAGAGATCAACTATAACAACACTATTGTAAGTGCATGCTTTTATTA
TAATTTCTTTTTAGTGATGCCTGTGTTTATTGGGGGTTTTGGAAATTGGTTGCTACCTCTGATGCTGGGAGCACCAG
ATATAGCTTTTCCCGTTTAAATAATTTAAGATTTTGATTACTTCTCCGGCCCTTATTTTATTAGTTTCTTCTGCTATA
GTAGAAAAGGGGGCAGGCACTGGTTGAACGTGTATCCTCCCTAGCTAGTAATATGGCTCACGCAGGTCCTTCTGT
TGACTTAGCTATTTTTCCTTGCATTTAGCGGGTGCATCTTCCATTCTAGGATCATTAAATTTCAATACCACCGTTATT
AATATGCGATGAGTTGGAATGAATATGGAGCGCGTCCATTATTTGTATGAGGGGTTTTAATTACTGTAATTCCTTTTA
TTACTATCTTACCCGTAAGCGGGTGCAATCACTATGCTTTTAAACAGATCGGAACCTAAATACTTCATTTTCGAT
CCTGCGAGGAGGAGGTGATCCAATTTTATATCAGCACTATTTTGTATTTTGGTCCACCCTGAGTTTAA
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Current GenBank BLAST scores for *Drawida eda* preliminary COI data (% congruence similarity)

EF077597.1 *Drawida japonica japonica* voucher 06-270 Identities = 512/641 (79%)
 GQ500902.1 *Drawida japonica* voucher LBM128000000 Identities = 485/614 (78%)
 GQ500900.1 *D. hattamimizu* voucher LBM1380000082 Identities = 487/633 (76%)

Catalogue of the enchytraeid worm collection (Oligochaeta: Enchytraeidae) of the Natural History Museum in London.

I. Spirit collection

G. BOROS¹ and E. SHERLOCK²

Abstract. The catalogue of the enchytraeid spirit collection in the Natural History Museum, London is presented. Two lists are given: 1) Inventory of the collection listed in alphabetical order of genera, and 2) Alphabetical list of the species with the valid genera names.

INTRODUCTION

The Natural History Museum in London houses one of the oldest and largest natural history collections in the world. The collection started as part of the British Museum in Bloomsbury, but by 1881 the natural history collections had become so large that they acquired a building in their own right, the Natural History Museum in South Kensington.

During the 18th century the Museum's specimens were obtained largely from private benefactors, the most notable being Sir Hans Sloane, however it was the expeditions overseas that really kept the collections growing rapidly during the 19th Century (Whitehead & Keates, 1981). Expeditions mounted by Cook and Banks, the Challenger expedition and Charles Darwin's voyages on the Beagle being notable examples (Lincoln & Rainbow, 2003). The Collections continue to grow into the 21st century from further expeditions, and donations from all over the world.

The enchytraeid holdings, although forming a small part of the annelid collection, are nevertheless not inconsequential. They are housed in two parts: the wet and the slide collection. The wet collection dates back to 1904 and houses over 150 jars of specimens. Highlights include worms from famous expeditions such as the Discovery and

Terra Nova Expeditions and there are even worms collected from a rare visit to the grounds of Buckingham Palace. Famous external contributors include Beddard, Stephenson and Friend. All three of these men produced major works on the Oligochaeta. In fact Beddard's collection, (Beddard was author of "A monograph of the order of Oligochaeta" in 1895) was bought by the Museum in 1904 (Stearn, 1998). This signifies that the importance of the Oligochaete worms was beginning to be known and appreciated by the Museum. 1904 was also the year that the Museum saw the first real 'Vermes worker' appointed, Harry Baylis (Stearn, 1998). The start was a promising one for the Oligochaetes as he was initially interested in African earthworms. By 1915 he had then described 3 species of Enchytraeidae including erecting the new genus *Aspidodrilus*. However, Baylis decided his real passion was for Nematodes and Parasitic worms. His attentions shifted and the Oligochaete collections lost the close attention they had gained. Baylis did not significantly enhance the enchytraeid collections and an oligochaete focused staff member did not arrive until Reginald Sims in 1961. Sims, although primarily known for his work on earthworms, made a significant contribution to this collection in his time at the museum. However it was his short term successor Dr. Černosvitov, who made the greatest impact. His most notable contribution to the taxonomy of this group world wide was his sys-

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tematic revision of the Enchytraeidae, and work on the fauna of the Balkan countries. For the Museum, it was the large amount of material donated to the collection. Černosvitov's large contribution to the collection was in fact not amassed whilst officially working for the museum. His story was a tragic one, 4 days after finally obtaining the job he really wanted, being appointed to the staff of the Natural History Museum London, he died of a heart attack concluding his work prematurely. The Museum still has not had a dedicated researcher to the enchytraeids however, we hope by publishing these papers we will be opening this collection up to the wider community and promoting the wealth of material housed here. We hope to encourage researchers to visit and use the collections as well as to donate and enhance them for years to come.

This paper details the spirit collection at the Museum and forms part one of a two part series of papers listing outlining the Enchytraeid collection.

Unfortunately there are many specimens in the collection where the determiner is not recorded; therefore we cannot be sure of the authenticity of every species recorded here. In addition, taxonomic changes in the family Enchytraeidae were not followed properly e.g. synonyms or incorrect labelling can occur. The authors publish this catalogue without taxonomic revision.

LIST OF GENERA AND SPECIES

Genus *Achaeta* Vejdovsky, 1877

Achaeta bohemica (Vejdovsky, 1879)

05. 10. 1904. Loc: Hamburg, Beddard's collection.

Achaeta incisa Friend, 1911 – nomen dubium (Černosvitov 1937b)

01. 03. 1949. Loc: Mansfield, Nottinghamshire, Leg. Rev. H. Friend, 05. 08. 1912. (Friend 1912a).

Achaeta neotropica Černosvitov, 1937

945-948. 01. 03. 1949. Loc: Loreto and Buenos Aires, Argentina, Černosvitov's collection (Černosvitov 1937a).

Achaeta sp.

22. 09. 1936. Hanperden, Hertfordshire Leg. K.D. Bawoja.

Genus *Aspidodrilus* Baylis, 1914

Aspidodrilus kelsalli Baylis, 1914

1-2. 04. 01. 1923. Type of genus and species Loc: Sierra Leone, West Africa, on large earthworm, Leg. Major H. Kelsall (Baylis, 1914).

Genus *Bryodrilus* Ude, 1892

Bryodrilus ehlersi Ude, 1892

537-539. 01. 03. 1949. Loc: Mt. Hoverla 1950 m, Carpathian Mts. Leg. L. Černosvitov, 25. 08. 1925.

Genus *Buchholzia* Michaelsen, 1887

Buchholzia fallax Michaelsen, 1887

05. 10. 1904. Loc: Hamburg, Beddard's collection.

Genus *Cernosvitoviella* Nielsen & Christensen 1959

Cernosvitoviella atrata (Bretscher, 1903)

566-569. 01. 03. 1949. Loc: Mt. Hoverla 1950 m Leg. L. Černosvitov, 24. 08. 1926.

Cernosvitoviella briganta Springett, 1969

20. 03. 1969. Syntype Loc: Juncetum squarosi, Moorhouse National Reserve, Westmorland Leg. J. Springett.

Genus *Cognettia* Nielsen & Christensen, 1959

Cognettia glandulosa (Michaelsen, 1888)

05. 10. 1904. Loc: Hamburg, Beddard's collection.

Cognettia sphagnetorum (Vejdovsky, 1877)

169-171. 01. 03. 1949. Loc: Bethesda, North Wales Černosvitov's collection.

Genus *Enchytraeus* Henle, 1837

Enchytraeus albidus Henle, 1837

20-22. 11. 11. 1915. Loc: Campbelltown, Kintyre Leg. H.A. Baylis.

1-10. 06. 07. 1923. Loc: Raynes Park, Leg. Messrs. Carter & Co.

707-717. 05. 10. 1904. Loc: Gulf of Kiel, Beddard's collection.

707-717. 05. 10. 1904. (duplicates) Loc: Gulf of Kiel, Beddard's collection.

1-5, 17. 06. 1907. Loc: shore, Advent Bay, Spitsbergen Leg. Gregory.

73-77. 23. 06. 1931. Loc: Maiviken Bay, South Georgia, Leg. "Discovery 1925-1927".

8-12. 06. 12. 1930. Loc: Dundee Leg. Mrs. M. Drummond, 1930.

- 34-35. 22. 03. 1926.** Loc: Guernsey, "from a tomato" Leg. E.R. Spyer.
5-7. 04. 05. 1932. Loc: Torridon, Scotland Leg. Miss. E. Nicol.
193-198. 03. 05. 1948. Loc: Ashford, Kent Leg. J.H.P. Sankey 1945, Det. L. Černosvitov.
199-204. 03. 05. 1948. Loc.: Leicester district, in a green house Leg. H.P. Moon.
10-18. 18. 1963. Loc: Buckingham Palace Gardens Leg. A.J.N. Det. R.W. Sims.
221-225. 01. 03. 1949. Loc: Cheddar Gorge Leg. L. Černosvitov, 04. 04. 1942.
11-12. 08. 12. 1949. Loc: Jan Mayen Isl. North Finland Leg. S.R. Nutman, Černosvitov's collection.
1-2. 25. 02. 1949. Loc: Percolating sewage filters at Oswaldtwistle, Accrington, Lancashire Leg. T.G. Tomlinson, 1945.
1420. 29. 04. 1926. Loc: Sewage farm, Norwich Leg. J. Howard.
1-10. 27. 07. 1939. Loc: Brook Green Laboratory from compost Leg. J. Baker
10-18. 18. 1963. Loc: Buckingham Palace lawns Leg. R.W. Sims, 11. 05. 1962.
9-13. 29. 07. 1929. Loc: Kungsuk, M. Godthaab, West Greenland Leg. R.G. Kingston.
2-4. 21. 02. 1933. Loc: Bear Isl., Walrus Bay, Spitsbergen Leg. Dr. J. Stephenson, Oxford Univ. Exp. 1925.
92-93. 08. 06. 1925. Loc: Liefde Bay, Spitsbergen Leg. Oxford Univ. Exp. 1925.
44-45. 08. 06. 1925. Loc: Liefde Bay, Spitsbergen Leg. Oxford Univ. Exp. 1925.
- Enchytraeus aporus* Stephenson, 1925 = *Marionina aporus* (Stephenson, 1925) (Nielsen & Christensen, 1959).
- Enchytraeus argenteus* Michaelsen, 1889 = *Marionina argentea* (Michaelsen, 1889) (Nielsen & Christensen 1959).
- Enchytraeus australis* Stephenson, 1932
71-72. 23. 06. 1931. Loc: Maiviken Bay, South Georgia Leg. "Discovery" 1925-1927.
91-94. 23. 06. 1931. Co-types Loc: Gough Island Leg. "Discovery" 1925-1927 (Stephenson 1932).
- Enchytraeus barkudensis* Stephenson, 1915 = *Stephensiella marina* (Moore, 1902) (Coates 1983)
- Enchytraeus buchholzi* Vejdovsky, 1879
30. 11. 1950. Loc: Northiam, Sussex Leg. J. Barnett.
1-2. 07. 12. 1949. Loc: Jerusalem, Palestine Leg. Dr. K. Reich, 31. 05. 1936.
- 1001-1005. 01. 03. 1949.** Typical and atypical Loc: Loreto, Argentina Černosvitov's collection.
1-8. 10. 1977. Loc: Gill cavity of *Potamon magnum* Leg. Dr. Rahan, 1976.
3-6. 25. 02. 1949. Loc. Percolating sewage filters at Oswaldtwistle, Accrington, Lancashire Leg. T.G. Tomlinson, 1945.
65-70. 01. 03. 1949. Loc: Dublin Leg. Rev. H. Friend, 10. 03. 1913.
32-33. 22. 03. 1926. Loc: Hoddeston Leg. E.R. Spyer.
- Enchytraeus carcinophilus* Baylis, 1915
1. 2. 4-7. 02. 05. 1915. Loc: South Trinidad Leg. "Terra Nova Expedition" 1910 (Baylis 1915a).
- Enchytraeus cavicola* Stephenson, 1924 = *Hemienchytraeus stephensoni* (Cognetti, 1927) (Schmelz & Collado 2007).
- Enchytraeus colpites* Stephenson, 1932 = *Lumbricillus colpites* (Stephenson, 1932) (Nielsen & Christensen 1959).
- Enchytraeus crymodes* Stephenson, 1922 = *Marionina crymodes* (Stephenson, 1922) (Nielsen & Christensen 1959).
- Enchytraeus eltoni* Stephenson, 1924 = *Lumbricillus eltoni* (Stephenson, 1924) (Nielsen & Christensen 1959).
- Enchytraeus hyalinus* (Eisen) var. *densus* Friend 1912
60-64. 01. 03. 1949. Loc: Gilsland, Northumberland Leg. Rev. H. Friend (Friend 1912b).
- Enchytraeus indicus* Stephenson, 1912
32-38. 1965. Loc: Hazelmere, High Wycombe, Bucks Leg. B.M. Gerard, 19. 08. 1962.
- Enchytraeus kincaidi* Eisen, 1904
61-65. 08. 06. 1925. Loc: Liefde Bay, Spitsbergen Leg. Oxford. Univ. Exp. 1922 (Stephenson 1924).
- Enchytraeus liefdensis* Stephenson, 1924 = *Enchytraeus kincaidi* Eisen, 1904 (Birkemoe & Dózsa-Farkas 1994).
- Enchytraeus minimus* Bretscher, 1899 = *Enchytraeus buchholzi* Vejdovsky, 1879 (Kasprzak 1986).
- Enchytraeus muscicola* Stephenson, 1924 = *Lumbricillus muscicolus* (Stephenson, 1924) (Nielsen & Christensen 1959).
- Enchytraeus parasiticus* Baylis, 1915
3. 02. 05. 1915. Loc: gill chamber of *Geocarcinus quadratus*, Clarion Island (Baylis, 1915b).
- Enchytraeus* sp.

41-43. 08. 06. 1925. Loc: Liefde Bay, Spitsbergen Leg. Oxford. Univ. Exp. 1922, Stephenson's collection.

1-12, 10. 05. 1937. Loc: Kelvedon, Essex Leg. J. Campbell.

43-44. 12. 03. 1934. Loc: waterfall, Christmas Island Leg. Dr. J. Harris, 10. 03. 1933.

45. 12. 03. 1934. Loc: Christmas Island Leg: D. Hughes, 20. 03. 1933.

1-20. 05. 05. 1922. Loc: heap of leaves in garden Leg. W.J. Letts.

7-10. 21. 02. 1933. Loc: Spitsbergen.

1-31. 02. 1983. Loc: Beaucheng, Falkland Isl. Leg. R.I. Lewis, 1980.

58-59. 01. 03. 1949. Loc: Dublin Leg. Rev. H. Friend, 03. 06. 1913.

Genus *Fridericia* Michaelsen, 1889

Fridericia agricola Moore, 1895

42. 01. 03. 1949. Loc: Hastings, Sussex Leg. Rev. H. Friend, 21. 12. 1911.

Fridericia bisetosa (Levinsen, 1884)

134-135. 01. 03. 1949. Loc: "said to have been passed to a urine of a man", Ireland Leg. L.P.W. Renouf, 1936 Černosvitov's collection.

136-139. 01. 03. 1949. Loc: Snowdon Leg. L. Černosvitov, 26. 08. 1941.

43-45. 01. 03. 1949. Loc: Pocklington, York Leg. Rev. H. Friend, 01. 12. 1913. Černosvitov's collection.

1. 08. 12. 1949. Loc: Puits du presbytère, Riche, Moselle, France Leg. P. Remy.

Fridericia bulboides Nielsen & Christensen, 1959

1-3. 6. 1964. Loc: Dale, Pembrokeshire, "on stones covered with *Spirorbis tridentatus*" Leg J.H. Crother.

Fridericia bulbosa (Rosa, 1887) – nomen dubium (Schmelz 2003)

140-143. 01. 03. 1949. Loc: Holyhead Leg. L. Černosvitov, 28. 07. 1941. Černosvitov's collection.

37-39. 12. 03. 1934. Loc: Christmas Island, Indian Ocean Leg. Dr. J. Harris, 13. 03. 1933.

Fridericia callosa (Eisen, 1878)

144-147. 01. 03. 1949. Loc: Barrynarbor, Devon Leg. L. Černosvitov, 14. 07. 1941. Černosvitov's collection.

4-10. 07. 12. 1949. Loc: Palestine Leg. Dr. K. Reich, 13. 02. 1938.

990-1000. 1. 03. 1949. Loc: Loreto, Argentina. Černosvitov's collection.

Fridericia carmichaeli Stephenson, 1915 = *F. Peregrinabunda* Michaelsen, 1913 (Schmelz 2003)

Fridericia connata Bretscher, 1902

148-149. 01. 03. 1949. Loc: Martin, North Devon, "bank of small stream" Leg. L. Černosvitov, 13. 07. 1942.

Fridericia galba (Hoffmeister, 1843)

1099-1100. 05. 10. 1904. (with duplicates) Loc: New Zealand, Beddard's collection.

48. 10. 08. 1885. (No further information.).

Fridericia magna Friend, 1899

150-151. 01. 03. 1949. Loc: North Devon, "bank of small stream" Leg. L. Černosvitov, 13. 07. 1942.

Fridericia nigrina Frined, 1913 – nomen dubium (Schmelz 2003)

40-41. 01. 03. 1949. Type Loc: Hastings, Sussex Leg. Rev. H. Friend, 21. 12. 1911. (Friend 1913).

72. 01. 03. 1949. Leg. Rev. H. Friend.

Fridericia peregrinabunda Michaelsen, 1913

80. 12. 05. 1925. Co-types of *F. carmichaeli* Stephenson, 1915 Loc: Rungnect tea estate, Darjeeling (Stephenson 1915).

Fridericia perrieri (Vejdovsky, 1878)

152-153. 01. 03. 1949. Loc: North Devon, "stream near Hunters Inn" Leg. L. Černosvitov, 10. 07. 1942.

3. 07. 12. 1949. Loc: Palestine Leg. Dr. K. Reich, 12. 12. 1936.

Fridericia pretoriana Stephenson, 1930

15-16. 02. 07. 1929. Loc: Pretoria, South Africa Leg. 02. 07. 1927. Stephenson's collection (Stephenson, 1930).

Fridericia polycheta Bretscher, 1900 – nomen dubium (Schmelz 2003)

06. 12. 1930. Loc: Dundee Leg. Mrs. M. Drummond.

Fridericia striata (Levinsen, 1884)

41-43. 09. 05. 1930. Loc: Uxbridge, Middlesex, "bark of a tree" Leg. G.M.M. Mambridge, 1930.

Fridericia sp.

485-510. 01. 03. 1949. Loc: Carpathian Mts. Černosvitov's collection

19-22. 18. 1963. Loc: Buckingham Pal. Gardens Leg. A.J.N. 1963. Det. R.W. Sims

2. 01. 03. 1964. Loc: Salt Lake City, Utah, USA Leg. G.F. Knowlton, 01. 03. 1962.

03. 03. 1964. Loc: Monticello, Utah, USA Leg. G.F. Knowlton, 29. 03. 1962.
1-7. 12. 09. 1938. Loc: Diigce, Bolu, Turkey Leg. Dr. J.

Genus: *Guaranidrilus* Černosvitov, 1937

Guaranidrilus cernosvitovi Healy, 1979
962-967. 01. 03. 1949. Loc: Loreto, Argentina Černosvitov's collection (Healy 1979)

Guaranidrilus columbianus (Michaelsen, 1913)
45. 05. 07. 1927. Loc: Medellin, Colombia Leg. Prof. Fuhrmann.

Genus: *Hemienchytraeus* Černosvitov, 1934

Hemienchytraeus stephensoni (Cognetti, 1927)
2-11. 14. 11. 1932. Loc: Loreto, Argentina, Černosvitov's collection.
56-60. 04. 01. 1949. Loc: Lagunilla, "on coarse sand" Leg. Titicaca Exp. 03. 09. 1939.
83. 12. 05. 1925. (cotype of *Enchytraeus cavicola*) Loc: Siju cave, Goro hills.

Hemienchytraeus sp.
981-987. 01. 03. 1949. Loc: Loreto, Argentina, Černosvitov's collection.
969-987. 01. 03. 1949. Loc: Loreto, Argentina Černosvitov's collection.
1931-1932 Loc: Loreto, Argentina, Černosvitov's collection.

Genus: *Henlea* Michaelsen, 1889

Henlea brucei Stephenson, 1922 = *H. perpusilla* Friend, 1911 (Dózsa-Farkas 1999).

Henlea columbiana Michaelsen, 1913 = *Guaranidrilus columbianus* (Michaelsen, 1913) (Healy 1979).

Henlea fragilis Friend, 1912 = *H. nasuta* (Eisen, 1878) (Černosvitov 1931).

Henlea heleotropha Stephenson, 1922
1-2. 08. 06. 1925. Loc: Liefde Bay, Spitsbergen Leg. Oxford Univ. Exp. 1923.

Henlea lampas (Eisen, 1878) – nomen dubium
50-52. 01. 03. 1949. Loc: Mansfield, Nottinghamshire Leg. Rev. H. Friend, 1912.

Henlea nasuta (Eisen, 1878)
53-57. 01. 03. 1949. Types Loc: Hastings, Sussex Friend's collection (Friend 1912c).

Henlea ochracea (Eisen, 1878)
48-49. 01. 03. 1949. Loc: England or Ireland, Friend's collection.

529-530. 01. 03. 1949. Loc: Priscop, Carpathian Mts. Leg. L. Černosvitov, 15. 08. 1926.

Henlea perpusilla Friend, 1911
154. 10. 03. 1949. Loc: Snowdon Leg. L. Černosvitov, 26. 07. 1941.
3-8. 08. 06. 1925. Loc: Liefde Bay, Spitsbergen Leg. Oxford Univ. Exp. 1921.

Henlea tenella Eisen, 1878 = *H. ochracea* (Eisen, 1878) (Nurminen 1973)

Henlea sp.
27-28. 21. 02. 1933. Loc: Spitsbergen
212-222. 36. 1962. F.B.A. River Laboratory, Dorset Summer Leg. R.W. Sims.

Genus *Hepatogaster* Čejka, 1910 - invalid genus, synonymised with *Henlea*

Hepatogaster tenellus Eisen, 1878 = *Henlea ochracea* (Eisen, 1878) (Nurminen 1973).

Genus: *Lumbricillus* Ørsted, 1844

Lumbricillus aegialites Stephenson, 1922 = *L. pagenstecheri* (Ratzel, 1869) (Nurminen 1965).

Lumbricillus aestuum (Stephenson, 1932)
1.017-1.028. 13. 1976. Loc: N° P.E. 12. Marion Islands, Indian Ocean Leg. Bakker van Zinderen, Det. E.G. Easton.

1.029. 12. 1976. Loc: N° Z4, Marion Islands, Indian Ocean Leg. Bakker van Zinderen Det. E.G. Easton.

1.029. 13. 1976. Loc.: N° P.E. 10, Marion Islands, Indian Ocean Leg. Bakker van Zinderen Det. E.G. Easton.

1.030. 13. 1976. Loc.: N° III, Marion Islands, Indian Ocean Leg. Bakker van Zinderen Det. E.G. Easton.

1.031-1.073. 13. 1976. Loc.: N° Z66, Marion Islands, Indian Ocean Leg. Bakker van Zinderen Det. E.G. Easton.

42-43. 23. 06. 1931. Loc: Bay of Isles, South Georgia Leg. "Discovery" 1925-1927 (Stephenson 1932).

Lumbricillus antarcticus Stephenson, 1932
89/90. 23. 06. 1931. Cotype. Loc: Wilson Harbour, South Georgia Leg. "Discovery" 1925-1927 (Stephenson 1932).

Lumbricillus arenarius (Michaelsen, 1888)

166-167. 01. 03. 1949. Loc: Bangor Leg. L. Černosvitov, 08. 04. 1941.

Lumbricillus christenseni Tynen, 1966

22. 01. 12. 1965. Syntypes. Loc.: Anglesey, N Wales (Tynen, 1966).

Lumbricillus colpites (Stephenson, 1932)

51-56. 23. 06. 1931. Loc: Bay of Isles, South Georgia Leg. "Discovery" 1925-1927 (Stephenson 1932).

Lumbricillus eltoni (Stephenson, 1924)

71-75. 08. 06. 1925. Co-types Loc: Liefde Bay, Spitsbergen Leg. Oxford Univ. Exp. 1922. Stephenson's collection.

Lumbricillus insularis (Ude, 1896)

9. 28. 04. 1903. Type (with duplicates) Loc: Elisabeth Isl. Strait of Magellan Leg. Dr. Michaelsen.

Lumbricillus lineatus (Müller, 1774)

8-10. 07. 10. 1931. Loc: From a London wash basin Leg. Humphrey Milford.

1-12. 23. 06. 1938. Loc: Hounslow, Middlesex Leg. J. Atkins.

1-4. 02. 07. 1933. Loc: Scarborough, North Yorkshire Leg. W. J. Clarke.

1. 09. 12. 1949. Loc.: Richmond, Surrey Leg. A. Goodie Det. L. Černosvitov.

63-70. 23. 06. 1931. Loc: Maivicken Bay, South Georgia Leg. "Discovery" 1925-1927.

36-40. 30. 03. 1932. Loc: Sewage beds, Liverpool Leg. A. N. Pillers.

2-10. 23. 06. 1931. Loc: Signy Isl., South Orkney Islands Leg. "Discovery" 1925-1927.

4-7. 06. 03. 1950. Loc: City water supply, from sink Leg. D.T. Lucke, 09. 03. 1943 and 13. 12. 1949.

4-24. 11. 10. 1954. Loc: Bank of decaying seaweed, St. Andrews.

370-373. 05. 10. 1904. (with duplicates) Loc: Hamburg, Beddard's collection.

49-59. 10. 1974. Loc: Farne Islands, Northumberland Leg. Dr. Johnston.

39-40. 30. 11. 1950. Loc: From rotting stems of *Spartina townsendi* Leg. C.E. Hubbard, 02. 02. 1950. Pres. R.K.C. Anstwick, 26. 04. 1950.

39. 29. 06. 1948. Loc: Domestic water supply, Slough, Berkshire Leg. G.M. Hobbin.

62-90. 04. 01. 1949. Loc: Taman Bay, Lake Titicaca, Leg. R. Lagunilla, R. Saracocha, Titicaca Expedition 1937.

1-5. 08. 03. 1938. Loc: Glomsford Water Supply Leg. R.D. Melford, 23. 03. 1928.

10. 08. 12. 1949. Loc: North Finland, near Petsamo, on shore Leg. A. Goode 12. 07. 1939. Det. Černosvitov.

155-162. 01. 03. 1949. Loc: Bangor, Anglesey, black rocks Leg. L. Černosvitov, 12. 04. 1941.

7-8. 25. 02. 1949. Loc. Percolating sewage filters at Oswaldtwistle, Accrington, Lancashire Leg. T.G. Tomlinson, 1945.

1. 17. 10. 1933. Loc: from a basin of a London house Leg. Chesterton and Sons.

1. 18. 06. 1934. Loc: Metropolitan Water Board.

1-15. 17. 09. 1935. Loc: London, from a drain Leg. E.R. Bole.

183-192. 03. 05. 1948. Sewage beds, Oddstock hospital, near Salisbury Leg. E.W. Moore.

Lumbricillus muscicolus (Stephenson, 1924)

87-91. 08. 06. 1925. (Cotype of *Enchytraeus muscicola*) Loc: Liefde Bay, Spitsbergen Leg. Oxford Univ. Exp. 1922, Stephenson's collection (Stephenson 1924).

Lumbricillus pagenstecheri (Ratzel, 1869)

11-40. 49-54. 66-70. 76-86. 08. 06. 1925. Loc: Spitsbergen Leg. Oxford Univ. Exp. 1925.

15-26. 21. 02. 1933. Loc: Spitsbergen.

1-14. 17. 05. 1934. Loc.: Petunia Bay, Svalbard Leg. Oxford Univ. Arctic Exp., 12. 07. 1933.

Genus *Marionina* Michaelsen, 1890

Marionina aestuum Stephenson, 1932 = *Lumbricillus aestuum* (Stephenson, 1932) (Nielsen & Christensen 1959).

Marionina aporus (Stephenson, 1925)

9-10. 08. 06. 1925. Loc: Liefde Bay, Spitsbergen Leg. Oxford Univ. Exp. 1925 (Stephenson 1925)

94-100. 08. 06. 1925. Duplicates.

Marionina argentea (Michaelsen, 1889)

(No catalogue number or additional information.)

Marionina cambrensis O'Connor, 1963 = *Oconorella cambrensis* (O'Connor, 1963) (Rota 1995).

Marionina crymodes (Stephenson, 1922)

5-6. 21. 02. 1933. (Types of *Enchytraeus crymodes*) Loc: Spitsbergen Leg. Oxford Univ. Exp. 1922, Stephenson's collection.

Marionina georgiana (Michaelsen, 1888)

61-22. 23. 06. 1931. Loc: South Georgia Leg. "Discovery" 1925-1927.

