

Earthworm (Clitellata: Megadrili) taxonomy in the last 200 years: A homage to András Zicsi (1928–2015)

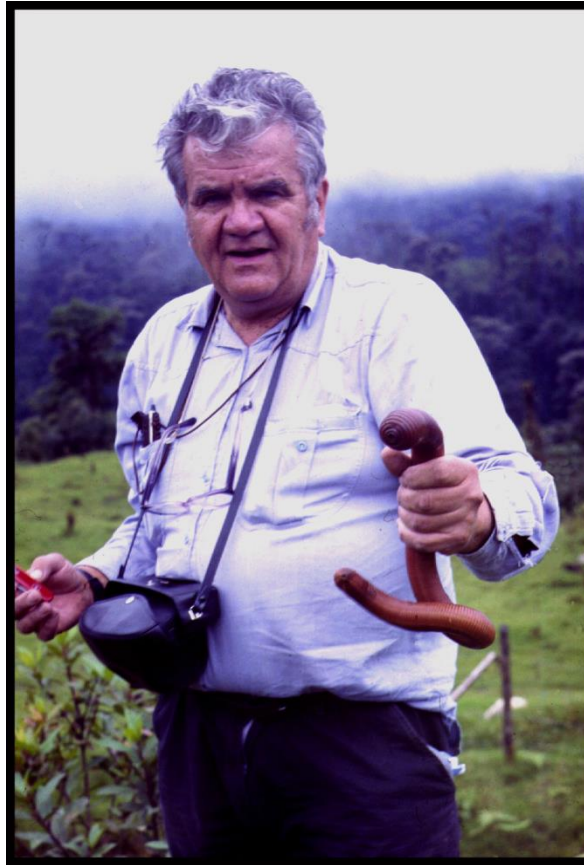
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Abstract. Prof. Dr. András Zicsi, the renowned soil biologist and earthworm taxonomist passed away on 22 July, 2015 at the age of 87. To honour his enormous contribution in exploring earthworm biodiversity all over the world, we provide a brief, albeit subjective overview of the history of earthworm taxonomy in the last two century.



To date, approximately 6200 earthworm species have been described (Csuzdi 2012), the first being *Lumbricus terrestris* by Carolus Linnaeus in 1758. Rate of species description in the subsequent decades was slow; only around 30 species were added, most of them by Savigny (1826). Not surprisingly, all of these belong to the Holarctic family, Lumbricidae. The first non-European species, *Glossoscolex giganteus* Leuckart, was described in 1835 from Brazil, South America, but up to the 1850s earthworm research still focused on the European fauna.

While in the first century of earthworm taxonomy (1758–1865) only *ca.* 70 new species descriptions were published, the situation markedly improved by the 1860s when a new generation of zoologists began exploring this important soil animal group. Research by Johan Gustaf Hjalmar Kinberg (1820–1908), Edmond Perrier (1844–1921), Gustav Eisen (1847–1940), Rutgerus Horst (1849–1930), László Örley (1856–1887), Daniel Rosa (1857–1944) and Frank Evers Beddard (1858–1925) dramatically improved our knowledge of both earthworm diversity and their geographical distribution (Fig. 1). Other distinguished zoologists, Johann Wilhelm Michaelsen (1860–1937), Sir Walter Baldwin Spencer (1860–1929), Sir William Blaxland Benham (1860–1950) and Luigi Cognetti De Martiis (1878–1931) joined this group, making fundamental contributions to earthworm taxonomy.

Between 1886–1905 approximately 1300 earthworm species, about 25% of total known species richness (Csuzdi 2012), were described from all over the world (Fig. 1). Additionally, this era produced the first modern earthworm monographs (e.g. Örley 1885, Benham 1886, Beddard 1895, Rosa 1893, 1895). Among these, Michaelsen's famous synthesis (1900) represents a milestone in modern earthworm taxonomy and systematics. Michaelsen's other main contribution was the first global biogeographical synthesis of the earthworm fauna, including the first comprehensive summary of invasive peregrine species (Michaelsen 1903). We can right-

fully call the turn of the nineteenth century “the golden age” of earthworm taxonomy.

This fruitful period of megadrilology ended abruptly with the outbreak of World War I. Between 1915–1918 only 147 species were described, mainly by Michaelsen and John Stephenson (1871–1933). Recovery from the wartime era was quite slow; still, two prominent books were published in this period: *The Fauna of British India* (Stephenson 1923) and *The Oligochaeta* (Stephenson 1930). During this time a new generation of scientists, Gordon Enoch Gates (1897–1987), Lev Černosvitov (1902–1945) and Grace Evelyn Pickford (1902–1986) joined Michaelsen and Stephenson. By the mid-1930s productivity almost reached the peak of the turn of the century (Fig. 1). This upward trend was again interrupted by the deaths of Stephenson (1933) and Michaelsen (1937), and World War II. Between 1940–45 only 120 earthworm species were described, mainly by Gates (e.g. 1940, 1945) and Černosvitov (1940, 1942). Additionally, Victor Pop (1903–1976) published his high-impact synthesis, which profoundly influenced the 20th century Lumbricidae systematics (Pop 1941). The war and deaths of iconic persons like Černosvitov, Stephenson, and Michaelsen took a major toll on megadrilology.

With only 159 new earthworm species descriptions, the decade of 1946–1955 represented a low point in earthworm taxonomy. After World War II, Pop continued working on the Romanian earthworm fauna (Pop 1949), and his son, Victor V. Pop (1936–) followed his footsteps decades later. Fortunately, a new generation of earthworm taxonomists, including Kenneth Ernest Lee (1927–2007), Pietro Omodeo (1919–) and Barrie Gillean Molyneux Jamieson (1934–) revived the field, bringing it out of its dormant state. The recovery continued in the mid-1960s when, along with Danuta Jadwiga Plisko (1927–), Reginald William Sims (1926–2012), Marcel Bouché and Gilberto Righi (1937–1999), András Zicsi started working on earthworms.

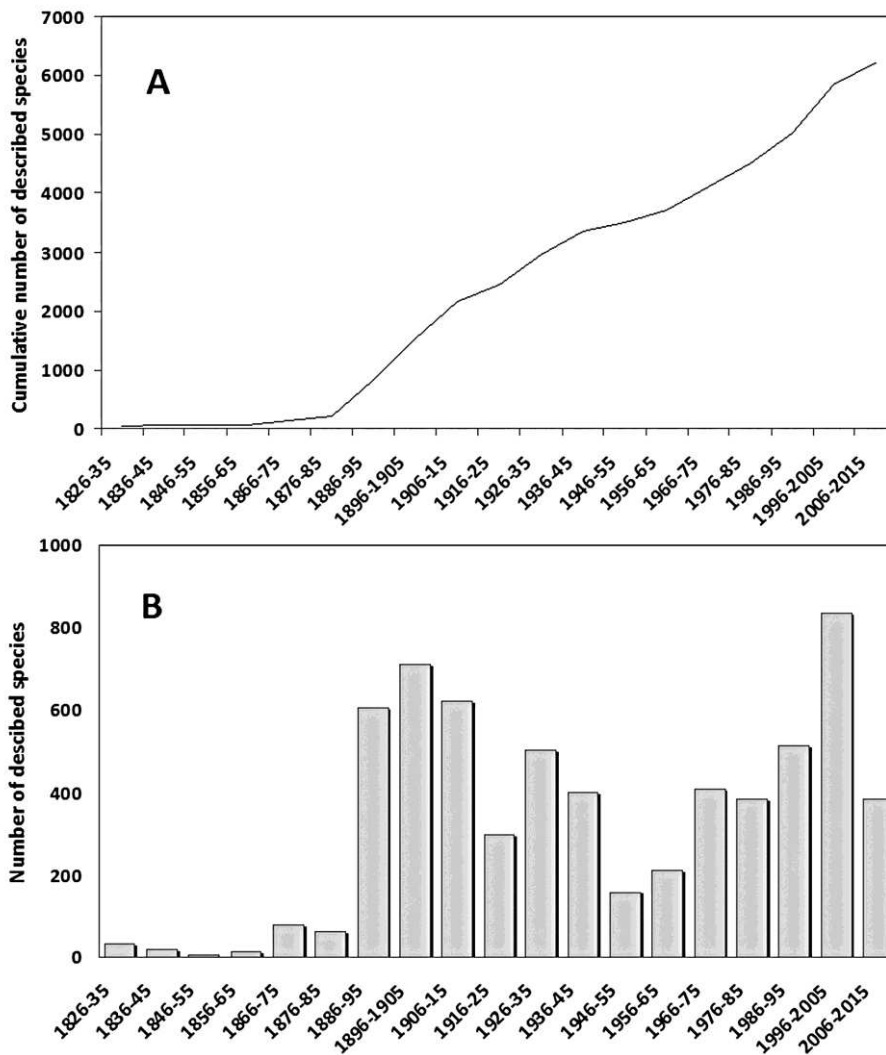


Figure 1. Rate of description of new species. A: Cumulative number of new species between 1826 and present. Intervals are decades. B: Number of earthworm species described after Savigny (1826). Intervals are decades.

In his early career Dr. Zicsi's research focused on agroecosystems, specifically on the role of the earthworms in organic matter decomposition. (Zicsi 1955, 1958ab). However, early on he realized that correct species identification is essential to properly interpret ecological data. He continued conducting field observations and experiments in earthworm ecology; at the same time, he wanted gain deeper taxonomical insight into this keystone soil invertebrate group. His collaboration with Victor Pop, whom he visited several times in Cluj (Romania), was crucial in

his professional development, as an earthworm taxonomist.

Between 1960s and mid-1980s Dr. Zicsi's taxonomic work focused on the Holarctic family Lumbricidae. In this group, he described over 60 species new to science; most of them remained valid up today (Csuzdi 2012). In a thorough revision of the Lumbricidae species, described up to 1971, he reported that out of the 561 Lumbricidae species names almost half, 271 fell into synonymy. Moreover, authors who pub-

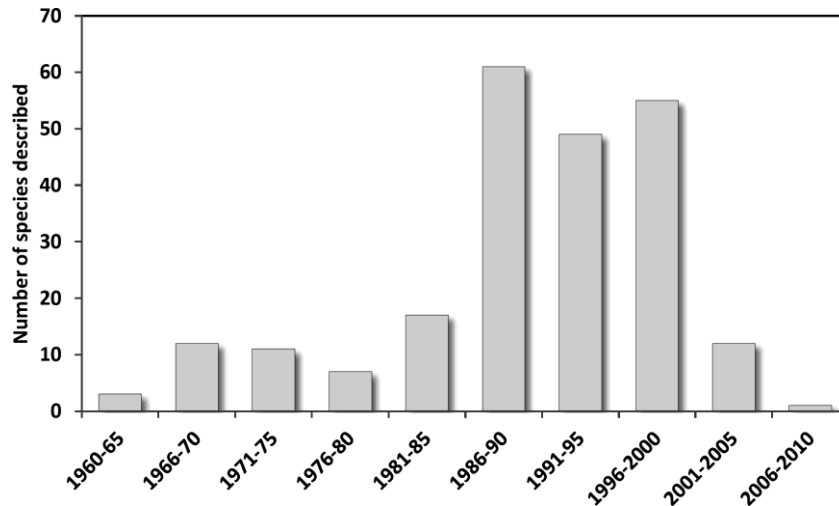


Figure 2. Number of earthworm species described by A. Zicsi between 1960–2010.

lished only one or two papers in the field of earthworm taxonomy, almost always produced synonymic names (Zicsi 1974, 1982).

In the mid-1960s Dr. Zicsi had the opportunity to join to several collecting expeditions led by the late János Balogh, an expert in oribatid mites. These expeditions, supported by UNESCO, resulted in a huge earthworm material (3000 specimens representing 120 species) from Africa (Balogh *et al.* 1965) and South America (Andrássy *et al.* 1967, Balogh *et al.* 1969). However, this invaluable collection remained unprocessed until the middle 1980's when the present first author (Csaba Csuzdi) joined Prof. Zicsi's laboratory (Fig. 2). First, the African material was processed, which resulted in description of 20 species new to science belonging to the families Benhamiidae and Eudriliidae (Zicsi & Csuzdi 1986a,b, Csuzdi & Zicsi 1989).

Also in the late 1980s, a new opportunity emerged to continue the global exploration of earthworm diversity and distribution. In collaboration with the Pontificia Universidad Católica del Ecuador, Quito, and with financial support from the Hungarian Academy of Sciences, six collecting trips to Ecuador and Colombia were organized, resulting in an ex-

tremely rich earthworm and other soil invertebrate material (Zicsi & Csuzdi 2008). Prior to these expeditions only 39 earthworm species, described mainly by Cognetti (1904, 1905, 1906), were known from Ecuador. Dr. Zicsi examined over 10,000 specimens, described 68 species new to science, and added 32 new records, bringing up the number of earthworms recorded from Ecuador to 139 (Zicsi 2007). Dr. Zicsi published this and previously collected material from South America, in 43 papers, under a series title "Regenwürmer aus Südamerika" (see full list of publications). This extensive research made Ecuador the best explored country in South America regarding its earthworm fauna (Fig. 3). To this day, no new species has been added to the list.

Between 1986–1993, Dr. Zicsi travelled to Tanzania (1987, 1989) and carried out field collections with his friend the renown bryologist Tamás Pócs, then a professor at the University of Dar es Salaam. In South Africa (1990, 1991) he collected together with Danuta Plisko (Natal Museum, Pietermaritzburg).

In the late 1990s Dr. Zicsi's beloved wife was diagnosed with Alzheimer's disease. While caring for her, Dr. Zicsi's scientific activity gradually diminished, and in his final years he withdrew from public life.

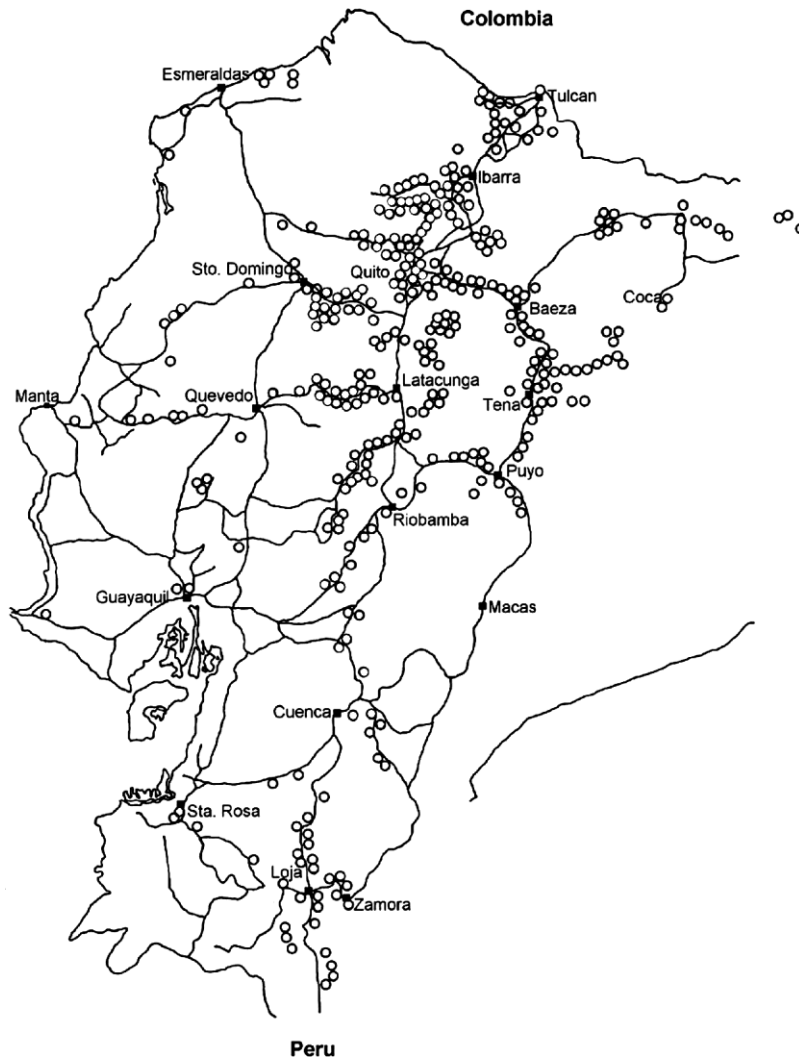


Figure 3. Sampling localities in Ecuador between 1986–1993. Localities less than 10 km apart are represented in the same circle.

Dr. Zicsi had a tremendous impact on the earthworm taxonomy of the 20th century. Here we highlight two examples of his lasting legacy: the number of his taxonomy publications (137), and the establishment of one of the largest earthworm collections in the world. The “Zicsi” collection, currently deposited in the Hungarian Natural History Museum, Budapest, consists of over 100,000 specimens representing more than 800 earthworm species. A total of 228 of these have been described by Dr. Zicsi and his co-authors (Csuzdi 2012). In an era of diminishing interest and funding for “traditional” zoology research, including utilizing museum collec-

tions, he recognized the need to train and mentor a young scientist who will continue curating this invaluable collection. Today this is the task of the present first author.

Professor Zicsi’s death is a great loss for the international earthworm taxonomist community, but efforts to explore and understand earthworm biodiversity continue. At the end of 20th century megadrilology is again an active field, mainly through the works of Robert J. Blakemore, Samuel W. James, Huei-Ping Shen, Jiang-Ping Qiu, Dario Diaz Cosin (and his students), and others (Fig. 1). New methodologies (e.g. bar-

coding, molecular-taxonomy) are integrated with traditional approaches (Aspe *et al.* 2016, Blakemore *et al.* 2010, Csuzdi *et al.* 2016), providing new insights the taxonomy and systematics of earthworms. Still, many regions on the Earth remain to be explored. These areas, especially the tropics, might harbour hundreds of undescribed taxa, some in the danger of extinction even before being described. Our hope is that again a young generation of earthworm taxonomists will emerge, who will continue the work of their predecessors, such as Dr. András Zicsi. The efforts of these scientists have to be recognised, valued, and properly funded. They will continue exploring global diversity while also resolving taxonomical issues of this ecologically keystone group.

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Appendix 1. Complete list of publications of András Zicsi
http://opuscula.elte.hu/PDF/Tomus47_1/Zicsi_complete.pdf

Darwin's earthworms (Annelida, Oligochaeta, Megadrilacea) with review of cosmopolitan *Metaphire peguana*–species group from Philippines

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Abstract. A chance visit to Darwin allowed inspection of and addition to Northern Territory (NT) Museum's earthworm collection. Native *Diploretoma zicsii* sp. nov. from Alligator River, Kakadu NP is described. Town samples were dominated by cosmopolitan exotic *Metaphire bahli* (Gates, 1945) herein keyed and compared morpho-molecularly with *M. peguana* (Rosa, 1890) requiring revision of allied species including Filipino *Pheretima philippina* (Rosa, 1891), *P. p. lipa* and *P. p. victorias* sub-spp. nov. A new *P. philippina*-group now replaces the *dubia*-group of Sims & Easton, 1972 and *Amyntas carinensis* (Rosa, 1890) further replaces their *sieboldi*-group. Lumbricid *Eisenia fetida* (Savigny, 1826) and Glossoscolecid *Pontoscolex corethrurus* (Müller, 1857) are confirmed introductions to the NT. mtDNA barcodes newly include *Metaphire houletti* (Perrier, 1872) and *Polypheretima elongata* (Perrier, 1872) spp.-complexes from the Philippines. *Pithemera philippinensis* James & Hong, 2004 and *Pi. glandis* Hong & James, 2011 are new synonyms of *Pi. bicincta* (Perrier, 1875) that is common in Luzon. Vietnamese homonym *Pheretima thaili* Nguyen, 2011 (non *P. thaili* Hong & James, 2011) is replaced with *Pheretima baii* nom. nov. Two new Filipino taxa are also described: *Pleionogaster adya* sp. nov. from southern Luzon and *Pl. miagao* sp. nov. from western Visayas.

Keywords. Soil fauna, invertebrate biodiversity, new endemic taxa, mtDNA barcodes, Australia, EU.

INTRODUCTION

Biodiversity assessment is important to gauge natural resources and determine regional changes. Earthworms are a crucial component of terrestrial fauna, vital for soil health and primary productivity (Darwin 1881), but their biodiversity in Australia's Northern Territory is poorly known and no comprehensive inventory yet exists. Rapid preliminary assessment is possible from inspection of museum collections and survey of botanic gardens. Both being concentrated repositories for endemic natives and introduced exotics which require considerable taxonomic expertise in order to identify correctly. The current study attempted a pilot earthworm eco-taxonomic biodiversity assessment during the author's brief visit to Darwin, the Territory's capital city, in March, 2015.

Although tropical Northern Territory occupies a vast area (1,420,970 km²) and an early descrip-

tion was of native *Diploretoma eremia* (Spencer, 1896) from Alice Springs, only a dozen natives and just 8 exotics reviewed 33 years ago by Easton (1982) then Blakemore (1994, 1999, 2002, 2012a), give a present total of ca. 20 earthworm species – about the same number as found on a single farm in the south (see Dyne 1987, Dyne & Jamieson 2004, Blakemore 1994, 2008c).