- 1. 01. 04. 1916.** Loc: Falkland Isl. Leg. Dr. J.H. Ashworth, R. Vallentin's collection.
544. 05. 10. 1904. Loc: South Georgia Beddard's collection.
74-79. 01. 03. 1949. Loc: Middlesboro and Dublin Leg. Rev. H. Friend 1912 (Middles.) and 1913 (Dub.).
- Marionina monochaeta* (Michaelsen, 1888)
718. 05. 10. 1904. Loc: South Georgia Beddard's collection.
78-80. 23. 06. 1931. Loc: 53°52'30S, 36°00'08W Leg. "Discovery" Exp. 1925–1927.
- Marionina grisea* Stephenson, 1932
95. 23. 06. 1931. Loc: Wiencke Isl., Palmer archipelago Leg. "Discovery" 1925–1927 (Stephenson 1932).
- Marionina subtilis* (Ude, 1896)
9-10. 27. 09. 1926. Loc: Ushuaia, Tierra del Fuego Leg. Dr. Michaelsen.
- Marionina* sp.
374-380. 05. 10. 1904. Loc: Plymouth, Beddard's collection.
178-181. 01. 03. 1949. Loc: Bangor, North Wales, sea shore Leg. L. Černosvitov, 09. 04. 1941.
64-157. 31. 1978. Loc: River Bann Esturay, North Ireland.
64-157. 31. 1978 Loc: River Bann Esturay, North Ireland Leg: W. Soetikno, 14. 03. 1977. Det. E.G. Easton.
- Genus *Mesenchytraeus* Eisen, 1878**
- Mesenchytraeus armatus* (Levinsen, 1884)
421. 01. 03. 1949. Loc: Bogdan, Carpathian Mts. Leg. L. Černosvitov, 06. 08. 1925.
37. 01. 03. 1949. Loc: Faroe Isl. Černosvitov's collection.
545. 05. 10. 1904. Loc: Hamburg Beddard's collection.
- Mesenchytraeus eltoni* Stephenson 1925
71-75. 08. 06. 1925. Co-types Loc: Liefde Bay, Spitsbergen Leg. Oxford Univ. Exp. 1925 (Stephenson 1925).
- Mesenchytraeus ogloblini* Černosvitov, 1928
396-420. 01. 03. 1949. Types. Loc: Apšinec, Carpathian Mts. Leg. (Černosvitov, 1928).
- Mesenchytraeus solifugus* (Emery, 1898)
1233-1237. 2006. Loc: Anderson glacier, Olympic Mts. Washington State, USA Leg. Benjamin Lee, 23. 07. 2005.
1238-1241. 2006. Comox Glacier, Vancouver Island, British Columbia, Canada Leg. Benjamin Lee, 30. 07. 2005.
- Mesenchytraeus* sp.
1. 21. 02. 1933. Loc: Spitsbergen.
70-72. 03. 1967. Loc: Bowling greens, Hurling Club Raynes Park, London Leg. S.M. Smith 28. 04. 1966. Det. R.W. Sims.
55-60. 08. 06. 1925. Loc: Liefde Bay, Spitsbergen Leg. Oxford Univ. Exp. 1925.
7-9. 02. 1962. Loc: Barrackpore, Calcutta, India Leg. G. Michael Det. R.W. Sims.
- Genus *Michaelsena* Ude, 1896 – invalid genus, synonymised with other genera**
- Michaelsena subtilis* Ude, 1896 = *Marionina subtilis* (Ude, 1896) (Nielsen and Christensen 1959).
- Genus *Oconnorella* Rota, 1995**
- Oconnorella cambrensis* (O'Connor, 1963)
41. 1. 09. 1964. Syntypes Loc: soil in coniferous forest Bangor, North Wales.
- Genus *Pachydrilus* Claparède, 1861 - invalid genus, synonymised with other genera**
- Pachydrillus insularis* Ude, 1896 = *Lumbricillus insularis* (Ude, 1896) (Nielsen & Christensen 1959)
- Pachydrillus lineatus* (Müller, 1774) = *Lumbricillus lineatus* (Müller, 1774) (Nielsen & Christensen 1959)
- Genus *Stephensiella* Černosvitov, 1934**
- Stephensiella marina* (Moore, 1902)
129. 12. 05. 1925. Loc: Barkuda, Chilka Lake.
- Genus *Stercutus* Michaelsen, 1888**
- Stercutus niveus* Michaelsen, 1888
311-313. 05. 10. 1904. (with duplicates) Loc: Hamburg Beddard's collection.

LIST OF SPECIES IN ALPHABETICAL ORDER

- aegialites Lumbricillus* Stephenson, 1922 = *pagenstecheri Lumbricillus* (Ratzel, 1869)
aestuum Lumbricillus (Stephenson, 1932)
aestuum Marionina Stephenson, 1932 = *aestuum Lumbricillus* (Stephenson, 1932)
agricola Fridericia Moore, 1895
albidus Enchytraeus Henle, 1837
antarcticus Lumbricillus Stephenson, 1932
aporus Enchytraeus Stephenson, 1925 = *aporus Marionina* (Stephenson, 1925)
aporus Marionina (Stephenson, 1925)
arenarius Lumbricillus (Michaelsen, 1888) Knöllner, 1935
argentea Marionina (Michaelsen, 1889)
argenteus Enchytraeus Michaelsen, 1889 = *argentea Marionina* (Michaelsen, 1889)
armatus Mesenchytraeus (Levinsen, 1884)
atrata Cernosvitoviella (Bretscher, 1903)
australis Enchytraeus Stephenson, 1932
barkudensis Enchytraeus Stephenson, 1915 = *marina Stephensoniella* (Moore, 1902)
bisetosa Fridericia (Levinsen, 1884)
bohémica Achaeta (Vejdovsky, 1879)
briganta Cernosvitoviella Springett, 1969
brucei Henlea Stephenson, 1922 = *perpusilla Henlea* Friend, 1911
buchholzi Enchytraeus Vejdovsky, 1879
bulboides Fridericia Nielsen & Christensen, 1959
bulbosa Fridericia (Rosa, 1887) – nomen dubium
callosa Fridericia (Eisen, 1878)
cambrensis Marionina O'Connor, 1964 = *cambrensis Oconnorella* (O'Connor, 1964)
cambrensis Oconnorella (O'Connor, 1964)
carcinophilus Enchytraeus Baylis, 1915
carmichaeli Fridericia Stephenson, 1915 = *F. peregrinabunda* Michaelsen, 1913
cavicola Enchytraeus Stephenson, 1924 = *stephensoni Hemienchytraeus* (Cognetti, 1927)
cernosvitovi Guaraniidrilus Healy, 1979
christenseni Lumbricillus Tynen, 1966
colpites Enchytraeus Stephenson, 1932 = *colpites Lumbricillus* (Stephenson, 1932)
colpites Lumbricillus (Stephenson, 1932)
columbiana Henlea Michaelsen, 1913 = *columbianus Guaraniidrilus* (Michaelsen, 1913)
columbianus Guaraniidrilus (Michaelsen, 1913)
connata Fridericia Bretscher, 1902
crymodes Enchytraeus Stephenson, 1922 = *crymodes Marionina* (Stephenson, 1922)
crymodes Marionina (Stephenson, 1922)
ehlersi Bryodrilus Ude, 1892
eltoni Enchytraeus Stephenson, 1924 = *eltoni Lumbricillus* (Stephenson, 1924)
eltoni Lumbricillus (Stephenson, 1924)
eltoni Mesenchytraeus (Stephenson, 1925)
fallax Buchholzia Michaelsen, 1887
fragilis Henlea Friend, 1912 = *nasuta Henlea* (Eisen, 1878)
galba Fridericia (Hoffmeister, 1843)
georgiana Marionina (Stephenson, 1922)
glandulosa Cognettia (Michaelsen, 1888)
grisea Marionina Stephenson, 1932
heleotropa Henlea Stephenson, 1922
hyalinus var. *densus Enchytraeus* Friend 1912
incisa Achaeta Friend, 1911 – nomen dubium
indicus Enchytraeus Stephenson, 1912
insularis Lumbricillus (Ude, 1896)
insularis Pachydriulus Ude, 1896 = *insularis Lumbricillus* (Ude, 1896)
kelsalli Aspidodrilus Baylis, 1914
kincaidi Enchytraeus Eisen, 1904
lampas Henlea (Eisen, 1878) – nomen dubium
liefdensis Enchytraeus Stephenson, 1924 = *kincaidi Enchytraeus* Eisen, 1904
lineatus Lumbricillus Müller, 1774
lineatus Pachydriulus (Müller, 1774) = *lineatus Lumbricillus* (Müller, 1774)
magna Fridericia Friend, 1899
marina Stephensoniella (Moore, 1902)
minimus Enchytraeus Bretscher, 1899 = *Enchytraeus buchholzi* Vejdovsky, 1879
monochaeta Marionina (Michaelsen, 1888)
musciicola Enchytraeus Stephenson, 1924 = *Lumbricillus muscicolus* (Stephenson, 1924)
musciolus Lumbricillus (Stephenson, 1924)
nasuta Henlea (Eisen, 1878)
neotropica Achaeta Cernosvitov, 1937
nigrina Fridericia Friend, 1913 – nomen dubium
niveus Stercutus Michaelsen, 1888
ochracea Henlea (Eisen, 1878)
oglobini Mesenchytraeus Cernosvitov, 1928
pagenstecheri Lumbricillus (Ratzel, 1869)
parasiticus Enchytraeus Baylis, 1914
peregrinabunda Fridericia Michaelsen, 1913
perpusilla Henlea Friend, 1911
perrieri Fridericia (Vejdovsky, 1878)
polycheta Fridericia Bretscher, 1900 – nomen dubium
pretoriana Fridericia Stephenson, 1930
solifugus Mesenchytraeus (Emery, 1898)
sphagnetorum Cognettia (Vejdovsky, 1877)
stephensoni Hemienchytraeus (Cognetti, 1927)
striata Fridericia (Levinsen, 1884)
subtilis Marionina (Ude, 1896)
subtilis Michaelsena Ude, 1896 = *subtilis Marionina* (Ude, 1896)
tenella Henlea Eisen, 1878 = *H. ochracea* (Eisen, 1878)
tenellus Hepatogaster Eisen, 1878 = *H. ochracea* (Eisen, 1878)

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Taxonomical and faunistical studies on the Uropodina mites of Greece (Acari: Mesostigmata)

J. KONTSCHÁN¹

Abstract. Elaboration of a rich “Berlese” material from Greece yielded twelve Uropodina species from different parts of the country. Six of them, namely *Trachytes aegrota* (C. L. Koch, 1841); *Urodiaspis pannonica* Willmann, 1951; *Uroobovella fracta* (Berlese, 1916); *Neodiscopoma splendida* Kramer, 1882; *Uropoda mazsalakiae* Kontschán, 2005 and *Uropoda minima* Kramer, 1882, are new to the fauna of Greece. Three species, *Trachytes parnonensis* sp. nov., *Uroobovella graeca* sp. nov. and *Cillibavellas* sp. nov. proved to be new to science. With 24 figures.

In the last decade, several expeditions were organized to the Balkan Peninsula by the researchers of the Hungarian Natural History Museum to collect snails, water insects, and soil animals (mites, springtails, nematodes, and earthworms). Till now several mite groups from this materials have been elaborated, e.g. Oribatida and Uropodina mites were published from Albania (Kontschán, 2003a; Mahunka, 2008), Gamasina (Zerconidae) and Uropodina mites were listed from Croatia (Kontschán, 2005, 2006, 2007a; Ujvári, 2008) and Slovenia (Kontschán, 2009; Ujvári, 2009), and furthermore several records of the Uropodina mites were mentioned from Bulgaria as well (Kontschán, 2004, 2007b).

Uropodina mites is a widely distributed group of the soil mesofauna. Recently more than two thousand species are known from all over the world, but only cca. 350 species are listed from Europe (Błoszyk, 1999). Notwithstanding that the Uropodina fauna of Central Europe is well investigated, we have only a few data on uropodids of the large, well-separated region, the Balkan Peninsula (Kontschán, 2003a, b, 2004, 2005, 2007a, b, 2008). Especially few data are present from Greece which is the largest country in the Balkan. From here only eight Uropodina species are listed so far (Kontschán, 2003b).

The present paper contains another six new records and descriptions of three new species of Uropodina mites from our three last expeditions to Greece (2006 to Pindos Mts, 2007 to Thrakia and 2008 to Peloponnesus).

MATERIALS AND METHODS

Specimens were cleared in lactic acid and later stored in alcohol. Drawings were made with the aid of a drawing tube. Specimens examined are deposited in the Collections of Soil Zoology of the Hungarian Natural History Museum (HNHM) and Natural History Museum Geneva (NHMG). Abbreviations used: h1–h4, hypostomal setae, St1–St5, sternal setae. Measurements are given in micrometres (µm), width of idiosoma was taken at the level of the coxae IV.

All specimens were collected in 2006 and 2009 by László Dányi, Jenő Kontschán and Dávid Murányi, in 2007 by László Dányi, Zoltán Eröss, Zoltán Fehér, Jenő Kontschán and Dávid Murányi.

RESULTS

Trachytidae

Trachytes aegrota (C. L. Koch, 1841)

(Fig. 1)

Material examined. E-1994. Greece, Kastoria, Visina, stream with alder forest, 15.V.2006 N40°36'31.9" E21°18'13.5", 851 m, alder forest, from leaf litter and soil.

Distribution. Europe.

Remark. This is the first record from Greece.

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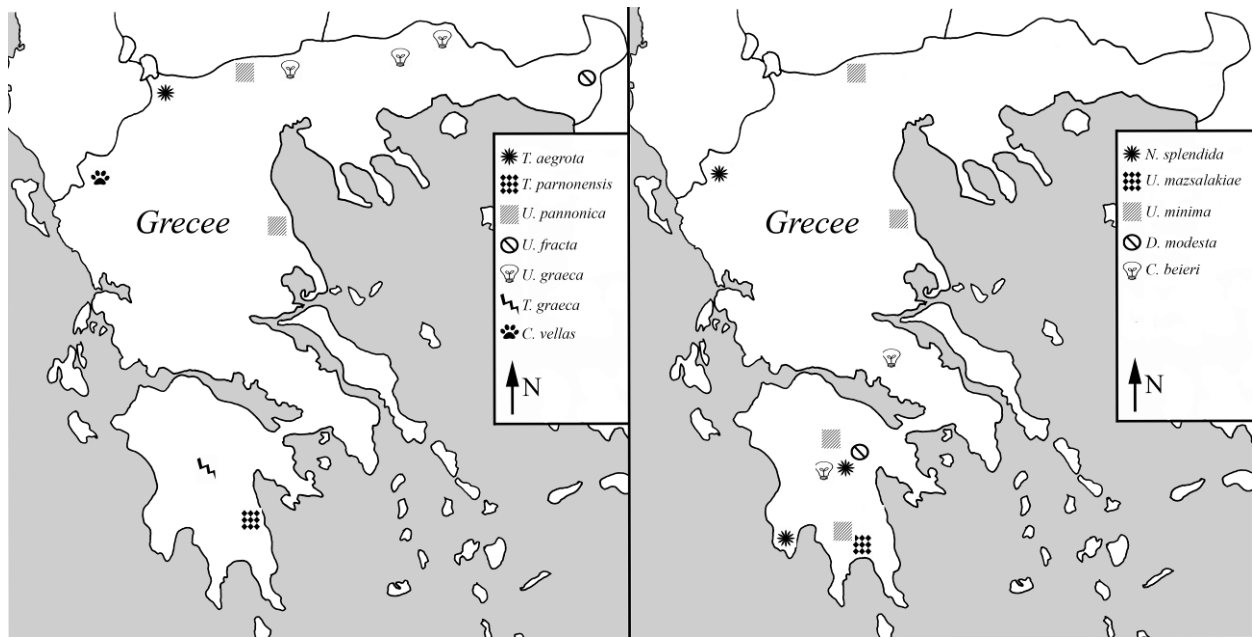


Figure 1. Occurrences of the recorded Uropodina species in Greece

***Trachytes parnonensis* sp. nov.**

(Figs. 1–6)

Material examined. Female holotype, E-2570. Greece, Arkadia County, Parnon Mts, Mesorahi, chestnut and oak mixed forest, south of the village, 900 m, N37°22.222' E22°32.121', 02.IV. 2009. Paratypes: four females and one male, same data as for holotype. Holotype, two female and one male paratypes deposited in HNHM, two female paratypes deposited in NHMG.

Diagnosis. Genital shield of female axe-like. Ventral and inguinal shields fused laterally. Pygidial shield of female rounded and deep incision can be found on caudal region of dorsal shield, contrary incision absent and pygidial shield large and oval in male. Whole surface of idiosoma covered by oval pits. Strongly sclerotised Y-shaped line can be found near anterior margin of sternal shield.

Female. Length of idiosoma 630–650 µm, width 340–410 µm (n = 4). Shape of idiosoma pear-like.

Dorsal idiosoma (Fig. 2). Marginal and dorsal shields anteriorly fused. Deep lateral incision present on dorsal shield. Pygidial shield small and rounded placed between the posterior margin of dorsal shield and the anterior margin of postdorsal shield. All setae on dorsal, marginal, and post-dorsal shields smooth and needle-like. Surface of dorsal idiosoma covered by oval pits.

Ventral idiosoma (Fig. 3). Sternal setae short, smooth, and needle-like. St1 and St2 situated near the anterior margin of genital shield, St3 on the level of posterior margin of coxae III, St4 situated on adgenital platelets, St5 can be found near the basal margin of genital shield. Sternal shield without ornamentation, but bears a strongly sclerotised Y-shaped line near the anterior margin. Ventral and inguinal shields fused laterally, covered by oval pits and bear long and needle-like setae. Setae X5 and X4 with small platelets which situated on membranous cuticle. Adanal setae and post-anal setae similar in shape to ventral setae, ad1 as long as ventral setae, but ad2 and postanal seta two times shorter than ad1.

Genital shield axe-shaped, without process, with adgenital platelets and oval pits. Genital

shield situated between coxae III and IV. Peritremes long and straight situated near coxae III.

Tritosternum (Fig. 4) with wide basis, tritosternal laciniae subdivided into four branches.

Gnathosoma (Fig. 4). Corniculi horn-like, internal malae apically serrate. Hypostomal setae h1 long and smooth, h2 four times shorter than h1 and their shape similar to that of h1, h3 similar to h1 in shape and size, h4 as long as h2, but their margin serrate. Chelicerae not clearly visible. Tibia of palps bear two serrate setae in ventral part. Epistome basally serrate and apically pilose.

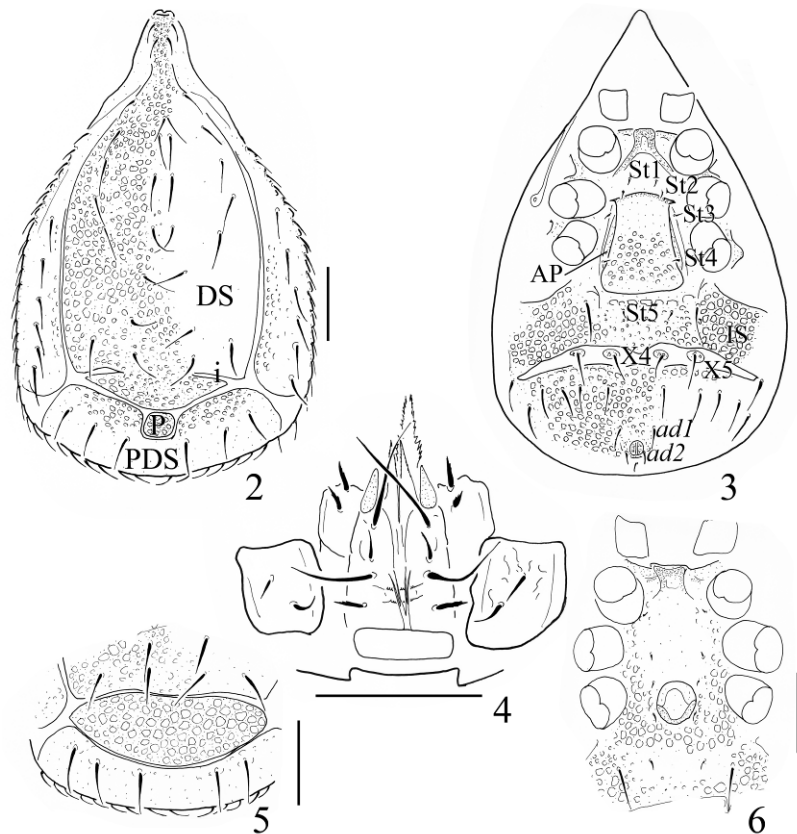
Male. Length of idiosoma 590 μm , width 350 μm ($n = 1$). Shape of idiosoma, ornamentation, and chaetotaxy of the dorsal part as in female. Dorsal incision absent, pygidial shield large, oval, and covered by oval pits (Fig. 5). Sternal setae

and needle-like, ornamentation on sternal shield alveolar. Genital shield oval and placed between coxae IV. (Fig. 6). Ventral setae and ornamentation similar to those of female.

Larva and nymphs unknown.

Etymology. The name of the new species refers to the mountain where it was collected.

Remarks. Fusion of the inguinal and ventral shields only in *Trachytes minima* Trägårdh, 1910, *Trachytes minimasimilis* Mašán, 1999, *Trachytes irinae* Pecina, 1970 and *Trachytes splendida* Hutu, 1973 can be observed, however in these species the setae X4 and X5 are placed in the fused shields. These setae in the new species are situated on small platelets on membranous cuticle and furthermore the incisions on dorsal shield are unique in the genus *Trachytes*.



Figures 2–6. *T. parnonensis* sp. nov. 2 = dorsal view, 3 = ventral view, 4 = ventral view of gnathosoma (female), 5 = caudal region of dorsum, 6 = intercoxal region (male) (Scale bar: 100 μm). (abbreviations: DS: dorsal shield, PDS: postdorsal shield, P: pygidial shield, AP: adgenital platelets, IS: inguinal shield, St1-St5 sternal setae, ad1-2: adanal setae)

Trematuridae

Trichouropoda graeca Kontschán, 2003

(Fig. 1)

Material examined. E-2563. Greece, Arkadia County, Tetrazi Mts, Ag. Theodora, rocky maple forest, 490m, N37°21.269' E21°58.782', 05.IV.2009.

Distribution. Greece.

Urodinychidae

Urodiaspis pannonica Willmann, 1951

(Fig. 1)

Material examined. E-2571. Greece, Larisa County, Ossa Mts, beech forest, 1115 , N39°47.865' E22°45.298', 09.IV.2009.04.09.; E-2182. Greece, Serres County, Vrondous Mts, pine forest at the Lailias mountain hut, 1500m, N41°15.310' E23°35.286' from pine leaf litter, 30.III.2007.

Distribution. Central- and Southern-Europe.

Remarks. This is the first record from Greece.

Uroobovella fracta (Berlese, 1916)

(Fig. 1)

Material examined. E-2190. Greece, Rodopi County, Sapka Mts, torrent in an oak forest 14 m east of Nea Sanda, 651m, N41°07.672' E25°53.223' from decayed tree, 04.IV.2007.

Distribution. Central- and Southern-Europe.

Remarks. This is the first record from Greece.

Uroobovella graeca sp. nov.

(Figs. 1 and 7–14)

Material examined. Female holotype, E-2160, Greece, Drama County, Falakro Mts, beech forest beneath the sky centre, 1186 , N41°17.582' E24°00.422', beech leaf litter, 31.III.2007. Paratypes: one male and one female, E-2167, Greece, Serres County, Orvilos Mts, rocky forest 8 km east of

Angistrou, 661 , N41°23.936' E23°30.321', from soil, 30.III.2007 (Holotype and these two paratypes deposited in HHNM); one female, E-2174, Greece, Drama County, Dit-Rodopi Mts, forest stream S of Mikromilia, 430m, N41° 23.326' E24°10.078', from leaf litter, 31.III.2007 (deposited in NHMG).

Diagnosis. Whole idiosoma covered by oval pits except sternal shield which is smooth. Dorsal, ventral, and marginal setae serrate, except setae i1, which robust and pilose, sternal setae short and smooth. Genital shield of female scutiform.

Female. Length of idiosoma 440–460 µm, width 290–310 µm (n=3). Shape of idiosoma oval.

Dorsal idiosoma (Fig. 7). Marginal and dorsal shields completely separated. All dorsal setae serrate (Fig. 9), except i1 which robust and pilose (Fig. 8). Marginal setae similar in shape and length to dorsal setae (Fig. 10). Dorsal and marginal shields bear alveolar ornamentation.

Ventral idiosoma (Fig. 11). Sternal setae short, smooth, and needle-like. St1 placed near anterior margin of genital shield, St2 on the level of central region of coxae II, St3 on the level of central region of coxae III and St4 situated on the level of anterior margin of coxae IV. Sternal shield covered by some alveolar pits. Ventral shield with alveolar ornamentation, all ventral setae serrate, except two pairs setae on central region which are needle-like and smooth. Adanal setae smooth and two times shorter than ventral setae, postanal setae similar in shape to ventral setae, but two times shorter. Genital shield scutiform, without processes and with oval pits. Genital shield placed between coxae I and IV. Peritreme and stigmata not clearly visible.

Tritosternum (Fig. 12) with narrow basis, tritosternal lacinae subdivided into three branches, central one long, serrate, and other two laterals short and smooth.

Gnathosoma (Fig. 12). Corniculi horn-like, internal malae smooth, epistome apically serrate.

Hypostomal setae h1 long and smooth, h2 four times shorter than h1 and their margins smooth, h3 two times longer than h1, their margins smooth, h4 as long as h2 their margin serrate. Chelicerae not clearly visible. Tibia of palps bear one smooth and one serrate setae in ventral part. Epistome illustrated in Fig. 13.

Legs. First leg with ambulacral prolongation, all setae of legs smooth and simple.

Male. Length of idiosoma 440 μm , width 310 μm (n=1). Shape of idiosoma, ornamentation, and chaetotaxy of the dorsal part as in female. Sternal setae on anterior region of genital shield (St1–St4)

short and smooth, but St5 two times longer than other sternal setae. Sternal shield covered by oval pits. Genital shield oval and placed between coxae IV (Fig. 14). Ventral setae and ornamentation similar to those of female.

Etymology. The name of the new species refers to the country where this species was collected.

Remarks. The new species belongs to the *pulchella*-group (Hirschmann, 1989). Only one species is known from this group in Europe, the others occur in Chile, Sri-Lanka, and Japan. The most important differences between the new species and the only European species *U. pulchella* (Berlese, 1904) are summarized in Table 1.

Table 1. Distinguishing characters between *U. pulchella* and *U. graeca*

	<i>U. pulchella</i>	<i>U. graeca</i>
Setae i1	similar to other dorsal setae	more robust than other dorsal setae and bear pilose margins
Ornamentation on dorsal shield	irregular	oval
Genital shield of female	shape linguliform and its anterior margin with wide process	scutiform and without process
Preanal line	present	absent
Dorsal and marginal shields	separated	fused

Uropodidae

Cilliba vellas sp. nov.

(Figs. 1 and 15–24)

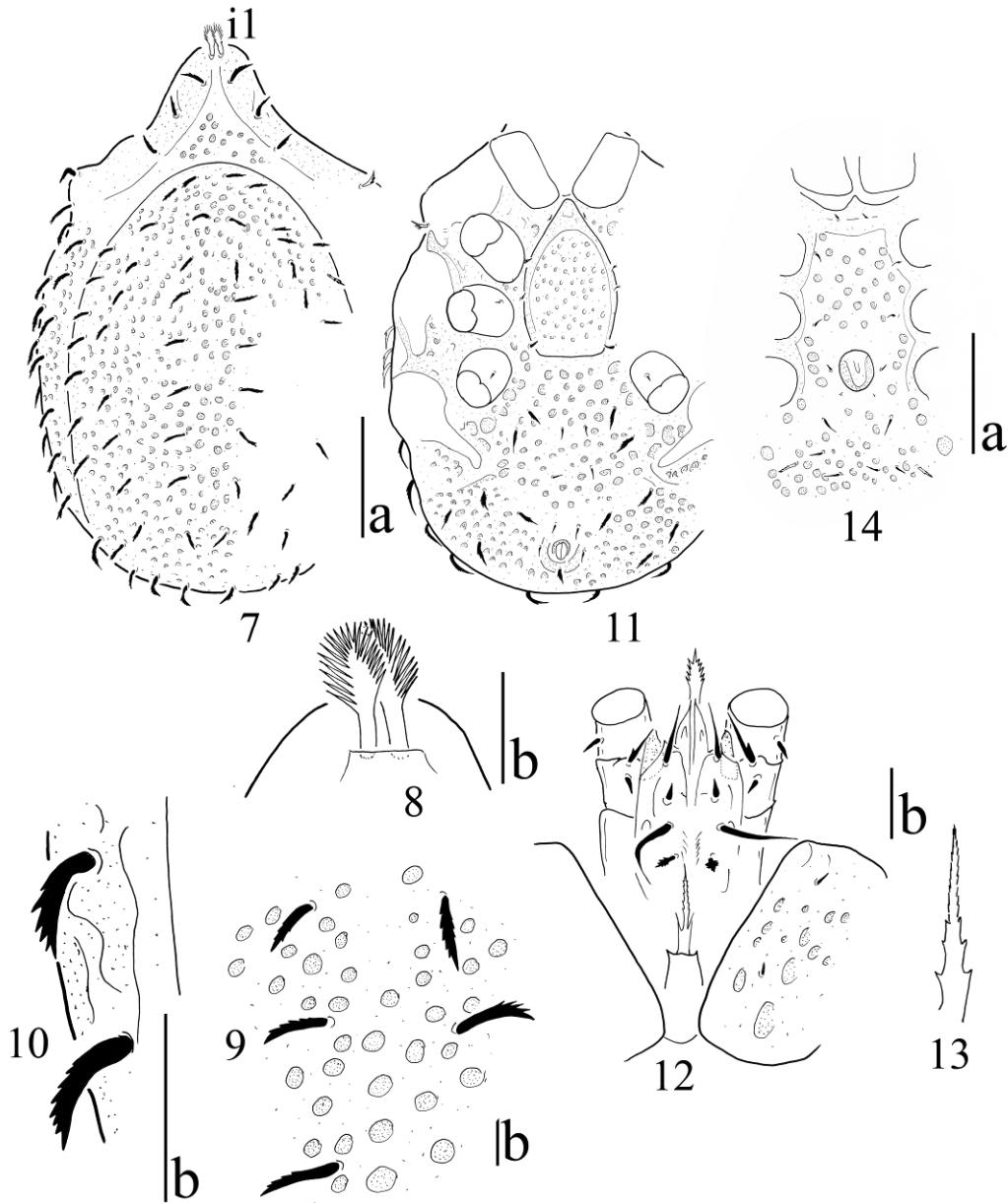
Material examined. Female holotype, E-1986, Greece, Ioannina County, Kalpaki, Vellas Monastery, karstic spring, 12.05.2006 N39°51'57.0" E20°37'26.1", 419 m a.s.l., 12.V.2006. Paratypes: two females and one male same data as for holotype. Holotype and male paratype deposited in HNHM, two female paratypes deposited in NHMG.

Diagnosis. Whole idiosoma covered by small alveolar ornamentation. Dorsal, ventral, and sternal setae smooth and needle-like, except i1 which have pilose margins apically. Dorsal shield bearing an m-shaped well-sclerotised region near caudal margin. Peritremes L-shaped.

Female. Length of idiosoma 950–980 μm , width 780–810 μm (n = 3). Shape of idiosoma oval.

Dorsal idiosoma (Fig. 15). Marginal and dorsal shields completely separated. All dorsal setae smooth and needle-like, except i1 which have pilose margins (Fig. 16). Marginal setae similar in shape to dorsal setae, but two times shorter (Fig. 17). Dorsal shield bearing an m-shaped well-sclerotised region near the caudal margin (Fig.18). Ornamentation of dorsal and marginal shields alveolar.

Ventral idiosoma (Fig. 19). Sternal setae short, smooth, and needle-like. St1 placed on the level of anterior margins of coxae II, St2 on the level of posterior margin of coxae II, St3 on the level of central region of coxae III and St4 situated on the level of anterior margins of coxae IV. St5 placed in posterior corners of the genital shield. Sternal



Figures 7–14. *U. graeca* sp. nov. 7 = dorsal view, 8 = il setae, 9 = dorsal setae and ornamentation, 10 = marginal setae, 11 = ventral view, 12 = ventral view of gnathosoma, 13 = epistome (female), 14 = intercoxal region (male)
(Scale bars: a: 100 μ m, b: 20 μ m)

shield covered by alveolar pits. Ventral shield with alveolar ornamentation, all ventral setae smooth and needle-like, their shape and position are illustrated on Fig. 19. Adanal setae and post-anal setae smooth and needle-like, ad1 two times shorter than ad2 and postanal seta.

Genital shield linguliform, without process, covered by oval pits, and placed between coxae II and IV.

Stigmata situated near coxae II, peritreme L-shaped.

Tritosternum (Fig. 20) with wide basis, trito-sternal laciniae subdivided into six branches.

Gnathosoma (Fig. 20). Corniculi horn-like, internal malae long and smooth. Hypostomal setae h1 long and smooth, h2 and h3 five times shorter than h1 and their shape similar to that of h1, h4 as long as h2, but their margin serrate. Epistome basally serrate and apically pilose (Fig. 21). Fixed digit of chelicerae longer than movable digit (Fig. 22). Tibia of palps bearing one big V-form seta and one serrate seta in ventral part.

Male. Length of idiosoma 980 µm, width 810 µm (n = 1). Shape of idiosoma, ornamentation, and chaetotaxy of the dorsal part as in female. All sternal setae short and needle-like. Genital shield oval and placed between coxae IV (Fig. 23). Ventral setae and ornamentation similar to those of female. Tibia of palps bearing two serrate setae (Fig. 24).

Etymology. The name of the new species refers to the monastery where this species was collected.

Remarks. The m-shaped well-sclerotised region near the caudal margin of dorsal shield hitherto has not been observed in the genus *Cilliba* v. Hayden, 1826.

***Neodiscopoma splendida* Kramer, 1882**

(Fig. 1)

Material examined. E-2579. Greece, Messinia County, Haravgi, Polilimnio, gorge south of the village, 290 m, N36°58.916' E21°51.036', 05.IV.2009; E-2574. Greece, Arkadia County, Vitina, stream and its gallery, woody pasture southwest of the city, 960m, N37°39.031' E22°10.156', 06.IV.2009; E-1986. Greece, Ioannina County, Kalpaki, Vellas Monastery, karstic spring, N39°51' 57.0" E20°37'26.1", 419m, from moss, 12.V.2006.

Distribution. Europe.

Remark. This is the first record of *N. splendida* from Greece.

***Uropoda mazsalakiae* Kontschán, 2005**

(Fig. 1)

Material examined. E-2584, Greece, Lakonia County, Trinisa, seashore and mouth section of a stream near the village, N36°48.251' E22°37.086', 03.IV.2009.

Distribution. Croatia and Greece.

Remark. This is the first record of *U. mazsalakiae* from Greece.

***Uropoda minima* Kramer, 1882**

(Fig. 1)

Material examined. E-2583. Greece, Arkadia County, Aroania Mts, Planitero, Platanus gallery of Aroanios (Ladon) Stream west of the village, 600 m, N37°55.985', E22°09.503', 07.IV.2009; E-2571. Greece, Larisa County, Ossa Mts, beech forest, 1115 m, N39°47.865', E22°45.298', 09.IV.2009; E-2576. Greece, Lakonia County, Taigetos Mts, Poliana (Krioneri), mixed gallery of Varbaras Stream above the village, 985m, N36°57.952', E22°22.884', 03.IV.2009; E-2182. Greece, Serres County, Vrontous Mts, pine forest at the Lailias mountain hut, 1500 m, N41°15.310', E23°35.286', from pine leaf litter, 30.III.2007.

Distribution. Europe.

Remark. This is the first record of *U. minima* from Greece.

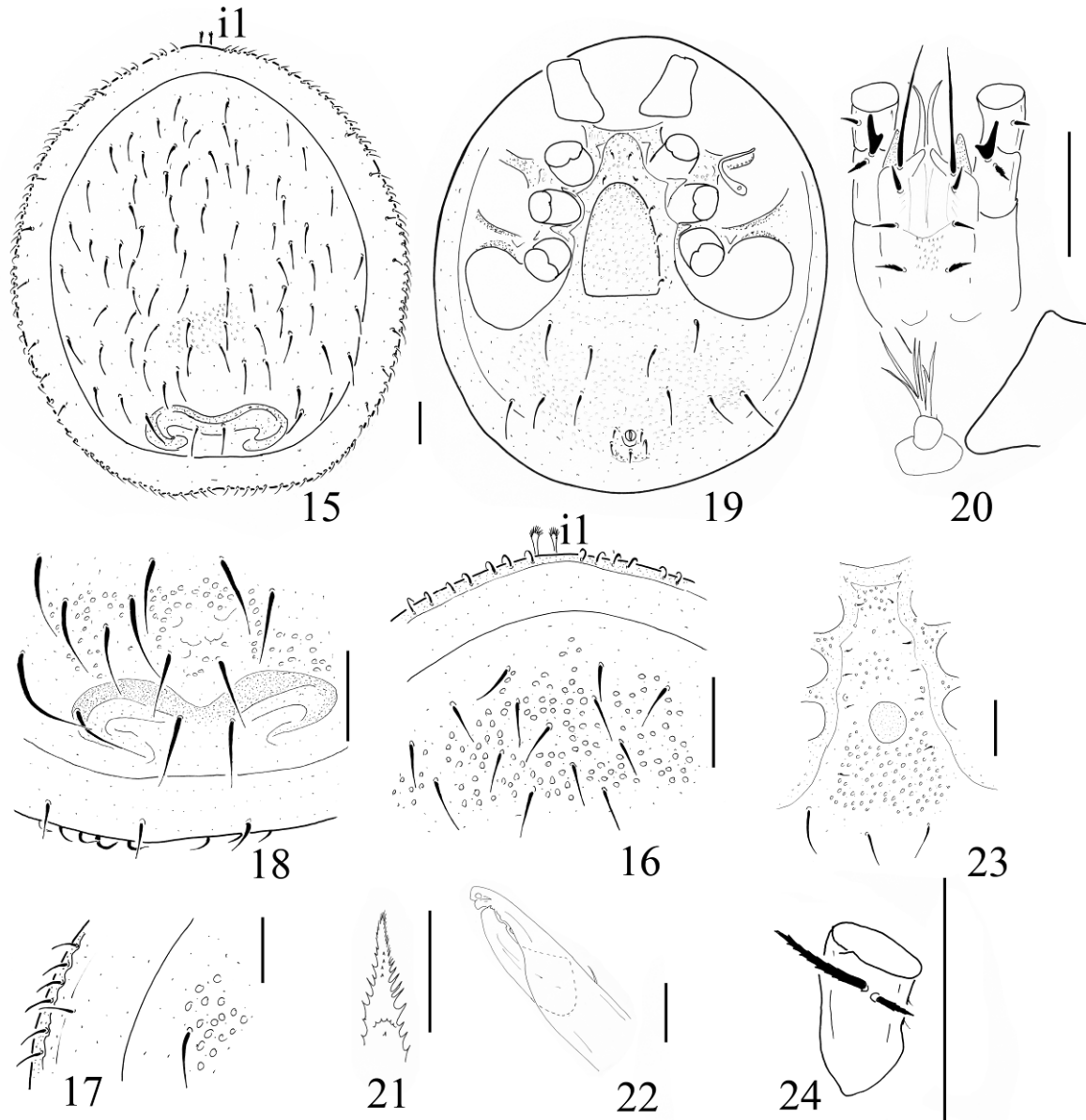
Discourellidae Baker & Wharton, 1952

***Discourella modesta* (Leonardi, 1899)**

(Fig. 1)

Material examined. E-2574. Greece, Arkadia county, Vitina, stream and its gallery, woody pasture southwest of the city, 960 m, N37°39.031' E22°10.156', 06.IV.2009.

Distribution. Europe.



Figures 15–24. *C. vellas* sp. nov. 15 = dorsal view, 16 = *il* setae and anterior region of dorsum, 17 = marginal setae, 18 = caudal region of dorsum, 19 = ventral view, 20 = ventral view of gnathosoma, 21 = epistome, 22 = chelicera (female) 23 = intercoxal region, 24 = Setae on tibia of balp (male) (Scale bar: 100 μ m)

***Crinitodiscus beieri* Sellnick, 1931**

(Fig. 1)

Material examined. E-2573. Greece, Phocis County, Parnassos Mts, Eptolofos, streamshore Platanus trees in the village, 860 m, N38°35.565',

E22°29.236', 08.IV.2009.; E-2563. Greece, Arkadia County, Tetrazi Mts, Ag. Theodora, rocky maple forest, 490 m, N37°21.269' E21°58.782', 05.IV.2009.

Distribution. Greece.

DISCUSSION

Three of the already known species found possess a typical Mediterranean distribution. *Trichourpoda graeca* is so far recorded only from Greece and missing from the fauna of the neighbouring countries in the Balkan Peninsula. The same phenomenon is observed for the species *Crinitodiscus beieri* (Sellnick, 1931) as well. This species was described from Greece and so far has not been found elsewhere (Athias-Binche & Błoszyk, 1985).

The genus *Crinitodiscus* Sellnick, 1931 shows a typical East-Mediterranean distribution; several of its species are known from Crete, Iran (Athias-Binche & Błoszyk 1985), Turkey (Athias-Binche & Błoszyk, 1985; Bal, 2006), and Albania (Kontschán, 2003). This distribution type is not unknown among the members of the soil fauna. Similar East-Mediterranean distribution can be found also in earthworms (Pavliček *et al.*, 2003, 2006), moss mites (Mahunka, 1979) and Gamasina mites (especially in the members of the family Zerconidae (Ujvári, 2008).

Until the lower Miocene, a continental bridge existed between Asia Minor and the Balkan Peninsula which aided the colonization and distribution of the soil animals between Asia Minor and the Balkan. At the end of the Miocene, this bridge ceased to exist and Asia Minor, the Balkan Peninsula and the Aegean islands separated from each other (Simaiakis *et al.*, 2004). The East-Mediterranean distribution type observed in the above mentioned soil fauna groups well corresponds with this geological phenomenon.

Uropoda mazsalakiae was described from Croatia (Kontschán, 2005) from decayed seagrass. According to my assumption this species has a salt tolerance hence it can be found in the sea-shore regions similarly to several other Uropodina species with littoral occurrences (Coineau & Travé, 1964; Kontschán, 2007).

The other already described species found (*Trachytes aegrota*, *Urodiaspis pannonica*, *Uroobovella fraca*, *Neodiscopoma splendida*, *Uropoda minima*, *Discourella modesta*) are widely di-

stributed in Europe, they can be found in central and southern part of the continent.

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***Megaphyllum silvaticum* (Verhoeff, 1898) (Diplopoda: Julida), a new species to the Hungarian millipede fauna, with notes on the status of *M. s. discolor* (Verhoeff, 1907) and on their relationship to *M. projectum* Verhoeff, 1894**

E. LAZÁNYI and Z. KORSÓS¹

Abstract. The species *Megaphyllum silvaticum* (Verhoeff, 1898) was found in the Aggtelek National Park, northeastern Hungary, as new to the millipede fauna of the country. A short review on the male and female genital morphology and distribution of *M. silvaticum*, *M. s. discolor* (Verhoeff, 1907) and *M. projectum* Verhoeff, 1894 is given. According to our observation the subspecies *discolor* should be regarded only a variation with no taxonomical value. Although the male gonopods of *M. silvaticum* and *M. projectum* are really close to each other, the different female vulvae, observed and illustrated here for the first time, justify their separate specific status.

INTRODUCTION

Megaphyllum silvaticum (Verhoeff, 1898) was described from Mt. Postăvarul (= Schulergebirge), near Braşov, Romania (Verhoeff, 1898: p. 157, Fig. 26). A decade later, Verhoeff described its subspecies *discolor* from Kočevje, Slovenia (= Gottschee) (Verhoeff, 1907: p. 307, Fig. 18). Males of the two subspecies can be distinguished from each other according to the length of the posterior process – „Mesomeritfortsatz” by Verhoeff, or „Paracoxitfortsatz” by Attems (1926) – of the opisthomere. If it exceeds in length the anterior process („Schutzblattfortsatz” by Verhoeff, or „Solänomeritquerlappen” by Ložek & Gulička (1962)), then it is *M. s. discolor*.

M. silvaticum is regarded as a Carpathian species (Golovatch, 1992), mostly found at higher elevations (Verhoeff, 1907). It has already been reported from Austria (Voigtländer *et al.*, 1997), Slovakia (Mock, 2001), Ukraine (Chornyi & Golovatch, 1993), Romania (Tăbăcaru, 1976), Croatia (Strasser, 1965), Slovenia (Strasser, 1966), Italy (Foddai *et al.*, 1995), Poland (Stojałowska & Starega, 1961), and Russia (Lokšina & Golovatch, 1979). The new Hungarian record fits very well into this distribution pattern. The diplopod fauna of the Aggtelek National Park has already been surveyed (Lazányi & Korsós, 2009) but due to the

difficult morphological situation of the species group, *M. silvaticum* was omitted from the species list (see Discussion).

One aim of our present study was to make a provisional distribution map of the two subspecies and to reconsider the subspecific status of *M. s. discolor*. Sometimes *M. s. silvaticum* and *M. s. discolor* are found at the same region (Schmölzer-Falkenberg, 1975; Strasser, 1971). Without a precise observation of the gonopods *M. s. silvaticum* can be misidentified as the common species *M. projectum* Verhoeff, 1894. In several parts of their distribution the two species have overlapping areas (e.g. Attems, 1929). Verhoeff (1898) in his original description of *M. silvaticum*, already mentioned the morphological similarity of the two species, and later discussed it in details, too (Verhoeff, 1899, 1907). He found no reliable morphological differences for females, so the other aim of our study was to recheck it, and to find a key for distinguishing females on the basis of vulval morphology.

MATERIAL AND METHODS

The Aggtelek National Park (ANP) is situated at the northeastern border of Hungary, and was founded in 1985. In 1987 the Hungarian Natural History Museum (HNHM) started a collecting

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project which officially lasted for four years, but additional collectings were performed until 2002. Millipedes derived from sifting and hand-sorting are preserved in 70 % ethanol in the Myriapoda Collection of the Department of Zoology, HNHM. For study, we used a Leica M125 stereo microscope, and, if needed, animals were temporarily fixed with lubricant gel in the alcohol.

The *M. silvaticum* male specimen from ANP was compared to the *M. s. silvaticum* type specimen from Museum für Naturkunde, Berlin (ZMB 12976, 1♂: gonopods, holotype, slide preparation. Nr.1254, Coll. Verhoeff, Schuler, Deubel leg.), and to the *M. s. discolor* type specimens from Zoologische Staatssammlung München (1♂: gonopods, regarded as type specimen, slide preparation, A20033660, Bruck). Gonopods of the type specimens were newly drawn at the collections (ZMB and ZSM). We had three additional male specimens in the Myriapoda Collection, HNHM, from Maramureş County, Romania (Korsós & Lazányi, 2008) (2♂: Rodna Mts., Borşa, Staţiunea Borşa, limestone rocks on pasture over the ski course, 1521 m, N47°35'–E24°48', 26.09.2006, leg. Dányi, L., Kontschán, J. & Murányi, D.; 1♂: Maramureş Mts., Borşa-Băile Borşa, Vinişor Valley, middle section, spring in beech forest, 988 m, N47°40'–E24°47', 22.05.-2007, leg. Csuzdi, Cs., Dányi, L., Kontschán, J. & Murányi, D.).

Comparison of females was based upon *Megaphyllum* female specimens from the Maramureş project (Korsós & Lazányi, 2008), from the Aggtelek National Park, and from other parts of Hungary. Vulvae were prepared in Faure-Berlése medium then removed by distilled water and relocated in 70 % ethanol into the collection. After some hours of incubation the internal structure of vulvae (e.g. apodemic tube, ampulla, appendix) were investigated under a light microscope (Leica DM-1000). One of the vulvae was left intact, the other was dissected into the parts bursa and operculum, and these were used to count the setae on their surface.

RESULTS

We compiled a distribution map of *M. s. cf. silvaticum* and *M. s. cf. discolor* (Fig. 1) on the basis of individuals identified in the present study and of literature data. Those data in the literature where exact localities (i.e. at least township names) are given are supplied with data where only wider areas were published.

One male specimen resembling *Megaphyllum s. discolor* was found in the collection from the Aggtelek National Park, northeastern part of Hungary. The sample originated from the valley of the Kecső Stream, collected on the 28th of April, 1989, by Imre Fürjes, assistant curator at that time in the Myriapoda Collection, HNHM. Unfortunately, the label did not contain further data (e.g. habitat type). The specimen is in the developmental stadium XI, with 49+1+T segments, with 44 ocelli on the right, and 45 on the left side. Length is ca. 47.8 mm, height at the 26th segment 2.9 mm. The gonopods (Fig. 2) agree well with the gonopods of the type specimen of *M. s. discolor* (Fig. 3).

The male specimens from Statiunea Borşa, Maramureş (Fig. 4) are similar to the type specimen of *M. s. silvaticum* (Fig. 5). Details of the two males are as follows: (1) stadium X, 46+1+T segments, 41 ocelli on the left, and 40 on the right side, length ca. 30 mm, height at the 25th segment 2 mm; (2) stadium X, 45+2+T segments, 38 ocelli on the left, and 41 on the right side, length appr. 33.2 mm, height at the 25th segment 2.4 mm. The male specimen from Vinişor Valley, Maramureş, however, has different gonopods (Fig. 6). It is in stadium XI, with 49+1+T segments, 44 ocelli on each side, its length is appr. 43.7 mm, height at the 26th segment: 2.7 mm.

As regards the female vulvae (Figs. 7–8), two types were found in the females of the ANP material, from Szentmargitfalva (southwestern border of Hungary), and from Maramureş.

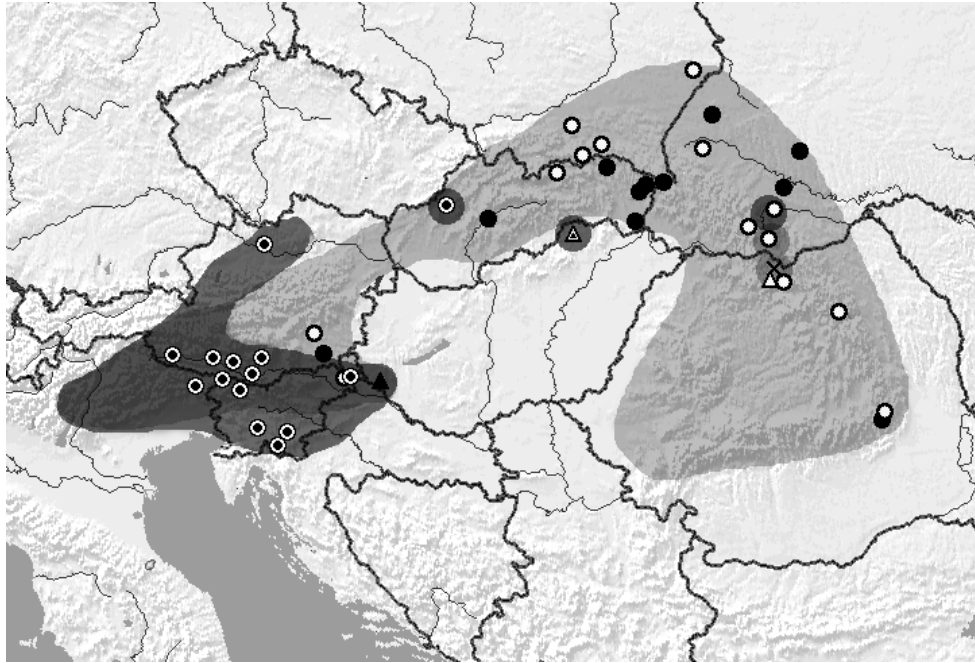


Figure 1. Distribution of *Megaphyllum silvaticum*. Black dots: *M. silvaticum* (without subspecific allocation); white-centered dots: *M. s. cf. silvaticum*; black-centered dots: *M. s. cf. discolor*; black triangle: *M. s.* from Szentmargittfalva; black-centered triangle: *M. s. cf. discolor* from Jósvalfő, Aggteleki NP; white-centered triangle: *M. s. cf. silvaticum* from Stațiunea Borșa, Maramureș; cross-sign: third type of *M. silvaticum* from Vinișor Valley, Maramureș. The light grey distributional area refers to *M. s. cf. silvaticum*, darker grey area to *M. s.* specimens having gonopods with the shortest posterior process; the darkest distributional areas to *M. s. cf. discolor*

Detailed data of one female with the vulva type shown in Fig. 7 (ANP, Szögliget, Patkós valley, 2. May 1988, leg. Z. Korsós): it is in stadium XII, with 49+1+T segments, 47 ocelli on the right and 48 on the left side, its length is ca. 46.7 mm, height at the 26th segment 3.6 mm. Age of females with this vulva type ranged between the stadia XI–XIII. Females of stadium X (and below) had vulvae still in underdeveloped stage. Chaetotaxy of this vulva type is variable, usually about 50, not symmetrically distributed setae can be found on each bursae, and 10–18 setae are both on the anterior and on the caudal half of each operculum.

Detailed data of one female with the other vulva type, shown in Fig. 8 (ANP, Szögliget, Ménes valley, leaf litter, 31. October 1989, leg. Z.

Korsós): it is in stadium X, with 49+2+T segments, 39 ocelli on the right and 38 on the left side, its length is ca. 23.6 mm, height at the 27th segment 2.9 mm. Age of females with this vulva type ranged between stadia X–XI. Chaetotaxy of this vulva type is also variable, usually 4–11 setae are both on the anterior and on the caudal half of each bursae, and 5–3 setae are both on the anterior and on the caudal half of each operculum.

Both species showed the same sexual dimorphism in colour pattern: males dark brown, or dark grey, with one longitudinal black line dorsally; females had three longitudinal lines dorsally, a black one surrounded by two bright yellowish ones, the basic body colour was brighter than males', and varied from light to dark greyish brown.

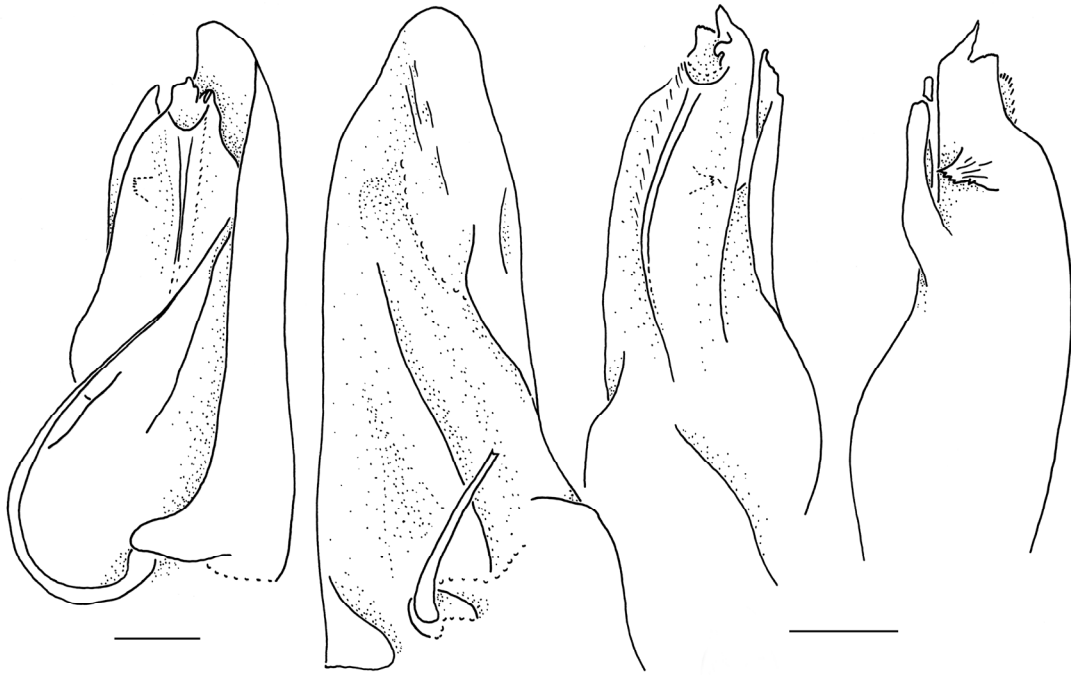


Figure 2. *Megaphyllum silvaticum* male from Jósvalfő, Hungary. Right gonopods as they are joined *in situ*, mesal view (scale bar: 0.2mm); left promere, meso-caudal view; left opisthomere, mesal and lateral view, respectively (posterior process broken) (scale bar: 0.2 mm)

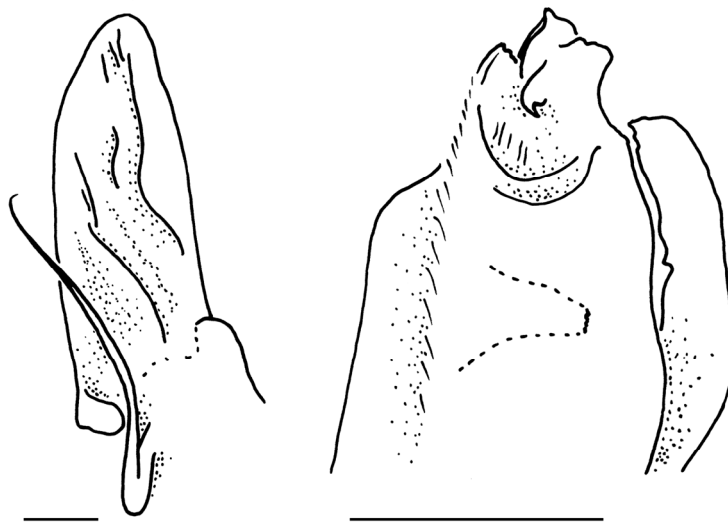


Figure 3. *Megaphyllum silvaticum discolor* male type specimen from Bruck, Austria. Left promere, meso-caudal view, left opisthomere, mesal view (scale bars: 0.2 mm)

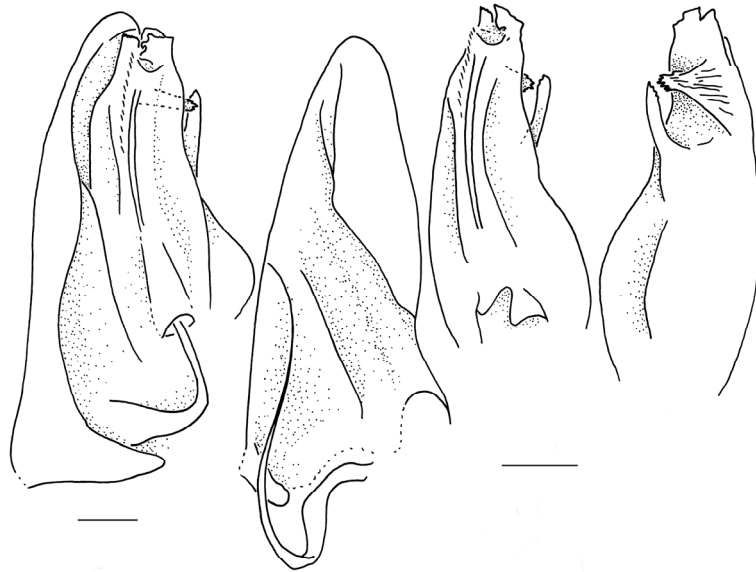


Figure 4. *Megaphyllum silvaticum* male specimen from Statiunea Borşa, Maramureş. Left gonopods as they are joined *in situ*, mesal view (scale bar: 0.2 mm); left promere, meso-caudal view; left opisthomere, mesal and lateral view, respectively (scale bar: 0.2 mm)

DISCUSSION

The distribution map (Fig. 1) seems to show an ambiguous distribution pattern for *M. s. cf. silvaticum* and *M. s. cf. discolor*. *M. s. cf. discolor* is likely to be restricted to the southwestern part of the distribution area. The problem arises, however, as the Hungarian *M. s. cf. discolor* specimen and the specimen from Skalka (Verhoeff, 1941) are in the centre of the area of *M. s. cf. silvaticum*. If we take into consideration those distributional records from the literature which refer to wider areas, we clearly get two overlapping ranges. The male from the extreme northeast with different gonopods further complicates the concept. Jawłowski already reported remarkable variability in the length of the opisthomere's posterior process from Ukraine (Jawłowski 1936, with figures on three types of gonopods, figs. 10–13). In Zaroślak he also found a gonopod like the one we had from Vinişor Valley. He supposed that the length of the posterior process is in relationship with the altitude above sea level, i.e. the higher is the elevation the smaller the is the process. Ložek & Gulička (1962) in their work on the millipede fauna of NE Slovakia mention that

they found considerable gonopod variation of *M. silvaticum* in the size of the anterior process of the opisthomere. They found no variability in the length of the posterior process with regard to geographical altitude. Neither did our data support Jawłowski's assumption.

Although Verhoeff (1907) gave a detailed morphological description of the two forms, he admittedly could not attach coherent distributional patterns to them. He declared his opinion on the concepts of subspecies and of variation, that he did not consider the geographical distribution as relevant, only morphology. According to the modern concept of subspecies, a disjunct distributional pattern is important, so the form *discolor* can not presently be considered as a subspecies. Our investigation of females supports this statement (see below).