The current report stems from a chance stop-over in Darwin allowing inspection of NT Museum's entire earthworm collection as well as a day (13th March, 2015) assessing the biodiversity of the Botanic Gardens. An earlier brief search (12th March, 2015) of likely shoreline hotspots on Mindil Beach, Fannie Bay failed to find *Pontodrilus litoralis* (Grube, 1855) that is known from the adjacent Harbour (Hanley 1997). Enquiries suggest quarantine excludes vermicomposting *Eudrilus eugeniae* (Kinberg, 1867) (see Blakemore 2015), whereas cosmopolitan exotic *Metaphire bahli* (Gates, 1945) was confirmed as common and

perhaps dominant elsewhere in and around Darwin township.

Resolving simple placement of *Metaphire bahli* has required extensive revision as its separation from prior *M. peguana* (Rosa, 1890) had been contentious until molecular methods apparently allowed differentiation (e.g. Nguyen *et al.* 2012: tab. 1 and Nguyen 2013: 123, fig. 3.39 showing 10.7% genetic separation in Vietnam; cf. its misidentification by Loongyai *et al.* 2011 in Thailand). Relationship to *Pheretima bangoiana* Michaelsen, 1934 and *P. saigonensis* Omodeo, 1956 remained unresolved as both were listed as synonyms (priority!) of *P. bahli* by Thai (2000) and Nguyen (2013: 46). Superficially similar Filipino taxon *Pheretima philippina* (Rosa, 1891) is reviewed.

The Darwin material directly links to the author's recent Philippine studies since several exotics were found in common and some natives are seemingly also new species. However, comparison of exotics and/or natives from the Philippines is inordinately difficult it being the only country in Asia without a complete checklist of earthworm species and to further lack specific DNA data (see Blakemore 2008a: map). Plus morphological synonymy is rife and earthworm species misidentifications by non-specialists are common in Philippines as elsewhere, which may also partly account for anomalous "interspecific comparisons" of their DNA concluded by Kvist (2014). For example, Blakemore (2010) found *Pheretima* (*Pheretima*) *urceolata* (Horst, 1893: 322) to include: *Pheretima baweanensis* Michaelsen, 1924; ?*P. ditheca* Michaelsen, 1928; James', 2004 *P. baletai*, *P. bukidnonensis*, *P. heaneyi* & *P. kitangladensis*; *P. simsi* James & Hong, 2004; Hong & James', 2008 *P. abiadai* and *P. nagaensis*; plus *P. batoensis*, *P. bicolensis*, *P. buhienensis*, *P. camarinensis*, *P. doriae*, *P. gorasi* and *P. viracensis* all by Hong & James, 2009.

DNA extraction was attempted for all new material in this report. For earthworms, initial molecular treatment was by Siddall *et al.* (2001) with first explicit typification by Blakemore *et al.* (2010) using the mtDNA COI barcode standard with 3% threshold (Hebert *et al.* 2003).

MATERIALS AND METHODS

Taxonomic identifications follow keys and classifications in Sims & Easton (1972) updated by Blakemore (2000, 2008a, 2012a). New specimens in 80% EtOH are lodged in the NT Museum and provided small tissue samples for mtDNA COI barcoding with preliminary analysis via NCBI-BLAST (Altshul *et al.* 1990) compared using MEGA6 (Tamura *et al.* 2013). The evolutionary history was inferred by using the Maximum Likelihood method based on the Tamura-Nei model (Tamura & Nei 1993). The tree with the highest log likelihood is shown. Initial tree(s) for the heuristic search were obtained automatically by applying Neighbor-Join and BioNJ algorithms to a matrix of pairwise distances estimated using the Maximum Composite Likelihood (MCL) approach, and then selecting the topology with superior log likelihood value. The tree is drawn to scale, with branch lengths measured in the number of substitutions per site (next to the branches). The analysis involved 33 nucleotide sequences. Codon positions included were 1st+2nd+3rd+Noncoding. All positions containing gaps and missing data were eliminated. There were a total of 527 positions in the final dataset.

Philippine material originally in 70% EtOH now in 100% Glycol intended for deposition in the National Museum, Manila is held under Fisheries Department license at UPV, Miagao Museum, care of School of Technology Dean, Dr. Emeliza C. Lozada. All PI collecting was overseen by UPV staff using my APN funds. Discussion and Conclusions are confined to Remarks after species' descriptions. Genbank accessions for Fig. 1 are in Table 1.

Abbreviations used: ANIC – CSIRO's Australian National 'Insect' Collection; APN – Asia Pacific Network; C – circumference of body; EU – European Union; Fp, Mp, Np, Sp – female, male, nephro-, & spermathecal pores; GMs – genital markings; lhs, rhs – left, right hand sides; NT – Northern Territory; PI – Philippine Islands; UPV – Uni. Philippines, Visayas; PNG – Papua New Guinea; syn. – synonym; US – U.S.A.

Table 1. Genbank Accession Numbers for Figure 1.
(batch BankIt1852350)

Code	Acc. No.	Code	Acc. No.
P0	KT626574	P15	KT626587
K1a	KT626575	Pe1	KT626588
K1b	KT626576	Pe2	KT626589
K2	KT626577	Pe3	KT626590
P1	KT626578	Pe4	KT626591
P4	KT626579	Pe7	KT626592
P5	KT626580	Pe8	KT626593
P7	KT626581	Pe9	KT626594
P9	KT626582	M1	KT626595
P10	KT626583	D3	KT626596
P11	KT626584	D4	KT626597
P12	KT626585	D5	KT626598
P14	KT626586		

TAXONOMIC RESULTS

Family classification of megadrile Oligochaeta Grube, 1850 s. lato (= Clitellata but see Timm 2012) as used herein follows Blakemore (2000, 2013a) rather than Gates (1972).

Entire earthworm samples in NT Museum collection identified by the author

- D992: "EAST PT (Block) A/11 5/5/75 Coll. R. Pengelley." Two medium-sized *Metaphire bahli* (Gates, 1945).
 D994: "EP RF B1 11/5/75"; "E. Pt Darwin E.P." An *M. bahli* mature.
 D995-D1020 (excluding D1003, 1009 and 1012), D1025-D1028 and D1041 were all *Metaphire bahli* from East Point, Darwin with collection details similar to D992.
 D1021: "Moulden Palmerston NT Coll. M. Neal 25 March, 1999"; "ex soil in Moulden Staghorn Crt garden." Ca. 15 specimens, all poorly preserved, identified as *M. bahli*; *Diploptrema* sp1 and *Diploptrema* sp2.
 D1022: Same details as D1021, *M. bahli* and *Diploptrema* sp. (too poor to describe).
 D1023: "Virginia nr Darwin Coll. S. Gregg Nov 20, 1995". An immature megadrile.
 D1038: "EAST POINT, DARWIN N.T. 12°25'S 130°49'E Coll. R. Pengelley 17 Jan 1976"; "CSIRO PT BLOCK A 17/1/76 EW." Three *Diploptrema* sp. (poor preservation).
 D1039: "N.T. Darwin 20.xii.1992 M.B. Malipartu."; "Berlesate ex log." 18 specimens ?*Amyntas* sp. (poor preservation).
 D1419: Described below as *Diploptrema zicsii* sp. n.; DNA samples D-1-2.
 D1427: "W247"; "Commercial worm farm 33 Dalwood Rd, Karama NT 12°23.304'S 130°54.307'E Coll: R.W. Swan 17/03/2010". Two lumbricid *Eisenia fetida*.

D1530: Two *M. bahli* from Darwin Botanic Gardens, larger one providing DNA (D-3); coll. RJB 13th March, 2015.

D1528: One *Pontoscolex corethrurus* from Darwin Botanic Gardens DNA (D-4); coll. RJB 13th March, 2015 (other specimens not kept).

D1529: One *M. bahli* from the NT Museum grounds near the laboratory DNA (D-5); coll. RJB 13th March, 2015.

In addition, an exotic "*Dichogaster* sp." (Oligochaetidae, Benhamiinae) was identified in a sample (Blakemore 1995: ANIC RB.95.27.2) provided in January, 1994 by Randal Hinz from a 20-year-old rehabilitated mine site in lateritic soils at Gove Peninsula, Northern Territory, characterized in Blakemore (2002, 2012a) thus: *One pair of spermathecal pores in ab lines in 8/9. Two oesophageal gizzards in 7 & 8, three pairs of calciferous gland in 15-17, prostates paired in 17 only with long penial setae. Spermathecal duct tapering from spheroid ampulla with small diverticulum mid-length, nephridia in approximately 10 rows per side.*

Other specimens from this Gove site were cosmopolitan *Dichogaster saliens* (Beddard, 1893) as a new exotic record for NT plus a new native *Diploptrema* sp. (ANIC: RB.95.27.1) that I had at the time hoped to shortly publish contingent upon funding.

Description of new and known Northern Territorian/PI taxa

ACANTHODRILIDAE Claus, 1880 *sensu* Blakemore 2000, 2013a

Diploptrema Spencer, 1900

Eodrillus Michaelsen, 1907

Diploptrema zicsii sp. nov.

(Figure 2)

Material examined. Labelled: "*Naididae (Oligochaeta)* S. Alligator River Kakadu NP NT 13°31.465'S 132°31.899'E. Coll. R.C. Willan & party 10/07/2004." In red pen on lid: "100% Ethanol". Two specimens, a mature – D1419, the Holotype – plus D1531 an immature Paratype ex D1419; providing tissue samples D-1 & D-2 that due to aging unfortunately failed to yield DNA (Prof. Chris Austin pers. comm.).

Description. Yellowy in alcohol. Size, 25 x 1.7 mm with 105 segments. Prostomium prolobous. First dorsal pore small in 8/9. Closely paired lumbricine setae; genital setae in 9 displaced anteriorly above ventral pads; penial setae in 17 & 19; setae *ab* not found on 18. Clitellum annular 13–16 or thereabouts. GMs paired tumid pads in 9 plus

elongate patch in 16/17 and two pairs of sucker-like discs in 17/18 & 18/19 between prostatic pores and seminal grooves from 17–19. Spermathecal pores near setal *a* lines in 7/8 & 8/9. Female pores paired above setae *a* on 14. Acanthodriline male pores not located (likely in position of missing *ab* setae?).

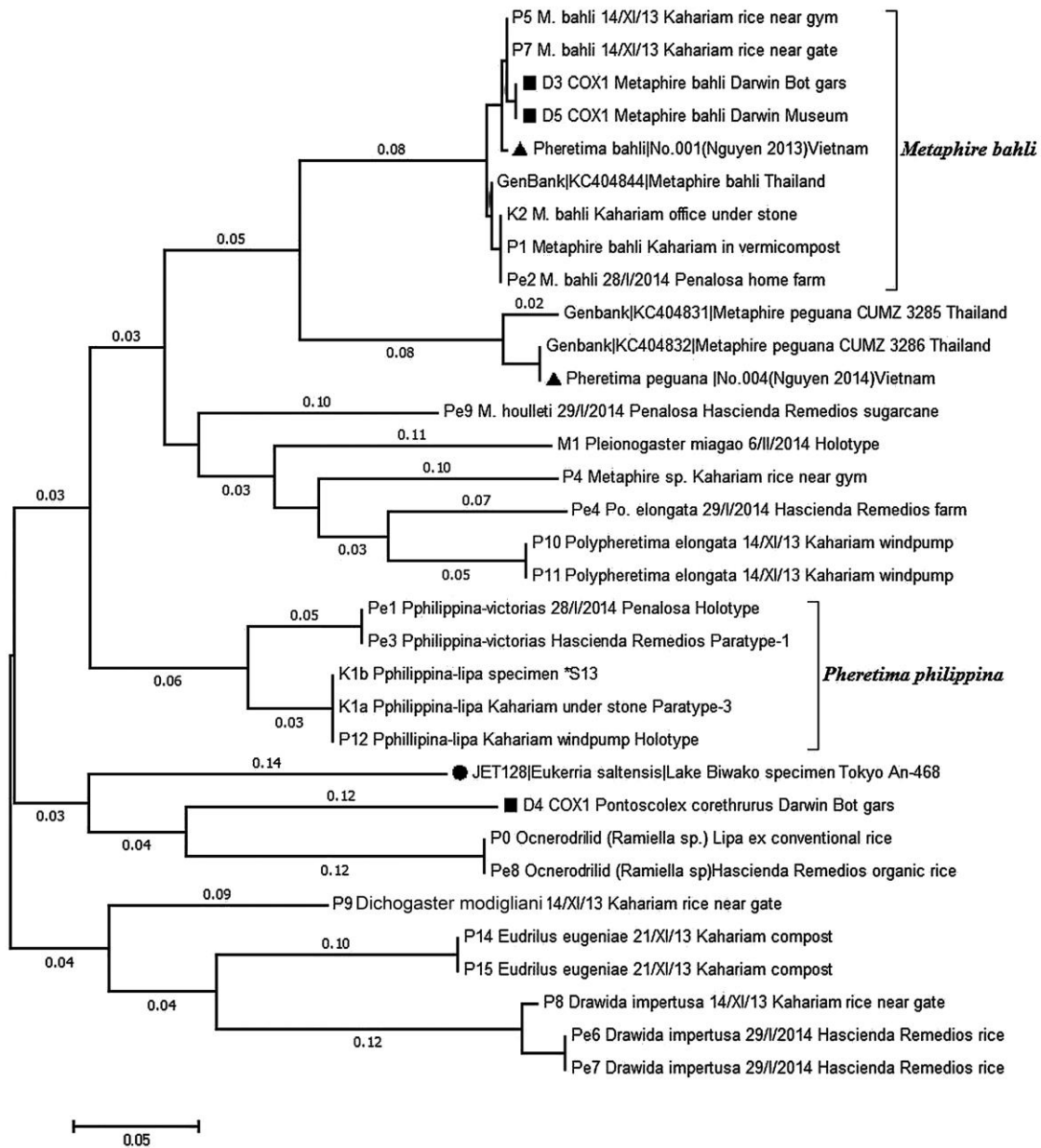


Figure 1. Phylotree from MEGA6 with specimen details in text and from Blakemore (2015) and Blakemore *et al.* (2014); black squares are for Darwin, triangles for Vietnam and a circle for the Japanese Lake Biwa outgroup taxon.

Septa 4/5/6 thin, 6/7 a bit thicker, others again thin. Pharyngeal mass in 4. Gizzard muscular in 5. Spermathecae in 8 & 9 as spherical ampulla on thin duct with multi-loculate, sessile diverticulum occupying duct mid-length. Genital setae overlain by spermathecae in 9. Dorsal blood vessel single; last hearts in 13. Holandric: testes free and iridescent in 10 & 11; seminal vesicles in 9–12 the latter largest. Ovaries with large egg cluster in 13; ovisacs or pseudovesicles in 14. Intestinal origin in 16; no calciferous glands. Prostates with penial setae in 17 & 19. No tumidity noted ventrally in region of spermathecae nor male pores. Nephridia vesiculate, holoic. Gut contains colloidal material.

Immature Paratype appears to have segments 1-2 fused; moreover it lacks the GM pads in 9 but has faint markings in 16/17 and pairs in 17/18 & 18/19. Penial setae are present in 17 & 19 and no *ab* were found on 18 in position of male pores.

Etymology. Named in tribute to Prof. Dr. András Zicsi the Hungarian oligochaete systematist of renown.

Remarks. Having seminal vesicles in 9–12, the current mature specimen most closely resembles Spencer's *D. eremia* which is itself similar to *D. shandi* Jamieson & Dyne, 1976 from Bing Bong Road, NT. *D. eremia* differs however in many points, such as having several ventral GMs in some of 19/20–29/30 and twin diverticula to its spermathecae. The spermatheca of *D. shandi* are more similar to *D. zicsii* and it has a GM pad in 16/17 too; however, it has extra markings in 19/20–21/22 and entirely lacks both the distinctive pads with genital setae in 9 and the paired GMs in 17/18 & 18/19. Its prostates extend through segments to 24 or 25 unlike in the current species where they are mostly confined to 17–19, although this character is probably of lesser import.

MEGASCOLECIDAE Rosa, 1891 s. stricto

Amyntas Kinberg, 1867, *Metaphire* Sims & Easton, 1972, *Pheretima* Kinberg, 1867 s. stricto and *Polypheretima* Michaelsen, 1934 (see Blakemore, 2008b)

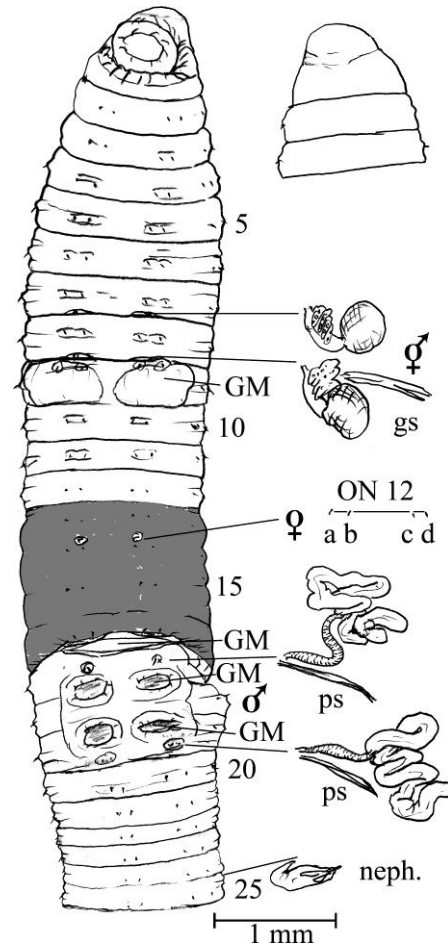


Figure 2. *Diploretrema zicsii* sp. nov. Holotype. gs = genital setae, ps= penial setae.

***Metaphire bahli* and allied spp reviewed chronologically after a key to the species**

Note. Taxonomic differentiation between *Pheretima* and *Metaphire* is mainly on the presence of nephridia on the spermathecal ducts in the former (also sometimes found in *Amyntas* that, however, has superficial male pores and is the prior “default” pheretimoid genus) (Sims and Easton 1972). The function of spermathecal nephridia has not been adequately explained; perhaps they communicate with the lumen as with the enteronephric, septal nephridia first noted by Bahl (1919) for some pheretimoids or, more likely, they are exonephric, integumentary nephridia incidentally collected by developing spermathecae as they impinge through the body wall.

**Key to pheretimoids with spermathecal pores
6/7/8/9 and GMs paired within 17-19**

1. Male pore superficial 2
Male pore non-superficial 6
2. GMs in 17/18 & 18/19 median to line of male pores 3
GM in 17/18 & 18/19 more widely paired and other GMs
may be present..... 4
3. Green with fetid smell, coils in soil, spermathecal diverticu-
cula longer than ampullae.....
.....*Amyntas hupeiensis* (Michaelsen, 1895)
Asian cosmopolitan, common in paddy – see Blakemore
(2012a) for full description.
Pale colour, very active in soil, spermathecae variable in
number with diverticula short or absent
.....*Amyntas micronarius* (Goto & Hatai, 1898)
from Japan & Korea (including Jeju) – see Blakemore
(2012b) for full description.
4. GMs in 17–19 also *A. minahassa* (Michaelsen, 1896)
from North Celebes.
GMs other than 17/18 & 18/19 lacking..... 5
5. Male pore on discoidal porophore
.....*Amyntas fucosus* (Gates, 1933)
from Myanmar.
Male pore simple....*Amyntas enkyokuan* (Ohfuchi, 1951)
from Sansei, China.
6. Intestinal caeca simple from 27 7
Intestinal caeca manicate in 27 or simple in 22 12
7. GMs paired within 18 or overtly near (one or more may be
missing) 8
GMs in 17/18 & 18/19 invaginate
.....*Metaphire bahli* (Gates, 1945).
8. Nephridia absent from spermathecal ducts..... 9
Nephridia on spermathecal ducts.....
.....*Pheretima philippina* (Rosa, 1891)
sub-spp from PI; GMs actually within copulatory pouch,
sometimes everted on preservation.*
9. Male & spermathecal pores ca. 0.3 or more circumference
apart 10
Male & spermathecal pores much closer
.....*M. saigonensis* (Omodeo, 1956).
10. GMs sucker-like in 17/18 & 18/19.....
.....*Metaphire peguana* (Rosa, 1890).
GMs not so 11
11. GMs small inside Sp pores and/or male pores.....
.....*Metaphire houlleti* (Perrier, 1872).
Small GM discs equatorial 17 & 19.....
.....*Metaphire posthuma* (Vaillant, 1868)
cosmopolitan, typically four pairs of spermathecae in 5/6/7
/8/9 but anterior pair may be aborted as in some of its *Peri-
chaeta affinis* Perrier, 1872 synonym, or further reduced.
12. Caeca manicate.....
.....*Metaphire pacseana* (Thai & Samphon, 1988)
ex Vietnam/Laos.
Intestinal caeca simple in 22..... *Pithemera eldoni* (Gates,
1975) from PNG.