Verhoeff (1898) in his original description stated that regarding to form, sculpture, and size *M. silvaticum* looks like *M. projectum*, so he specified the differences in the gonopods, and gave an illustration of the opisthomere (Verhoeff, 1898, fig. 26).



According to our observations, gonopods of adult males really look differently, even *in situ*, and this can rarely change due to its actual position during fixation in ethanol. Dissected gonopods at high magnification under stereo or biological microscope are clearly different. One year later Verhoeff (1899) gave a description of the females which, nevertheless, fits well to *M. projectum* females, too. He observed one difference between the two species in the striation of the prozonites, but later he rejected it as not reliable (Verhoeff, 1907). He found some differences in the coloration, but even if it was useful, there are many known colour variations of *Megaphyllum* females, and after preservation in ethanol, such colour differences can easily vanish.

Figure 5. *Megaphyllum silvaticum* male holotype, from Schuler (i.e. Mt. Postăvarul). Left promere, meso-caudal view; left opisthomere, lateral view (scale bar: 0.2 mm)



Figure 6. *Megaphyllum silvaticum* male specimen from Vinișor Valley, Maramureș. Right gonopods as they are joined *in situ*, mesal view (scale bar: 0.2 mm); left promere, meso-caudal view; left opisthomere, mesal and lateral view, respectively (scale bar: 0.2 mm)

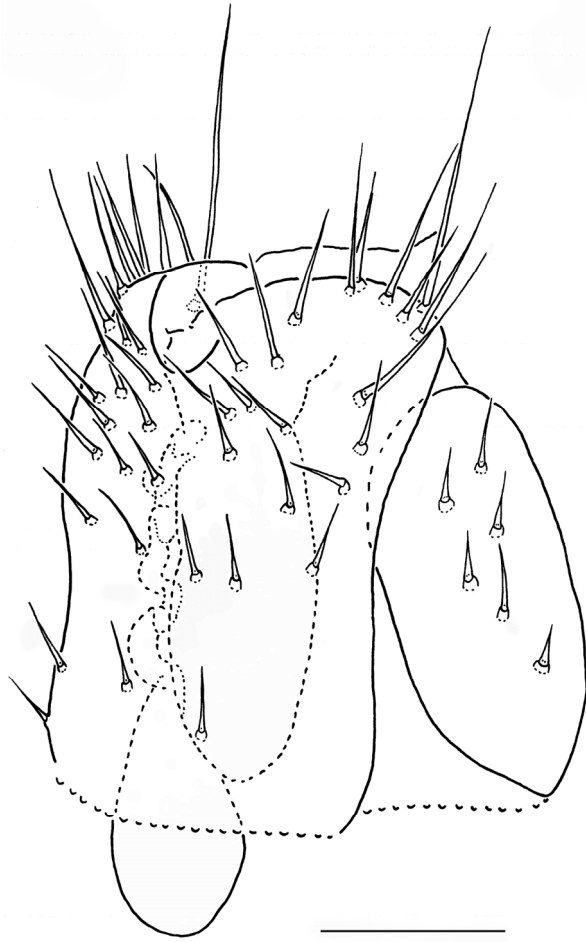


Figure 7. *Megaphyllum projectum* female, left vulva, meso-caudal view (scale bar: 0.2 mm)

Our efforts to find female differences proved to be successful when looking at the female vulvae. There is one early pioneer work on the female characterisation of Hungarian diplopods, but Sziráki (1966) dealt only with the external morphology of vulvae. Based on his work and our present study the *Megaphyllum* females from different parts of Hungary with spiral apodemic tube (Fig. 7) and big ampullas belong to the species *projectum*. The entire vulva is relatively bigger than the other type (Fig. 8, see scale bars), and in most cases, the big ampulla can be seen after dissection, with high magnification, in stereo microscope, too. In Maramureş (Korsós & Lazányi, 2008) only two species of *Megaphyllum* were found, *M projectum* and *M. silvaticum*, whereas in

the ANP, in our earlier survey (Lazányi & Korsós, 2009), presence of *M. unilineatum* was proved as well. The latter species can easily be identified, so we can state, that the more simple type of vulvae (Fig. 8) belongs to *M. silvaticum*. The inner structure of this vulva type needs preparation in Faure-Berlése medium. An other point which can help at the identification is the age of the individuals. It seems that by *M. silvaticum* the adult female specimens are in the developmental stadia X-XI, while by *M. projectum* they are in the stadia XI-XIII. Thus, a female in the stadia XII-XIII probably belongs to the species *M. projectum*.

In conclusion, we found three different types of *Megaphyllum silvaticum* male gonopods, with no relation to any distribution pattern, and only one type of female vulvae. Thus we can say that all types of males belong to one species, to *M. silvaticum*, which can have a special variability of the length in the posterior process. The form *discolor* henceforward cannot be considered as a subspecies, only a variation with no taxonomical value.

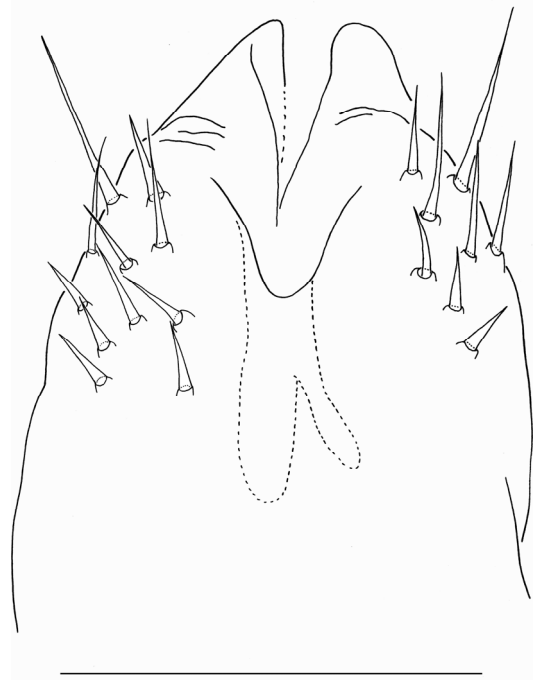


Figure 8. *Megaphyllum silvaticum* female, right vulva, mesal view (scale bar: 0.2 mm)

M. projectum is a very common Central European forest species sometimes in very high abundance, so in general ecological or faunistic studies usually it is difficult to expect to dissect all the individuals for male gonopod inspection. However, as at higher elevations *M. silvaticum* can co-occur with *M. projectum*, and their external morphology is highly similar, the closer investigation of selected males and/or females for their sexual organs is inevitable to prove the presence or absence of one or the other species.

Acknowledgements. We would like to thank Prof. Jason Dunlop and the European Commission's (FP 6) Integrated Infrastructure Initiative program SYNTHESYS for supporting the project „DE-TAF-5589: Revision of the *Megaphyllum projectum* (Verhoeff, 1894) species-group” at the Museum für Naturkunde, Berlin (to EL). Prof. Roland Melzer at the Zoologische Staatssammlung München, is also acknowledged for his help and arrangement of the type materials investigated. László Dányi (HNHM) is gratefully acknowledged for his continuous advices and assistance during the examination of the specimens.

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New and little known oribatid mites from Madagascar (Acari: Oribatida). I.

S. MAHUNKA¹

Abstract. A list of the newly studied and identified oribatids from Madagascar (Malagasy Republic) is given. Altogether 17 species are mentioned from several sites of the island including four new species and a new subspecies belonging in the families Steganacaridae, Oppiidae and Austrachipteriidae, respectively. Two species, *Eniochthonius sumatranus* Mahunka, 1989 and *Cultroribula bicuspidata* Mahunka, 1978 are recorded for the first time from Madagascar. With 25 figures.

INTRODUCTION

For some time I have been studying the oribatid fauna of Madagascar (Mahunka, 2002, 2009 a, b). The final aim is to write a monograph of this unique and very rich fauna. For achieving this goal I try to identify and discuss as much oribatid species as possible deriving from different parts of the island. In this contribution, I present the species collected by Dr. Csaba Csuzdi in Vohimana Reserve, Dr. Tamás Pócs in several localities of Antsiranana and Tomasina Provinces and Dr. Dénes Balázs in different regions of the great island.

Present article comprises descriptions and/or discussions of 17 species belonging in different oribatid families. Of them, four species (*Notophthiracarus inusitatus*, *N. pseudosomalicus*, *Fusuloppia variosetosa* and *Lamellobates cuneatus* spp. nov.) and one subspecies (*Austrophthiracarus aokii malagasensis* ssp. nov.) are new to science. Two further, little known species (*Eniochthonius sumatranus* Mahunka, 1989 and *Cultroribula bicuspidata* Mahunka, 1978) are reported for the first time from Madagascar.

In this paper, as in the earlier ones, I follow the system of Norton & Behan-Pelletier (2009), and besides I also use some works which were mentioned in my previous publication on this subject (Mahunka, 2008). In the descriptions I use the morphological terminology of Norton & Behan-Pelletier (2009) and furthermore those of other authors (e.g. Mahunka & Zombori, 1985; Nied-

bala, 1992, 2001, 2004, 2008; Norton *et al.*, 1997, Weigmann, 2006; Woas, 2002).

Depositories. The material examined is deposited in the Hungarian Natural History Museum, Budapest (HNHM), and some paratypes and voucher specimens in the Muséum d'Histoire naturelle de Genève (MHNG).

LOCALITIES

Afr-311 Madagascar, Ranomafana, E from Fianarantsoa, soil samples from litter of tropical rain forest, 24-26. September 1979. Leg. D. Balázs.

Afr-918 Madagascar, Antsiranana Prov., Réserve Spéciale de Manongarivo. Tall mesic evergreen forest with huge sandstone cliffs and boulders 7.5 km SW of Antanambao village, at the W side of Ambakatra river. At 460-570 m alt. 13°55.5'N, 48°27.3'E. 24. July 1998. Leg. T. Pócs. (No. 9857).

Afr-921 Madagascar, Toamasina Prov., Mananara Nord Biosphere Reserve and National Park. Lowland rainforest on the E slopes of Mahavoho Hill (very wet types along Mahavoho River, with many tree ferns, palms and Pandanus spp., less humid on slopes) at 220-300 m alt. 16°27'S, 49°46.9-47.5'E. Date: 14-15, Aug. 1998. Leg. T. Pócs. (No. 9878).

Afr-923 Madagascar, Toamasina Prov., Maromizaha forest. Mossy montane rainforest with bamboo (*Nastus* sp.) undergrowth on the summit ridge of Mt. Maromizaha, south of the Andasibe Nat. Park and the Antananarivo Toamasina road, 2 km W of Anevoka village, at 1080-1214 m alt. 18°57.8'S, 48°27.5'E. Date: 26. August 1998. Leg. T. Pócs. (No. 9890).

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Afr-996 Madagascar, Vohimana Reserve, primary forest. 17. April 2008. Leg. Cs. Csuzdi.

LIST OF THE NEWLY IDENTIFIED SPECIES

CTENACARIDAE Grandjean, 1954

Beklemishevia demeteri Mahunka, 1984
Locality: Afr-921.

ENIOCHTHONIIDAE Grandjean, 1947

Eniochthonius sumatranus Mahunka, 1989
Locality: Afr-923.

EPILOHMANNIIDAE Oudemans, 1923

Epilohmannia insignipes Balogh, 1962
Locality: Afr-923.

EUPHTHRACARIDAE Jacot, 1930

Microtritita hauseri Mahunka, 1994
Locality: Afr-923.

STEGANACARIDAE Niedbala, 1986

Austrophthiracarus aokii malagasensis sp. nov.

Hoplophorella vitrina (Berlese, 1962)
Locality: Afr-918.

Notophthiracarus inusitatus sp. nov.

Notophthiracarus pseudosomalicus sp. nov.

Notophthiracarus zebra Balogh, 1962
Locality: Afr-923.

ASTEGISTIDAE Balogh, 1961

Cultroribula bicuspidata Mahunka, 1978
Locality: Afr-921.

CERATOPPIIDAE Kunst, 1971

Trichoppia longiseta Balogh, 1960
Locality: Afr-923.

OPPIIDAE Sellnick, 1937

Fusuloppia variosetosa sp. nov.

Gressitoppia sensilla (Mahunka, 2002)
Locality: Afr-923.

Rugoppia boraha (Mahunka, 1994)
Locality: Afr-921.

MICROZETIDAE Grandjean, 1936

Rhopalozetes madecassus Mahunka, 1993
Locality: Afr-923.

AUSTRACHTERIIDAE Luxton, 1985

Lamellobates cuneatus sp. nov.

TEGORIBATIDAE Grandjean, 1954

Lemurobates antsiranana Mahunka, 1997
Localities: Afr-921, Afr-996.

DESCRIPTIONS

Austrophthiracarus aokii malagasensis sp. nov.

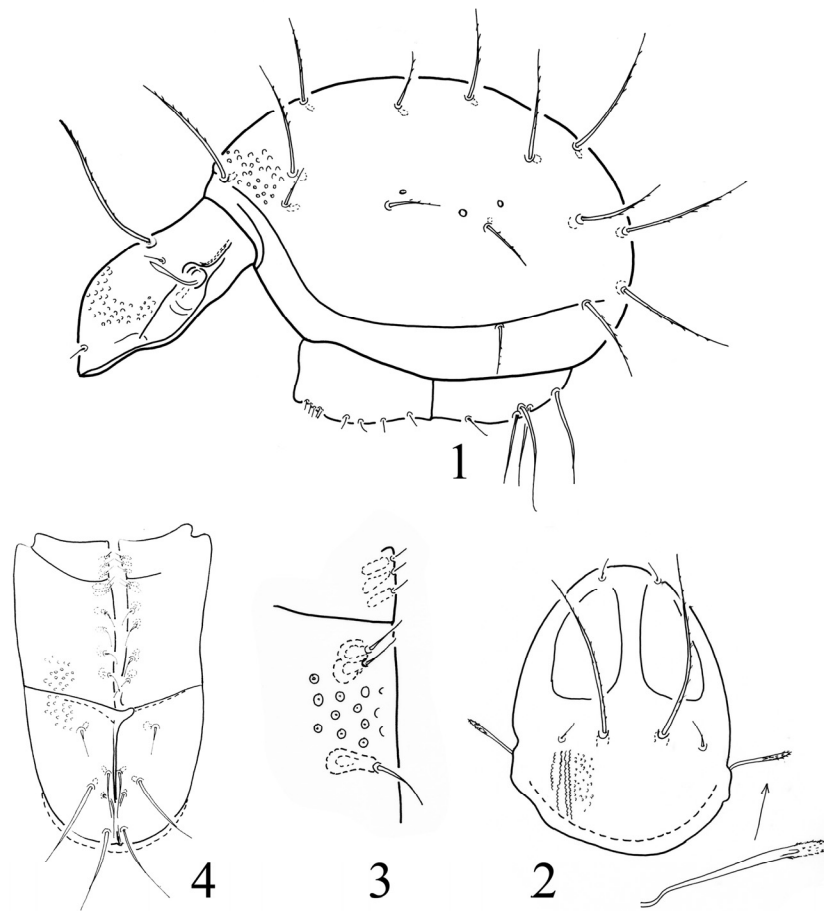
(Figs 1–4)

Material examined. Holotype: Madagascar, Toamasina Province. Maromizaha forest. 26. August 1998. Leg. Dr. T. Pócs (9890) (Afr-923). 1 paratype from the same sample. Holotype (1786-HO-10) and paratype (1786-PO-10) are deposited in the HHNM.

Diagnosis. With the main characters of *Austrophthiracarus aokii* (Mahunka, 1983). Median cristata absent, sigillar fields well observable, with parallel median borders. Lateral carina and lateral rim weak, partly short. Sinus line and distinct posterior furrows well observable. Sensillus long with asymmetrical distinct head. Prodorsal and notogastral setae short, bacilliform, notogastral setae varying in length. Formula of genital setae 6:3. Adanal setae ad_2 and ad_3 much longer than anal setae.

Measurements. Length of prodorsum: 347–500 μm , length of notogaster: 556–1014 μm , height of notogaster: 388–626 μm .

Prodorsum. Colour light brown. Ornamented by small foveolae, which ordered in some furrows basally, lateral part along the margin smooth. Median cristata absent, sigillar fields well visible (Fig. 2). A distinct lateral carina short, reaching to the relatively long sinus line. Rostral setae very short, straight, setiform. Interlamellar setae erect, covered by short spicules. Lamellar and exobothridial setae minute. Sensillus straight, its peduncle long, thin, its head weakly separated, with roughened distal margin.



Figures 1–4. *Austrophthiracarus aokii malagasensis* ssp. nov. 1 = body in lateral view, 2 = genitor-anal region, 3 = arranged of the anterior genital setae, 4 = prodorsum in dorsal view

Notogaster. Ornamented by strong sculpture (Fig. 1), consisting of small foveolae.

Fifteen pairs of different length notogastral setae. All setae setiform, covered with small acicules or cilia. Two pairs of lyrifissures *ia* and *im* present.

Ventral parts. Formula of genital setae 6:3. Setae *g*₅–*g*₆ located very near to each other, in paraxial position. All genital setae arising in one row (Fig. 3). Formula of anoadanal setae 2:3. Anal setae equal in length, thin, setiform. Among the adanal setae *ad*₁ and *ad*₂ longer than the anal ones (Fig. 4).

Leg. Chaetotaxy of legs complete type, setae *d* on genu well visible. Setae of *d* on femur I large, well curved interiorly, located near to the anterior margin.

Remarks. The new subspecies comes close to the nominate subspecies, however *aokii malagasensis* can be distinguished from *aokii aokii* by the very short and straight rostral setae arising near its rostral margin (long and curved in *aokii aokii*), by the position of genital setae (arising in two rows in *aokii aokii*), and the shape of sigillar fields of prodorsum. The nominate subspecies was recorded from Kenya and Tansania.

Etymology. The specific epithet refers to the locality of this species.

***Notophthiracarus inusitatus* sp. nov.**

(Figs 5–9)

Material examined. Holotype: Malagasy Republic, Toamasina Province. Maromizaha forest. 26. August 1998. Leg. Dr. T. Pócs (9890) (Afr-923). 2 paratypes from the same sample. Holotype (1787-HO-10) and 1 paratype (1787-PO-10) deposited in the HNHM, 1 paratype in the MHNG.

Diagnosis. Median crista absent, sigillar fields not observable. Lateral carina and lateral rim present. Sinus line and distinct posterior furrows well observable. Sensillus long with asymmetrical distinct head. Prodorsal and notogastral setae short, bacilliform, all equal in length. Formula of genital setae 5:4. Adanal setae ad_2 and ad_3 far removed anteriorly.

Measurements. Length of prodorsum: 110–143 μm , length of notogaster: 230–275 μm , height of notogaster: 120–170 μm .

Prodorsum. Colour light yellow, its dorsal outline uniformly convex anteriorly, straight basally. Ornamented by foveolae anteriorly and by furrows basally (Figs. 5, 8), lateral part along the margin smooth. Median crista absent, fields invisible because of strong sculpture. A distinct lateral carina, long, reaching to the rostrum, sinus line long, lateral rim short not reaching over the sinus line. Rostral, and interlamellar setae erect, latter one similar to notogastral setae, covered by short spicules in its distal part. Lamellar and exobothridial setae minute. Sensillus (Fig. 9) long, its peduncle conspicuously long, thin, its head well separated, asymmetrical, with roughened margin.

Notogaster. Ornamented by strong sculpture medially (in dorsal view), consisting of small foveolae ordered in irregularly longitudinal fur-

rows (Fig. 5). Fifteen pairs of short, rigid, obtuse notogastral setae present, covered with small spicules in their distal end. Setae c_1 and c_3 located much nearer to collar margin than setae c_2 . Alveoli of vestigial setae arising between setae f_1 . All setae – except p setae – nearly equal in length. Two pairs of lyrifissures ia and im present.

Ventral parts (Figs. 6–7). Anal plates with a distinct, thin ventral edge. Formula of genital setae 5:4. Formula of ano-adanal setae 2:3. Anal setae equal in length, thin, setiform. Among the adanal setae ad_1 and ad_3 slightly longer than the anal ones, setae ad_2 much thicker and longer than all of other setae. Adanal setae ad_2 and ad_3 far remote anteriorly from anal setae.

Legs. Chaetotaxy of legs complete type. Setae of d on femur I short, well curved interiorly, located near to the anterior margin.

Remarks. The new species is easily distinguishable from all congeners by the shape and arrangements of the adanal setae.

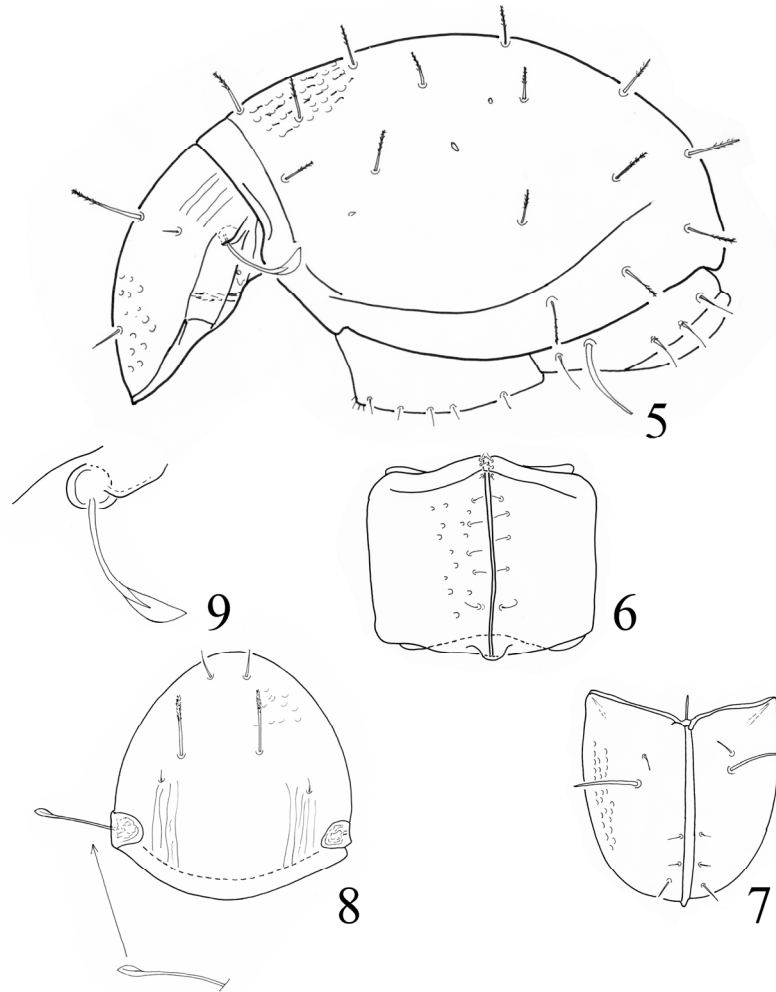
Etymology. The name refers to the unusual position of the adanal setae.

***Notophthiracarus pseudosomalicus* sp. nov.**

(Figs 10–17)

Material examined. Holotype: Madagascar, Toamasina Province. Maromizaha forest. 26. August 1998. Leg. Dr. T. Pócs (9890) (Afr-923)). 1 paratype from the same sample. Holotype (1788-HO-10) and 1 paratype 1788-PO-10) are deposited in the HNHM.

Diagnosis. Median crista absent, sigillar fields well observable. Lateral carina and lateral rim present. Sinus line absent and distinct posterior furrows not observable. Sensillus medium long with distinct head. Prodorsal and notogastral setae short, bacilliform, all equal in length. Genital setae arising in one row. Formula of genital setae



Figures 5–9. *Notopthiracarus inusitatus* sp. n. 5 = body in lateral view, 6 = genital plate, 7 = anoanal plate, 8 = prodorsum dorsal view, 9 = sensillus

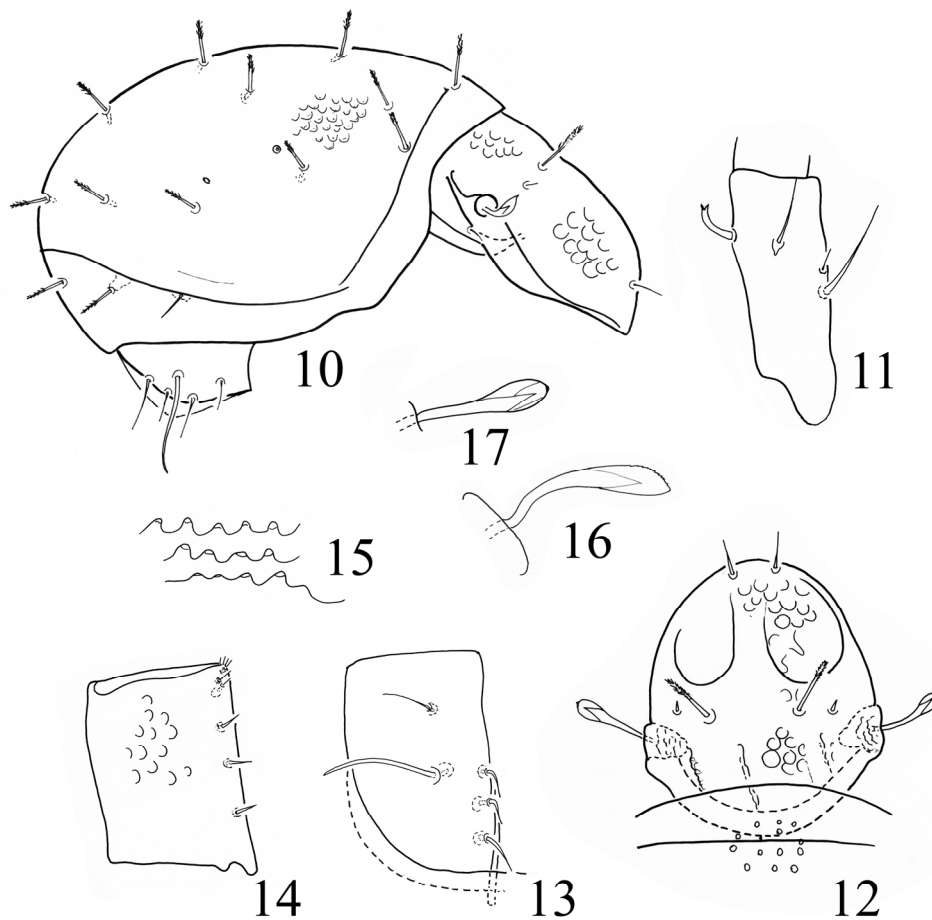
4:5. Adanal setae ad_2 much longer and thicker than anal and other adanal ones. Chaetotaxy of legs of complete type.

Measurements. Length of prodorsum: 164–187 μm , length of notogaster: 318–335 μm , height of notogaster: 218–236 μm .

Prodorsum. Colour light brown, its dorsal outline uniformly convex anteriorly, straight basally. Ornamented by very large foveolae, which compose 1–2 irregular furrows basally. Lateral part along the margin smooth. Median crista absent, sigillar fields well observable, median fields bor-

dered with parallel lines. A short, distinct lateral carina, reaching to the rostrum present. Sinus line absent, lateral rim very narrow (Fig. 10). Rostral setae straight, setiform, smooth (Fig. 12), interlamellar setae erect, covered by short spicules in its distal part. Lamellar setae short, spiniform, wide basally, exobothridial setae minute. Sensillus (Figs. 16–17) comparative long, its peduncle much longer than head, it phylliform, asymmetrical, with roughened margin.

Notogaster. Ornamented by strong sculpture, consisting of small, very deep foveolae ordered in



Figures 10–17. *Notophthiracarus pseudosomalicus* sp. n. 10 = body in lateral view, 11 = femur of leg I, 12 = prodorsum in dorsal view, 13 = anoadanal plate, 14 = genital plate, 15 = sculpture of notogaster, 16, 17 = sensillus in dorsal and lateral view

irregularly longitudinal furrows (Fig. 15). Fifteen pairs of short, rigid, obtuse notogastral setae present, covered with small spicules in their distal end. Setae c_1 and c_3 located nearer to collar margin than setae c_2 . Alveoli of vestigial setae arising between setae f_1 . All setae – except p setae – nearly equal in length. Two pairs of lyrifissures ia and im present.

Ventral parts. Anal plates with a distinct, thin ventral edge. Formula of genital setae 4:5 (Fig. 14). Formula of anoadanal setae 2:3 (Fig. 13). Anal setae equal in length, thin, setiform, adanal setae ad_1 slightly longer than the anal ones, setae ad_2 much thicker and longer than all of other setae, located near to anal ones.

Legs: Chaetotaxy of legs complete type. Setae of d on femur I well developed, with bifurcate distal end (Fig. 11). Seta d of leg IV well developed.

Remarks. The new species is very close to *Notophthiracarus parasomalicus* Niedbala, 2001 described from Madagascar, but easily distinguished from its congeners by the complete type of legs (incomplete in *parasomalicus*) and by the shape of setae d of leg I. *N. somalicus* (Berlese, 1923) probably does not belong to the genus *Notophthiracarus*.

Etymology. The name refers to the relationship of the new species.

***Fusuloppia variosetosa* sp. nov.**

(Figs 18–22)

Material examined: Holotype: Madagascar, Ranomafana, E from Fianarautsaa, soil samples from litter of tropical rain forest, 24–26. September 1979. Leg. D. Balázs (Afr-311). 1 paratype from the same sample. 2 paratypes: Madagascar, Toamasina Prov., Mananara Nord Biosphere Reserve and National Park. Lowland rainforest on the E slopes of Mahavoho Hill (very wet types along Mahavoho River, with many tree ferns, palms and Pandanus ssp., less humid on slopes) at 220–300 m alt. 16°27'S, 49°46.9–47.5'E. Date: 14–15, Aug. 1998. Leg. T. Pócs. (No. 9878). (Afr-921). Holotype (1789-HO-10) and 2 paratypes (17889-PO-10) are deposited in HNHM, 1 paratype in MHNG.

Diagnosis. Rostrum rounded. Prodorsal surface with three pairs of interbothridial maculae. Lamellar setae located nearer to rostral than interlamellar setae. Sensillus very long, narrow, slightly dilated medially. Twelve pairs of notogastral setae present, two pairs of them very short. Setae c_2 reduced. Coxisternal region well sclerotised apodemes II and sejugal apodemes wide, apodemes IV conspicuously bent along genital opening. Sternal apodema also strong, with drop-shaped features. Genitoanal setal formula 5 – 1 – 2 – 3. Lyrifissures *iad* in adanal position. All legs very long.

Measurements. Length of body: 634–662 μm , width of body: 316–358 μm .

Prodorsum. Rostral part wide, rostrum without sharp apex or incisure, rounded, nearly conical in dorsal view. Median costulae absent, three pairs of maculae located comparatively near to each other, in interbothridial region and three or four larger ones located laterally. Prodorsal setae long, simple, ratio of them: $in > le > ex > ro$ (Fig. 18). Interlamellar setae thicker than the others, well pilose, lamellar setae thinner, arising nearer to rostral than interlamellar ones. Exobothridial setae simple. Bothridium well developed, with a small basal lath posteriorly. Sensillus very long, direct-

ed laterally, slightly dilated medially (Fig. 19), resembling *Salix* leaves, all distinctly barbed.

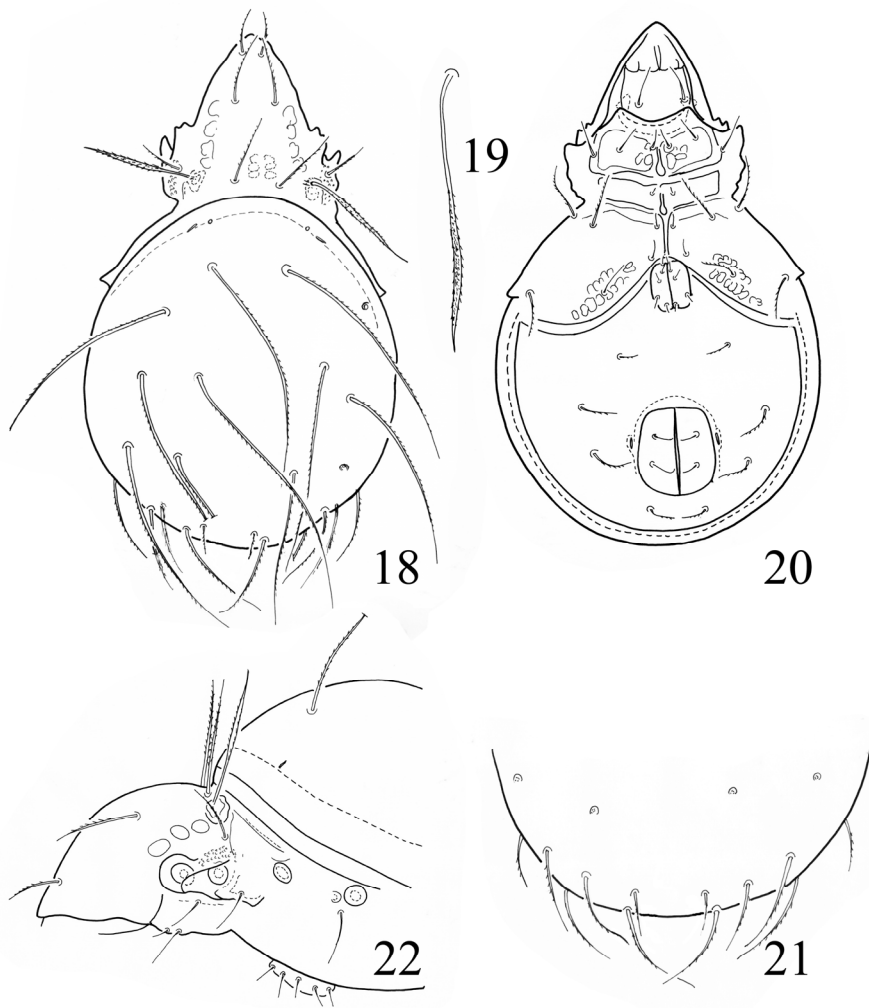
Notogaster. Round in dorsal, semicircle in lateral view. Dorsosejugal suture convex medially, crista absent. Twelve pairs of notogastral setae present, setae c_2 reduced. Two pairs (h_1 and p_1) extremely short simple (Fig. 21), p_2 and p_3 setiform, short. All median setae (*da-dp* and *la-lp*) well developed, extremely long, finely barbed.

Lateral part of podosoma. Exobothridial region well granulate, without longitudinal crest. Pedotecte I and II small, discidium very long (Fig. 22).

Ventral parts. Coxisternal region well sclerotised. Apodemes and epimeral borders – except *ap. 3* and *bo. 3* connected each other. On *bo. 2* and *bo. sej.* with median epimeral fossa. *Bo. 4* distinctly curved, reaching behind genital aperture (Fig. 20). Sternal apodemes mostly developed, but apodema between *ap. 2* and *ap. sej.* partly absent. Epimeral surface ornamented by polygonal pattern, epimer 1 granulate anteriorly. Median epimeral setae short, some lateral ones conspicuously long. Some of them finely roughened. All setae in the aggenital region short and simple, setae in the anal region much longer than genito-aggenital ones. Setae ad_1 in post, setae ad_2 in paraanal, lyrifissures *iad* in adanal position. All setae covered by short bristles.

Legs. All segment conspicuously thin, long, exceptionally long all tibia and femora. Leg IV nearly as long as the length of notogaster.

Remarks. Apart from *Fusuloppia variosetosa* sp. nov. two other species belong to the genus *Fusuloppia* Balogh, 1983: the type species of the genus (*Oppia simplex* Balogh, 1961 = *Fusuloppia neonominata* Subias 2004) and an other one published from Tanzania (*Fusuloppia fusuligera* (Balogh, 1962)). The new species is distinguishing from *fusuligera* by the much shorter prodorsal and notogastral setae, from the *neonominata* by the shape of sensillus (its head is well separate in *neonominata*, gradually narrowed anteriorly in the new species), and from both earlier described



Figures 18–22. *Fusuloppia variosetosa* sp. n. 18 = body in dorsal view, 19 = sensillus, 20 = body in ventral view, 21 = posterior part of notogaster, 22 = podosoma in lateral view

species by the much thicker and strongly chitinised *ap. 2.* and *ap. sej.* (much thinner in *neonominata* and *fusuligera*).

Etymology. The species epithet refers to the conspicuously short posteromarginal and very long notogastral setae in anterior position.

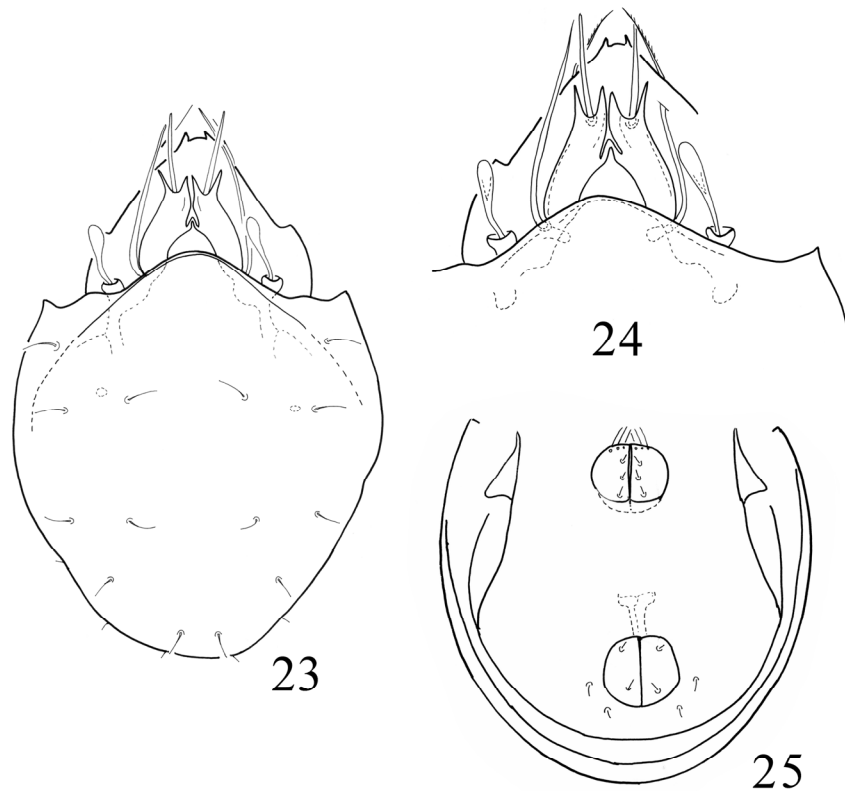
***Lamellobates cuneatus* sp. nov.**

(Figs. 23–25)

Material examined. Holotype: Madagascar, Vohimana Reserve, primary forest. 17. April 2008. Leg. Cs. Csuzdi (Afr-996). 1 paratype from

the same sample. Holotype (1790-HO-10) and 1 paratype (1790-PO-10) are deposited in HHNM.

Diagnosis. With the characters of *Lamellobates* (see Nübel-Reidelbach & Woas 1992). Rostral apex with lateral teeth. Between them a convex median elevation. Lamellae concave laterally, with two long, sharply pointed apices. Lamellar setae thick, bacilliform, interlamellar setae much longer, setiform. Sensillus long, fusiform, dilated distally. Ten pairs of fine notogastral setae present. Coxisternal region weakly sclerotised. Genito-anal setal formula 6 – 1 – 2 – 2. Lyrifissures *iad* in adanal position. All legs monodactylous.



Figures 23–25. *Lamellobates cuneatus* sp. n. 23 = body in dorsal view, 24 = prodorsum, 25 = posterior part of ventral plate

Measurements. Length of body: 275–282 μm , width of body: 188–197 μm .

Prodorsum. Rostral part wide, rostral apex with two lateral teeth and a shorter rounded median elevation. Rostral setae long, arising laterally, their form similar to the interlamellar setae. Lamellae conspicuously converging medially, their lateral margin convex distally (Fig. 23). Two apices present bearing bacilliform lamellar setae, both equal in length, median apex wider than the spiniform lateral one. Lamellae basally connected with each other by a bent interlamellar tubercle (Fig. 24). Bothridium well rise from the anterior margin of the notogaster. Sensillus fusiform, dilated distally.

Notogaster. Surface smooth. Anterior margin of notogaster undulate, with a pair of deep hollow

laterally. Ten pairs of fine notogastral setae (Fig. 23), and 4 pairs of small sacculi present.

Lateral part of podosoma. Tutorium large, with sharply pointed distal end. Pedotectum I large. Pteromorpha well covered the acetabula II–IV, bearing a small spine laterally.

Ventral parts. Epimeral surface smooth, apodemes weakly developed. Epimeral setae short, simple and thin. Ventral plate smooth. Genito-anal setal formula: 6 – 1 – 2 – 2 (Fig. 25). Anterior genital setae much longer than the three posterior pairs. Two pairs of adanal setae very short, aggenital and anal setae also minute.

Legs. All legs monodactylous.

Remarks. On the basis of the shape of lamellae and lamellar apices the species of the genus *Lamellobates* Hammer, 1958 fall in three groups:

1) Inner apex lost, inner margin rounded (*L. palustris* Hammer, 1958), 2) Inner apex very long, much longer than the outer one (*L. orientalis* Csi-szár, 1961), 3) Inner and outer apices equal in length (*L. engelbrechti* Mahunka, 1989).

The new species belongs to the third group. It can be distinguished from all congeners by the conspicuously long and diverging outer lamellar cusp.

Etymology: The species name refers to the shape of the lamellar apices.

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First records of zerconid mites (Acari: Mesostigmata: Zerconidae) from Albania, with description of three new species

ZS. UJVÁRI¹

Abstract. Elaborating a material collected from different regions of Albania, eleven species of the genus *Zercon* (Zerconidae) were identified, three of them, *Z. albanicus* sp. nov., *Z. cavatus* sp. nov. and *Z. elongatus* sp. nov., proved to be new to science. Short description of male and deutonymph of *Z. villosus* and morphological notes on *Z. spatulatus* are also provided. New occurrences of each species are depicted on maps as well.

INTRODUCTION

Zerconid mites occur in soil and leaf-litter of woodlands, grasslands and among mosses and lichens. They are oligophagous predators but their biology is scarcely known. Highest diversity of Zerconidae is experienced in the temperate climatic zone and a great number of species occur in the Mediterranean; e.g. 69 species are known from Turkey (Urhan, 2008, 2009, 2010).

Faunistical and taxonomical studies on Balkan Peninsula started in the middle of the last century. Willmann (1941) published the first notes on Zerconidae from Balkanic caves. In the following decades, Bulgaria became the focus of Zerconidae studies; Balogh (1961) described *Zercon bulgaricus* Balogh, 1961 from the country, Koyumdjieva (1986) listed six, and later three more (Koyumdjieva, 1993) species, and in last years Błaszak & Polańska (1998) described further two species, *Zercon villosus* Błaszak & Polańska, 1998 and *Zercon serenoides* Błaszak & Polańska, 1998, from Rila Mts. Meanwhile Košir (1974) reported two species, *Zercon primus* Košir, 1974 and *Zercon plumatopilus* Athias-Henriot, 1961, from the alpine zone of present Macedonia (Solunska Glava), and *Carpathozercon tuberculatus* (Košir, 1974) from present-day Slovenia. Recently the whole Balkan Peninsula was targeted by Hungarian researchers in the framework of a National R&D Programme entitled "The origin and genesis of fauna of the Carpathian Basin:

diversity, biogeographical hotspots and nature conservation significance". Several expeditions have been organized by the researchers of the Hungarian Natural History Museum resulted in a rich „Berlese” sample material. Elaborating the material collected, Kontschán (2006) described *Zercon kosovina* Kontschán, 2006 from Kosovo, and listed two other species from the country. Apart from this latter study Ujvári (2008, 2010) investigated the fauna of Croatia, describing *Zercon kontschani* Ujvári, 2008 from Papuk Mts. and further four species new to science, and furthermore reported 16 species new to the fauna of the country.

Several soil-inhabiting groups, e.g. oribatid mites (Mahunka & Mahunka-Papp, 2008), turtle mites (Kontschán 2003) and springtails (Kontschán *et al.*, 2003; Traser & Kontschán 2004) have already been elaborated from the material collected during the Albanian expeditions (Fehér *et al.*, 2004), however zerconid mites of the country have not been studied so far.

MATERIAL AND METHODS

Mites were extracted using Berlese funnels, then cleared with lactic acid, and mounted in glycerine. Preparations were examined using a light microscope; drawings were made with the aid of a drawing tube. Scanning micrographs were taken in the Hungarian Natural History Museum, Budapest with a HITACHI SN 2600 scanning

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electron microscope; specimens investigated were spotter coated by golden-palladium. Mites are stored in 70% ethanol, in the Collection of Soil Zoology of Hungarian Natural History Museum. The terminology of setae follows Lindquist & Evans (1965), with modifications for the caudal region as given by Lindquist & Moraza (1998). The system of notation for dermal glands and lyrifissures follows Johnston & Moraza (1991). All measurements including scale bars of the figures are given in micrometers. Abbreviations used: LD: László Dányi, ZE: Zoltán Eröss, ZF: Zoltán Fehér, DM: Dávid Murányi, AH: András Hunyadi, JK: Jenő Kontschán.

RESULTS

Zercon albanicus sp. nov.

(Figs 1–4, 25, 27)

Material examined. Holotype: female: E-2278: Albania, Periferi Dibrë, Mali i Korabit, north-eastern slope of Maja e Korabit (snow smelt feeded bog), from moss, 2300 m a.s.l., N41° 47.948' E20°33.251', 27.06.2007., leg. LD, ZE, ZF, DM, AH. Paratypes: 4 females, 2 males and 2 deutonymphs, locality and date same as that of the holotype. 1 female, 1 deutonymph: E-2266: Albania, Periferi Dibrë, Mali i Korabit, ca. 5.5 km east of Radomirë southern slope, over Fushë Korabit (opened brook, cave and rocks), from moss, 1905 m a.s.l., N41°49.121' E20°32.240', 27.06.2007., leg. LD, ZE, ZF, DM, AH. 4 females, 3 males: E-2269: Albania, Periferi Dibrë, Mali i Korabit, Maja e Korabit peak region (grassland) 2751 m a.s.l., N41°47.601' E20°32.634', 27.06.2007., leg. LD, ZE, ZF, DM, AH. 6 females, 1 male, 1 deutonymph: E-2280: Albania, Periferi Dibrë, Mali i Korabit, northeastern slope of Maja e Korabit (torrent and wet meadow), from moss, 2300 m a.s.l., N41°48.143' E20°33.285', 27.06.2007., leg. LD, ZE, ZF, DM, AH. 5 females: E-2281: Albania, Periferi Tiranë, 7 km south of the Tiranë junction along the Klos-Elbasan road (beech forest) dry-rotten wood, 1370 m a.s.l., N41°19.895' E20°08.454', 30.06.2007., leg. LD, ZE, ZF, DM, AH. 33 females, 1 male: E-2290:

Albania, Periferi Tiranë, 7 km south of the Tiranë junction along the Klos-Elbasan road (beech forest), leaf litter, 1370 m a.s.l., N41°19.895' E20°08.454', 30.06.2007., leg. LD, ZE, ZF, DM, AH. 2 females: E-2291: Albania, Periferi Mat, 3 km north of Qafa e Shtyllës, on the Klos-Elbasan road, 1.3 km north of the conj. to Tiranë, (limestone rocks), leaf-litter, 1500 m a.s.l., N41° 22.270' E20°05.126', 30.06.2007., leg. LD, ZE, ZF, DM, AH. 1 female: E-2295: Albania, Periferi Elbasan, north of Cerunjë, 26 km from the Elbasan junction on the road to Qafa e Shtyllës (beech forest, pond), soil, 1200 m a.s.l., N41°15.109' E20°05.801', 30.06.2007., leg. LD, ZE, ZF, DM, AH.

Diagnosis. Anterior margin of ventroanal shield with two pairs of setae. Dorsal cavities weakly developed. Opisthonotal J-setae short, smooth or finely pilose. Setae Z4-5 and S3-5 long, distally pilose, with hyaline sheaths. Glands dgJ4 (Po3) situated posteromedially to setae Z4. Posterior surface of opisthonotum smooth.

Description. Female. Length of idiosoma: holotype 450 µm (440-475 µm in paratypes), width: holotype 345 µm (335-350 µm in paratypes).

Dorsum (Fig. 1). Podonotum with 20 pairs of setae. Setae j1 serrate, central podonotal setae needle-like, smooth or very finely barbed, s5 apically pilose, marginal setae barbed. Gland openings gdj2 (po1) situated below the line connecting j3 and s1, gdj4 (po2) on line connecting j4 and z4, gds4 (po3) medially to the line connecting s4 and s5. Surface of the shield covered by irregular, tile-like pattern.

Opisthonotum with 21 pairs of setae. J-setae short, smooth or finely pilose. Setae Z1-3 and S2 similar in shape and length to J-setae. Z4-5 and S3-5 elongated, distally pilose, bearing hyaline sheaths, each reaching beyond the margin of idiosoma. Marginal setae decreasing in length posteriorly, the anterior two pairs barbed, posterior ones smooth, pointed. Number of marginal setae often varies (6-8). Length of setae and distance between setal insertions as in table 1. Gland openings gdz6 (Po1) situated anterolaterally to Z1, gdZ2 (Po2)

on the line connecting Z2 and S3 equidistantly, gdJ4 (Po3) posteromedially to setae Z4, gdS5 (Po4) on the line connecting S5 and JV5. Marginal serration shallow and obtuse. Anterior half of opisthonotum covered by tile-like ornamentation, posterior surface smooth. Dorsal cavities uniform, weakly developed, saddle-like, with undulate margins.

Venter (Fig. 2). Chaetotaxy, adenotaxy, poroidotaxy and shape of ventral shields typical for the genus. Sternal shield 72 µm long, 70 µm wide at level of setae st2, covered by reticulate pattern, its posterior margin concave. Peritremal setae r1 often delicately barbed, r3 distally pilose, with hyaline sheath. Peritremes slightly bent. Peritremal shield ornamented by some longitudinal fissures. Glands gv2 with 4–5 openings on large adgenital platelets. Anterior margin of ventroanal shield with two pair of setae. Postanal seta distally serrate. Setae JV5 distally pilose. Anal valves with eanal setae. Ventroanal shield covered by squamous ornamentation.

Male (Figs 3). Length of idiosoma: 340–365 µm, width: 253–260 µm.

Chaetotaxy, adenotaxy and poroidotaxy of dorsal shields similar to that of female. Length of setae and distance between setal insertions as in table 1. Sternogenital shield divided by a weakly sclerotized slit between st1-2, bearing five pairs of setae. A single, elongate postgenital sclerite can be found between adgenital platelets.

Deutonymph (Fig. 25). Length of idiosoma: 410–418 µm, width: 295–303 µm.

Chaetotaxy, adenotaxy and poroidotaxy of dorsal shields generally similar to that of adults. On podonotum, setae j1 serrate, s3, s5-6 elongate, distally pilose, z4 apically barbed, other setae smooth. Elongate opisthonotal setae longer in proportion to the body length than in adults. Length of setae and distance between setal insertions as in table 1. Ornamentation of dorsal shields weakly developed, but similar to that of the adults.

Etymology. The name of the new species refers to the country, where it was collected.

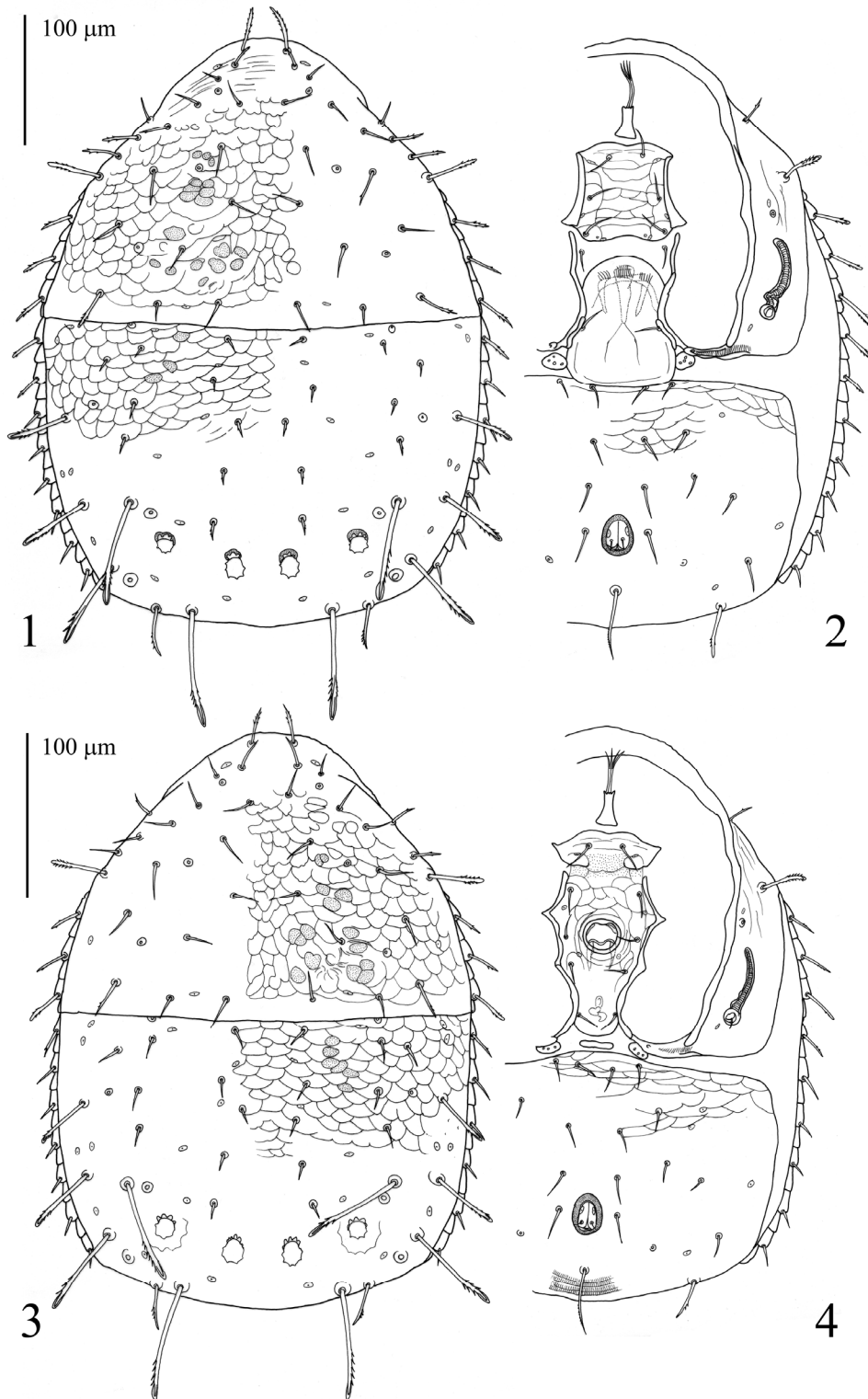
Remarks. *Z. albanicus* sp. nov. belongs to the group of species with a full complement of podonotal and opisthonotal setae, two pairs of setae on anterior margin of ventroanal shield, short J-setae, short and elongate Z1-3, apically pilose Z4-5 and S4-5 setae. The three other species of the group (*Z. csuzdii* Ujvári, 2009, *Z. ponticus* Balan, 1991 and *Z. zelawaiensis* Sellnick, 1944) easily can be distinguished from *Z. albanicus* sp. nov. by the ornamentation of posterior surface of opisthonotum (smooth in *Z. albanicus* sp. nov., covered by small alveolar pits in others), and situation of glands gdJ4 (below the line connecting J5 and Z4 in *Z. albanicus* sp. nov., lying above the former line in *Z. csuzdii* and *Z. ponticus*, lying anteriorly to J5 in *Z. ponticus*). Besides setae S3 spatuliform, reaching beyond the margin of idiosoma, majority of marginal setae smooth, pointed in *Z. albanicus*, similarly to *Z. zelawaiensis* (in which elongate setae pointed, not spatuliform), in the remaining two species, however, S3 pointed, not reaching the margin of idiosoma and majority of the marginal setae are apically pilose. Furthermore, in *Z. zelawaiensis*, setae J5 situated far above the level of dorsal cavities, in others shifted posteriorly, at least to the level of the lateral cavities.

***Zercon cavatus* sp. nov.**

(Figs. 5–8, 27)

Material examined. Holotype: female: E-2281: Albania, Periferi Tiranë, 7 km south of the Tiranë junction along the Klos-Elbasan road (beech forest) dry-rotten wood, 1370 m a.s.l., N41° 19.895' E20°08.454', 30.06.2007., leg. LD, ZE, ZF, DM, AH. Paratypes: 1 female, locality and date same that of the holotype. 1 female: E-2279: Albania, Periferi Tiranë, beech forest along the Klos-Elbasan road, above the reservoir, leaf-litter, 1155 m a.s.l., N41°16.165' E20°05.088', 30.06.2007., leg. LD, ZE, ZF, DM, AH.

Diagnosis. Anterior margin of ventroanal shield with one pair of setae. Dorsal cavities large, strongly sclerotized, with axes converging posteriorly. Opisthonotal setae smooth or finely



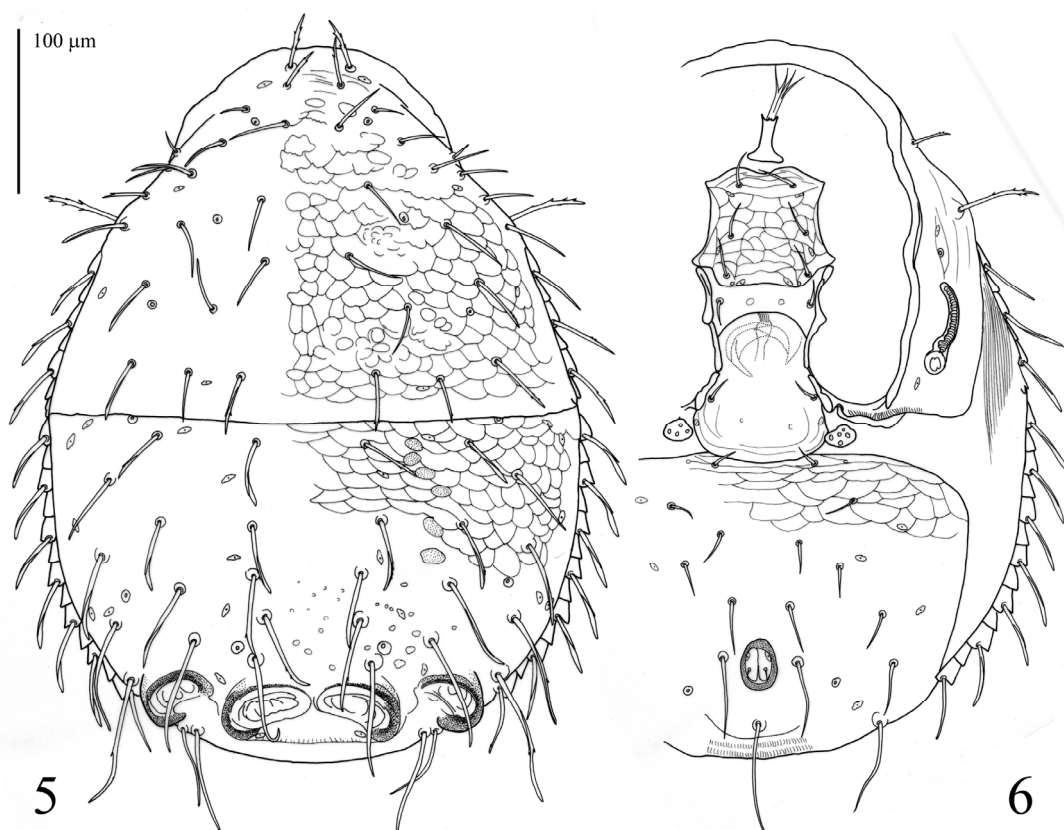
Figures 1–4. *Zercon albanicus* sp. n.: 1 = dorsal view of female, 2 = ventral view of female, 3 = dorsal view of male, 4 = ventral view of male

pilose, with weakly developed hyaline sheaths. Each opisthotal setae elongated, J1, Z1 and S2 similar in shape to other opisthotal setae, not reaching the following's bases though. Glands dgJ4 (Po3) situated anterolaterally to setae J5. Posterocentral surface of opisthonomum covered by alveolar pits. Marginal serration acuminate.