*Several other Philippine pheretimoids have markings in 17/18 & 18/19 such as *Pheretima albobrunnea* and *P. incerta* – both poorly described by Beddard (1912) – and *Pleionogaster adya* sp. nov. (as described below) but these have spermathecae in 4/5/6/7/8/9, 5/6/7/8/9, and 7/8/9 respectively. Two other sexthecal/octothecal species: *P. decipiens* Beddard, 1912: 180 and *P. benguetensis* Beddard, 1912: 183 lack GMs, but data provided herein suggest these require review and possible restoration [cf. *P. vaillanti* (Beddard, 1890) currently in *P. darnleiensis* (Fletcher, 1886) that Gates (1937: 320) also recorded from “Batoran, Luzon” (= Bataan?) as “*Pheretima indica*”]. Sivickis (1930) studied what he identified as *P. benguetensis* from UP, Manila and from Pasig township; it is also claimed from Quezon City, Luzon. However, *P. decipiens* is the page prior species should they eventually be united, which at present I avoid doing.

It is here derived that *P. decipiens* which occasionally has spermathecae in 6/7/8/9, typically has four spermathecal pairs in 5/6/7/8/9 since Beddard (1912) compared it to members of the *P. darnleiensis*-group with four pairs in 5/6/7/8/9 and stated: *the number of spermathecae (although I found only 3 pairs in one individual) serves to differentiate P. decipiens [also four pairs in 5/6/7/8/9] from P. philippina [three pairs in 6/7/8/9] and P. pura [two pairs in 6/7/8].*

Sims & Easton (1972: 239) put *P. decipiens* in a *Metaphire planata*-group with spermathecae in 6/7/8, this in error I believe for two reasons: Firstly, they defaulted to *Metaphire* rather than to prior *Pheretima* if state of nephridia on spermathecae was unknown (as stated by Sims & Easton 1972: 231); secondly, spermathecae are interpreted as being in 5/6/7/8/9 in typical *decipiens* from Beddard’s rambling account as just noted above, thus it more properly belongs in their *Pheretima darnleiensis*-group.

Blakemore *et al.* (2007a: 29) newly put *decipiens* in synonymy of *P. darnleiensis* – supported at least in one of Beddard’s (1912: 182) specimens having “*a small accessory diverticulum*”

thought characteristic of *darnleiensis*. This move at that time was mainly because Sims & Easton (1972: 261) had included *P. benguetensis* Beddard, 1912 under *P. darnleiensis* and because Beddard (1912: 181, 183) had repeatedly said his *decipiens* and *benguetensis* are almost identical. Both *decipiens* and *benguetensis* have enlarged setae with reduced numbers in segments 2–9 [not just in 2–8 as claimed by Hong & James (2010: 530)] which supposedly separated them from *P. darnleiensis* and its ilk according to Beddard (1912: 181) although Sims & Easton's (1972: 262) redescription allowed this in *P. darnleiensis* too (cf. *P. poiana* Michaelsen, 1913 with spermathecae in 6/7/8/9 as with the sexthecal form of *P. decipiens*).

Pheretima decipiens was differentiated from *P. benguetensis* by Beddard (1912: 182) only by smaller size (i.e., somewhat shorter than 150–190 mm) and by its spermathecal diverticulum being not so long as the spermatheca itself (longer in *benguetensis*); perhaps also intestinal origin in 16 or 17 (but actually 16?), respectively. These characteristics also apply to sympatric *P. cabigati* Hong & James, 2008; Hong & James', 2010 *P. pugnatoris* and *P. tabukensis*; Hong & James' 2011a *P. margaritata*, *P. kalbaryoensis*, and *P. thaii*; and *P. barligensis* Hong & James, 2011b – all potential junior synonyms of *P. darnleiensis* and/or *P. decipiens* and needing yet more work.

Note. Taxonomic ‘housekeeping’ requires Vietnamese *Pheretima thaii* Nguyen, 2011 (published in March, 2011, Dr Nguyen Duc Thanh pers. comm., non prior *P. thaii* Hong & James, 2011 from Philippines published 28th Feb., 2011), a primary homonym named after Dr. Thai Tran Bai, be given a replacement name, here as *Pheretima bairi* **nom. nov.** with author Dr Nguyen Thanh Tung's permission (Dr Nguyen Duc Ahn pers. comm. 13th April, 2015). This species and its companion are then both transferred to *Metaphire* as *M. bairi* (Blakemore, 2016) and *M. mangophila* (Nguyen, 2011) **combs. novae**.

Pheretima decipiens Beddard, 1912: 180 is herein compared in part (its sexthecal form) to

new *P. philippina* sub-spp. described below. Simultaneously, *Pheretima incerta* Beddard, 1912: 197 is again transferred as a likely synonym of *Metaphire posthuma* in the description immediately following.

Metaphire posthuma (Vaillant, 1868)

(Figures 3A–D, 10)

Perichaeta posthuma Vaillant, 1868: 228, (non figs. 1–8); 1869: figs. 9–11. [Type locality Java. Types in Paris Museum, possibly AE656-668].

Perichaeta affinis Perrier, 1872: 106, fig. 66; 1875: 1044. [Type localities Saigon and Luzon, P.I. Type in Paris AE669].

Amyntas posthumus: Michaelsen 1899: 74.

?*Amyntas quadripapillatus* Michaelsen, 1899: 93, fig. 17 (of a spermatheca). [From Sumatra, Bindjey Estate. Types in Hamburg missing?]. **Syn. nov.?**

Pheretima posthuma: Michaelsen 1900: 295 (syn. *affinis*); Gates 1972: 212; Nguyen 2013: 56, figs. 2.5, 3.11 (syn. *incerta*, *rhabdoida* Chen, 1938).

?*Pheretima incerta* Beddard, 1912: 197. [From Manila, Luzon, P.I. Types?].

[*Pheretima rhabdoida* Chen, 1938. From Hainan. Types? This is unlikely synonym as the taxon, supposedly having superficial male pores, is now held in *Amyntas*].

Metaphire posthuma: Sims & Easton 1972: 239 (*posthuma*-group); Blakemore 2002, 2008b (syn. *affinis*, *incerta*), 2012a (syn. *affinis*).

Notes. Few reliable characters separate octothecal *P. incerta* from octothecal forms of *M. posthuma*, apart, perhaps, last hearts supposedly in segment 12. Sims & Easton (1972: 237, 243) misspell subspecies name *Amyntas kanrazanus incretus* (Kobayashi, 1937) as “*incertus*” and say “(non Beddard, 1912)” confusing it with *P. incerta*, thus no replacement name is required, as already noted by Blakemore (2013b: 28). *Metaphire quadripapillata* (Michaelsen, 1899: 93) is similar, if not newly synonymous, too.

Charles Darwin (1881: 106) (mistakenly?) attributed to it large tower-like casts found at Nice in southern France (Fig. 3D) and it was also recorded from Kew Gardens, London by Beddard (1906) – both were new European records. Full description and distribution is provided by Gates (1972) and Blakemore (2002, 2012a).

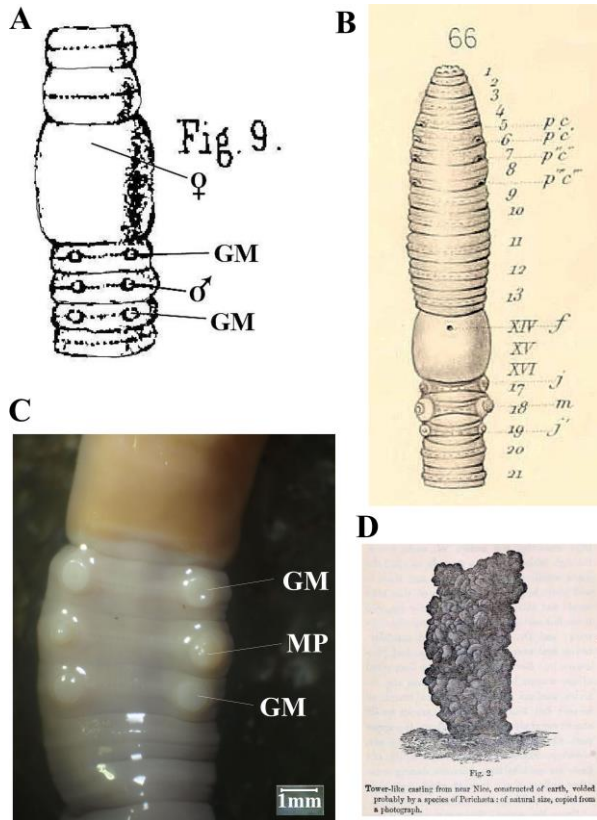


Figure 3. *Metaphire posthuma* (Vaillant, 1868): A = From Vaillant (1869: fig. 9); B = Synonym *Perichaeta affinis* Perrier, 1872: fig. 66; C = Male field photo (RJB Feb., 2014) of specimen newly record from Mindanao, PI; D = Casts from Darwin (1881: fig. 2).

***Metaphire houlleti* (Perrier, 1872)**

(Figures 1, 3D, 4, 10)

Metaphire houlleti is part of a species-complex s. Blakemore (2012a) (*Pheretima houlleti* s. Gates 1972) thought to comprise parthenogenetic morphs distinguishable by somatic and genital characters with number of spermathecae ranging from three pairs in 6/7/8/9 to fewer in various athecal morphs (Gates 1972). Synonyms number around fifteen names, most recently including Taiwanese *Amyntas huangi* James *et al.* 2005. A cosmopolitan complex (Fig. 10) here barcoded apparently for the first time (Figs. 1 & 4) with BLAST of JET-147 vs. Pe9 Identities = 511/632

(81%), i.e., different taxa, confirming a molecular species-group requiring review with possible restoration of some earlier synonyms; Blakemore (2011, 2012a) provides full details. It is currently spp-group representative of more than 42 named taxa, cf. *M. peguana* spp-group of originally just three (*bahli*, *peguana*, and *saigonensis*) from Sims & Easton (1972: 239).

Perichaeta houlleti (= *M. houlleti*) was also assumed by Darwin (1881: 106) partly responsible along with *Pe. affinis* (= *M. posthuma*) and *Perichaeta luzonica* Perrier, 1875 – a junior synonym of *Lampito mauritii* Kinberg, 1867 (and partly of *Polypheretima elongata*?) – for casts found at Nice, France (Fig. 3D). All three exotics were introduced to the EU in historical/imperial times but their current status is unknown.

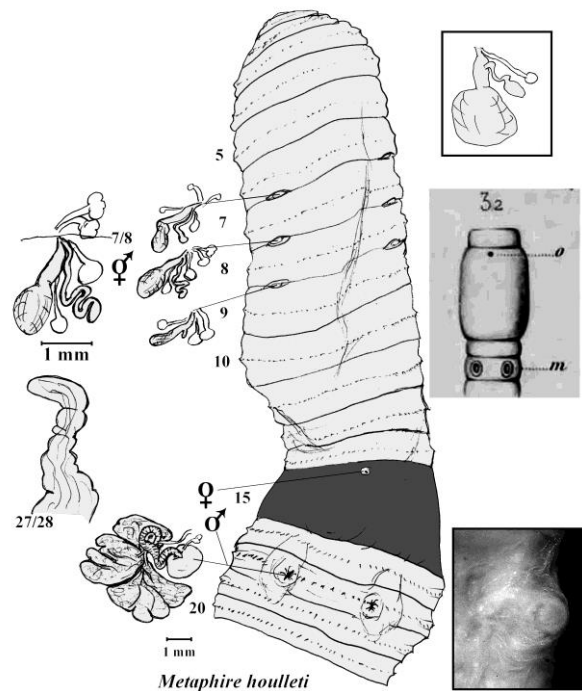


Figure 4. *Metaphire houlleti* species-complex: Thai specimen (Tokyo NMST An 425, DNA JET-147) compared to Perrier's original fig. 32; boxed are a spermatheca sketch and rhs male field photo of Filipino Hacienda Remedios organic canefield specimen (DNA Pe9). Note: DNA samples differed 19% suggesting different taxa.

***Metaphire peguana* (Rosa, 1890)**

(Figures 1, 5A–D, 10)

Perichaeta peguana Rosa, 1890: 113, figs. 6–8 (pg. 1057). [Type locality Rangoon. Types in Genoa, 44037 and, from Gates (1925: 327), in British Museum and US Museum Cat. No. 46]; Rosa 1898: 289 [augmented original account on Thailand material in London from “*Chan-taboon, Siam*” (inspected by Beddard 1900?)].

Amyntas (*Pheretima*) *peguanus*: Michaelsen 1899: 7 (noting similarity to *A. hupeiensis*).

Amyntas peguanus: Beddard 1900: 628.

Pheretima peguana: Michaelsen 1900: 292, 1922: 44 (in part?); Stephenson 1923: 308, 1932: 49, fig. 5 (of spermatheca); Gates 1925: 561, 1972: 207 [syn. *saigonensis*; (non Ohfuchi 1957: 171 from Okinawa that is actually an *Amyntas* sp.)].

Pheretima (*Pheretima*) *peguana*: Omodeo 1956: 325, figs. 1, 3, 5. [?Non Michaelsen 1922: 44 (cf. *M. saigonensis*)].

[*Pheretima saigonensis* Omodeo, 1956: 327. Locality Saigon. Types in Verona, 15].

Metaphire peguana: Sims and Easton 1972: 239 (*peguana*-group); Blakemore 2002, 2003: 33, 2006, 2008, 2009: 265, 2010, 2012a. [Non Somniam & Suwanwaree (2009: 222) misidentification based on Somniam (2008: figs. A, 10D, F) of another species].

Diagnosis. Bright red dorsum. 140–240 mm with 98–121 segments and 56 setae on 8 (ventral setae are larger and more widely separated). Spermathecal pores paired *ca.* 0.3 circumference apart in 6/7/8/9. Male pores within copulatory pouches on segment 18. Genital markings paired rings with central apertures across 17/18 & 18/19. Spermathecal diverticula much coiled. Intestinal caeca simple, smooth edged from 27.

Distribution. Myanmar; Thailand; Vietnam; Cambodia (Thai & Do 1989); Penang, Malay peninsula; Singapore; Java (Tandjong Priok, Djakarta *cf.* *M. saigonensis*); Borneo (“*Lombok Bay, Labuan*”, *i.e.*, Kalimantan and East Malaysia); St Paul’s Cathedral Calcutta (Kolkata) and Indian Botanic Gardens at Howrah, but now (after Gates 1972: 209) excluding Japan (Okinawa). Possibly confused with *P. bahli* in the past.

Remarks. Gates (1972: 209) said that one or more of the genital markings in 17/18 & 18/19 are occasionally absent and preservation may cause eversion of male organs from copulatory pouches (*cf.* *P. philippina*). He included *saigonensis* in synonymy because the differences by which it was distinguished “*are quantitative, trivial, and of*

characters liable to more or less individual variation.” However, the description by Omodeo (1956: figs. 1, 3, 5 – here as Fig. 5C vs. 5D) shows its male and spermathecal pores much closer than in *M. peguana* proper. Moreover, Omodeo (1956: 325) thought Michaelsen’s (1922: 44) “*P. peguana*” from Java possibly refers to *M. saigonensis* which – if correct – would expand its distribution to Indonesia. Until confirmation, I suggest confining a restored *M. saigonensis* to its type locality of Saigon (Ho Chi Minh City).

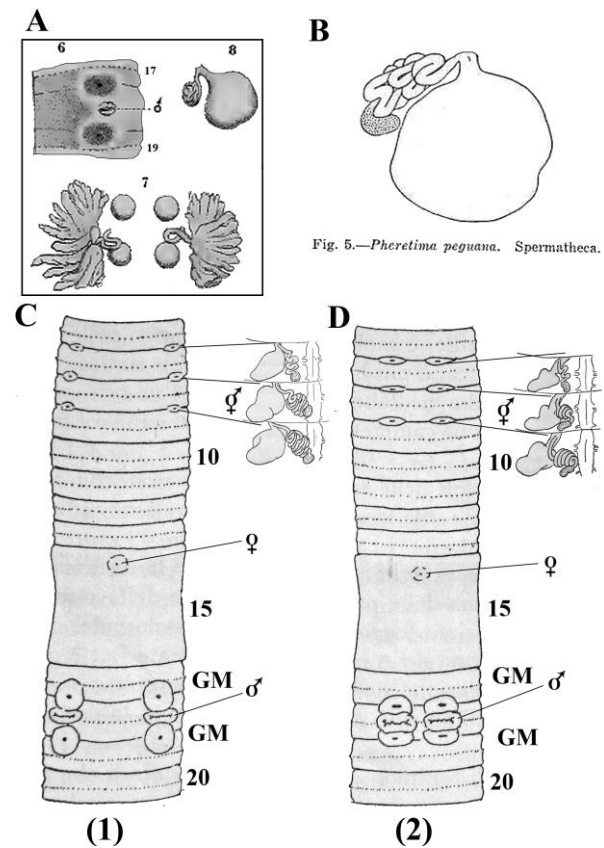


Figure 5. *Metaphire peguana* (Rosa, 1890). A = Rosa’s figs. 6–8; B = Stephenson’s (1932: fig. 5); C = *M. peguana* (1) *cf.* D = *M. saigonensis* (2) after Omodeo (1956: figs. 1–4).

***Pheretima* (*Pheretima*) *philippina philippina* (Rosa, 1891)**

(Figure 6)

Perichaeta philippina Rosa, 1891: 397, fig. 5 (of internal male organs only). [Type locality “*Insel Cebu*”. Types in Vienna].

?[*Amyntas bindjeyensis* Michaelsen, 1899: 94, fig. 18. Now retained in *Metaphire*].

Amyntas philippinus: Beddard 1900: 616 (syn. *bindjeyensis*).

Pheretima philippina: Michaelsen 1900: 294, 1913: 89 [comparing his new *P. poiana* with spermathecae in 6/7/8/9 to *Metaphire merabahensis* (Beddard & Fedarb, 1895) with spermathecae in 5/6/7/8, both from Sarawak; he was likely mistaken to say the latter was probably the same as *P. philippina*]; ?non Gates 1937: 327 (see *P. philippina victorias* ssp. nov. below).

Pheretima (Pheretima) philippina: Sims and Easton 1972: 239 (mistakenly in a *pura*-group with spermathecae in 6/7/8 rather than its proper *dubia*-group herein replaced with a *philippina*-group with spermathecae in 6/7/8/9).

Description. Dark slate-coloured, black/brown. Size 180–240 x 7 mm (cf. 200–300 mm current specimens). Segments 115–125. First dorsal pore 11/12. Perichaetine with 44 setae on 8; 70 setae on 12 (type). Clitellum annular 14–16. GMs absent. Spermathecal pores three pairs in 6/7/8/9 in setal lines five or six. Female pore central on 14. Male pores as wrinkled secondary pores in setal line seven or eight on 18.

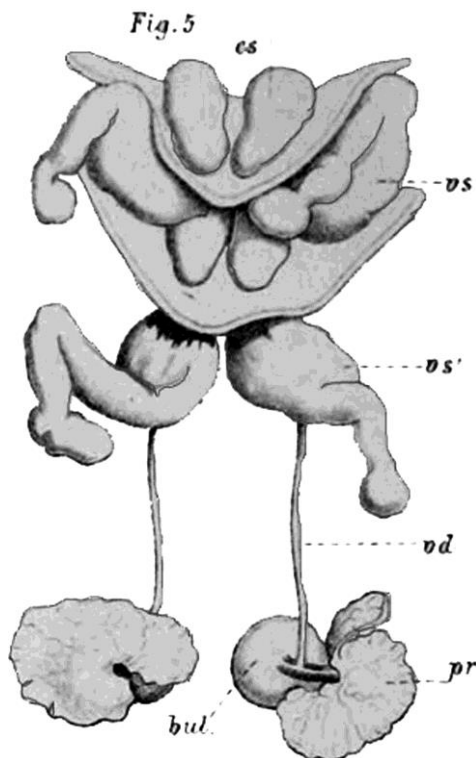


Figure 6. Male organs of sixthelical *Pheretima philippina* (Rosa, 1891: fig. 5) (surprisingly the only figure available for this classical, group representative species).

Septa 7/8 and 10/11/12/13 thick, 8/9/10 aborted. Crop in 7; gizzard in 8. Spermathecae in 7–9 as spherical or pear-shaped ampulla on thick duct (nephridia attached) having thin diverticulum with terminal bulb. Hearts in 10–13. Holandric: saccular testis in 10 & 11; seminal vesicles in 11 & 12 the latter pair with longer diverticula. Ovaries in 13; no ovisacs. Prostates smallish, kidney-shaped, racemose in 18 with short, unbent duct to muscular copulatory pouches. Nephridia meroic. Intestinal caeca extend for three segments from 26 (origin likely in 27).

Distribution. Cebu (type-locality); cf. Luzon and Negros Isls. (new sub-spp. below).

Remarks. Rosa said his species was similar to *P. vaillanti* (Beddard, 1890) from Manila that, however, has four pairs of spermathecae and is currently held under *P. darnleiensis*. Sumatran *P. bindjeyensis* was vouched for by Michaelsen (1913: 90) and put in *Metaphire* by Sims & Easton (1972) who listed all species regardless of synonymy.