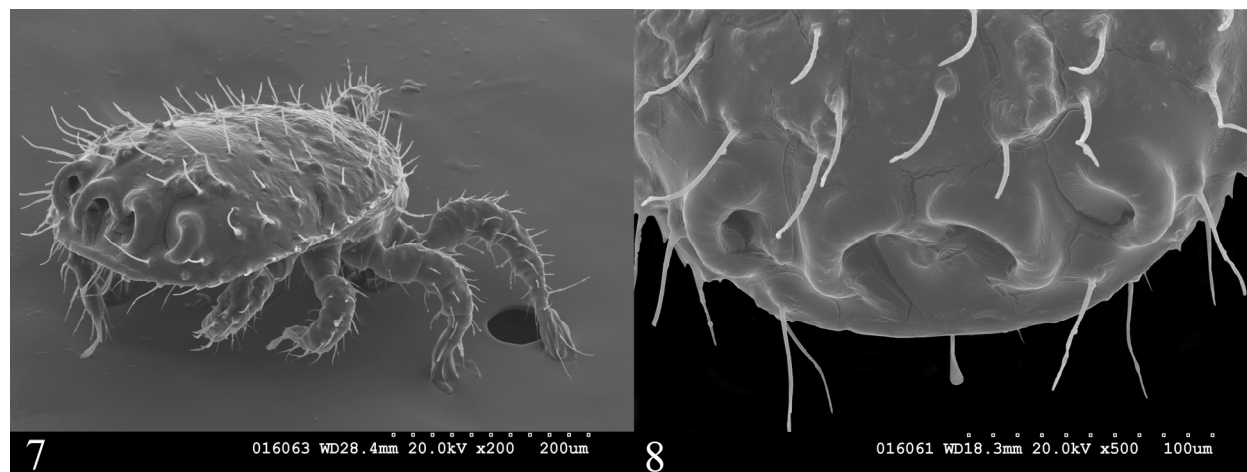
Description. Female. Length of idiosoma: holotype 435 µm (415-440 µm in paratypes), width: holotype 335 µm (330-340 µm in paratypes).

Dorsum (Fig. 5). Podonotum with 20 pairs of setae. Setae j1-2 serrate, central podonotal setae smooth and needle-like, j6, z6, s2-6, r4-5 finely pilose apically, usually with weakly developed hyaline sheaths. Gland openings gdj2 (po1) situated below the line connecting j3 and s1, gdj4 (po2) on line connecting j4 and z4, gds4 (po3) medially to the line connecting s4 and s5, near s4. Surface of the shield covered by tile-like pattern.

Opisthonomum with 21 pairs of setae, each elongate, slightly broadening apically, with an edge running along the setal body. J1, Z1 and S1-2 not reaching bases of the following setae in the series, others reaching beyond bases of the following one. Setae S3-5, Z4-5 and J5 reaching beyond margin of opisthonomum. Length of setae and distance between setal insertions as in table 2. Gland openings gdz6 (Po1) situated anterolaterally to Z1, gdZ2 (Po2) on the line connecting Z2 and S4, near S4, gdJ4 (Po3) anterolaterally to setae J5, gdS5 (Po4) on line connecting S5 and JV5, covered by strongly sclerotized margins of lateral dorsal cavities. Marginal serration acuminate. Anterior surface of opisthonomum covered by tile-like ornamentation, posterocentral surface with a few protuberances. Dorsal cavities strongly sclerotized, considerably large, their lateral margins emerging from the level of dorsum (Figs 7-8). Axes of cavities converging posteriorly. Posterior margin of idiosoma sturdy, well-sclerotized.



Figures 5-6. *Zeron cavatus* sp. n.: 5 = dorsal view of female, 6 = ventral view of female



Figures 7–8. *Zercon cavatus* sp. n.: 7 = posterolateral view of female, 8 = opisthonotal surface with dorsal cavities

Venter (Fig. 6). Chaetotaxy, adenotaxy, poroidotaxy and shape of ventral shields typical for the genus. Sternal shield 71 μm long, 68 μm wide at level of setae st2, covered by reticulate pattern, its posterior margin straight or slightly concave. Both peritremal setae finely pilose apically. Peritremes slightly bent. Peritremal shield ornamented by longitudinal fissures. Glands gv2 with 4–5 openings on large adgenital platelets. Anterior margin of ventroanal shield with one pair of setae. Setae JV3 reaching the basis of adanal setae which long, reaching beyond insertion of postanal seta. Setae JV5 similar in shape to ventral setae, apically tapering. Anal valves with euanal setae. Ventroanal shield covered by squamous ornamentation.

Etymology. The name of the new species refers to the large, cave-like posterodorsal structures.

Remarks. The new species belongs to the group of species with one pair of setae on anterior the margin of ventroanal shield and bearing large, strongly sclerotized dorsal cavities which are equal in size. *Z. cavatus* is unique in the group by the shape of setae (others have long, distally pilose, apically broadening setae on posterolateral surface of opisthonotum) and the appearance of dorsal cavities (extraordinarily large, lobe-like in the new species, significantly smaller in other species of the group).

Zercon elongatus sp. nov.

(Figs 9–12, 27)

Material examined. Holotype: female: E-2278: Albania, Periferi Dibrë, Mali i Korabit, north-eastern slope of Maja e Korabit (snow smelt feeded bog), from moss, 2300 m a.s.l., N41° 47.948' E20°33.251', 27.06.2007., leg. LD, ZE, ZF, DM, AH. Paratype: deutonymph, locality and date same that of the holotype.

Diagnosis. Anterior margin of ventroanal shield with two pairs of setae. Dorsal cavities of general size, circular, with undulate margins. J-setae and marginal setae short, smooth, Z3-5 and S3-5 apically pilose, with hyaline sheaths. Glands dgJ4 (Po3) situated on the line connecting Z3 and Z4. Anterior surface of opisthonotum covered by tile-like ornamentation, posterior surface smooth. Marginal serration shallow and obtuse. Shape of body elongate.

Description. Female. Length of idiosoma: 460 μm, width: 290 μm.

Dorsum (Fig. 9). Podonotum with 20 pairs of setae. Setae j1 serrate, central podonotal setae smooth and needle-like, marginal setae finely pilose apically, with small, rounded hyaline sheaths. Gland openings gdj2 (po1) situated below the line connecting j3 and s1, near s1, gdj4

(po2) on line connecting j4 and z4, gds4 (po3) medially to the line connecting s4 and s5, near s4. Surface of the shield covered by tile-like pattern.

Opisthonotum with 21 pairs of setae. Each J-setae short, smooth and needle-like, similarly to Z1-2 and S1-2, none of them reaching the following bases. Setae S3 three times longer than former, with small hyaline tips. Setae Z3-5 and S4-5 similar in shape and length, apically pilose, with extensive hyaline sheaths (Fig. 12), none of them reaching bases of the following one. Marginal setae short, smooth or finely pilose, pointed. Length of setae and distance between setal insertions as in table 3. Gland openings gdz6 (Po1) situated anterolaterally to Z1, gdZ2 (Po2) above the line connecting Z2 and S3, gdJ4 (Po3) on the line connecting Z3 and Z4, gdS5 (Po4) posteromedially to S5. Marginal serration shallow and obtuse. Anterior surface of opisthonotum covered by tile-like ornamentation, posterior surface smooth. Dorsal cavities of general size, rotund, with undulate margins.

Venter (Fig. 10). Chaetotaxy, adenotaxy, poroidotaxy and shape of ventral shields typical for the genus. Sternal shield 76 µm long, 63 µm wide at level of setae st2, covered by reticulate pattern, its posterior margin slightly concave. Peritremal setae r3 apically feathered, with hyaline endings. Peritremes slightly bent. Peritremal shield ornamented by small fissures. Glands gv2 with 4-5 openings on conspicuous adgenital platelets. Anterior margin of ventroanal shield with two pairs of setae. Paired ventroanal setae short, smooth and needle-like, postanal seta elongated, with narrow, lanceolate hyaline tip. Anal valves with euanal setae. Ventroanal shield covered by squamous ornamentation.

Deutonymph (Fig. 11). Length of idiosoma: 370 µm, width: 232 µm.

Chaetotaxy, adenotaxy and poroidotaxy generally similar to that of mature stages. Central podonotal setae markedly longer than J-setae, Z1-2, S1-2 and R-setae of opisthonotum. Setae S3 longer in proportion to the body length than in adult stages, similar in shape to Z3-5 and S4-5. Length of setae and distance between setal insertions as in table 3. Dorsal cavities as for the adults, however weakly sclerotized. Ornamenta-

tion of podonotal shield weakly developed, not conspicuous on opisthonotum.

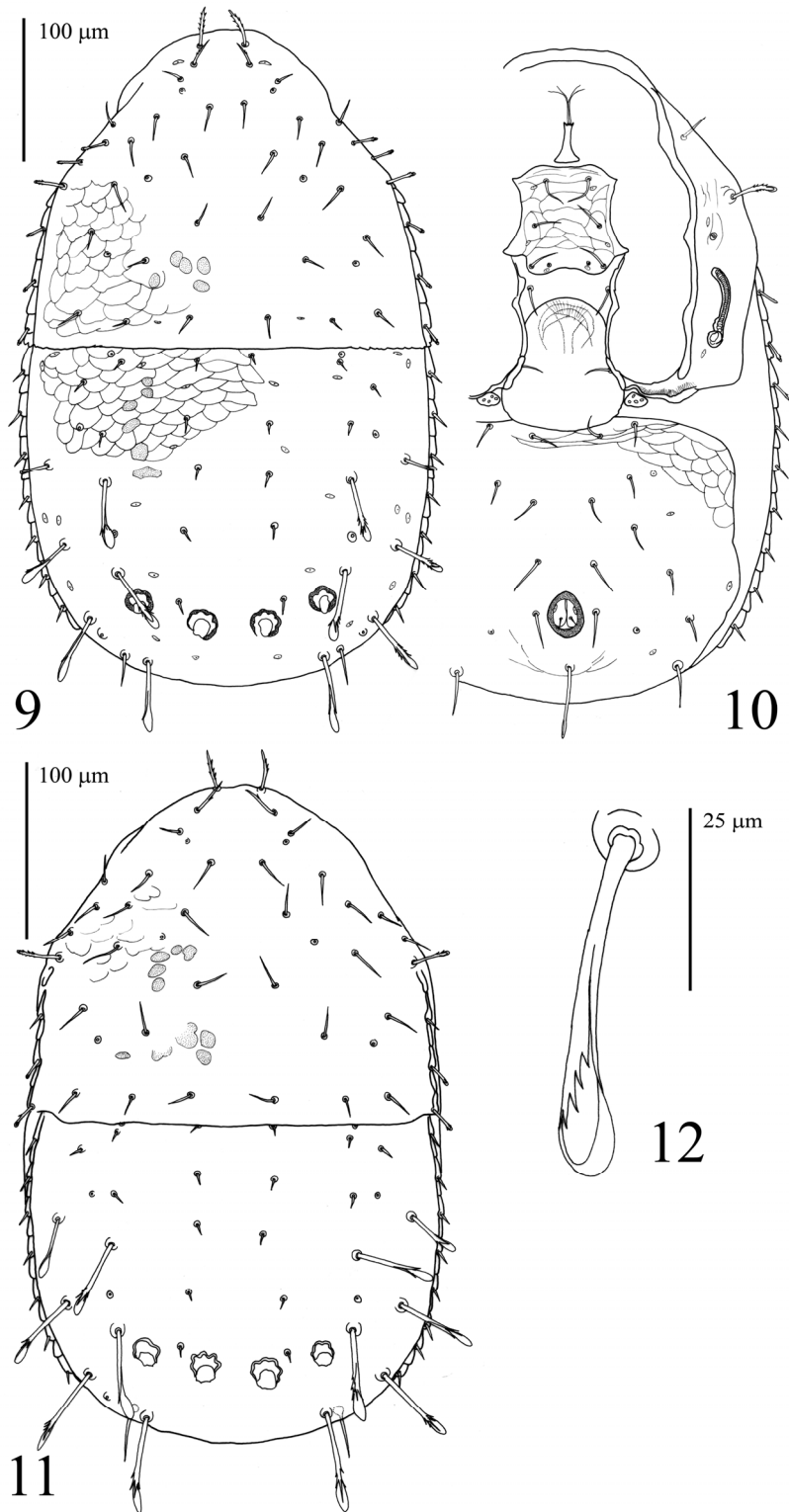
Etymology. The name of the new species refers to its elongate body shape.

Remarks. *Zercon elongatus* sp. nov. belongs to the group of species with a full complement of podonotal and opisthonotal setae, two pairs of setae on the anterior margin of ventroanal shield, short J-setae and short, pointed marginal setae. Within this group, opisthonotum of *Zercon andrei* Sellnick, 1958, *Zercon foveolatus* Halašková, 1969 and *Zercon pinicola* Halašková, 1969 are covered by large alveolar pits, while the posterior surface of opisthonotum smooth in *Zercon berleseii* Sellnick, 1958 and covered by small pits in *Zercon hemimbricatus* Skorupski & Luxton, 1996. The new species is most similar to *Z. hemimbricatus* on the basis of the similar shape of opisthonotal setae (longer setae blunt and do not bear hyaline tips in *Z. berleseii*, while apically pilose and bearing broad hyaline sheaths in *Z. hemimbricatus* and *Z. elongatus*). The two species can be distinguished according to the following features: in *Z. hemimbricatus*, glands gdJ4 is situated on the line connecting J4 and Z4, the posterior surface of opisthonotum is covered by small, distinct pits, dorsal cavities are weakly sclerotized, the shape of idiosoma is oval (480 µm long, 345 µm wide); in *Z. elongatus* sp. nov., the glands gdJ4 are situated on the line connecting Z3 and Z4, the posterior surface of opisthonotum is smooth, dorsal cavities are well-sclerotized, rotund, the shape of idiosoma is oblong (460 µm long, 290 µm wide). Apart from these morphological differences *Z. hemimbricatus* has only been recorded from the British Isles so far.

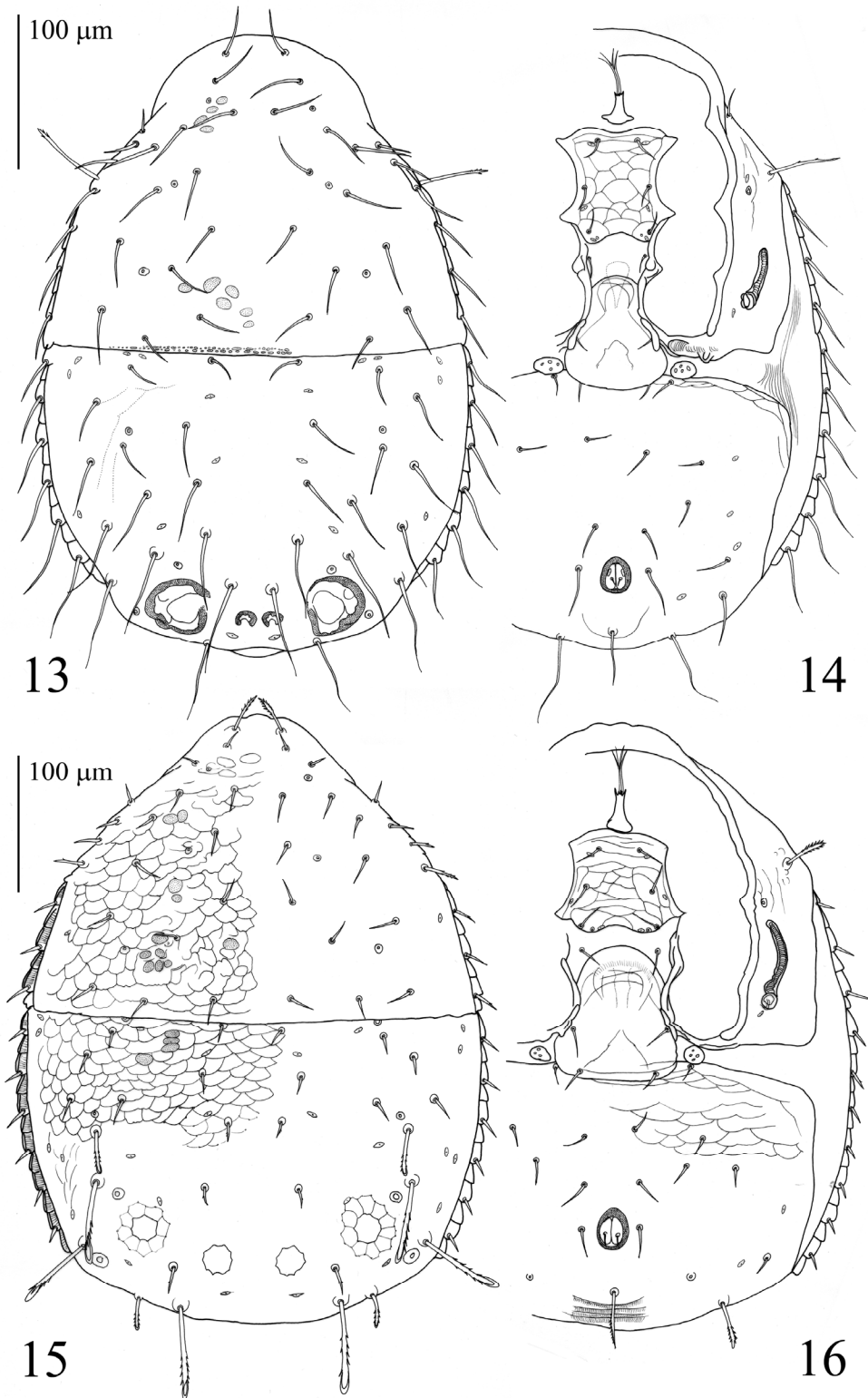
***Zercon bulgaricus* Balogh, 1961**

(Figs 13–14, 27)

Material examined. E-2287: Albania, Periferi Dibrë, 9 km north of Cidhnë along the Çidhën – Fushë-Lurë road (rocks, beech forest and dry grassland), leaf-litter, 1330 m a.s.l., N41°48.896' E20°16.651', 29.06.2007., leg. LD, ZE, ZF, DM, AH. (3 females).



Figures 9–12. *Zercon elongatus* sp. n.: 1 = dorsal view of female, 2 = ventral view of female, 3 = dorsal view of deutonymph, 4 = seta Z3



Figures 13–16. 13 = dorsal view of *Z. bulgaricus*, 14 = ventral view of *Z. bulgaricus*, 15 = dorsal view of *Z. zangherii*, 16 = ventral view of *Z. zangherii*

Remarks. The species is new to the fauna of Albania. A similar species was found in Turkey (Urhan & Ayyildiz 1996), in my opinion, however, it is conspecific with *Zercon bercziki* Ujvári, 2009, which was described from the Crimean Peninsula, Ukraine (Ujvári 2009). Dorsal cavities are equal in size in *Z. bercziki* as well as in the Turkish specimens and both bear alveolar ornamentation posterodorsally, while inner dorsal cavities are significantly smaller and posterodorsal surface is smooth in *Z. bulgaricus*.

Distribution. Bulgaria, Albania (Fig. 28).

***Zercon horsaensis* Mašán & Fend'a, 2004**

(Figs 17–18, 29)

Material examined. E-1854: Albania, 2 km northeast of Leskovik (limestone rocks), 1010 m a.s.l., N40° 09.160' E20°37.180', 03.07. 2003., leg. ZE, JK, DM, ZF. (1 female). E-1871: Albania, Periferi Tepelenë, gorge of a brook, 1 km east of Progonat, along the road from Tepelenë to Progonat, 950 m a.s.l., N40°12'36.8" E19° 57'41.1", 11.10.2004., leg. ZF, JK, DM. (1 female). E-2067: Albania, Periferi Skrapar, Tomor Mts, Ujanik, gorge of the Ujanik stream, N40°37.969' E20°12.969', 965 m a.s.l., 23.08. 2006., leg. ZF, AH, DM. (2 females).

Remarks. The species is new to the fauna of Albania. Specimens collected are similar to *Zercon delicatus* Urhan & Ekiz, 2002 (Turkey) and *Zercon rupestrinus* Błaszak, 1979 (Russia, Tien-Shan Mts) as well, by similar chaetotaxy and poroidotaxy. In *Z. rupestrinus*, posterodorsal surface is smooth, unlike *Z. horsaensis* and *Z. delicatus* which have reticulate-alveolar pattern. While setae J2, Z2 and S2 are pilose distally, setae S3 are spatuliform and reaching beyond the margin of idiosoma in *Z. delicatus*, former setae are smooth, S3 are pointed and not reaching margin of idiosoma in *Z. horsaensis* and the Albanian specimens. However some spatuliform setae are shorter in the Albanian specimens (e.g. Z3 not reaching bases of Z4) than in *Z. ho-*

rsaensis, it can be intraspecific variation which is usual in Zerconidae regarding characters like this.

Distribution. Slovakia, Albania (Fig. 29).

***Zercon plumatopilus* Athias-Henriot, 1961**

(Fig 28)

Material examined. E-2279: Albania, Periferi Tiranë, beech forest along the Klos-Elbasan road, above the reservoir, leaf-litter, 1155 m a.s.l., N41°16.165' E20°05.088', 30.06.2007., leg. LD, ZE, ZF, DM, AH. (2 females). E-1871: Albania, Periferi Tepelenë, gorge of a brook, 1 km east of Progonat, along the road from Tepelenë to Progonat, 950 m a.s.l., N40°12'36.8" E19° 57'41.1", 11.10.2004., leg. ZF, JK, DM. (4 females, 1 deutonymph). E-2067: Albania, Periferi Skrapar, Tomor Mts, Ujanik, gorge of the Ujanik stream, N40°37.969' E20°12.969', 965 m a.s.l., 23.08.2006., leg. ZF, AH, DM. (1 female).

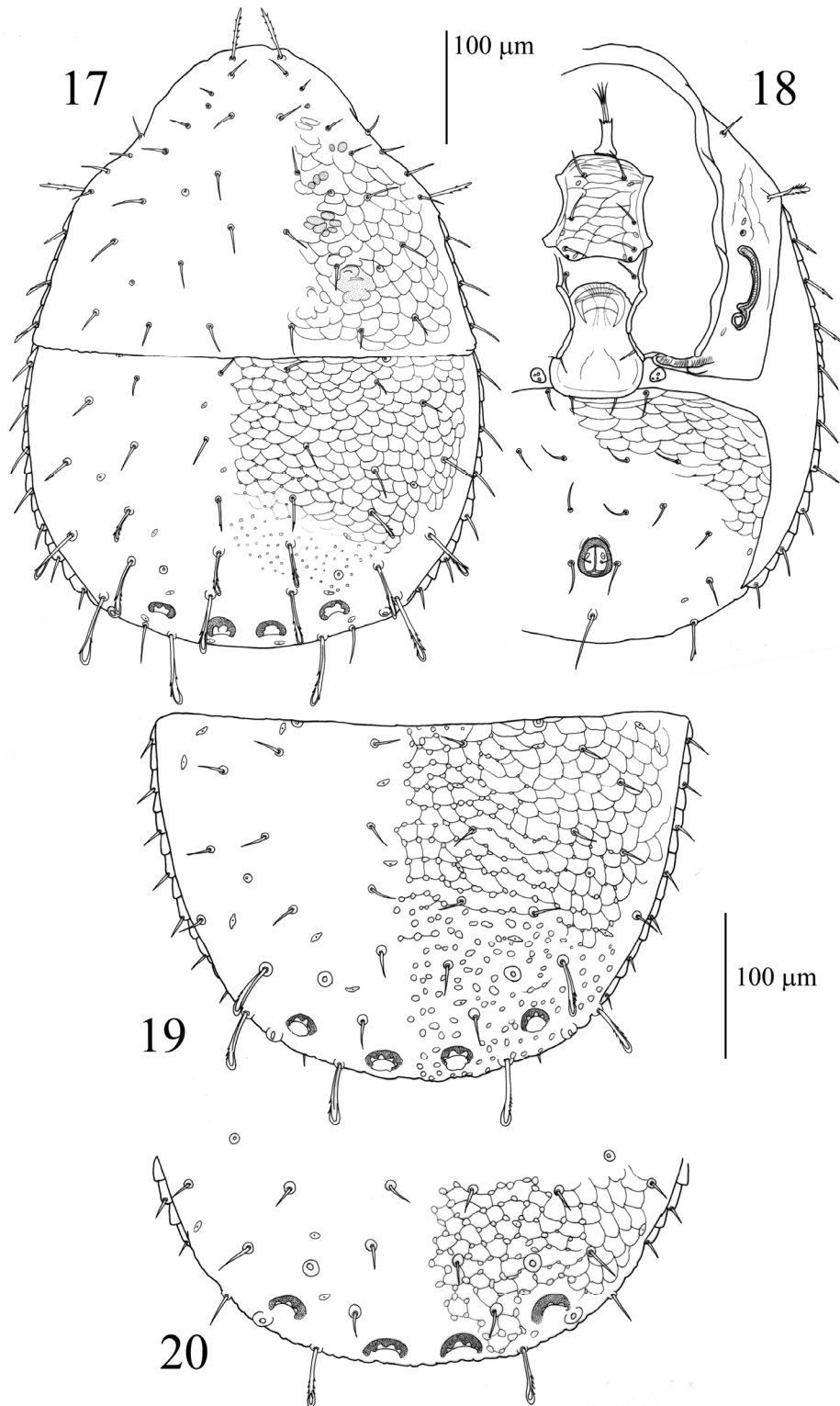
Remarks. The species is new to the fauna of Albania.

Distribution. Appenin Peninsula, Balkan Peninsula, Turkey (Fig. 28).

***Zercon serenus* Halašková, 1969**

(Fig 30)

Material examined. E-1853: Albania, southwest of Fushë-Lurë, Liqeni i Vogel (near brook, mixed pine-beech forest), 1710 m a.s.l., N41°47.587' E20°11.733', 28.06.2003., leg. ZE, JK, DM, ZF. (1 female, 1 deutonymph). E-2281: Albania, Periferi Tiranë, 7 km south of the Tiranë junction along the Klos-Elbasan road (beech forest) dry-rotten wood, 1370 m a.s.l., N41° 19.895' E20°08.454', 30.06.2007., leg. LD, ZE, ZF, DM, AH. (2 females). E-2290: Albania, Periferi Tiranë, 7 km south of the Tiranë junction along the Klos-Elbasan road (beech forest), leaf litter, 1370 m a.s.l., N41°19.895' E20°08.454', 30.06.2007., leg. LD, ZE, ZF, DM, AH. (1 male). E-2291: Albania, Periferi Mat, 3 km north of Qafa e Shtyllës, on the Klos-Elbasan road, 1.3 km north



Figures 17–20. 13 = dorsal view of *Z. horsaensis* 14 = ventral view of *Z. horsaensis*, 15 = opisthonorium of *Z. spatulatus*, 16 = caudal part of *Z. spatulatus* collected near Radomirë

of the conj. to Tiranë, (limestone rocks), leaf-litter, 1500 m a.s.l., N41°22.270' E20°05.126', 30.06.2007., leg. LD, ZE, ZF, DM, AH. (3 females, 1 male, 1 deutonymph). E-2287: Albania, Periferi Dibrë, 9 km north of Cidhnë along the Cidhnë – Fushë-Lurë road (rocks, beech forest and dry grassland), leaf-litter, 1330 m a.s.l., N41°48.896' E20°16.651', 29.06.2007., leg. LD, ZE, ZF, DM, AH. (3 females, 2 males).

Remarks. The species is new to the fauna of Albania.

Distribution. Central-Europe, Balkan Peninsula (Fig. 30).

***Zercon spatulatus* C. L. Koch, 1839**

(Figs 19–20, 30)

Material examined. E-1852: Albania, Okol, at the "Waterfall with a basin"(near the brook, limestone rocks, mixed forest), 900 m a.s.l., N42°24.137' E19°45.791', 05.07.2003., leg. ZE, JK, DM, ZF. (20 females, 5 males). E-1853: Albania, southwest of Fushë-Lurë, Liqeni i Vogel (near brook, mixed pine-beech forest), 1710 m a.s.l., N41°47.587' E20°11.733', 28.06.2003., leg. ZE, JK, DM, ZF. (10 females). E-1858: Albania, over Shkëmbi i Qytetit cave, 4 km southwest of Bishnicë, towards Shpelle (limestone and conglomerate rocks), 1140 m a.s.l., N40°55.258' E20°26.946', 01.07.2003., leg. ZE, JK, DM, ZF. (1 female). E-2266: Albania, Periferi Dibrë, Mali i Korabit, ca. 5.5 km east of Radomirë southern slope, over Fushë Korabit (opened brook, cave and rocks), from moss, 1905 m a.s.l., N41°49.121' E20°32.240', 27.06.2007., leg. LD, ZE, ZF, DM, AH. (4 females). E-2273: Albania, Periferi Korçë, 1 km west of Vithkuq, upper gorge of Lumi i Osumit, 1300 m a.s.l., from moss, N40°32.268' E20°34.198, 01.07.2007., leg. LD, ZE, ZF, DM, AH. (1 female, 1 deutonymph). E-2281: Albania, Periferi Tiranë, 7 km south of the Tiranë junction along the Klos-Elbasan road (beech forest) dry-rotten wood, 1370 m a.s.l., N41°19.895' E20°08.454', 30.06.2007., leg. LD, ZE, ZF, DM, AH. (4 females, 1 male). E-2283: Albania, Periferi Dibrë, Mali i Korabit, ca. 6 km

east of Radomirë, southern slope over Fushë Korabit (cave and limestone rocks), from moss, 2010 m a.s.l., N41°48.921' E20°32.691', 28.06.2007., leg. LD, ZE, ZF, DM, AH. (10 females, 7 males, 5 deutonymphs, 5 protonymphs). E-2285: Albania, Periferi Mat, 1 km south of Gurri-Bardhë along the Klos-Elbasan road (secondary forest), from moss, 800 m a.s.l., N41°26.759' E20°04.489', 30.06.2007., leg. LD, ZE, ZF, DM, AH. (2 females). E-2287: Albania, Periferi Dibrë, 9 km north of Cidhnë along the Cidhnë – Fushë-Lurë road (rocks, beech forest and dry grassland), leaf-litter, 1330 m a.s.l., N41°48.896' E20°16.651', 29.06.2007., leg. LD, ZE, ZF, DM, AH. (1 female).