***Pheretima philippina*-group takes priority from Sims & Easton's, 1972 *dubia*-group**

Pheretima philippina Rosa, 1891 rightly belongs in Sims & Easton's *dubia*-group that originally comprised four species with spermathecae in 6/7/8/9, viz.: *callosa* Gates, 1937: 313, *dubia* (Horst, 1893: 68) and *korinchiana* Cognetti, 1922: 2 both from Sumatra, plus *poiana* Michaelsen, 1913: 88 from Sarawak and Kalimantan. However, Cognetti (1922: 2, figs. 3A–B) described *P. korinchiana* with spermathecae in either 7/8/9 (*sluiteri*-group) or 6/7/8/9 (*philippina*-group); Cognetti's figures did not show nephridia on spermathecal ducts but placement in *Pheretima* is likely accepted following inspection of British Museum paratypes (1927:7.30.1–2) by Sims & Easton (1972: 180).

Gates (1937) described *P. callosa* on a specimen (330 mm long) from Benguet, northern Luzon, separating it from (his concept) of *P. philippina* on a few anatomical points (noted under description of *P. philippina lipa* ssp. nov. below).

Five “*dubia*-group” *Pheretima* from northern Luzon, PI were added by Hong & James (2010, 1011a, b), viz.: *P. balbalanensis* & *P. banaoi* from Kalinga Province; *P. globosa* from Ilocos Norte; and *P. lamaganensis* & *P. julkai* from Mountain Province – all of which are small and similar (synonyms?) that they nevertheless thought different to *P. philippina* (and *P. callosa*?). Having spermathecae impinging either before or after a septum is largely incidental and irrelevant taxonomically, e.g., these varied intra-specifically in *P. decipiens* Beddard (1912: 182) and *P. monticola* Beddard (1912: 197) and are often seen in other species (pers. obs.). Hong and James (2011b: 24) misinform that *P. philippina* type-locality is Mindoro.

Taxonomic note. *Pithemera glandis* Hong & James, 2011a is clearly a new synonym, along with *Pi. philippinensis* James & Hong, 2004, of prior *Pi. bicincta* (Perrier, 1875) from Luzon. Also their *Pheretima aguinaldoi* and/or *P. banaoi* and *Pithemera levii* are *incertae sedis* as Hong & James (2010: fig. 2 cf. figs. 3 & 4 and 2011b: fig. 7) have obviously miscounted segments.

DNA data (Fig. 1) is newly provided for *P. philippina* that, however, shows genetic differences of >8% indicating likely separate taxa. Since neither group is from the nominal type-locality (Cebu Island), and it is not certain that Gates was dealing with typical material from Negros Is. either, they are both here named at subsp. level pending fuller resolution. Descriptions of these two newly proposed *P. philippina*-group taxa follow.

***Pheretima philippina lipa* ssp. nov.**

(Figures 1, 7A–J)

?*Pheretima decipiens* Beddard, 1912: 180 part (specimen with “only 3 pairs” of spermathecae thus likely compliant with *philippina*-group). [From 1,524 m at Benguet, Luzon as for *benguensis* from Beddard (1912: 183). Types missing].

Material examined. Holotype, UPV specimen code #S24 mature, 300 mm long, sketched and dissected providing DNA tissue sample (P12)

from beside wind-pump and water tank next to caribou wallow at Kahariam organic farm Lipa City (13°56'28"N 121°09'44"E), Batangas, PI; coll. 14th Nov., 2013 by RJB & Rowena Ocenar; Paratype-1 #S25 slightly smaller specimen (200 mm long) from same batch that agrees superficially (no DNA); Paratype-2 #S26: same batch, mature 200 mm long with everted male pores, providing DNA (code P13 that, due to avoidable UPV delay in sending, yielded no result); Paratype-3 #S14 acitellate mature, 200 mm long, dissected and providing DNA sample (K1a) from under stone beside farm office coll. RJB 14th Aug. 2013; Paratype-4 #S19 mature 245 mm long from rice paddy near shooting range (DNA P6 nil result) coll. 14th Nov. 2013. Specimen UPV #S13 mature (310 mm), dissected providing DNA (“K1b”) from greenhouse at Kahariam in vermicompost, 22nd Nov. 2013 by UPV staffers.

Diagnosis. Large worm with dark dorsum but paler intersegments and setal auriolae. Complying with nominal species except size range slightly larger (viz. ca. 200–300 mm by 5.5 mm), first 9 segments are darker with larger setae (as per *P. decipiens*), pro-epilobous prostomium, dorsal pores from 12/13, setae ca. 40–50, ca. four or six setae between male pores. Copulatory pouch contains two genital pads either side of the penis, which may be everted on preservation, as seen in Paratype-2. Septa 8/9/10 aborted. Peptonephridia in 4–6. Spermathecae in 7–9 as spherical ampulla on thick duct (with nephridia attached) having straight or slightly wavy diverticulum almost to tip of ampulla with terminal bulb. Seminal vesicles in 11 & 12 have appendages. Last hearts are in 12 (or 13 in #S13). Prostates on short duct. Intestine from 16; caeca thin and simple from 27; gut contains soil rather than litter.

Etymology. After type locality near Lipa City, Batangas.

Distribution. Southern Luzon (and more northerly for “*decipiens*” specimen?).

Remarks. The two prior sixthelal species from Philippines are *P. philippina* (Rosa, 1891) from Cebu (plus Gates' 1937: 327 claim from Negros

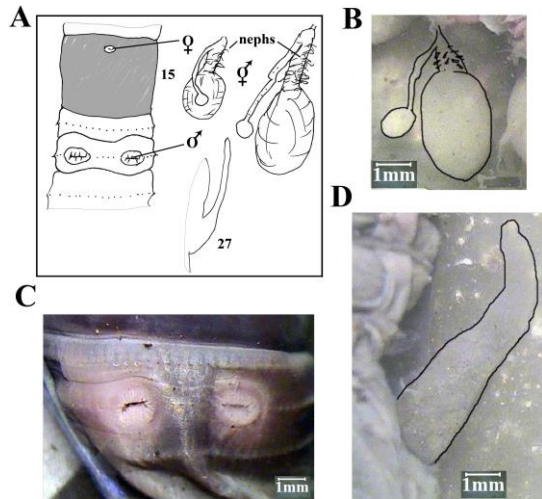


Figure 7. *Pheretima philippina lipa* ssp. nov. Holotype (#S24, DNA P12) with male pores retracted. A = Male field sketch with 9hs spermatheca (plus enlargement) and intestinal caeca; B–D = photos of same with organs outlined.

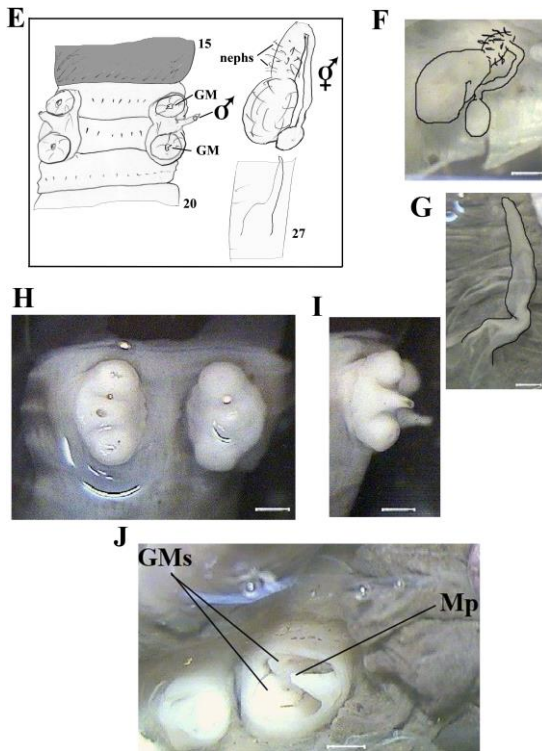


Figure 7. *Pheretima philippina lipa* ssp. nov. Paratype 2 (#S26) with everted male organs: E = Sketch of male field, spermatheca and caecum; F–I photos of same with organs outlined; J = Specimen #S13 (DNA K1b) copulatory pouch sectioned with enclosed penis to male pore (Mp) and GMs either side. DNA K1b matched Holotype's (P12) and other sample 100% – see Fig. 1.

Occidental but see *P. philippina victorias* ssp. nov. below) and *P. callosa* Gates, 1937: 313 from Benguet both of which were thought closely similar. In fact Gates (1937: 315, 329) differentiated his new species *callosa* only by its larger size (330 by 16 mm vs. ca. 120–240 by 8 mm), the larger setal numbers (70–114 vs. 36–70), the rudimentary condition of septum 8/9 (which however was variable), a vertically cleft penis tip, and the binding together of loops of the spermathecal diverticula (in *P. callosa*). The diverticulum in *P. philippina* is typically more straight (and some of the other characters apply more to *P. p. victorias*).

On balance the current specimens comply with *P. philippina* rather than *P. callosa*; slight differences are that the last hearts were in 12 (13 in nominal taxon and S13) and that the intestine commenced in 16 in current specimens (rather than 15 in Gates's specimens – see *P. p. victorias*). Some characters merge with those of *P. callosa* but the spermathecal stalks are straight and the setae apparently fewer; moreover, *P. philippina* has priority should these two taxa eventually merge.

The present sub-species has setae fewer in the anterior and numbering about 40–50 after segment 9 (agreeing with *P. decipiens*); spermathecae in 7–9 with straight diverticula, and septa 8/9/10 aborted, *i.e.*, different to *P. callosa*. The DNA COI barcode, that had no close match on Genbank, is definitive for the new holotype.

***Pheretima philippina victorias* ssp. nov.**

(Figure 1)

?*Pheretima philippina*: Gates 1937: 327. Supposed new material from US Nat. Mus. Cat. No. 20152 one mature specimen “V A18 Adodolay [sic]. Md X. Balabag Silay. Occ. Negros. 12/11/29. No. 109780” and Cat. No. 20153 two matures from “Negros Is. P.I. Bashford Dean. No. 38683.” Note that “Adudulay” is the Ilonggo name for the large black native worms (Delia deGuzman at Hacienda Remedios, pers. comm. Jan. 2014; cf. *Polypheretima elongata* name).

Material examined. Holotype, UPV specimen code #P1 large, dark, subadult providing DNA

tissue sample (Pe1) from Peñalosa home farm/shop Victorias City (10°54'N 123°05'E), Negros Occidental, PI; coll. 28th Jan., 2014 by RJB; Paratype-1 #P3 large, dark mature DNA sample (Pe3) collected same day from Hacienda Remedios organic farm on road beside woodland with many worm castings; Paratype-2 #P5 29th Jan., 2014 HR farm in rice paddy embankment (DNA Pe5 gave no results two months later); other specimens from canefields, paddy and vegetable plots (not kept).

Other material? Apart from Gates' specimens noted above, US Cat. No. 27587 one *Pheretima* specimen from "Hda. Bacayan, Victorias, Occ. Negros. Philippine I. Va2 12/8, 1927 W.D. Pierce GC [Good Condition] Id. G.E. Gates, 1957 Acc. No. 106537."

Diagnosis. Complying tolerably with nominal species morphologically, Gates' specimens were perhaps a bit shorter (122–197 mm) with fewer setae numbering 36 on 8 then to 53–64 (Gates). First dorsal pore was in 12/13 but Gates found a pore-like marking in 11/12 too. Other possible differences described by Gates are presence of thin septum 8/9 and intestinal origin in 15. In one of Gates specimens the copulatory chamber was partially everted exposing posterior GM protuberance. Septum 8/9 was present but 9/10 was lacking. The slender diverticulum typically extends to or beyond ampulla tip (unlike in *P. p. lipa*) and has a seminal chamber of variable shape (Gates).

Etymology. After type location near Victorias City, Negros.

Distribution. Northern Negros Occidental, PI.

Remarks. The DNA barcode data define this taxon separate from the other new sub-sp. (>8%, Fig. 1). Differences from *P. callosa* Gates, 1937 have already been explained.

***Amyntas bangoianus* (Michaelsen, 1934)**

(Figure 8)

Pheretima (*Ph.*) *bangoiana* Michaelsen, 1934: 505, fig. 6–8. [From Cam Rahn Bay (Port of Ba Ngoi), Vietnam. Type in Paris (576)].

Amyntas bangoianus: Sims and Easton 1972: 236 (*sieboldi*-group); Blakemore 2008b.

Remarks. Michaelsen (1934: 508) states that male pores are simple and that "Kopulations-taschen" are absent, thus belonging in *Amyntas* rather than *Metaphire*. In addition, its GMs are clearly quite separate from those typical of *M. bahli* (Gates, 1945) and it is thus removed from supposed synonymy even though it had priority!

Taxonomic note. Sims and Eastons' group taxon, previously *Amyntas sieboldi* (Horst, 1883) that was transferred to *Metaphire* by Blakemore (2003: 34, 2011: 10), is hereby replaced by next prior group representative: *Amyntas carinensis* (Rosa, 1890) as a new *carinensis*-group comprising about 50 taxa, including *A. bangoiana*, listed by Sims and Easton (1972: 236) and Easton (1979: 119).

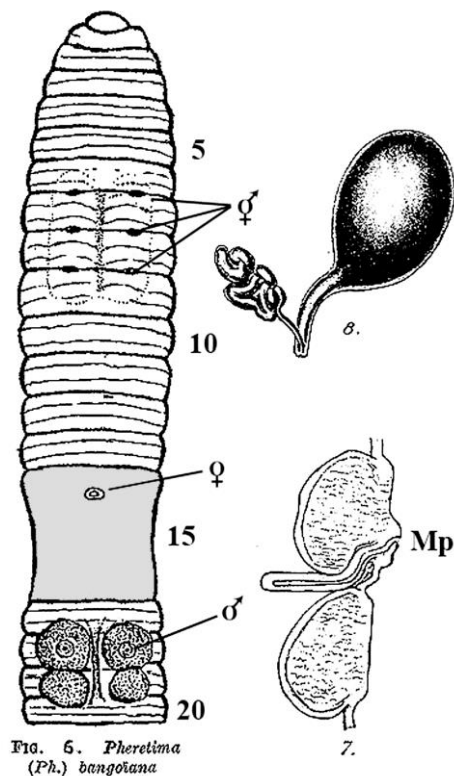


FIG. 6. *Pheretima* (*Ph.*) *bangoiana*

Figure 8. *Amyntas bangoianus* (Michaelsen, 1934: fig. 6–8) (Mp - superficial male pore).

***Metaphire bahli* (Gates, 1945)**

(Figures 1, 9A–D, 10)

Pheretima bahli Gates, 1945: 85. [Type locality Colombo, Sri Lanka. Types, supplied by Kirtisinghe (as *P. peguana*), originally in Prof. Bahl's collection, now lost]; Gates, 1972: 209; Thai, 2000 (part. with supposed syns. *saigonensis*, *bangoiana*).

?*Pheretima* sp. Gates 1972: 210. [Believed from Thailand; male field more depressed than usual in *M. bahli* (cf. *M. peguana*, *M. pacseana*, *M. saigonensis*)].

Metaphire bahli: Sims and Easton 1972: 239 (*peguana*-group); Easton 1982: 730, fig. 4f; Blakemore 1994: 364, 1999: 187, 2002, 2008b, 2009: 265, 2012a.

Material examined. UPV sample #S15 clitellate mature, 135 mm long, dissected and providing DNA sample (K2) from under stone beside farm office Kahariam farm, Lipa City, Batangas, coll. RJB 14th Aug. 2013; #S16 mature 95+ mm long (DNA P1), from same location but in vermicompost beds coll. RJB & RO 14th Nov. 2013; also same day #S18 one of three specimens, 105 mm long from rice paddy near gym (DNA P5); #S20 mature from rice paddy beside gate (DNA P7); plus #P2 longest of four matures providing DNA (Pe2) Penalosa farm, Victorias coll. RJB 28th Jan. 2014; and #S31 two matures (both length = 120 mm), from Hacienda Remedios farm, Negros in cane/banana grove coll. RJB 30th Jan. 2014. Other specimens inspected from Darwin Museum, NT are presented in Results section above.

Diagnosis. Red-brown colour. 110–150 x ca. 4–6 mm. *Metaphire* with paired spermathecal pores 0.25 (Easton, 1982) or <0.5C (Gates, 1972) apart in 6/7/8/9. Diverticula coiled with terminal bulb. Paired GMs in line with male pores in 17/18 & 18/19 always invaginate (cf. *M. peguana*). Intestinal caeca simple.

Distribution. Sri Lanka, the Philippines [previously from Manila and Clark Field (= Angeles City; Gates and pers. obs.), Sual (Pangasinan) and Sibuyan Island (US NMNH Museum specimen), currently from Batangas and Negros as new records], Laos, Vietnam (Thai & Samphon 1989), Cambodia (Thai & Do 1989 and pers. obs. at Angkor Wat Temple, 11th Nov., 2003), Thailand

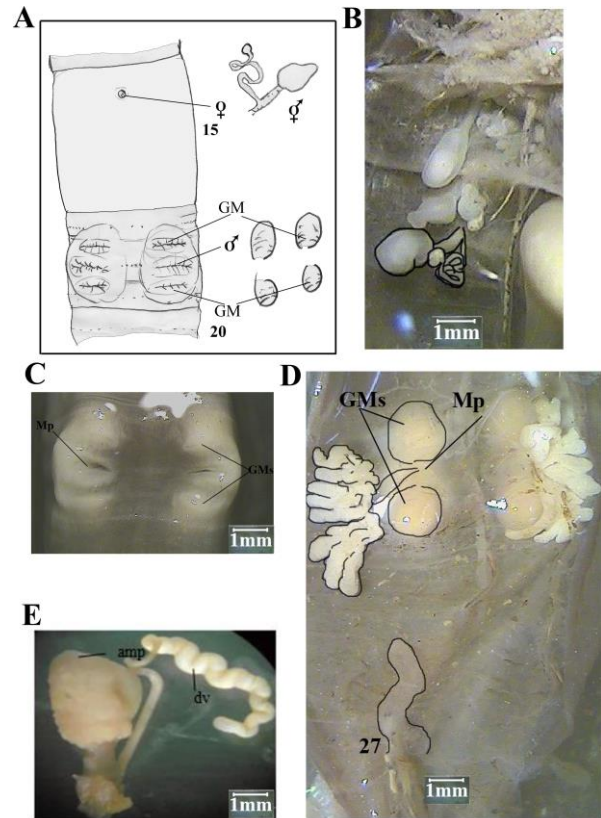


Figure 9. *Metaphire bahli* (Gates, 1945). A = Male field and spermatheca (Darwin specimens); B–D = photos of same from Kahariam #S15 with organs outlined; cf. E = *Metaphire pacseana* (Thai & Samphon, 1988) from Nguyen (2014: fig. 1B).

(Gates 1972: 210, Blakemore 2008a and information in Introduction above), and from northern Australia. Its records in Australia are from around Darwin, NT (Easton 1982): from Snake Bay, Melville Island, Elizabeth River 8 Km S of Darwin and beside Manton River 60 Km S of Darwin; in current studies it was found exclusively in the central Bicentennial park of Darwin through to the Botanic Gardens there with many specimens in drainage ditches or dried on pavements. Gates (1972) thought that the original home may be centered in what is now Thailand/Laos and other records were by introduction. Interestingly, Gates (1972: 210) noted that *M. peguana* and *M. bahli* had not been recorded from the same locality, although Thai & Samphon (1989: 75) and Nguyen (2013: tab. 3.1) recorded them both in Mekong Delta sites in Vietnam (Blakemore *et al.* 2007b: 29).



Figure 10. Indo-Australasian distribution of tropical cosmopolitan *Metaphire* spp. (Asia map courtesy of CIA: <http://www.loc.gov/item/2004627975/#about-this-item>).

Ecology. Current studies found *M. bahli* with organic sugarcane, rice and bananas in PI and in Darwin Botanic Gardens in vicinity of introduced plants including teak (*Tectona grandis* L.) itself native to Thailand/Laos and introduced to Sri Lanka by the Dutch in 1680. If associated with teak plantations it may be expected in Africa and the Caribbean too, but this is just one of many possible means of transportation of what may now be considered such a major cosmopolitan species. Habitats are variable: e.g, parks, fields, woodlands, paddy and in vermicompost wormbeds (Kahariam farm, Batangas). Associated with presence of this worm is rich, well drilled topsoil with copious surface casts in Darwin Gardens where it is predated by Bush Turkey, *Megapodius reinwardt* Dumont, 1823 (pers. obs.), i.e., at least partly a litter dweller, partly a topsoil species. Refuerzo and Reyes (1959) reported it in Philippines as an

intermediate host of nematode *Metastrongylus apri* (Gmelin, 1790) [syn. *Metastrongylus elongatus* (Dujardin, 1845)] lungworms parasitic in domestic pigs or wild boars, occasionally infecting ruminants and, rarely, humans.

Behaviour. Usual ‘snaking’ escape response. Field identification by slight pressure around male pores causes eversion of these plus GPs to give a 6-pointed star formation.

Remarks. Full description is provided in Blakemore (2012a). A Vietnamese paper by Thai (2000) repeated in PhD thesis by T.T. Nguyen (2013: 46) suggested *Pheretima bahli* synonyms of *Metaphire saigonensis* (Omodeo, 1956) and *Amyntas bangoiana* (Michaelsen, 1934) but if it were so, then the latter species would have taken priority from Gates’ *bahli*, as briefly summarized

above. The current study counter-indicates their mutual inclusion as GMs differ at least; moreover, it is now well defined genetically.

Metaphire pacseana (Thai & Samphon, 1988)

(Figure 9E)

Pheretima pacseana Thai & Samphon, 1988: 8. [From Pacse, Laos and ?Vietnam. Types?].
Metaphire pacsana : Blakemore, 2008b: 74.

Remarks. Thai and Samphon (1989: 64, 75) argued that their *pacseana* from Laos explained the relationship between *M. bahli* and *M. peguana*: It has similar markings 17/18 & 18/19 but is larger, up to 270 mm long, with diverticulum twice the length of the ampulla plus duct (no nephridia), and a deeply incised and multiple intestinal caeca. Tentative placement in *Metaphire* by Blakemore (2008) is supported by a photograph in Nguyen (2014: fig. 1B) lacking nephridia on the spermathecal duct (although he yet lists it as "*Ph. pacseana* Thai, 1987") – see Fig. 9E.

***Polypheretima elongata* (Perrier, 1872) species-complex**

(Figure 1)

Polypheretima elongata complex: Sims & Easton 1972: 252, Easton 1976, 1979.

Comprising: *acystis*, *annectens*, *barami*, *baritoensis*, *biserialis*, *bonensis*, *elongata*, *everetti*, *kinabaluensis*, *klabatensis*, *koroensis*, *mahakkami*, *monocystis*, *phacellotheca*, *sarawacensis*, *seriatus*, *stelleri* & *tinjarana*.

Material examined. From current studies, UPV #S23 three worms in clay near wind-pump at Kahariam farm coll. 14.XI.2013 by RJB & RO (DNA P10-11 from a mature and an immature specimen); mature specimens #R2 from clay at wind-pump and #R3 in sand by stream both collected 21st Jan. 2014 RJB & RO (DNA taken but not sent for testing by UPV); #P4 three specimens, two matures up to 500 mm long from rice and one medium specimen from cane at Hacienda Remedios coll. 28th Jan., 2014 RJB (lat-

ter specimen provided DNA sample Pe4); #S30 five matures from Tagbac farm, Orton in rice paddy coll. 12th Feb., 2014 by UPV staffers & RJB (DNA sample T1 not sent to lab by UPV).

Other material. Gates (1937: 318) mentions specimens from Batoran, Luzon and Negros Island; plus US Nat. Mus. Cat. No. 28711 has one specimen of *Pheretima elongata* (Perrier) labelled "*Lago, Bacayen, Victorias, Occ. Negros, cane-field soil. VAI7 July 8, 1927 W.D. Pierce GC* [Good Condition] *Id. G.E. Gates 1957 Acc. No. 109780*". Note "*Lagu*" is the Ilonggo name for long, pale worms (*cf. Ph. p. victorias* name). Easton (1976: 51) has *elongata* specimens from Bataan, Luzon, Mindoro and Manila including "BM(NH) 1904:10.5.1-2 (*biserialis*: Beddard, 1890 ; syntypes of *acystis*)".

Remarks. Full ecological and taxonomic descriptions of this cosmopolitan species-complex are provided by Easton (1976, 1979) and Blakemore (1994, 2002, 2012a) wherein its misidentification in India for vermicomposting is noted. Although only the nominal species is now reported from the Philippines, BLAST analysis of the DNA data presented here shows >11% difference thus review/restoration of its components is warranted. Consideration should also be give to supposed natives such as *Polypheretima monticola* (Beddard, 1912: 195) from Mt Pulong, Luzon that was itself poorly characterized and is without known types. It was described as 130 mm long with spermathecae paired in 5/6/7/8/9 and GMs paired in 9, 17 & 19–20 in one specimen but not so developed in the other. In this regard this second specimen is the same as *Po. bannaworensis* Hong & James, 2008 which may thus be in synonymy; one other of their Filipino species, *Po. fruticosa*, is *incertae sedis* as the segments are again miscounted in Hong and James (2008: fig. 2A).

Description of two new native *Pleionogaster* species from Philippines

The opportunity is here taken to describe two taxa of the author's concurrent PI studies.

MEGASCOLECIDAE Rosa, 1891

Genus *Pleionogaster* Michaelsen, 1892

Type: *Pl. jagori* Michaelsen, 1892 (non *horsti* Beddard, 1886, see Easton, 1979: 114).

***Pleionogaster adya* sp. nov.**

(Figures 11A–D)

Material examined. UPV#S3: Holotype, quiescent mature (DNA sample W2) found coiled in alluvial soil of banana grove (13:52:14.31323N 121:8:42.36106E) at Kahariam organic farm, Brgy. Adya, Lipa City, Batangas, Luzon; coll. RJB 28th Mar., 2013. [Specimens?: #R5 two matures from sand beside adjacent stream (possibly a different species), coll. RJB & RO 21st Jan., 2014 (DNA R5)].

Description. Unpigmented. Size 145 by 5 mm. Segments *ca.* 100+. Prostomium prolobous. First dorsal pore 11/12. Setae numerous >100 per segment. Nephropores, eight per side (as dark gaps in setal arcs). Spermathecal pores in 7/8/9 *ca.* 0.25C apart. Female pores on 14. Male pores superficial *ca.* 0.3C apart with dozen or more setae between. GMs weak, crescent-shaped pads paired in 17/18 & 18/19 just median to male pore line.

Septa strong in anterior and all present. Oesophageal gizzard in 8. Spermathecae in 8 & 9 as elongate ampulla undifferentiated from duct with stumpy clavate diverticulum $\frac{1}{3}$ as long ectally. Holandric. Testis in 10 & 11; seminal vesicles in 11 & 12. Last hearts in 13. Ovaries in 13. Prostates racemose on short duct in 18. Calciferous glands absent; intestine in 19; caeca absent. Intestinal gizzards appearing in 26–32 (four in series) highly muscularized and each preceded by equisized, flaccid crop. Typhlosole not found. Nephridia meroic in anterior with eight pairs per segment, just one pair visible >18/19.

Etymology. After type locality and only known location, Barangay Adya.

Remarks. Easton (1979: 115) combined *jagori* and *samariensis* Michaelsen, 1892, *ternatae* Michaelsen, 1896 plus *sivickisi* Stephenson, 1933 under *Pl. horsti* Beddard, 1886 whereas James (2006) – while questioning such synonymy but offering no resolution – proposed more than a dozen new species that are themselves mostly similar (many synonymous?). Male pores in current taxon (0.3C) are wider than Easton's *horsti* (*ca.* 0.25) and out of range (0.11–0.18C) of all of James' six species with four gizzards.

Crescentic marking are similar to those of generotype *Pl. horsti*, but the other GMs are lacking (possibly not fully developed) and the four intestinal gizzards appear within 26–32 rather than just 26–28,29. Compared to James' (2006: tab. 1), closest match is perhaps with *Pl. bicolensis* from Bicol, Luzon that, however, is darker with dorsal pores from 12/13, gizzards in 27–30 (*i.e.*, not so extensive), and a dozen nephridia per segment.

DNA data unfortunately unobtainable due to prolonged and avoidable delay in UPV sending tissue samples to the lab.

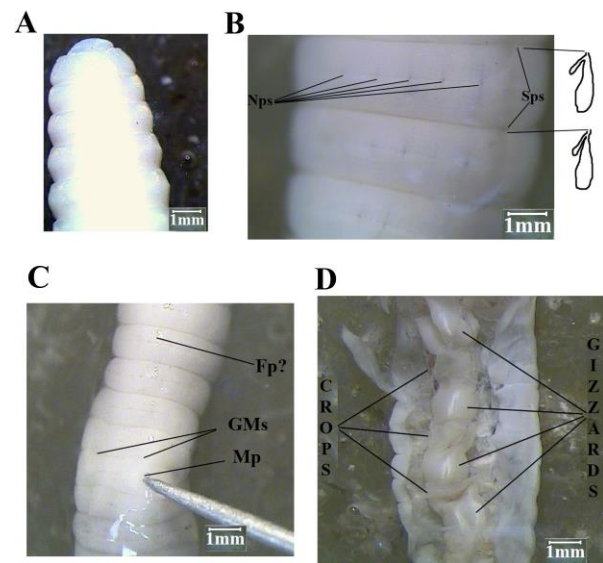


Figure 11. *Pleionogaster adya* sp. nov. Holotype. A = Prostomium; B = Spermathecal field X3 with sketch of spermathecae; C = Male field; D = intestinal gizzards in 26–32.

Pleionogaster miagao sp. nov.

(Figures 1, 12A–H)

Material examined. UPV#S7: Holotype, mature posterior amputee (dissected and providing genseq-1 DNA sample M1) from clay soil Brgy. Cagbang, Miagao (ca. 10°39'N 122°14'E), Iloilo, Panay Island. Coll. Jover Nuevaespana, Jess & King from Sulu Garden (Poseidon Sciences) 6th Feb., 2014.

Description. Unpigmented, clitellum yellowy in 14–16 ventrally and 14–½17 dorsally. Length 150 (+25 bulbous tail) = 175 mm by 6 mm. Segments 153 (+ 25) = 178. Prostomium prolobous (with pharynx everted). First dorsal pore 11/12. Setae numerous >100 per segment. Nephropores equatorial (fourteen to eighteen per segment in anterior). Spermathecal pores with puckered lips in 7/8/9 ca. 0.2C apart. Female pores below crease on 14. Male pores on round porophores as large puckered slits with ca. ten setae between the mounds. GMs represented by broad V-shaped papillae on mid-ventral pad in 16/17 just above setae arc, ellipsoid papillae paired postsetally in 17, broad insunk patches paired below male pores on 18, corresponding weaker pair of presetal papillae in 19 & 20 too, then weaker yet in 21–23 – these latter tapering as unapapillated pads.

Peptonephridial masses in 4 & 5. Septa 5/6/7/8 thickened, thereafter thin. Oesophageal gizzard weak in 8. Spermathecae in 8 & 9 as elongate ampulla on short muscular duct with stumpy clavate diverticulum ¼ as long ectally. Holandric. Testis in sacs in 10 & 11; seminal vesicles 11 & 12 (at least) last pair in 12 with digitiform diverticulum dorsally. Commissurals in 4–9, hearts 10–13. Ovaries fan-shaped sheets in 13; no ovisacs in 14. Prostates crescentic on short duct in 18. Calciferous glands absent; intestine in 19; intestinal caeca absent. Intestinal gizzards in 27–30 (four of) greatly distending segment lengthways with intraseptal crop preceding each. Typhlosole lamellate from ca. 60. Gut contains very fine silty clay without organic material suggesting geophagy. Nephridia meroic, ca. eight pairs per segment in anterior.

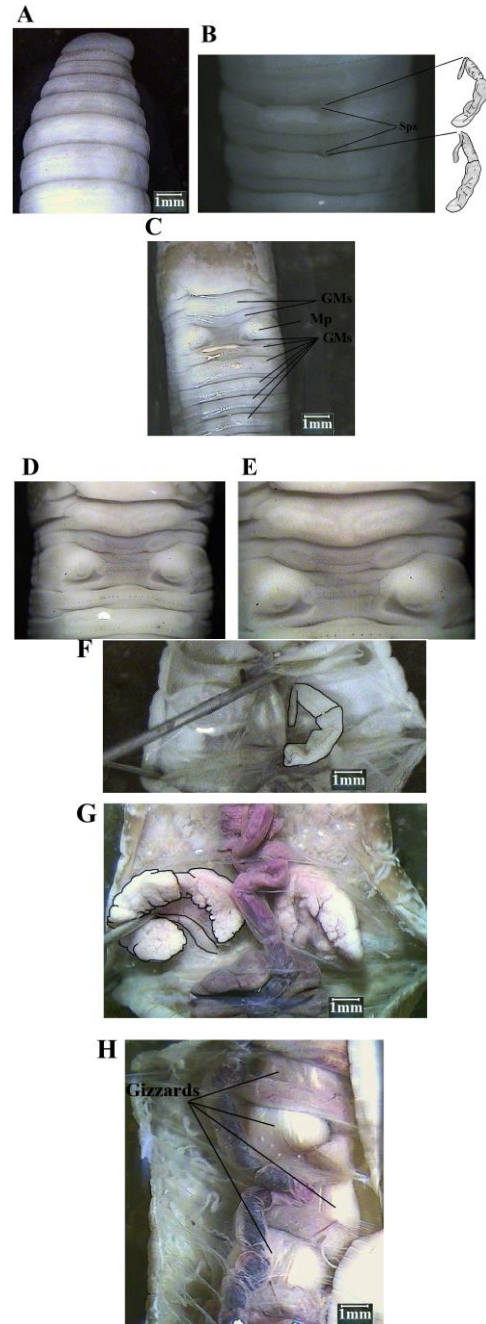


Figure 12. *Pleionogaster miagao* sp. nov. Holotype. A = Prostomium; B = Spermathecal field X2 with sketch of spermathecae; C = Male field X1; D–E Ditto X2–3; F = Spermathecae 8rhs next to oesophageal gizzard; G = Prostates, that on 18lhs outlined and overlain by dorsal blood vessel; H = Intestinal gizzards in 27–30 and lhs meganephridia.

Etymology. After type locality and only known location, Miagao township, Panay.

Remarks. Differences from *Pl. horsti* (Beddard, 1886) are that this often has mid-ventral GMs and the intestinal gizzards are confined in 26-28,29 according to Easton (1979: 115, fig. 46). Closest match with James (2006: tab. 1) is perhaps with *Pl. tiwiensis* from Tiwi, Luzon that has four intestinal gizzards variable in “xxvii-xxx (4), xxv-xxviii (1)”, i.e., in either 27–30 or 25–28; however, it is smaller (94–103 mm) and its spermathecae are 0.08C apart and male pores 0.12C apart with “5–6 setae between male pores” (cf. only four shown in his fig. 1A), fewer nephridia (6–10/segment), no diverticula to seminal vesicles in 12, typhlosole from “xlvii” and diverticulum about half the length of the spermatheca. Insufficient time/funds were available to further describe another *Pleionogaster* sp. n. (l = 25–27 mm #S32) from next to Sulu Gardens, Miagao.

mtDNA COI barcode (KT626595) here provides for the first time a definitive identification of a new *Pleionogaster* species.

Acknowledgements – Dr Chris Glasby, Curator at Museum and Art Gallery of NT (MAGNT), is thanked for facilitating study of their earthworm collection. Mr Bryan Harty, Director of the Botanic Gardens allowed access to gardens and permaculture terraces. In Philippines, property owners Messrs. Manuel “Nonong” Bagatsing and Ramon “Mon” Peñalosa kindly allowed sampling, while Jonathan Matias of Sulu Gardens gave support. DNA analyses (attempted on UPV delayed material) were by Dr Seunghan Lee of Hanyang Uni., Seoul; whereas Darwin samples were sequenced by Prof Chris Austin and Han Ming Gan at Monash University Malaysia Genomics Facility, Selangor; Dr Duc Anh Nguyen of Hanoi kindly sent me a copy of relevant parts of Omodeo’s *saigonensis* paper.

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New Australasian and Oriental *Triaenodes* species (Trichoptera: Leptoceridae)

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Abstract. The following new species are described from the long-horned caddisfly genera *Triaenodes* McLachlan, 1865; Vietnam: *T. catbana*, *T. sokaga*; Indonesia (Sumba Island): *T. sumbana*; Indonesia (Batanta Island): *T. apraka*, *T. bala*, *T. harmasa*, *T. izgaga*, *T. jobba*, *T. kalija*, *T. marleorum*, *T. nemapraka*, *T. sagodii*, *T. sarla*, *T. torpa*, *T. tudarda*, *T. zugora*; Indonesia (Papua): *T. atkarol*, *T. fodra*, *T. hasa*, *T. lemeza*, *T. tarula*, *T. zicsii*; Solomon Islands: *T. fura*, *T. gerela*, *T. picinka*; New Hebrides: *T. fioka*, *T. nakla*; Fiji Islands: *T. bunka*, *T. buzoga*, *T. ketaga*, *T. koba*, *T. ranca*. *Triaenodes dusra* Schmid described from China has been recorded from Malaysia and Vietnam. *Triaenodes pellectus* Ulmer described from Japan has been recorded from Vietnam. *Triaenodes pentheus* Malicky described from Thailand has been recorded from Vietnam. Phylogenetic relation of *Triaenodes paratlan* Oláh & Mey described from Indonesia (Papua) has been revised.

Keywords. Vietnam, Pacific Islands, Melanesia, Fiji Islands, New Hebrides, Solomon Islands, *Triaenodes*, new Species

INTRODUCTION

The caddisfly fauna of the Melanesia group of the Pacific Islands is poorly known. Especially New Guinea, the last unexplored island remained still virgin; huge territories are almost untouched by caddisfly collectors. In a recent taxonomic list of the Trichoptera described and recorded from New Guinea region we have registered altogether 352 species (Oláh 2012a). The high diversity of the island is documented by 338 endemic species, those described newly from the region, with a very tiny effort of collection. In the last few years we have devoted special effort to collect caddisflies in the Batanta Island of New Guinea. Between the years of 2010 and 2016 we have organised 9 field collecting expeditions financed by Hungarian bird-watching, bird photography, and scuba diving tourist industries. One expedition to the Arfak and Snow Mountains, West Papua was organised, financed and realised by Robert Horváth from the Papua Paradise Eco-Resort (Birie Island, Raja Ampat, Papua, Indonesia) and Nature Discovery Fund (Kisar-Hungary). Here we elaborate all the specimens and describe the new species of the long-horned caddisfly genus *Triaenodes* collected during these

expeditions as well as some other materials collected earlier partly by the author in Vietnam, Indonesia (Sumba Island), Solomon Islands, New Hebrides and Fiji Islands.

MATERIAL AND METHODS

We have installed UV light traps as well as collected specimens from white sheet illuminated by Honda generator or by battery powered lamps. The material including all holotypes and paratypes are preserved in 70–80% alcohol and deposited in the collection of the author under presented property of the Hungarian Natural History Museum (OPC) or in the Naturalis Biodiversity Center – Zoological Museum, Amsterdam, Netherlands (NBC-ZMAN) and in the British Natural History Museum (NHM).

TAXONOMY

Triaenodes aproka sp. nov.

(Figures 1–2)

Material examined. Holotype. Indonesia, Papua Barat, Batanta Island, Northern coast, Warmon stream, 0°48'1.52''S, 130°70'8.10''E, above se-

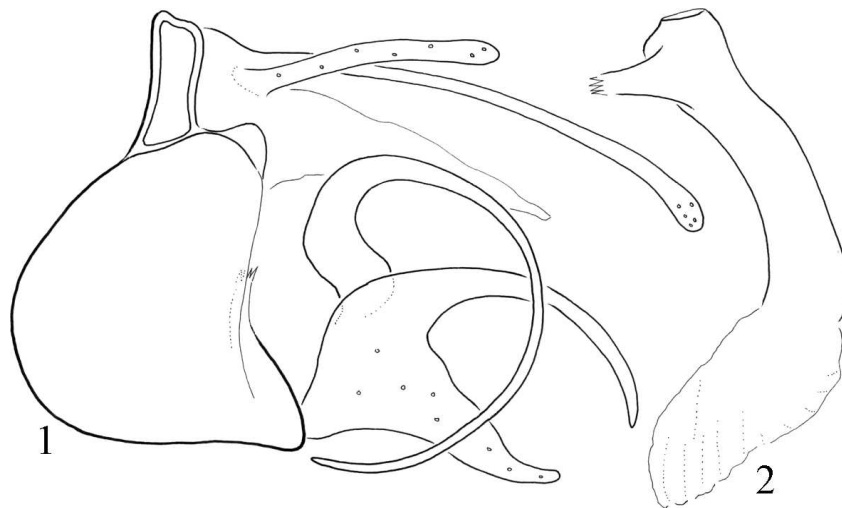
cond waterfall, 22.01.2013, light trap, leg R. Horváth (1 male, OPC). *Paratypes*. Papua Barat, Batanta Island, Northern coast, small stream with dry mouth: 0°49'27.84''S 130°38'45.02''E, 1000–1500m above dry mouth, 28.01.2012, light trap, leg R. Horváth (1 male, OPC). Papua Barat, Batanta Island, valley of Warmon Stream, upper waterfall, 0°50'23.25''S, 130°42'35.18''E, 150 m, 20.01.2014, at light, leg. T. Kovács, P. Juhász (1 male, OPC). Papua Barat, Batanta Island, Teluk Warai, stream, 0°50'51.0''S, 130°35' 14.0''E, 11.II.2015, at light, T. Kovács, P. Juhász (1 male, OPC). Papua Barat, Batanta Island, right side stream of Forum River, 0°52'22.7'', 130°27' 45.1'', 13.02.2015, at light, T. Kovács, R. Horváth, P. Juhász (1 male, OPC).