Remarks. The species is new to the fauna of Albania. Shape of setae Z4 and S5 is characteristically spatuliform in *Z. spatulatus*, however on specimens collected near Radomirë the shape of former setae is similar to anterior opisthotal setae, smooth and pointed (Fig. 20). This morphological variant was hitherto unknown, and a question arises if the specimens belong to a currently unknown taxon. Regarding other morphological features no differences can be found between the two types collected in Albania, and these characters are insufficient for the establishment of a new taxon, hence I identified those with smooth, pointed and needle-like Z4 and S5 as *Z. spatulatus*.

Distribution. Central Europe, Balkan Peninsula (Fig. 30).

***Zercon vacuus* C. L. Koch, 1839**

(Fig 29)

Material examined. E-2264: Albania, Periferi Mat, 6 km south of Gurri i Bardhë along the Klos-Elbasan road, gorge of Lumi i Guisës, 1025 m a.s.l., dry-rotten wood, N41°25.839' E20°05.518', 30.06.2007., leg. LD, ZE, ZF, DM, AH. (2 females). E-2279: Albania, Periferi Tiranë, beech forest along the Klos-Elbasan road, above the reservoir, leaf-litter, 1155 m a.s.l., N41°16.165' E20°05.088', 30.06.2007., leg. LD, ZE, ZF, DM, AH. (7 females, 2 males, 1 deutonymph). E-2292:

Albania, Periferi Dibrë, Krej-Lurë, southwest of the village (pasture), leaf-litter, 1010 m a.s.l., N41°49.934' E20°10.513', 29.06.2007., leg. LD, ZE, ZF, DM, AH. (32 females, 1 male). E-2291: Albania, Periferi Mat, 3 km north of Qafa e Shtyllës, on the Klos-Elbasan road, 1.3 km north of the conj. to Tiranë, (limestone rocks), leaf-litter, 1500 m a.s.l., N41°22.270' E20°05.126', 30.06.2007., leg. LD, ZE, ZF, DM, AH. (3 females, 1 male). E-2294: Albania, Periferi Kukës, 2 km north of Topojan along the Kukës-Novosejë road (gorge of a stream) 900m, N41° 59.200' E20°31.715', 24.06.2007., leg. LD, ZE, ZF, DM, AH. (1 female). E-2285: Albania, Periferi Mat, 1 km south of Gurri i Bardhë along the Klos-Elbasan road (secondary forest), from moss, 800 m a.s.l., N41°26.759' E20°04.489', 30.06.2007., leg. LD, ZE, ZF, DM, AH. (1 female).

Remarks. The species is new to the fauna of Albania.

Distribution. Central Europe, Balkan Peninsula (Fig. 29).

***Zercon villosus* Błaszak & Polańska, 1998**

(Figs 21–24, 26, 29)

Material examined. E-2282: Albania, Periferi Dibrë, Mali i Korabit, northern slope of Maja e Korabit (cave), from moss, 2530 m a.s.l., N41° 47.823' E20°32.722', 27.06.2007., leg. LD, ZE, ZF, DM, AH. (2 females, 2 males, 1 deutonymph).

Remarks. The species is new to the fauna of Albania. Albanian female (Figs 21–22) specimens differ from the Bulgarian ones by lacking of hyaline sheaths of some opisthonotal setae. Although both males and deutonymphs were found as well by Błaszak & Polańska (1998), in the original description of the species neither of these were described nor illustrated.

Male (Figs 23–24). Length of idiosoma: 382 µm, width: 253 µm.

Chaetotaxy, poroidotaxy and ornamentation of dorsal shields generally similar to that of the female (see: Błaszak & Polańska 1998). Central podonotal setae, however, smooth and needle-like, and lateral dorsal cavities are smaller than medial ones, which is undetectable in female. Marginal serration even more acuminate than in female. Sternogenital shield well-sclerotized, with five pairs of setae. Peritremes straight. A single, oval postgenital sclerite can be found between adgenital platelets.

Deutonymph (Fig. 26). Length of idiosoma: 393 µm, width: 263 µm.

Chaetotaxy, poroidotaxy and ornamentation of dorsal shields generally similar to that of the adults. J-setae and marginal setae shorter, S-setae longer in proportion to the body-length than in adults. J-setae barbed, none of them reaching bases of the following one in the series. S2 reaching beyond the margin of idiosoma.

Distribution. Bulgaria, Albania (Fig. 29).

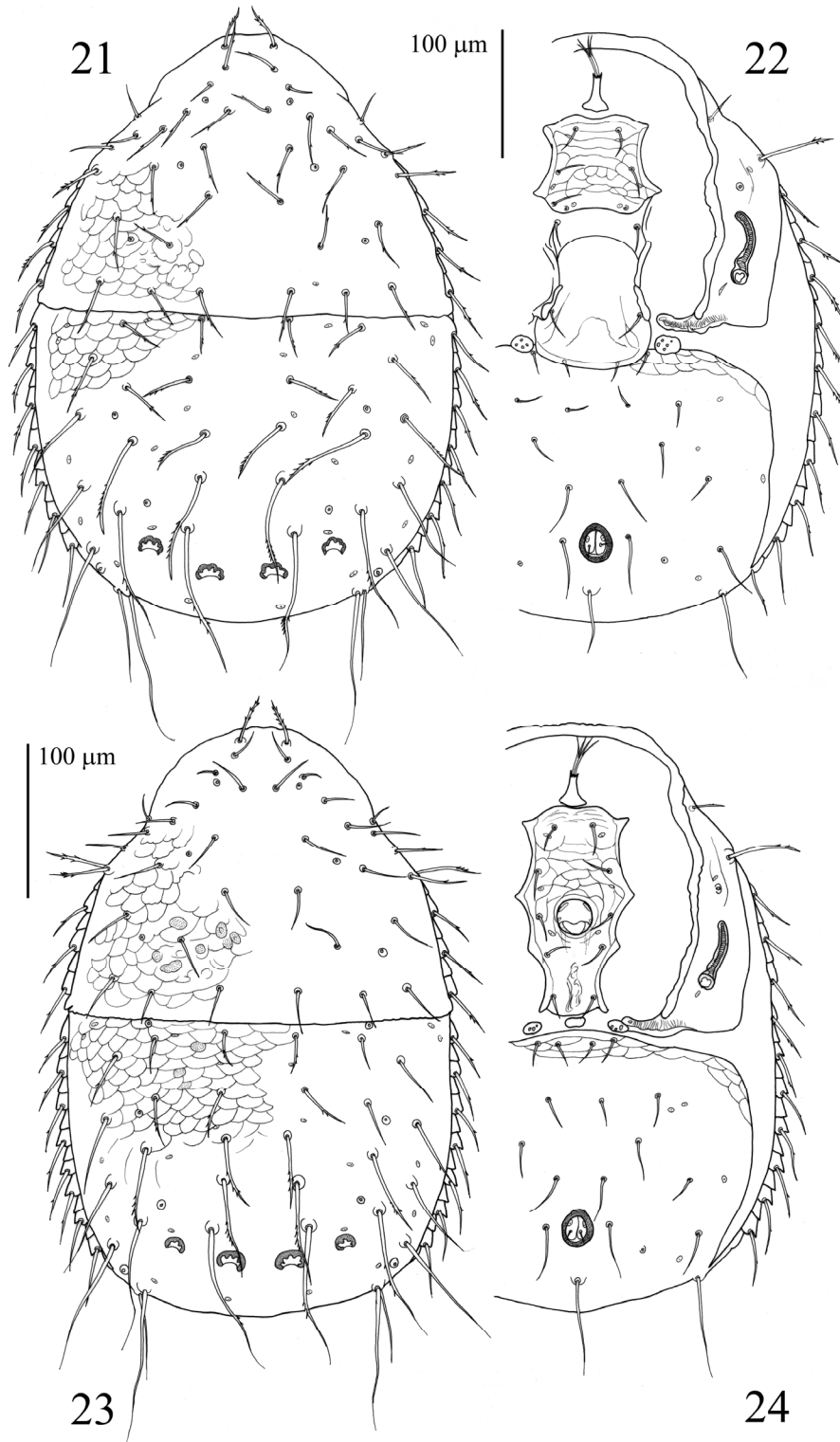
***Zercon zangherii* Sellnick, 1944**

(Figs 15–16, 28)

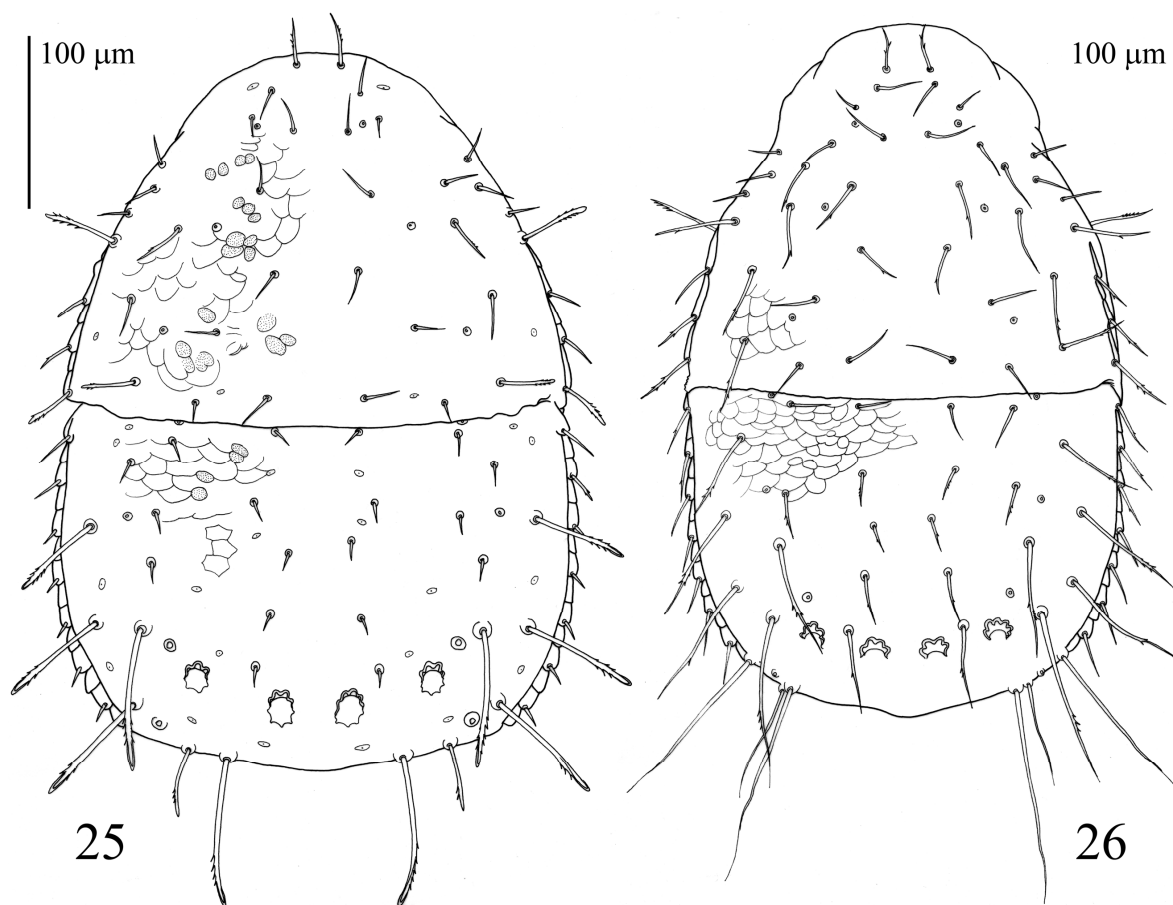
Material examined. E-2266: Albania, Periferi Dibrë, Mali i Korabit, ca. 5.5 km east of Radomirë southern slope, over Fushë Korabit (opened brook, cave and rocks), from moss, 1905 m a.s.l., N41°49.121' E20°32.240', 27.06.2007., leg. LD, ZE, ZF, DM, AH. (3 females, 1 male, 1 deutonymph). E-2279: Albania, Periferi Tiranë, beech forest along the Klos-Elbasan road, above the reservoir, leaf-litter, 1155 m a.s.l., N41°16.165' E20°05.088', 30.06.2007., leg. LD, ZE, ZF, DM, AH. (1 deutonymph). E-2282: Albania, Periferi Dibrë, Mali i Korabit, northern slope of Maja e Korabit (cave), from moss, 2530 m a.s.l., N41° 47.823' E20°32.722', 27.06.2007., leg. LD, ZE, ZF, DM, AH. (9 females, 1 male).

Remarks. The species is new to the fauna of Albania.

Distribution. Italy, Albania (Fig. 28).



Figures 21–24. *Zircon villosus*: 1 = dorsal view of female, 2 = ventral view of female, 3 = dorsal view of male, 4 = ventral view of male



Figures 25–26. 25 = *Z. albanicus* sp. n., dorsal view of deutonymph, 26 = *Z. villosus* sp. n., dorsal view of deutonymph

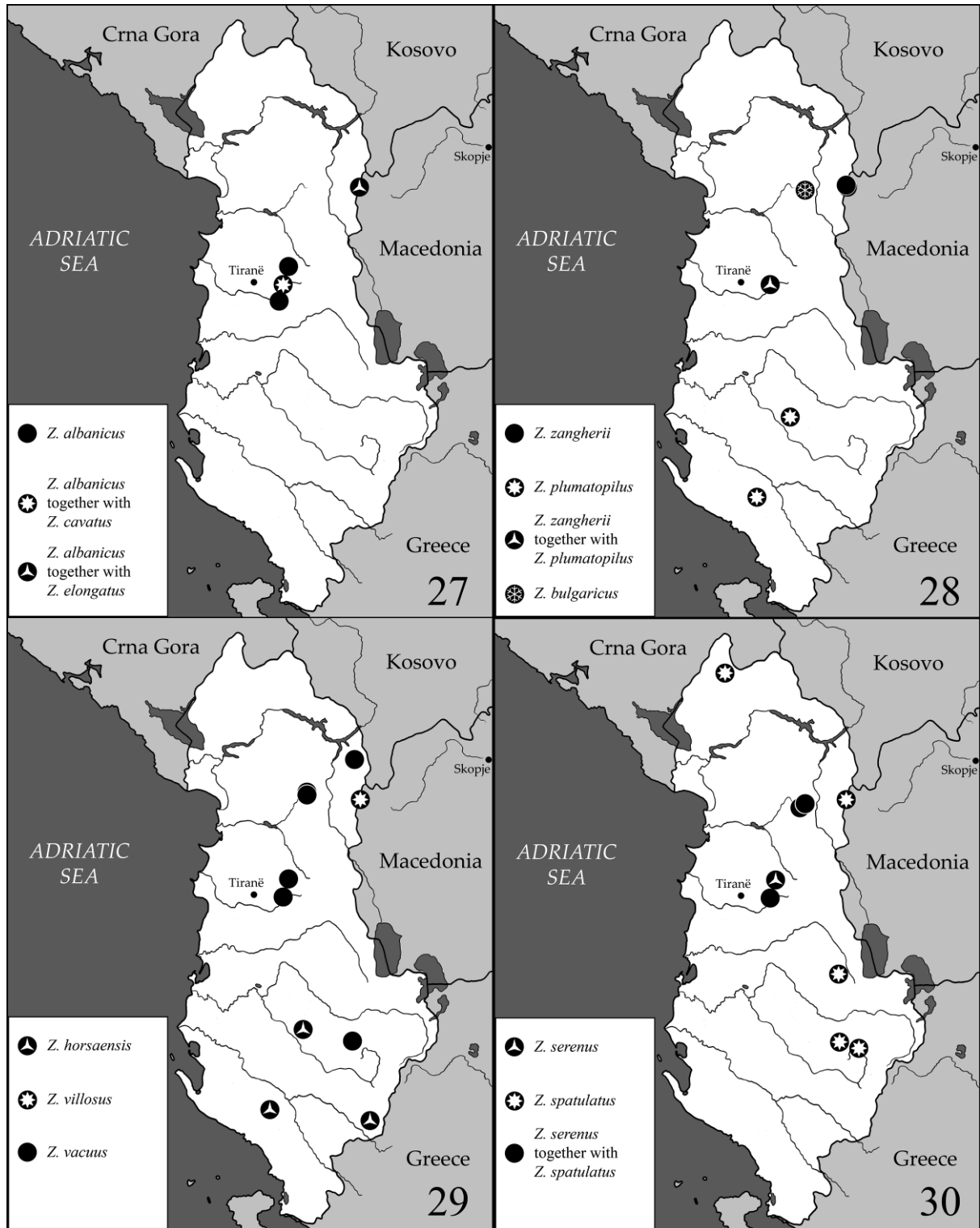
DISCUSSION

Altogether 11 species have been recorded from Albania, three of them, *Z. serenus*, *Z. spatulatus* and *Z. vacuus*, are known from several Central-European localities and apparently are prevalent in mountain woodlands (800–1500 m a.s.l.) of the northern and western part of the Balkan Peninsula as well. These species show a wide, Illyric distribution type and have presumably dispersed from the Balkan Peninsula to Central Europe. Earlier studies showed (Mahunka 1991, Mahunka & Mahunka-Papp 2004, 2007) that many Balkanic species migrated northward after the last glacial period, spreading through two different south-north migration routes as branches of a „pincers”: an Illyric and a Dacian route. *Z. serenus* and *Z. spatulatus* probably migrated through the western route up to the south western parts of Germany, and so are lacking in Transylvania, while *Z. vacuus* might have spread through both

paths, and prevalent in both the Illyric and Moesian regions with an eastern distribution border running alongside the Black Sea.

Z. bulgaricus, *Z. plumatopilus*, *Z. villosus* and *Z. zangherii* are typical Mediterranean species. While *Z. bulgaricus* and *Z. villosus* are only known from the Rila and Rhodope Mts (Bulgaria), *Z. zangherii* shows an Adriatic-Mediterranean distribution with its first data on the Eastern Adriatic coast. *Z. plumatopilus* possesses a wide East-Mediterranean area, stretching from the Adriatic to the Anatolian region.

There are only a few data on *Z. horsaensis*, it was known from the southern part of Slovakia so far and the presence of the species in Albania proves that the intermittent area is quite scarcely known. As I remarked above, the Albanian specimens are somewhat different from the Slovakian ones, and closely related to the Anatolian *Z. deli-*



Figures 27–30. Occurrences of *Zercon* species collected in Albania

catus as well. The similarity in the morphological characters indicates that *Z. horsasensis* is probably also a Mediterranean species and might have migrated through the Illyric route, however it has not yet been reported from the western region of the Carpathian Basin.

One of the new species, *Z. cavatus* sp. nov. shares some characters (for example strongly sclerotized, enlarged dorsal cavities) with a group of species distributed in the Mediterranean area (e.g. *Z. plumatopilus*) and may inhabit similar habitats in other regions of the Balkan Peninsula (and perhaps beyond it, towards Anatolia or the Apennin Peninsula as well).

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Table 1. Length of opisthonotal setae and longitudinal distance between their insertions in *Zercon albanicus* sp. n. (values in μm)

	♀	♂	DN		♀	♂	DN		♀	♂	DN
J1	12	12	11	Z1	9	14	14	S1	23	18	24
J1-J2	35	32	42	Z1-Z2	45	31	45	S1-S2	53	39	41
J2	11	11	13	Z2	12	13	12	S2	11	14	14
J2-J3	35	22	31	Z2-Z3	28	23	28	S2-S3	52	38	42
J3	12	10	12	Z3	13	12	13	S3	46	35	55
J3-J4	39	28	41	Z3-Z4	47	34	40	S3-S4	64	46	60
J4	11	10	10	Z4	80	62	82	S4	55	43	66
J4-J5	39	28	32	Z4-Z5	97	72	88	S4-S5	54	38	49
J5	14	10	11	Z5	87	68	86	S5	69	58	72

Table 2. Length of opisthonotal setae and longitudinal distance between their insertions in *Zercon cavatus* sp. n. (values in μm)

	♀		♀		♀
J1	38	Z1	35	S1	38
J1-J2	49	Z1-Z2	50	S1-S2	46
J2	43	Z2	42	S2	45
J2-J3	32	Z2-Z3	40	S2-S3	45
J3	48	Z3	56	S3	52
J3-J4	27	Z3-Z4	34	S3-S4	44
J4	55	Z4	70	S4	68
J4-J5	26	Z4-Z5	56	S4-S5	35
J5	70	Z5	63	S5	81

Table 3. Length of opisthonotal setae and longitudinal distance between their insertions in *Zercon elongatus* sp. n. (values in μm)

	♀	DN		♀	DN		♀	DN
J1	8	6	Z1	8	6	S1	11	10
J1-J2	46	29	Z1-Z2	48	34	S1-S2	41	28
J2	9	7	Z2	9	7	S2	9	8
J2-J3	36	30	Z2-Z3	36	30	S2-S3	59	42
J3	10	7	Z3	47	45	S3	21	33
J3-J4	41	38	Z3-Z4	64	45	S3-S4	58	49
J4	9	6	Z4	49	51	S4	38	49
J4-J5	50	31	Z4-Z5	64	51	S4-S5	53	41
J5	11	6	Z5	52	55	S5	48	50

A new species of the genus *Lagenonema* Andrassy, 1987 (Nematoda: Dorylaimidae) from West Bengal, India

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Abstract. During a taxonomic survey in Paschim Medinipur district of West Bengal, India, a new nematode species belonging to the genus *Lagenonema* Andrassy, 1987 was collected from the rhizosphere of banana roots. *Lagenonema thornei* n. sp. is characterized by having medium-sized body (female: 1.48–1.55 mm); abruptly narrowed, bottle-shaped cephalic region; amalgamated lips; tongue-shaped cardia; mono-opisthodelphic reproductive system with short pre-vulval uterine sac and long filiform tail. It closely resembles *L. longicaudatum* (Jairajpuri, Ahmad and Dhanachand, 1979) Andrassy, 1987 in V value, long filiform tail and tongue-shaped cardia. But differs in having longer body, odontostyle, odontophore and pre-vulval uterine sac; values of a, b, c and c' are also different.

INTRODUCTION

A new dorylaimoid nematode, *Lagenonema thornei* of the family Thornenematidae is being described and illustrated herein. The genus *Lagenonema* was erected by Andrassy (1987) by differentiating it from *Thornenema* Andrassy, 1959 in having abruptly narrowed, bottle-shaped anterior region, well sclerotized spatulate cephalic framework, smaller amphids and opisthodelphic female gonad. Jairajpuri and Ahmad (1992) did not agree with him and noted that *Lagenonema* was close to *Thornenema*. We however agree with Andrassy's opinion that *Lagenonema* is a well defined, distinct genus. Andrassy (1987) shifted four species under the genus *Lagenonema* from *Thornenema*, namely *L. caudatum* (Jairajpuri, Ahmad & Dhanachand, 1979), *L. longicaudatum* (Jairajpuri, Ahmad & Dhanachand, 1979), *L. loofi* (Jairajpuri, Ahmad & Dhanachand, 1980) and *L. wickeni* (Yeates, 1970). At the same time, he described *L. tropicum* Andrassy, 1987. Subsequently, another species, *L. clavicaudatum* Gambhir & Dhanachand, 1990 was added to the genus.

MATERIAL AND METHODS

Nematodes were collected from a rhizospheric soil sample (250 gm) around banana plantation (*Musa paradisiaca* L. cv. Kanthali). Soil sample was taken from a small area of 10 cm × 10 cm up to the depth of 20 cm, at a distance of 25 cm from the main bole of the orchard. The specimens were extracted from soil by Cobb's sieving technique (Cobb, 1918) and decanting method followed by Modified Baermann's funnel technique (Christie and Perry, 1951); processed by Seinhorst's slow dehydration method (Seinhorst, 1959). They were mounted on slides in anhydrous glycerin and sealed. Measurements were taken with the help of an ocular micrometer using Olympus research microscope with drawing-tube attachment; model no. BX 41. Dimensions were presented in accordance with de Man's formula (de Man, 1884). Positions of the oesophageal gland nuclei with Andrassy's formula (Andrassy, 1998). Diagrams were drawn with the help of a camera lucida.

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DESCRIPTION OF SPECIES

Lagenonema thornei n. sp.

(Fig. 1 A–E)

Measurements in Table I.

Female. Body slightly curved ventrally upon fixation, mainly at posterior region; tapering towards both the extremities. Cuticle with fine transverse striations; 2–3 μm thick at the base of lip region, 1.5–2.0 μm at midbody and 3–4 μm on tail. Lateral hypodermal chords occupying about 1/3 of body width at midbody. Body pores indistinct.

Lip region amalgamated, narrow and cylindrical-truncated in shape; 1/6–1/5 as wide as body width at neck base. Labial framework strongly sclerotized, post-labial sclerotization also well developed. Amphid cup-shaped with slit-like aperture, occupying about 1/3 of corresponding body width. Odontostyle cylindroid, 2.5–2.7 times the lip region width long; aperture about 1/4–1/3 of its length. Guiding ring single, at 1.3–1.5 times the lip region width from anterior end. Odontophore simple, rod-like, 1.3–1.4 times the odontostyle length. Nerve ring at 40–42% of neck length from anterior extremity. Basal expanded part of oesophagus (cylindrus) occupying 46–48% of the total oesophageal length. Glandularium 118–121 μm long. Cardia tongue-shaped. Positions of oesophageal gland nuclei are as follows: D = 60–61%; AS₁ = 19–20%; AS₂ = 33%; PS₁ = 58–59%; PS₂ = 58–59%.

Reproductive system opisthodelphic; prevulval uterine sac short, 3.5 μm long. Vulva a transverse slit; vagina thick-walled, extending inwards about half of corresponding body width. Oviduct separated by a sphincter from uterus. Ovary reflexed, 67–71 μm long; genital cells arranged in a single row except at the tip.

Prerectum 2.0–2.5 times anal body width long. Rectum as long as anal body diameter. Tail long, filiform, not constricted, with subacute terminus, about 9 times anal body width long. Two caudal pores present on each side of tail.

Male. Not found.

Differential diagnosis and relationships. *Lagenonema thornei* n. sp. is characterized by having abruptly narrowed, bottle-shaped anterior region, amalgamated lips, tongue-shaped cardia, monopisthodelphic reproductive system with short prevulval uterine sac and long filiform tail.

In the characteristic shape of lip region and the long filiform tail the new species closely resembles *Lagenonema longicaudatum* (Jairajpuri, Ahmad and Dhanachand, 1979) Andrassy, 1987. Besides, the V value and tail length also show similarities between them (V = 33–41%; tail 175–225 μm long in *L. longicaudatum*). Cardia tongue-shaped and male unknown in both species.

The new species differs from its relative in having longer body, odontostyle and odontophore (vs. L = 0.67–0.75 mm; odontostyle 10–11 μm ; odontophore 12–13 μm long). The values a, b, c and c' are also different in both species (a = 26–31; b = 4.3–4.7; c = 3–4; c' = 13–15 in *L. longicaudatum*). Prevulval uterine sac almost absent in *L. longicaudatum*, but a short sac is present in the new species.

Type habitat and locality. Rhizospheric soil of banana plantation (*Musa paradisiaca* L. cv. Kanthali) at Baroi village under Mohanpur block of Paschim Medinipur district, West Bengal, India. Collected by the first author on 24. July, 2005.

Type specimens. Specimens are deposited with the National Zoological Collections of Zoological Survey of India, Kolkata, West Bengal, India, under the Registration No. WN 1255 (Holotype) and WN 1256 (Paratypes).

Etymology. This new species is named after the late Professor Gerald Thorne, the outstanding authority on the order Dorylaimida.

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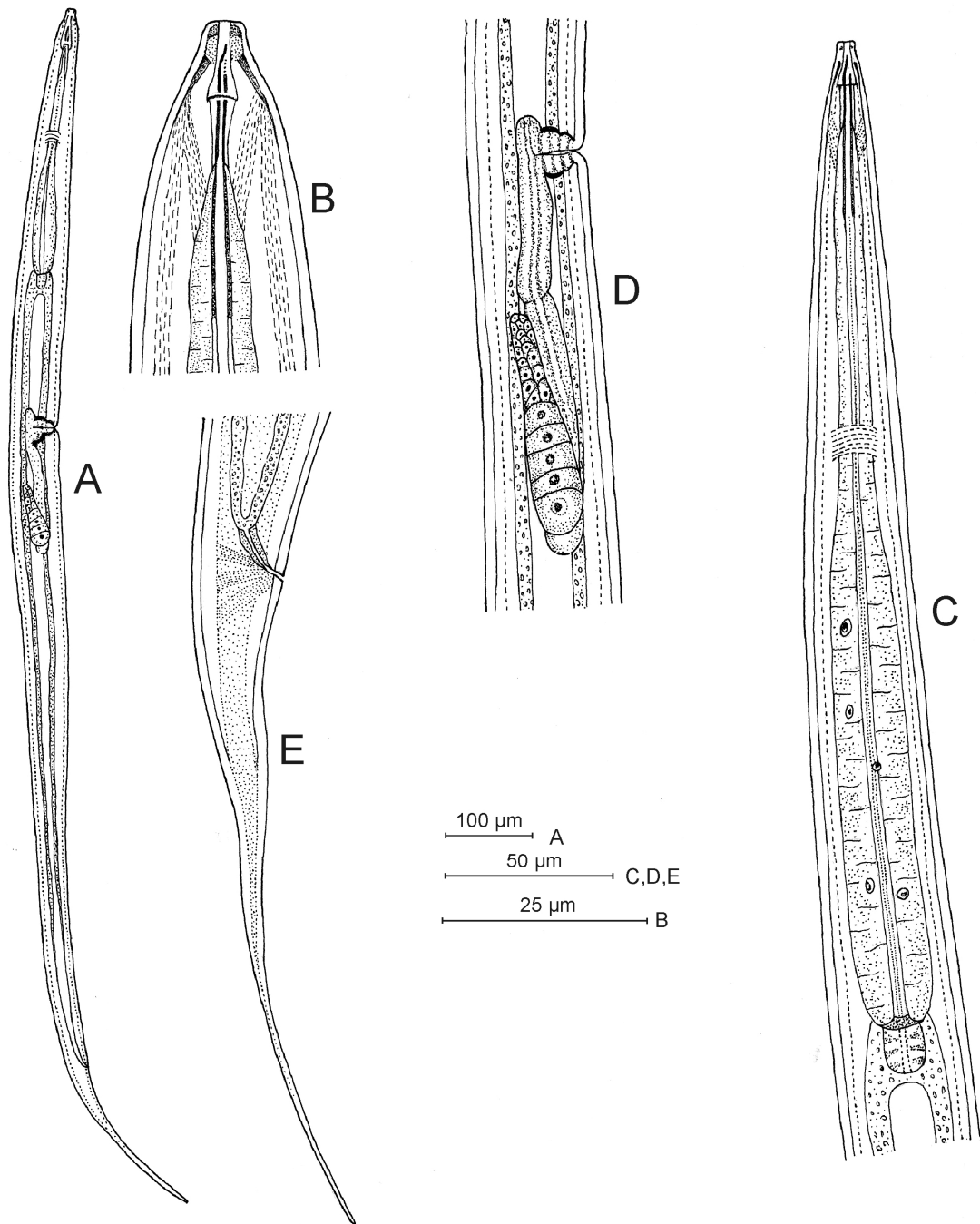


Figure 1. Camera lucida drawings of female *Lagenonema thornei* n. sp. A: entire body; B: anterior portion; C: neck region; D: vulva with posterior gonad; E: posterior portion

ration. We are truly indebted to Profs István Andrassy, Mahammad Shamim Jairajpuri and Wasim Ahmad for providing literature, valuable suggestion and continuous encouragement.