Diagnosis. The basic architecture of the genitalia, and particularly the dorsum of segment IX with suture separated tergum, is similar to *T. hasa* sp. nov. *T. paratlan* Oláh & Mey, *T. telefomicus* Kumanski. However the left mesal basodorsal process is present, not lost. Therefore this tiny species is probably the ancestral species of the lineage of the above mentioned three species with lost left mesal basodorsal process.

Description. Male (in alcohol). Brown animal, Scape slightly enlarged, without discernible scent organ; pedicel short, third segment long. Maxillary palp formula IV-I-II-III-V. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern and without any scent setae; forewing length 4 mm.

Male genitalia. Segment IX synsclerotized, subtriangular in lateral view; well-sclerotized frame of sutures encircles the very small tergite IX subdivided into three facets, as visible in dorsal view. Segment X comprising of filiform mesal process (upper process of segment X). Cerci setose filiform, half long as the segment X. Paraproct (lower process of segment X) forming a less sclerotized long mesal process. Gonopods bilobed apicad; upper lobe long arching digitiform, lower lobe shorter; a pair of mesal basodorsal process present curving upward and downward. Phallic organ with dilated membranous apical portion of the aedeagus; phallobase connected with a pair of lateral sclerotized strips to sclerotized strips produced discontinuity in ventrum IX.

Etymology. *aproka*, from “apróka” tiny in Hungarian, refers to small size.



Figures 1–2. *Triaenodes aproka* sp. nov. Male holotype, 1 = genitalia in left lateral view, without phallic organ, 2 = phallic organ in left lateral view.

***Triaenodes atkarol* sp. nov.**

(Figures 3–6)

Diagnosis. This new species shares similarities in the basic form of segment IX, segment X (upper part of segment X of Yang & Morse (1993)), paraproct (lower part of segment X of Yang & Morse (1993)), and gonopods of the *T. bernaysae* complex described from Australia by Neboiss and Wells (1998). The basodorsal process is lobose, curving posteriad and foot-shaped. Most close to the nominate species *T. bernaysae* Korboot, but differs by particular organisation of the above listed structures.

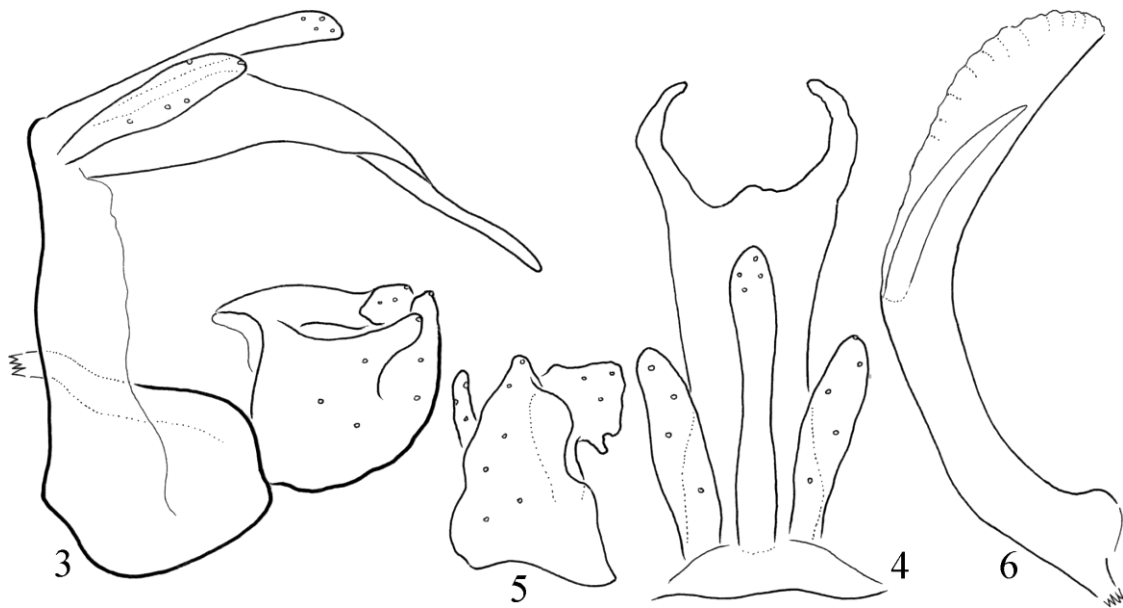
Material examined. Holotype. Indonesia, Papua Barat, Birdshead Peninsula, Neney Valley, Arfak, Benyas, 1°27'S 134°01'E, 722 m, 17.11.2011, leg. Papua Insect Foundation (1 male, NBC-ZMAN).

Description. Male (in alcohol). Pale animal. Scapus enlarged, second segment short, third segment long without any hair pencil of scent

organ. Maxillary palp formula IV-I-II-III-IV. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern; forewing length 8 mm.

Male genitalia. Segment IX subdivided by incomplete modified suture, producing a very narrow and high tergite and a low double long sternite; the lateral groove is vertical; a very pronounced pair of sclerotized strip, a chitinized support arisen from the dorsodistal region of sternite IX to the phallobase. Segment X organised into a long digitiform, apically setose median lobe. Paraproct bifid with mesad curving, “embracing” lateral arms; the most developed structure guiding the phallic organ dorsad. Cerci setose foliform. Gonopods broad base comprised of lateral finger-like process and a pair of basodorsal lobe with transversally directed terminal setose plate. Phallic organ uniform in diameter, curved downward and supplied with a single spine-like paramere.

Etymology. *atkarol*, from “átkarol” or “ölel” embrace in Hungarian, refers to the apical shape of paraproct in dorsal view.



Figures 3–6. *Triaenodes atkarol* sp. nov. Male holotype, 3 = genitalia in left lateral view, without phallic organ, 4 = genitalia in dorsal view, 5 = left gonopod in ventral view, 6 = phallic organ in left lateral view.

***Triaenodes bala* sp. nov.**

(Figures 7–9)

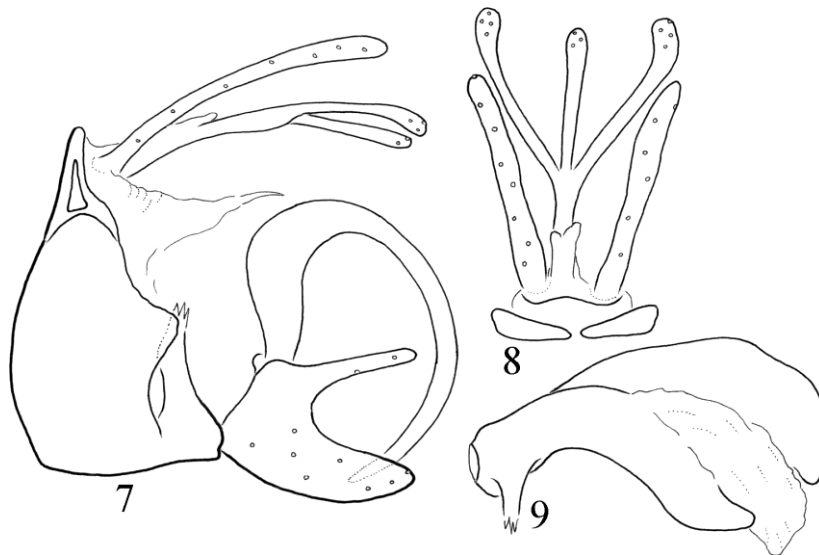
Diagnosis. Having the left mesal basodorsal process present and the right process is lost this new species differs from the sibling species *T. telefomicus* Kumanski and *T. paratlan* Oláh & Mey, *T. hasa* sp. nov. The mesal basodorsal process has no subapical arm present at *T. telefomicus* and *T. paratlan*, moreover having dilatation on the basal third of the process *T. bala* sp. nov. is closer to *T. hasa* sp. nov., but differs by the lateral profile of the mesal basodorsal process and of the phallic organ.

Material examined. *Holotype.* Indonesia, Papua Barat, Batanta Island, Northern coast, Warmon stream, 0°50'8.52"S, 130°42'50.4"E, below first waterfall, 22.01.2013, light trap, leg R. Horváth (1 male, OPC). *Paratype.* Papua Barat, Batanta Island, Kalijakut River, 0°52'49.1", 130°38'4.9", 16.02.2015, UV light-trap, leg. T. Kovács, P. Juhász, (1 male, OPC).

Description. Male (in alcohol). Brown animal, Scape enlarged, with scent organ of long black setae accompanied by a long flap; pedicel short, third segment long. Maxillary palp formula IV-II-I-III-V. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern; forewing length 6 mm.

Male genitalia. Segment IX synsclerotized, subtriangular in lateral view; well-sclerotized frame of sutures encircles the very small tergite IX subdivided into two facets, as visible in dorsal view. Segment X comprising of filiform trifid mesal process (upper process of segment X); the median arm of the trifid mesal process as long as the lateral processes; lateral processes with mesad turning capitate apex, a pair of short, bare digitate process present basodorsad. Cerci setose filiform, as long as the lateral processes of segment X. Paraproct (lower process of segment X) forming a short subtriangular plate with chazalae basad and setae apicad. Gonopods bilobed apicad; upper lobe digitiform, lower lobe lobate; right mesal basodorsal process lost, left mesal basodorsal process of the basal plate of gonopods curving upward, downward and rightward, dilated or bellied one third subbasad. Phallic organ with extremely developed high right ridge; phallobase connected with a pair of lateral sclerotized strips to ventroapical corner of segment IX; this sclerotized strips produced discontinuity in ventrum IX.

Etymology. *bala* from “bal, balos” left in Hungarian, refers to the left mesal basodorsal process of the basal plate on the gonopods present contrary to the other sibling species having the right process present and the left process lost.



Figures 7–9. *Triaenodes bala* sp. nov. Male holotype, 7 = genitalia in left lateral view, without phallic organ, 8 = genitalia in dorsal view, 9 = phallic organ in left lateral view.

***Triaenodes bunka* sp. nov.**

(Figures 10–13)

Diagnosis. Close to *T. rebellus* Eriksson & Johanson, but most close to *T. buzoga* sp. nov., but differs by having segment X with almost capitate apex, not clavate; apical margin of gonopode truncate, not rounded; mesal basodorsal process differently shaped; lateral flank on aedeagus low, not high.

Material examined. *Holotype.* Fiji Islands, Viti Levu, Mt. Victoria, 24.11.1970, leg H. S. & G. S. Robinson (1 male, NHM).

Description. Male (in alcohol). Brown animal, Scape enlarged, without discernible scent organ; pedicel short, third segment long. Maxillary palp formula IV-I-II-III-V. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern; forewing length 9 mm.

Male genitalia. Segment IX synsclerotized, the subdivided sternum with its posterior partially detached unit giving support to the phallobase by

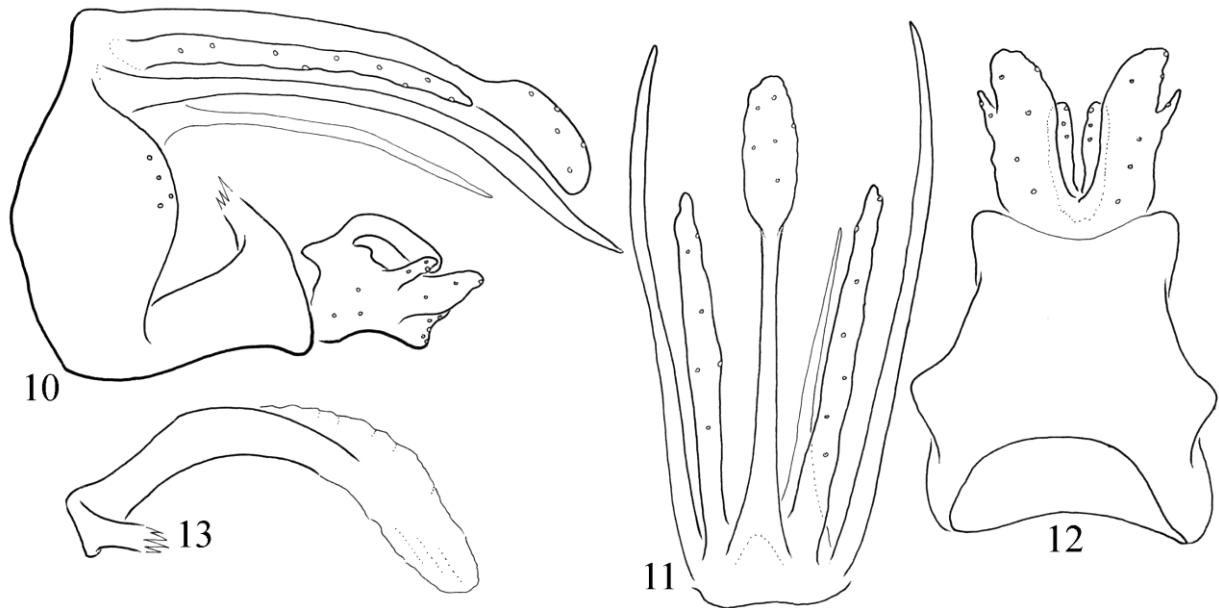
its sclerotized strips. Segment X (upper process of segment X) filiform with almost capitate apex. Cerci setose filiform, shorter than segment X. Paraproct (lower process of segment X) forming a pair of long filiform spine-like processes. There is a single asymmetric spine like shorter sclerotized pointed process attached to paraproct basement. Gonopods bilobed, apical margin oblique truncate; mesal basodorsal process of the basal plate of gonopods short capitate. Phallic organ forming a downward curving tube with membranous apex, phallosome with low lateral flank.

Etymology. *bunka* from “bunkó” clavate in Hungarian, refers to club-shaped, clavate, almost capitate apex of segment X.

***Triaenodes buzoga* sp. nov.**

(Figures 14–17)

Material examined. *Holotype.* Fiji Islands, Viti Levu, Savura Creek, 31.VII.1975, M. V. light leg. P. A. Maddison (1 male, NHM).



Figures 10–13. *Triaenodes bunka* sp. nov. Male holotype, 10 = genitalia in left lateral view, without phallic organ, 11 = genitalia in dorsal view, 12 = genitalia in ventral view, 13 = phallic organ in left lateral view.

Diagnosis. Most close to *T. bunka* sp. nov., but differs by having segment X with clavate apex; mesal basodorsal process differently shaped; lateral flank on aedeagus high, not low.

Description. Male (in alcohol). Brown animal, Scape enlarged, without discernible scent organ.; pedicel short, third segment long. Maxillary palp fomula IV-I-II-III-V. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern; forewing length 8 mm.

Male genitalia. Segment IX synsclerotized, the subdivided sternum with its posterior partially detached unit giving support to the phallobase by its sclerotized strips. Segment X (upper process of segment X) filiform with clavate apex. Cerci setose filiform, shorter than segment X. Paraproct (lower process of segment X) forming a pair of long filiform spine-like processes. There is a single, asymmetric spine like, shorter, sclerotized pointed process attached to paraproct basement. Gonopods bilobed, apical margin rounded; mesal basodorsal process of the basal plate of gonopods with downward curving apex. Phallic organ forming a downward arching tube with membranous

apex, phalotheca with high lateral flank.

Etymology. *buzoga* from “buzogányos” clavate in Hungarian, refers to club-shaped, apex of segment X.

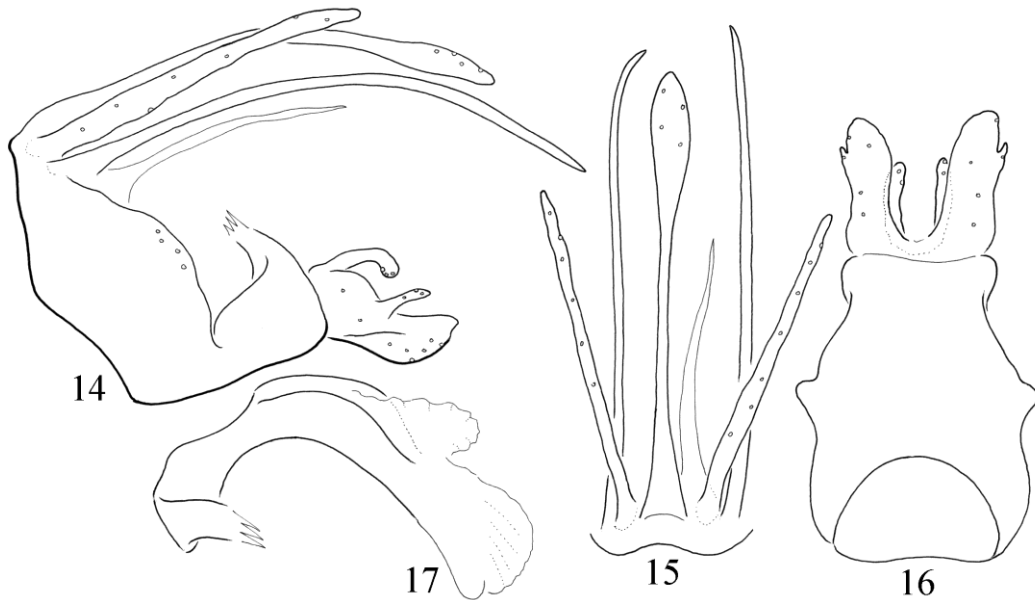
***Triaenodes catbana* sp. nov.**

(Figures 18–21)

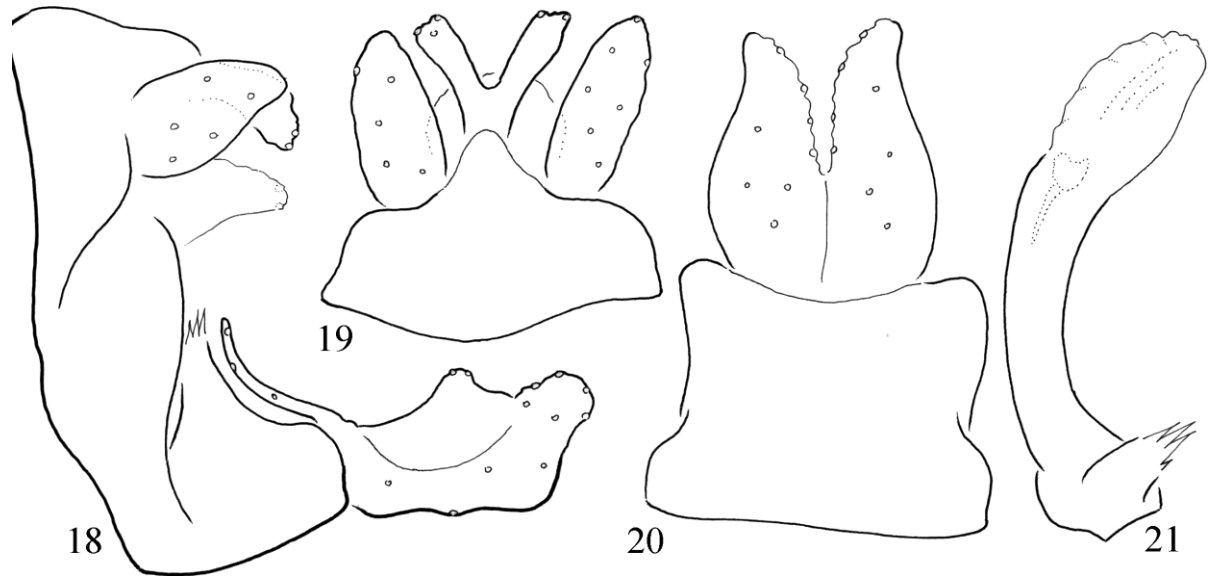
Diagnosis. Has similarity to *T. narkissos* Malicky, 2005 described from Thailand, but differs by having segment X deeply divided, differently shaped gonopods and mesal basodorsal process short, not long.

Material examined. *Holotype.* Vietnam, Cat Ba Island, Goi stream, 17.05.1987, singled leg. J. Oláh (1 male, OPC).

Description. Male (in alcohol). Brown animal. Scape enlarged, without discernible scent organ; pedicel short, third segment long. Maxillary palp fomula IV-I-II-III-V. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern; forewing length 7 mm.



Figures 14–17. *Triaenodes buzoga* sp. nov. Male holotype, 14 = genitalia in left lateral view, without phallic organ, 15 = genitalia in dorsal view, 16 = genitalia in ventral view, 17 = phallic organ in left lateral view.



Figures 18–21. *Triaenodes catbana* sp. nov. Male holotype, 18 = genitalia in left lateral view, without phallic organ, 19 = genitalia in dorsal view, 20 = genitalia in ventral view, 21 = phallic organ in left lateral view.

Male genitalia. Segment IX synsclerotized with an oblique suture demarking ventrum of tergite IX; the subdivided sternum with its posterior partially detached unit giving support to the phallobase by its sclerotized strips. Segment X (upper process of segment X) short and bifid. Cerci short broad foliform. Paraproct (lower process of segment X) fused basally forming a short hood over the phallic organ with indiscernible apex. Apical lobe of gonopods tapering apicad in ventral view. Mesal basodorsal process of the basal plate of gonopods slender, very thin, and short. Phallic organ forming a downward curving tube with membranous apex.

Etymology. *catbana*, named for the type locality.