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Table I. Measurements of *Lagenonema thornei* n. sp. (All measurements in μm , except L, in mm).

Morphometric characters	Holotype female	Paratype females (n = 10)	Mean \pm SD
L	1.54	1.48-1.55	1.51 \pm 0.02
a	39.8	39.5-39.8	39.6 \pm 0.1
b	5.2	5.0-5.2	5.1 \pm 0.1
c	7.9	7.7-7.9	7.8 \pm 0.1
c'	9.2	9.1-9.2	9.2 \pm 0
V	33.2	33.1-34.4	33.7 \pm 0.4
V'	38.0	38.0-38.2	38.1 \pm 0.1
G ₂	11.9	10.8-12.0	11.5 \pm 0.4
Height of lip region	3.6	3.6-3.6	3.6 \pm 0
Width of lip region	6.4	6.3-6.4	6.3 \pm 0
Amphid from anterior end	4.3	4.2-4.3	4.2 \pm 0
Odontostyle length	17.7	16.9-17.9	17.4 \pm 0.3
Length of stylet aperture	5.2	4.8-5.2	5.0 \pm 0.1
Odontophore length	24.3	23.4-24.4	23.9 \pm 0.3
Guiding ring from ant. end	9.6	9.1-9.6	9.3 \pm 0.2
Nerve ring from ant. end	121.6	119.7-121.4	120.7 \pm 0.7
Oesophageal length	294.5	291.8-296.1	294.1 \pm 1.4
Basal part of oesophagus	141.3	137.1-142.1	139.8 \pm 1.6
Length of cardia	13.2	12.9-13.2	13.0 \pm 0.1
Body width at neck base	37.1	36.8-37.1	37.0 \pm 0.1
Body width at vulva	38.8	37.4-38.9	37.7 \pm 0.4
Body width at anus	21.1	20.8-21.2	21.0 \pm 0.2
Vulva from anterior end	514.5	491.3-520.7	507.9 \pm 8.4
Length of posterior gonad	185.7	160.5-187.2	178.4 \pm 9.9
Prerectum	46.7	44.7-47.7	46.0 \pm 0.9
Rectum	21.4	20.8-21.4	21.1 \pm 0.2
Tail length	195.1	191.7-196.4	193.9 \pm 1.5

Nematodes from the Botanical Garden in Sopron, Hungary

M. KISS¹

Abstract. This article presents some nematode species observed in the Botanical Garden in Sopron, western Hungary. One species, *Anatonchus hortensis* is described in detail.

The Botanical Garden, the terrestrial nematodes of which were studied, is situated in Sopron, a West-Hungarian town. It is rich in various plant species, particularly the evergreen collection of the garden is of European reputation. Two dozens of species of fir trees, more than thirty species of spruces, more than thirty ones of junipers, barberries and hundreds of species of deciduous trees and shrubs are on show (Kocsó, 2003).

MATERIALS AND METHODS

Soil and moss samples were collected under *Metasequoia glyptostroboides* (dawn redwood), *Sequoia sempervirens* (coast redwood), *Taxodium distichum* (bald cypress), *Acer tetramerum* (birch-leaf maple) and soil of greenhouse from Sopron Botanical Garden (University of West Hungary), in September 2008 by the present author. Nematodes were isolated using Bearmann's funnel method (Andrássy & Farkas, 1988). They were fixed in FAA and then transferred in anhydrous glycerine by a slow method. The nematodes were examined using a light microscope. Drawings were made with the aid of a drawing tube attachment. Measurements were taken by an ocular micrometer, curved structures measured along medial line.

RESULTS

Twelve nematode species have been identified from terrestrial habitats of the Botanical Garden (Table 1). There were no nematodes in samples

taken from the greenhouse because the soil was treated with nematicid chemicals.

Anatonchus hortensis AndrÁssy, 1973

(Figs. 1–7)

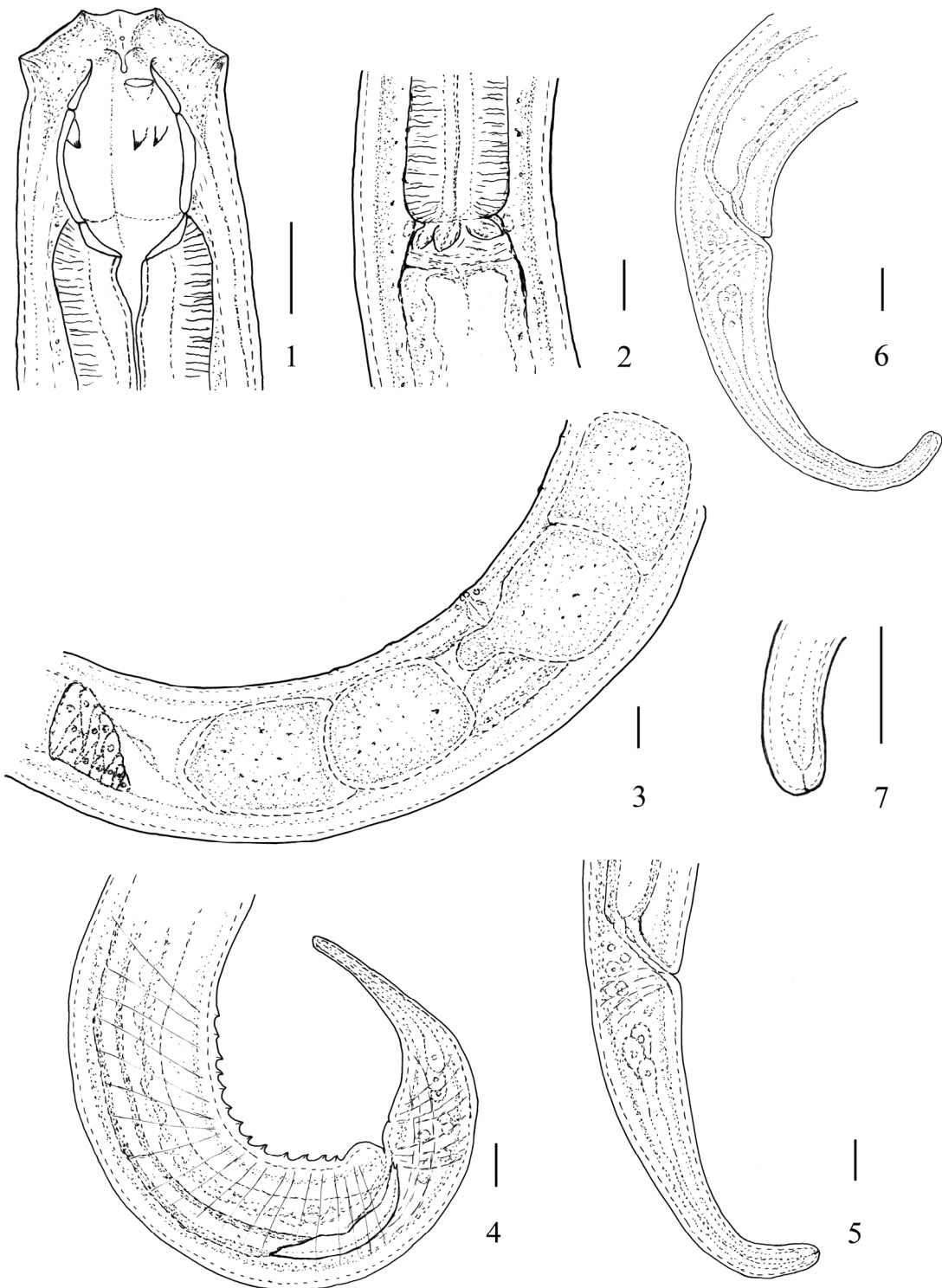
Females (n = 9): L = 1.5–2.0 mm; a = 21–23; b = 3.8–4.5; c = 8–12; c' = 3.0–4.8; V = 61–65%.

Males (n = 4): L = 1.5–1.8 mm; a = 20–22; b = 3.8–4.0; c = 10–12; c' = 2.9–3.9.

General description. Body ventrally curved, C-shaped after fixation, 74–84 µm wide at the mid-region. Cuticle smooth, 2–3 µm thick. Labial region 40–49 µm wide, slightly set off from body. Buccal cavity oblong, 41–46×23–28 µm. Dorsal and subventral teeth somewhat before the mid-stoma with apices located at 40–45 % (from anterior end of buccal capsule). Dorsal tooth 4–5 µm long. Oesophagus 412–450 µm long, occupying 24–27 % of entire body length. Body at proximal end of oesophagus 1.5–1.8 times as wide as head. Amphids located at level of anterior end of buccal cavity, 7 µm wide, cup-shaped, at 16–18 µm from anterior end. Oesophago-intestinal tubercles well developed.

Female. Female genital system amphidelphic, occupying 27–33 % of body length. Vulva transversal with slightly sclerotized lips. Vagina 21–25 µm long. Eggs: 75–92×50–56 µm, oblong, somewhat longer than wide, partly pressed against each other. Three females contain three, one four and two five eggs. Each gonad 3.5–4.1 times as long as body diameter. Anterior to vulva one or two, posterior to it two ventral papillae. Rectum 33–37 µm long, shorter than one anal body width.

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Figures 1–7. *Anatonchus hortensis* Andrassy, 1973. 1: anterior end; 2: cardiac region; 3: vulval region; 4: male tail; 5–6: female tail; 7 tip of female tail. (Scale bars 20 μ m each)

Distance between vulva and anus 2.3–2.9 times as long as tail. Tail 142–230 µm long, 9–12 % of total body length, 3.8–4.8 times as long anal body diameter. Tip of tail finely rounded. Caudal glands with terminal opening.

Male. Body more strongly curved in posterior region. Ventromedial supplements 13–14. Spicula 65–73 µm long, slender. Tail 150–180 µm long, 3.6–3.9 times the anal body diameter, 9–10 % of entire body length, elongate-conical, gradually tapering to the finely rounded terminus. Caudal glands and spinneret similar to those of females.

Remarks. *Anatonchus hortensis* was described by Andrásy (1973) from a garden soil in Budapest. Subsequently, it was observed in several countries in Europe, viz. Serbia, Romania, Bulgaria, Spain and France. Good descriptions are found in the publications of Barsi (1989), Popovici (1990) and Peneva, Neilson & Nedelchev (1999). The present specimens well correspond to the previous descriptions, only some minor morphometrical differences can be observed.

Habitat and locality. Soil and moss from under dawn redwood (*Metasequoia glyptostroboides*) and bald cypress (*Taxodium distichum*) from Sopron Botanical Garden; collected in September 2008 by the present author.

FURTHER SPECIES OBSERVED

Class TORQUENTIA

Plectidae

Anaplectus granulatus Bastian, 1865

Habitat and distribution. Cosmopolitan, one of the most common species of soil-inhabiting nematodes.

Plectus parietinus Bastian, 1865

Habitat and distribution. A very common cosmopolitan species, predominantly in terrestrial habitats.

Class SECERNENTIA

Cephalobidae

Acrobeles ciliatus Linstow, 1877

Habitat and distribution. A worldwide distributed species. Frequent in different terrestrial habitats.

Class PENETRANTIA

Tripylidae

Tripylina arenicola (de Man 1880) Brzeski, 1963

Habitat and distribution. Moderately frequent species, living in soil and moss.

Alaimidae

Alaimus primitivus de Man, 1880

Habitat and distribution. Very frequent species, terricolous and aquatic.

Alaimus similis Thorne, 1939

Habitat and distribution. Common species, frequent in soil.

Mylonchulidae

Mylonchulus brachyuris (Bütschli, 1873) Cobb, 1917

Habitat and distribution. Frequent in terrestrial habitats, distributed all over the world.

Aporcelaimidae

Aporcelaimellus alius Andrásy, 2002

Habitat and distribution. Soil species, known from Hungary: Fertő-Hanság National Park (Andrásy, 2002) and Sas Hill in Buda (Kiss, 2009).

Aporcelaimellus medius Andrásy, 2002 (Figs. 8–11)

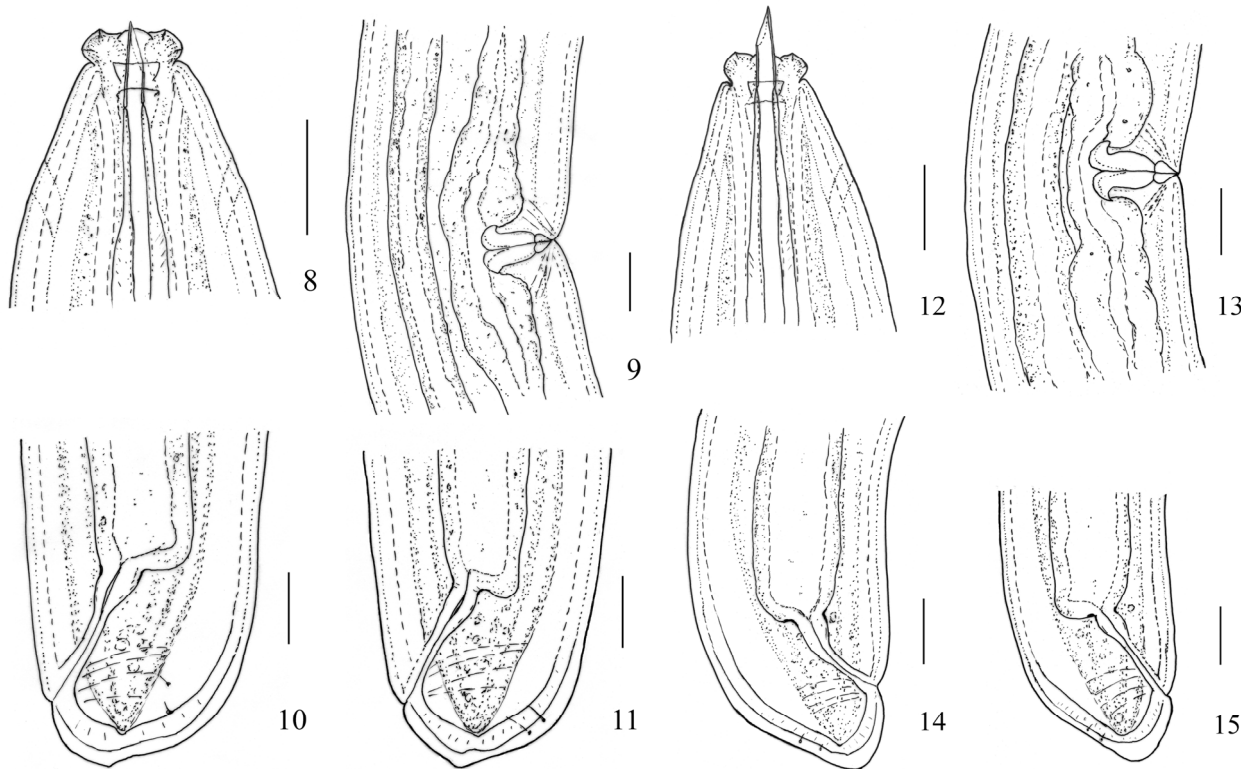
Habitat and distribution. Soil species, known from Hungary: Fertő-Hanság National Park (Andrásy, 2002).

Aporcelaimellus obtusicaudatus (Bastian, 1865) Altherr, 1968

Habitat and distribution. Cosmopolitan species, very frequent in a wide range of terrestrial habitats.

Aporcelaimellus samarcandicus (Tulaganov, 1949) Baqri & Khera, 1975 (Figs. 12–15)

Habitat and distribution. Known from Uzbekistan and Hungary, Fertő-Hanság National Park (Andrásy, 2002).



Figures 8–11. *Aporcelaimellus medius* Andrassy, 2002. 8: anterior end; 9: vulval region; 10–11: female tail. (Scale bars 20 µm each)

Figures 12–15. *Aporcelaimellus samarcandicus* (Tulaganov, 1949) Baqri & Khera, 1975. 12: anterior end; 13: vulval region; 14–15: female tail. (Scale bars 20 µm each)

Table 1. List of nematode species observed. 1: soil under *Metasequoia glyptostroboides* (dawn redwood); 2: soil under *Sequoia sempervirens* (coast redwood); 3: soil under *Taxodium distichum* (bald cypress); 4: soil from the greenhouse; 5: soil under *Acer tetramerum* (birch-leaf maple)

Species	1	2	3	4	5
<i>Acrobeles ciliatus</i>	-	+	-	-	-
<i>Alaimus primitivus</i>	-	-	+	-	+
<i>Alaimus similis</i>	+	-	+	-	+
<i>Anaplectus granulosus</i>	+	+	-	-	+
<i>Anatonchus hortensis</i>	+	-	+	-	-
<i>Aporcelaimellus alius</i>	+	-	+	-	+
<i>Aporcelaimellus medius</i>	+	-	+	-	+
<i>Aporcelaimellus obtusicaudatus</i>	-	+	+	-	+
<i>Aporcelaimellus samarcandicus</i>	+	-	+	-	-
<i>Mylonchulus brachyuris</i>	+	-	+	-	+
<i>Plectus parietinus</i>	+	+	-	-	-
<i>Tripylina arenicola</i>	+	-	+	-	+

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Zooplankton from a polluted river, Mula (India), with record of *Brachionus rubens* (Ehrenberg, 1838) epizoic on *Moina macrocopa* (Straus, 1820)

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Abstract. Rotifera and Cladocera are free living zooplankton elements known to dominate freshwater habitats. Few rotifers are known to be parasitic and epizoic living in association with other organisms. Zooplankton from the polluted river Mula, Pune, Maharashtra was sampled from January to November 2009. Eighteen rotifers and ten cladocerans were recorded during the study. Samples revealed rotifer *Brachionus rubens* (Ehrenberg, 1838) epizoic on cladoceran *Moina macrocopa* (Straus, 1820), the occurrence of which coincided with lower dissolved oxygen (DO) content. The rotifers *Asplanchnopus multiceps* (Schrank, 1793), *Lacinularia elliptica* (Shephard, 1897) and the cladoceran *Kurzia longirostris* (Daday, 1898) are new records to Maharashtra state. The present study was an attempt to monitor a polluted habitat for zooplankton fauna. Detailed studies on organically polluted eutrophic habitats could add new insights into zooplankton diversity and behaviour.

INTRODUCTION

Freshwater zooplankton fauna comprises Rotifera, Cladocera, Copepoda and Ostracoda of which Rotifera and Cladocera are relatively abundant. Zooplankton occupies an important position in the trophic structure and plays an important role in the energy transfer of an aquatic ecosystem.

Limnological studies in India have been focused mainly on molluscs, fish and birds whereas studies on zooplankton have been fairly neglected. Of the total rotifer count world wide (2030) only 360 species have been reported from India. This accounts for only 18 % of the total global fauna. The number of cladoceran species reported in India is 190 (Raghunathan & Kumar, 2002), though only close to a hundred species have been described in detail (Michael & Sharma, 1988). The global diversity of cladocerans is more than 600 species.

River Mula (Pune, India) is highly affected by domestic organic pollution. Therefore it was our endeavour to study the zooplankton fauna from this polluted water body.

Live samples revealed rotifer *Brachionus rubens* (Ehrenberg, 1838) epizoic on the cladoceran *Moina macrocopa* (Straus, 1820) in large numbers for the first time from Maharashtra state, along with few new records to Maharashtra state.

MATERIAL AND METHODS

The sampling was carried out at river Mula, (Pune, India) from 21st January to 21st November 2009, once every two months. River Mula originates in the Western Ghats (Mulshi, Maharashtra). Mula is a tributary of the Bhima River in Deccan Plateau, India.

Random water samples were collected from the littoral region of the river at Aundh bridge, Pune (18° 34' 06 N; 73° 48' 38 E). The collection site consisted of submerged aquatic plants *Vallisneria* and *Ipomea* species along the littoral region. The site is very close to a cemetery and a garbage depot. The site is regularly used for washing clothes and bathing.

Horizontal sampling for Rotifera was done using 53 µm mesh size Nytex nylon Plankton Net.

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Horizontal sampling for Cladocera was done using Nylon Net (150 µm). For Chydorid Cladocerans the littoral sediment was scraped using a hand net.

Samples were immediately preserved in 4% formaldehyde solution. Few live samples were also carried to the laboratory.

Temperature, pH, electric conductivity, total dissolved solids (TDS) and salinity were the parameters recorded onsite using Multiparameter PCS Tester 35 (Eutech, Singapore). Dissolved oxygen (DO) was calculated using the modified Winkler method (Montgomery, 1964) Cladocera and Rotifera were identified using Olympus Magnus (MS-24) dissecting binocular microscope and Olympus phase contrast microscope (Magnus MLXi) fitted with a digital camera (Sony DSC-W35) respectively. Identifications were made using keys by (Michael & Sharma, 1988; Korovchinsky, 1992; Smirnov, 1992; Sharma, 1983).

RESULTS

The study revealed 18 rotifers and 10 cladocerans from the collection site (Table 1). Physical-chemical parameters, which were recorded along with monthly occurrence of species, have been

listed in (Table 2). Though the species diversity of Rotifera was comparatively high, the most dominant group in terms of abundance was Cladocera. Six species of genus *Brachionus* were recorded during this study confirming the dominance of genus *Brachionus* (33 % of total rotifer count) as previously reported (Sharma, 1983). The rotifers *Asplanchnopus multiceps*, *Lacinularia elliptica* and the chydorid *Kurzia longirostris* are new additions to current zooplankton fauna of Maharashtra. The cladoceran *Kurzia longirostris* was predominant in sediment samples.

In March 2009 numerous *Brachionus rubens* were found to be epizoic on the body surface of the cladoceran *Moina macrocopa*, the number of rotifers attached to a single host ranging from 10–35. *Brachionus rubens* was relatively more attached to the posterior region, as compared to the head, antennae and limbs (Fig. 1). Further sampling revealed no such associations although free swimming specimens of *B. rubens* and *M. macrocopa* were observed. This is the first record of rotifer-cladoceran association from Maharashtra state.

Epizoic associations between rotifers and cladoceran were seen only in March 2009 when the dissolved oxygen content was lowest.

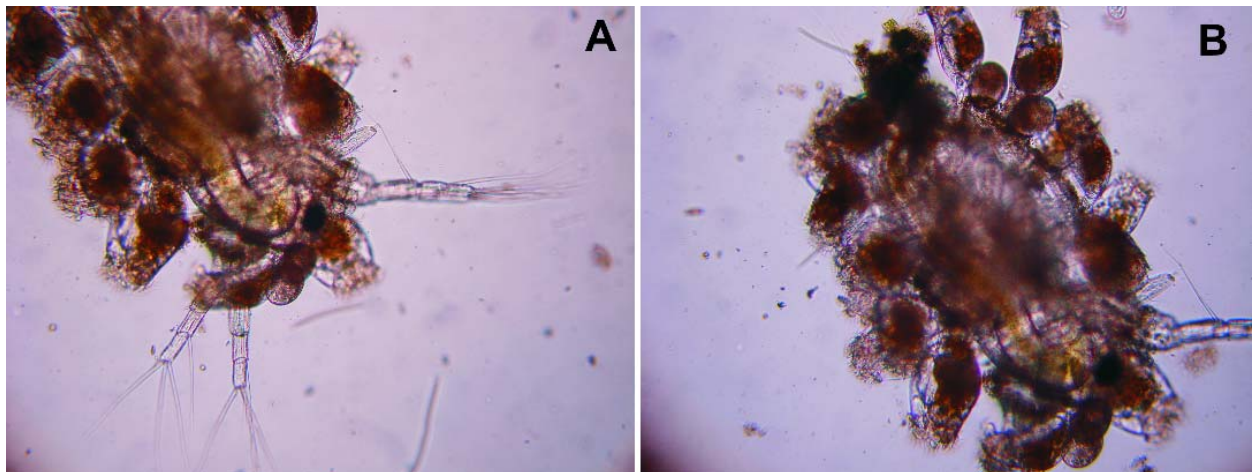


Figure 1. *Brachionus rubens* epizoic on *Moina macrocopa* from Mula River

Table 1. Month-wise distribution of recorded Rotifera and Cladocera (“+”: present, “-”: absent)

Zooplankton	Jan 21.01.09	March 21.03.09	May 21.05.09	Sept 21.09.09	Nov 21.11.09
Rotifera					
<i>Asplanchna brightwellii</i> Gosse, 1850	-	+	-	-	-
<i>Asplanchnopus multiceps</i> (Schränk, 1793)	-	+	-	+	-
<i>Beauchampiella eudactylota</i> Gosse, 1886	-	-	-	+	-
<i>Brachionus angularis</i> Gosse, 1851	-	+	+	-	-
<i>Brachionus calyciflorus</i> Pallas, 1766	-	+	+	-	-
<i>Brachionus caudatus</i> Barrois & Daday, 1894	+	+	+	-	-
<i>Brachionus falcatus</i> Zacharias, 1898	+	-	-	-	+
<i>Brachionus quadridentatus</i> Hermann, 1783	-	+	+	-	+
<i>Brachionus rubens</i> Ehrenberg, 1838	+	+	-	-	-
<i>Cephalodella</i> sp.	+	+	+	-	-
<i>Epiphanes brachionus spinosa</i> (Rousselet, 1901)	+	+	-	-	-
<i>Filinia longiseta</i> (Ehrenberg, 1834)	+	+	+	+	-
<i>Filinia terminalis</i> (Plate, 1886)	+	+	+	+	-
<i>Lacinularia elliptica</i> Shephard, 1897	-	-	-	-	+
<i>Platyonus patulus</i> Müller, 1786	+	+	+	+	-
<i>Platyias quadricornis</i> (Ehrenberg, 1832)	+	-	-	+	-
<i>Polyarthra vulgaris</i> Carlin, 1943	+	+	+	+	-
<i>Testudinella</i> sp.	+	+	-	-	+
Cladocera	-	-	-	-	-
<i>Ceriodaphnia cornuta</i> Sars, 1885	-	-	-	-	+
<i>Ilyocryptus spinifer</i> (Herrick, 1882)	-	-	-	+	+
<i>Karualona</i> sp.	-	-	-	+	-
<i>Kurzia longirostris</i> (Daday, 1898)	+	+	+	+	-
<i>Latonopsis australis</i> Sars, 1888	-	-	-	+	-
<i>Leydigia</i> sp.	+	-	-	+	+
<i>Macrothrix spinosa</i> King, 1953	-	-	-	+	-
<i>Moina macrocopa</i> (Straus 1820)	+	+	+	-	-
<i>Moina</i> sp	+	+	+	-	-
<i>Simocephalus vetulus</i> (Mueller 1776)	-	-	-	+	+

Table 2. Abiotic parameters of water Mula River. (Sampling has not been done in July 2009 due to heavy monsoon rains)

Abiotic parameters	21. Jan.'09	21. Mar.'09	21. May.'09	21. Sep.' 09	21. Nov. ' 09
pH	8.2	7.8	7.6	7.5	7.3
Temp (°C)	23.8	28.1	32.0	30.2	24.7
Conductivity ($\mu\text{S cm}^{-1}$)	633	615	470	719	791
TDS (mg L^{-1})	442	437	332	509	561
Salinity (mg L^{-1})	302	299	227	351	386
DO (mg L^{-1})	7.3	1.2	4.9	3.6	4.1

DISCUSSION

Few rotifers are known to live in association with other aquatic organisms such as *Daphnia*, *Asellus*, *Gammarus*, crayfish and crabs (May, 1989). However, much less information is available in India regarding such associations. Similar observations have been reported from West Bengal by Sharma (1979) and Iyer & Rao (1993, 1995).

Rotifers and cladocerans are known to co-exist in freshwater habitats and share similar feeding habits. *Brachionus rubens* is a frequently encountered epizoic species found attached to a variety of aquatic organisms like cladocerans, insects and copepods (Iyer & Rao, 1995). An epizoic rotifer lives on another animal for all or part of its life, but does not feed on its host. The rotifer is said to attach to the host carapace by means of sticky secretions from the foot glands (Shiel & Koste, 1985). Such associations can be detrimental to the host as it may lead to predation and loss of movement (Iyer & Rao, 1995).

Shiel & Koste (1985) reported such associations from farm dams in Australia. Iyer & Rao (1993) found such rotifer-cladoceran associations in ponds and tubs and stated infestation of *B. rubens* on Cladocera from organically polluted stagnant waters. We report *B. rubens* epizoic on *M. macrocopa* from an organically polluted river Mula for the first time from Maharashtra, India.

Iyer and Rao (1995) predicted the possible role of predatory rotifer *Asplanchna intermedia* (Hudson, 1886) in the formation of such rotifer-cladoceran associations. The presence of two predatory rotifers *Asplanchna brightwellii* and *Asplanchnopus multiceps* could be the possible reason for the association found in this habitat.

The results clearly indicate the species richness of the water body under study, despite lesser density of hydrophytes. All the recorded species were cosmopolitan.

Extensive studies in the future will reveal the actual diversity of zooplankton from freshwater bodies. The rotifer-cladoceran association studies will also add new insights into such interesting

behaviour. The periodic association of these organisms also needs to be addressed.

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