***Triaenodes dusra* Schmid, 1965**

Material examined. Malaysia, Perak, Temengor Lake, 6.12.1993, light leg. G. S. Robinson (1 male, OPC). Vietnam, Moc Chau, 25.10.1986 light leg. J. Oláh (1 male, 1 female; OPC). Bach Thai Province, Quang Chu, 24–25.05.1987, light leg. J. Oláh (6 males, OPC).

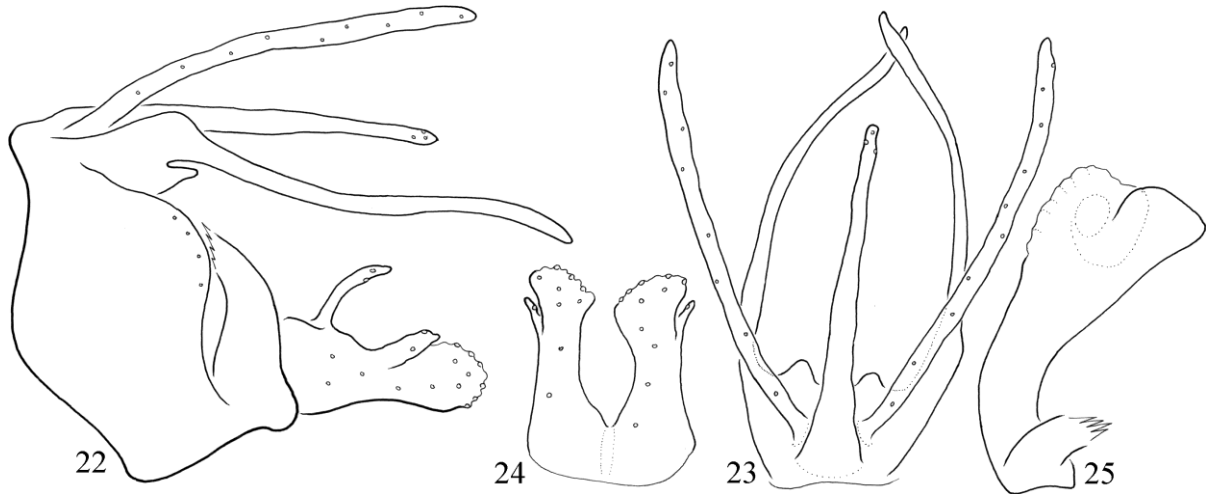
***Triaenodes fioka* sp. nov.**

(Figures 22–25)

Diagnosis. Most close to *T. nakla* sp. nov., but differs by having left arm of paraproct symmetrical with the right arm, not modified with apical third downward and mesad turning; paraproct basement with ventral process; apical margin of gonopods diverged laterad, not rounded in ventral view; mesal basodorsal process slender, not robust.

Material examined. *Holotype.* New Hebrides, Santo, Mt Tabwemasana, Nokowula Vill., 3700', 1–4.09.1971, leg G. S. Robinson, Royal Soc. New Hebrides, 1971 (1 male, NHM). *Paratype.* same as holotype (5 males, 7 females, NHM; 3 males, 2 females OPC).

Description. Male (in alcohol). Brown animal. Scape enlarged, without discernible scent organ; pedicel short, third segment long. Maxillary palp formula IV-I-II-III-V. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern; forewing length 7 mm.



Figures 22–25. *Triaenodes fioka* sp. nov. Male holotype, 22 = genitalia in left lateral view, without phallic organ, 23 = genitalia in dorsal view, 24 = genitalia in ventral view, 25 = phallic organ in left lateral view.

Male genitalia. Segment IX synsclerotized, the subdivided sternum with its posterior partially detached unit giving support to the phallobase by its sclerotized strips. Segment X (upper process of segment X) simple, shorter than cerci. Cerci setose filiform. Paraproct (lower process of segment X) forming a pair of long filiform spine-like processes, downward curving. Gonopods with bilobed apex, ventroapical lobe large diverged laterad in ventral view; mesal basodorsal process of the basal plate of gonopods slender, upward directed. Phallic organ forming a downward curving tube with membranous dorsal inflated lobes.

Etymology. *fioka* from “fióka” nestling in Hungarian, refers to the small ventral process on the paraproctal basement.

***Triaenodes fodra* sp. nov.**

(Figures 26–29)

Diagnosis. This new species has some similarity to *T. theiophora* complex of the *T. intricata* species group, but differs from all described species by having differently structured paraprocts and gonopods.

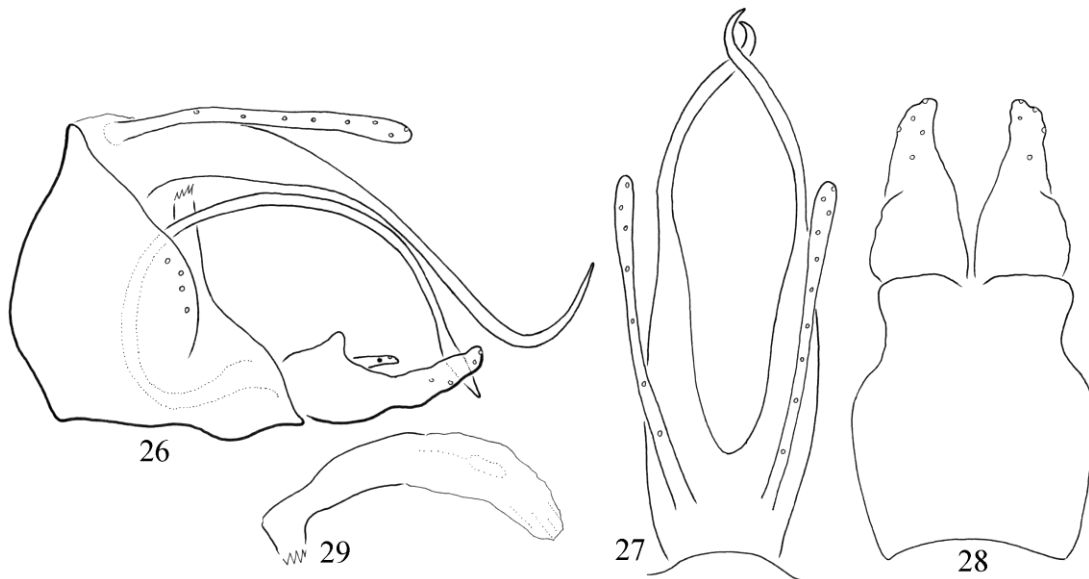
Material examined. Holotype. Indonesia, Papua Barat, Birdshead Peninsula, Arfak Mountains,

Demaisi, 1637 m, 1°10’S, 133°53’E, 14.02.2011, at light PIF expedition (1 male, OPC).

Description. Male (in alcohol). Small, narrow, brown animal. Scape enlarged, 1.2 times longer than head; scent organ covered dorsally with a long flap; pedicel short, third segment long. Maxillary palp formula IV-I-II-III-V. Spur formula 122. Wing membrane pale yellowish, without any pattern; forewing length 6 mm.

Male genitalia. Segment IX triangular, long ventrad, short dorsad, with suture dividing the sternum and separating the posterior sternal region with the phallobase supporting sclerotized strip. Segment X and paraproct fused, deeply subdivided producing the terminal third directed upward, mesad and laterad. Cerci setose digitiform. Gonopods ending in a slightly narrowing apical lobe in lateral view accompanied by a small finger-like mesal subapical process. Mesal basodorsal process slender curving anterad, dorsad and posterad. Phallic organ with short phallobase and the aedeagus without discernible lateral ridges; phallobase receives a pair of sclerotized strips, these strips are rather detached from the ventroapical region of sternite IX.

Etymology. *fodra*, from “fodor, bodor” frill, curl in Hungarian, refers to apical region of segment X with spine-like apices directed upward, mesad and laterad.



Figures 26–29. *Triaenodes fodra* sp. nov. Male holotype, 26 = genitalia in left lateral view, without phallic organ, 27 = genitalia in dorsal view, 28 = genitalia in ventral view, 29 = phallic organ in left lateral view.

***Triaenodes fura* sp. nov.**

(Figures 30–33)

Diagnosis. The strange and unique shape development on the head of segment X and on the apical lobe of gonopods differentiates *T. fura* sp. nov. from all the known species.

Material examined. Holotype. Solomon Islands, Guadalcanal, Popomanasiu approach, 6800 feet, 5.11.1965, black light, Royal Soc. Exped. B. M. 1966–1, (1 male, NHM).

Description. Male (in alcohol). Brown animal. Scape enlarged, without discernible scent organ; pedicel short, third segment long. Maxillary palp formula IV-I-II-III-V. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern; forewing length 7 mm.

Male genitalia. Segment IX synsclerotized, the subdivided sternum with its posterior partially detached unit giving support to the phallobase by its sclerotized strips. Segment X (upper process of segment X) with broadened head having variously enlarged humps of alveoli. Cerci setose filiform, slightly shorter than segment X. Paraproct (lower process of segment X) fused basally forming a hood over the phallic organ with bifid apex. Apical

lobe of gonopods vertically directed, armed with elongated alveoli. Mesal basodorsal process of the basal plate of gonopods slender, arching upward and downward posteriad. Phallic organ forming a downward curving and apicad broadening tube with membranous dorsal inflated lobes.

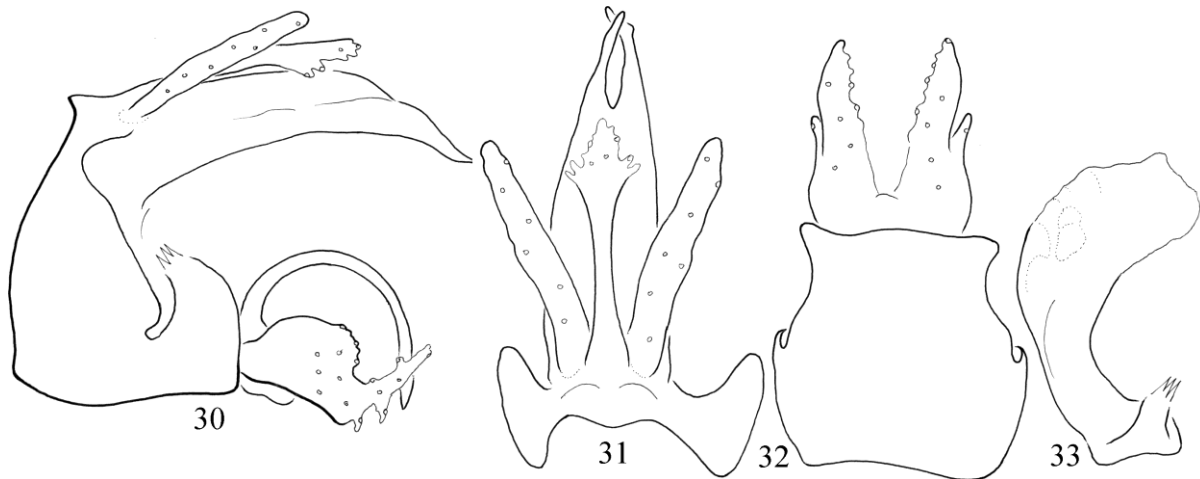
Etymology. *fura* from “fura” strange in Hungarian refers to the unique shape of the head of segment X as well as of the apical lobe on the gonopods.

***Triaenodes gerela* sp. nov.**

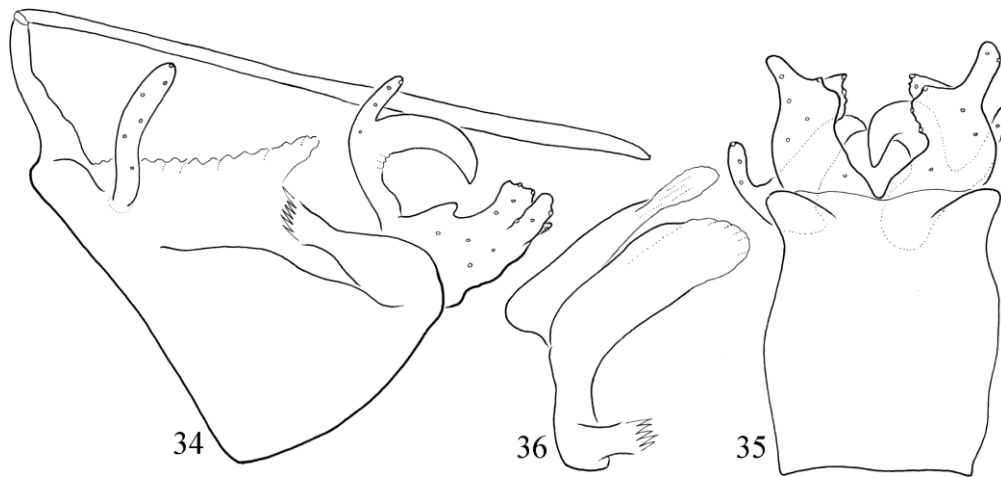
(Figures 34–36)

Diagnosis. The complex of segment X and paraproct evolved into a huge javelin operated by a basal shaft through an articulation pivot in combination with the movement of the phallic organ. Javelin complex connected to the phallobase by a highly wrinkled membranous probably flexible tissue regulating the mating movement of the two structures.

Material examined. Holotype. Solomon Islands, Guadalcanal, Popomanasiu approach, 6800 feet, 5.11.1965, black light, Royal Soc. Exped. B. M. 1966–1, (1 male, NHM).



Figures 30–33. *Triaenodes fura* sp. nov. Male holotype, 30 = genitalia in left lateral view, without phallic organ, 31 = genitalia in dorsal view, 32 = genitalia in ventral view, 33 = phallic organ in left lateral view.



Figures 34–36. *Triaenodes gerela* sp. nov. Male holotype, 34 = genitalia in left lateral view, without phallic organ, 35 = genitalia in ventral view, 36 = phallic organ in left lateral view.

Description. Male (in alcohol). Brown animal. Scape enlarged, without discernible scent organ; pedicel short, third segment long. Maxillary palp formula IV-I-II-III-V. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern; forewing length 6 mm.

Male genitalia. Segment IX synsclerotized, the subdivided sternum with its posterior partially detached unit giving support to the phallobase by its sclerotized strips. Segment X (upper process of segment X), the basal shaft and the paraproct (lower process of segment X), the huge apical

long and straight spine fused together by an articulation and forming together a javelin-shaped structure, performing some kind of javelin function during copulation process. Cerci setose short foliiform. Apical lobes of gonopods forming a rather complex structure. The pair of mesal basodorsal process of the basal plate of gonopods asymmetrical, but with similar basic structure; the lower arm of the bifid curving process more developed, more sclerotized without setae; the upper arm more slender and setose; right process double sized. Phallic organ forming a downward curving

and apicad broadening tube with lateral flanges; right lateral flange more produced.

Etymology. *gerela* from “gerely” javelin in Hungarian refers to the unique structure evolved by the fusion of segment X and paraproct.

***Trianenodes harmasa* sp. nov.**

(Figures 37–38)

Diagnosis. This new species having the mesal basodorsal process lobose and sternum IX subdivided belongs to the *bernaysae* complex of Neboiss and Wells, but differs from all the known species by the differently formed periphallallic organs.

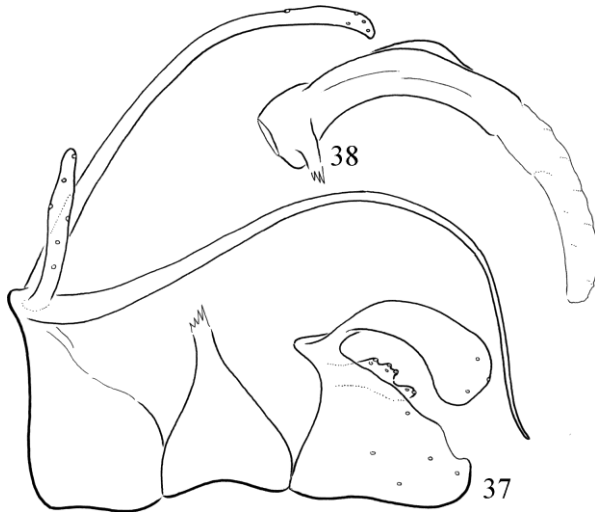
Material examined. Holotype. Indonesia, Papua Barat, Batanta Island, Northern coast, Warmon stream, 0°50'18.40''S, 130°42'41.91''E, above first waterfall, 21.09.2010, light trap, leg R. Horváth (1 male, OPC). *Paratypes.* Locality same as of holotype (1 male, OPC). Papua Barat, Batanta Island, Northern coast, Warmon stream, 0°50'23.25''S, 130°42'35.18''E, below second waterfall, 25.10.2010 light trap, leg R. Horváth (4 males, OPC). Papua Barat, Batanta Island, Northern coast, Warmon stream, 0°841'1.52''S, 130°70'8''E, above second waterfall, 22.01.2013, light trap, leg R. Horváth (1 male, OPC). Papua Barat, Batanta Island, Northern coast, small stream with dry mouth: 0°49'27.84''S, 130°38'45.02''E, 1000–1500m above dry mouth, 28.01.2012, light trap, leg R. Horváth (7 males, OPC). Papua Barat, Batanta Island, Northern coast, Ron stream, 0°49'16.37''S, 130°49'23.72''E, at hut, 8.09.2011, light trap, leg R. Horváth (1 male, OPC). Papua Barat, Batanta Island, Northern coast, small stream, 0°48'47.08''S 130°38'18.91''E, 250m from the mouth: 7.09.2011, light trap, leg R. Horváth (1 male, OPC). Papua Barat, Batanta Island, between Arefi and Teluk Warai, valley of „dried estuary of a stream”, 0°49'42.05''S, 130°38'12.23''E, 229 m, 27.01.2014, at light, leg. T. Kovács, P. Juhász (5 males, OPC). Batanta Island, Welebed, waterwork”, valley of Kalijakut River, 0°53'22.85''S, 130°38'25.91''E, 105 m, 23.01.2014, UV light-trap, leg. T. Kovács,

P. Juhász, R. Horváth (2 males, OPC). Papua Barat, Batanta Island, Welebed, valley of Kalijakut River, 0°53'12.88''S, 130°38'16.40''E, 138m, 23.01.2014, at light, leg. T. Kovács, P. Juhász, R. Horváth (3 males, OPC). Papua Barat, Batanta Island, valley of Warmon Stream, upper waterfall, 0°50'23.25''S, 130°42'35.18''E, 150m, 20.01.2014, at light, leg. T. Kovács, P. Juhász (3 males, OPC). Papua Barat, Batanta Island, valley of Waridor River, 0°51'48.7''S, 130°33'06.3''E, 88 m, 31.01.2014, at light, leg. T. Kovács, P. Juhász (1 male, OPC). Papua Barat, Batanta Island, right side stream of Forum River, 0°52'22.7''S, 130°27'45.1''E, 13.02.2015, at light, T. Kovács, R. Horváth, P. Juhász (5 males, OPC).

Description. Male (in alcohol). Pale animal. Scape little longer than head; scent setae yellow, short, covered with long flap; pairs of strong black scent setal row present on pronotum and smaller on mesonotum; pedicel short with a dorsal digitate elongated process, third segment longer than scape. Maxillary palp formula I-III-IV-II-V. Spur formula 1,2,2. Wing membrane pale yellowish, without any membrane pattern, but with short and long black alar scent setae; forewing length 6 mm.

Male genitalia. Segment IX comprised of the synsclerotized triangular basal ring and of the subdivided similarly triangular posterior partially detached unit giving support to the phallobase by its sclerotized strips. Segment X is represented by a single mesal long filiform process with slightly dilated apex. Cerci setose filiform, much shorter than segment X. Paraprocts forming a pair of long filiform process. Gonopods subtriangular in lateral view with a pair of apicomasal irregular setose lobe. The mesal basodorsal processes on the basal plate of the gonopods lobose. Phallic organ with short phallobase and the aedeagus with low lateral ridges; phallobase receives a pair of sclerotized strips, these strips arisen from the detached apical portion of sternite IX.

Etymology. *harmasa* from “hármás” triple in Hungarian refers to the three almost similarly shaped triangular structures composed of the genitalia: the segment IX, the detached posterior part of the subdivided sternum and the gonopode.



Figures 37–38. *Triaenodes harmasa* sp. nov. Male holotype, 37 = genitalia in left lateral view, without phallic organ, 38 = phallic organ in left lateral view.

***Triaenodes hasa* sp. nov.**

(Figures 39–42)

Diagnosis. Having the left mesal basodorsal process lost, similar to *T. telefomicus* Kumanski and *T. paratlan* Oláh & Mey, but differs from both by having the right mesal basodorsal process dilated and without any subapical process.

Material examined. Holotype. Indonesia, Papua Barat, Birdshead Peninsula, Arfak Mountains, mountain top stream, 2149m, 1°07.620'S 133°44.333'E, 19.05.2014, at light, leg. R. Horváth (1 male, OPC).

Description. Male (in alcohol). Brown animal, Scape enlarged, with scent organ of long setae accompanied by a long flap; pedicel short, third segment long. Maxillary palp formula IV-I-V-II-III. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern; forewing length 8 mm.

Male genitalia. Segment IX synsclerotized, subtriangular in lateral view; well-sclerotized frame of sutures encircles the very small tergite IX subdivided into three facets, as visible in dorsal view. Segment X comprising of filiform trifid mesal process (upper process of segment X); the

median arm of the trifid mesal process shorter than the lateral processes; a pair of short, bare digitate processes present basodorsad. Cerci setose filiform, as long as the lateral processes of segment X. Paraproct (lower process of segment X) forming a short subtriangular plate with chazae basad and setae apicad. Gonopods bilobed apicad; upper lobe digitiform, lower lobe lobate; left mesal basodorsal process lost, right mesal basodorsal process of the basal plate of gonopods curving upward, downward and leftward, highly dilated or bellied one third subbasad. Phallic organ with extremely developed high left ridge; phallobase connected with a pair of lateral sclerotized strips to ventroapical corner of segment IX; this sclerotized strips produced discontinuity in ventrum IX.

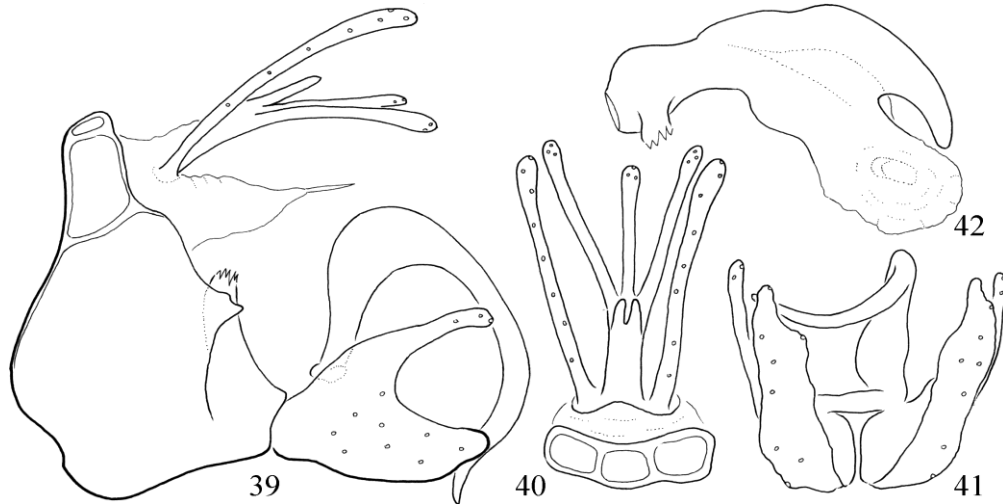
Etymology. *hasa*, from “hasas” bellied in Hungarian, refers to the dilated, bellied submedian section of the mesal basodorsal process arisen from the basal plate of gonopods.

***Triaenodes izgaga* sp. nov.**

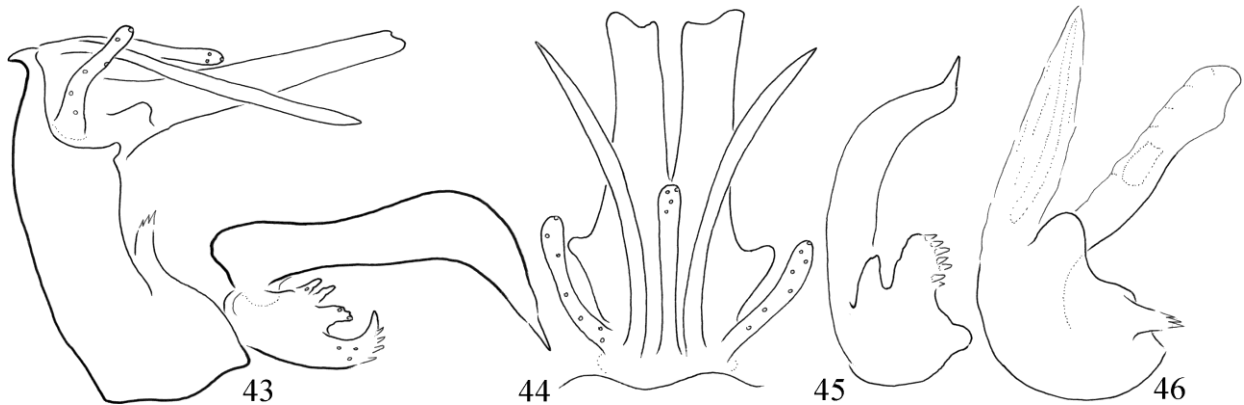
(Figures 43–46)

Diagnosis. The genus *Triaenodes* has lost the parameres and developed various androconium to replace or substitute paramere function in the sexual selection processes. This new species has a pair of huge parameres on the phallic organ. Similar pair of parameres positioned on the dorsum of the phallic organ has also been found at *T. costalis* Kimmins and *T. sinis* Malicky. *T. izgaga* is most similar to *T. sinis*, but differs by having parameres deeply excised and the lateral lobes each bifid, not shallow excised and the lateral lobes pointed; gonopods and the lateral basodorsal processes are differently shaped.

Material examined. Holotype. Indonesia, Papua Barat, Batanta Island, Northern coast, Ron stream, above hut, 0°49'18.03"S, 130°49'26.03"E, 15.10.2010, light trap, leg R. Horváth (1 male, OPC). **Paratypes.** Papua Barat, Batanta Island, Northern coast, Warmon stream, 0°50'18.40"S, 130°42'41.91"E, above first waterfall, 21.09.2010, light trap, leg R. Horváth (3



Figures 39–42. *Triaenodes hasa* sp. nov. Male holotype, 39 = genitalia in left lateral view, without phallic organ, 40 = genitalia in dorsal view, 41 = genitalia in ventral view, 42 = phallic organ in left lateral view.



Figures 43–46. *Triaenodes izgaga* sp. nov. Male holotype, 43 = genitalia in left lateral view, without phallic organ, 44 = genitalia in dorsal view, 45 = left gonopod in ventral view, 46 = phallic organ in left lateral view.

males, OPC). Papua Barat, Batanta Island, Northern coast, Warmon stream, 0°50'23.25''S, 130°42'35.18''E, below second waterfall, 25.10.2010 light trap, leg R. Horváth (2 males, OPC). Papua Barat, Batanta Island, Northern coast, Warmon stream, 0°50'29.47'' S, 130°42'29.16''E above second waterfall, 22.01.2013, light trap, leg R. Horváth (2 male, OPC). Papua Barat, Batanta Island, Northern coast, Warmon stream, 0°50'8.52''S, 130°42'50.4'' E, below first waterfall, 22.01.2013, light trap, leg R. Horváth (2 males, OPC). Papua Barat, Batanta Island, Northern coast, Waridor River 0°50'51.04'' S, 130°31'

10.85''E under great clearing, 18.01.2013, light trap, leg R. Horváth (1 male, OPC). Papua Barat, Batanta Island, valley of Warmon Stream, upper waterfall, 0°50'23.25''S, 130°42'35.18''E, 150m, 20.01.2014, at light, leg. T. Kovács, P. Juhász (14 males, OPC). Papua barat, Batanta Island, valley of Warmon Creck, lower waterfall, 0°50'04.50''S, 130°42'54.01''E, 37m, 21.01.2014, at light leg.T. Kovács, P. Juhász, R. Horváth (3 males, OPC). Papua Barat, Batanta Island, valley of Waridor River, 0°51'48.7''S, 130°33'06.3''E, 88m, 31.01.2014, at light, leg. T. Kovács, P. Juhász (1 male, OPC).

Description. Male (in alcohol). Medium-sized, brown animal. Scape enlarged, with scent organ covered with a long flap; brown short setae comprised of androconia; pedicel bears similar short brown setae of androconia; third antennal segment long. Black and long setae of androconia present as long tuft on the basal region of costal vein and on the tegula. Maxillary palp formula IV-I-II-(II,III,V). Spur formula 1,2,2. Wing membrane pale yellowish, without pronounced pattern; forewing length 9 mm.

Male genitalia. Segment IX fused and short, without any discernible suture or groove; posterior region of sternum IX giving a sclerotized strip to support phallobase. Segment X composed of a shorter digitiform setose mesal process and a pair of spine-like lateral process down and laterad directed. Paraproct evolved into a large plate over the phallic organ with basolateral humps and deeply divided bifid lateral lobes. Cerci setose digitiform, shorter than segment X. Gonopods with upward curving apex and one larger and two smaller digitiform dorsal process; huge spine-like lateral basodorsal process curving downward and mesad. Middle located phallic organ with enlarged phallobase; a unique pair of large paramere striated with a discernible internal spine-like structure; phallobase receives a pair of sclerotized strips, this strip detached from the ventroapical region of sternite IX.

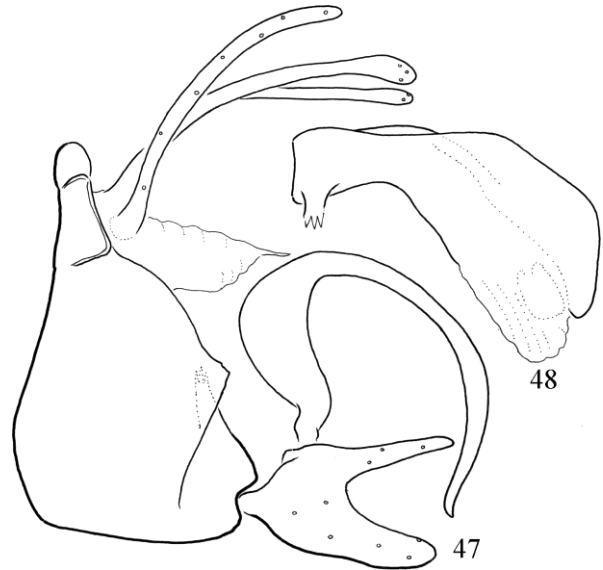
Etymology. *izgaga*, from “izgága” twitchy, restless in Hungarian, refers to the various brown antennal and black alar androconia evolved in sexual selection, as well as the presence in a highly produced form of the titillating parameres.

***Triaenodes jobba* sp. nov.**

(Figures 47–48)

Diagnosis. Having the left mesal basodorsal process lacking and the right process present, this new species is a sibling of the species *T. bala* sp. nov., *T. hasa* sp. nov., *T. paratlan* Oláh & Mey, and *T. telefomicus* Kumanski. The position of the dilation on the mesal basodorsal process distinguishes these siblings.

Material examined. Holotype. Indonesia, Papua Barat, Batanta Island, Northern coast, Waridor River 0°52'6.24"S, 130°31'30.58"E, 18.01. 2013, light trap, leg R. Horváth (1 male, OPC).



Figures 47–48. *Triaenodes jobba* sp. nov. Male holotype, 37 = genitalia in left lateral view, without phallic organ, 38 = phallic organ in left lateral view.

Description. Male (in alcohol). Brown animal, Scape enlarged, with scent organ of long black setae accompanied by a long flap; pedicel short, third segment long. Maxillary palp formula IV-II-I-III-V. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern; forewing length 7 mm.

Male genitalia. Segment IX synsclerotized, subtriangular in lateral view; well-sclerotized frame of sutures encircles the very small tergite IX subdivided into three facets, as visible in dorsal view. Segment X comprising of filiform trifid mesal process (upper process of segment X); the median arm of the trifid mesal process as long as the lateral processes; lateral processes with mesad turning capitate apex, a pair of short, bare digitate processes lacking or indistinct basodorsad. Cerci setose filiform, as long as the lateral processes of segment X. Paraproct (lower process of segment X) forming a short subtriangular plate with ch-lazae basad and setae apicad. Gonopods bilobed

apicad; upper lobe digitiform, lower lobe lobate; left mesal basodorsal process lost, right mesal basodorsal process of the basal plate of gonopods curving upward, downward and leftward, dilated or bellied one third basad. Phallic organ with extremely developed high left ridge; phallobase connected with a pair of lateral sclerotized strips to ventroapical corner of segment IX; this sclerotized strips produced discontinuity in ventrum IX.

Etymology. *jobba* from “jobb” right in Hungarian refers to the right mesal basodorsal process of the basal plate on the gonopods present.

***Triaenodes kalija* sp. nov.**

(Figures 49–52)

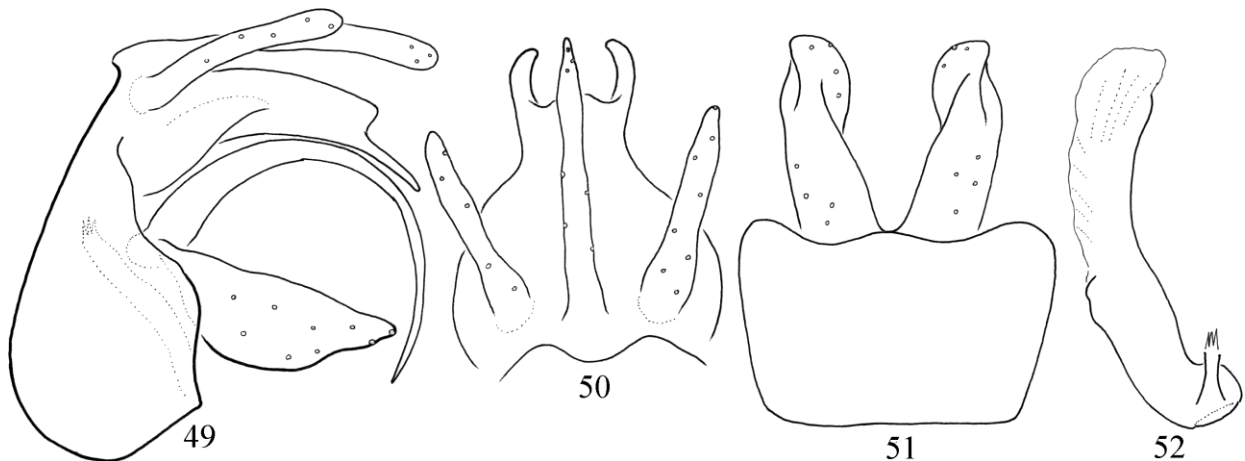
Diagnosis. The basic architecture of the genitalia is similar to *T. marleorum* sp. nov., *T. sarla* sp. nov., *T. tafana* Kimmins, *T. thespios* Malicky *T. torpa* sp. nov., but differs by having paraproct with lateral lobes; by different lateral profile of the gonopods; paramere lacking similarly to *T. sarla* sp. nov.

Material examined. *Holotype.* Indonesia, Papua Barat, Batanta Island, Welebed, “waterwork”, valley of Kalijakut River, 0°53'22.85"S, 130°

38'25.91"E, 105m, 23.01.2014, UV light-trap, leg. T. Kovács, P. Juhász, R. Horváth (1 male, OPC). *Paratypes.* Papua Barat, Batanta Island, Welebed, valley of Kalijakut River, 0°53'12.88"S, 130°38'16.40"E, 138m, 23.01. 2014, at light, leg. T. Kovács, P. Juhász, R. Horváth (5 males, 1 female; OPC). Papua Barat, Batanta Island, Kalijakut River, 0°52'49.1"S, 130°38'4.9"E, 16.02.2015, UV light-trap, leg. T. Kovács, P. Juhász, (12 males, 2 females; OPC). Papua Barat, Batanta Island, Kalijakut River, 0°52'52.0"S, 130°38'8.0"E, 16.02.2015, at light, leg. T. Kovács, P. Juhász (2 males, OPC).

Description. Male (in alcohol). Small, brown animal. Scape enlarged, without discernible scent organ and covering flap; pedicel short, third segment long. Maxillary palp formula IV-I-(II,III,V). Spur formula 1,2,2. Wing membrane pale yellowish, hyaline window present on lower anastomosis; forewing length 7 mm.

Male genitalia. Segment IX fused with triangular sternum and short tergum, without any discernible suture or groove. Segment X simplified into a single gradually tapering median process with few tiny emerged setae. Paraproct forming a broad based plate hooding the phallic organ, constricted subapicad and produced apicolateral lobes.



Figures 49–52. *Triaenodes kalija* sp. nov. Male holotype, 49 = genitalia in left lateral view, without phallic organ, 50 = genitalia in dorsal view, 51 = genitalia in ventral view, 52 = phallic organ in left lateral view.

Cerci setose digitiform, shorter than segment X. Gonopods subtriangular in lateral view; spine-like lateral basodorsal process curving. Middle located phallic organ more sclerotized ventrad; phallobase receives a pair of sclerotized strips from the ventroapical region of segment IX.

Etymology. Named for the type locality.

***Triaenodes ketaga* sp. nov.**

(Figures 53–56)

Diagnosis. Most close to *T. manni* Banks, 1936 described from Viti Levu, but differs by having cerci shorter than segment X, while cerci longer than segment X at *T. manni*; segment X broadly bifid, not simple; gonopods subquadrangular in lateral view, not with triangular apical margin and not constricted middle, mesal basodorsal process short and robust, not slender.

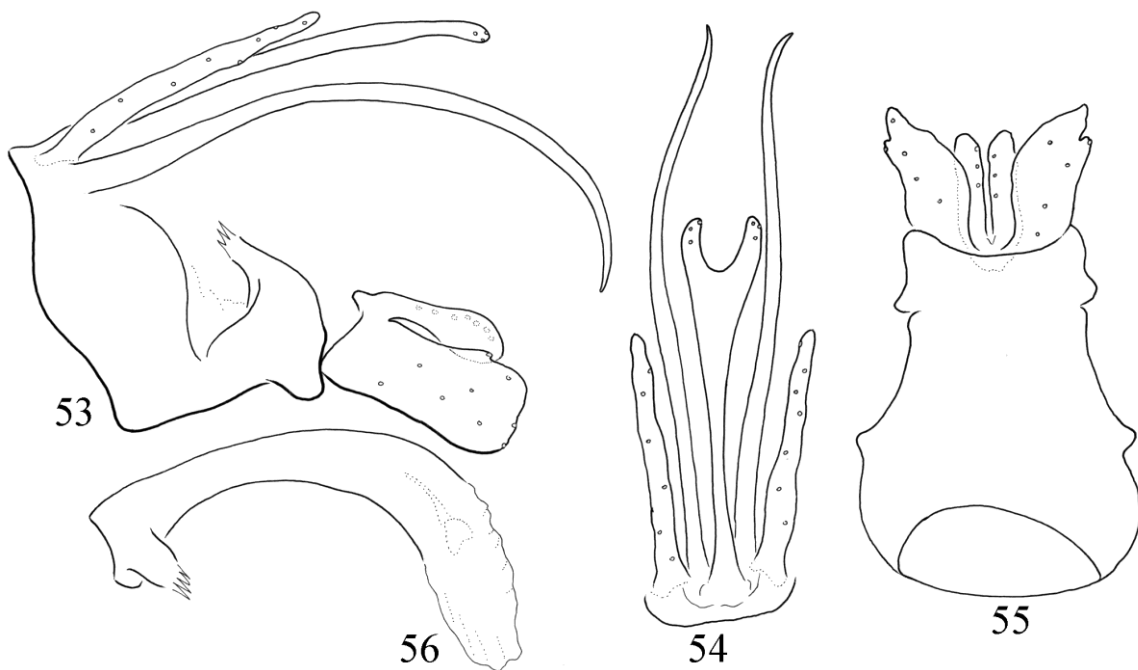
Material examined. Holotype. Fiji Islands, Viti Levu, Forestry Area, 10 m, Inland from Galoa, 31.08.1975, M.V. light, leg. P.A. Maddison (1

male, FVI4255, NHM).

Description. Male (in alcohol). Brown animal. Scape enlarged, without discernible scent organ, pedicel short, third segment long. Maxillary palp formula IV-I-II-III-V. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern; forewing length 6 mm.

Male genitalia. Segment IX synsclerotized, the subdivided sternum with its posterior partially detached unit giving support to the phallobase by its sclerotized strips. Segment X (upper process of segment X) comprising of filiform bifid mesal process; bifid apex broadening. Cerci setose filiform, shorter than segment X. Paraproct (lower process of segment X) forming a pair of long filiform spine-like processes, downward curving on its apical third. Gonopods subquadrangular in lateral view; small dorsal subapical lobe present; mesal basodorsal process of the basal plate of gonopods short capitate. Phallic organ forming a downward curving tube with membranous apex.

Etymolog. *ketaga* from “kétagú” two-armed in Hungarian refers to bifid apex of segment X.



Figures 53-56. *Triaenodes ketaga* sp. nov. Male holotype, 53=genitalia in left lateral view, without phallic organ, 54=genitalia in dorsal view, 55=genitalia in ventral view, 56=phallic organ in left lateral view.

***Triaenodes koba* sp. nov.**

(Figures 57–60)

Diagnosis. Most close to *T. bunka* sp. nov., but differs by having segment X with short capitate apex; pair of paraproct spines asymmetrical; gonopods with ventroapical lobe rounded, not truncate; mesal basodorsal process differently shaped; membranous endotheca more elaborated, especially on dorsum.

Material examined. Holotype. Fiji Islands, Vanua Levu, Savudvodro Dam, 10.02.1971, leg. G.S. Robinson (1 male, NHM).

Description. Male (in alcohol). Brown animal, Scape enlarged, without discernible scent organ; pedicel short, third segment long. Maxillary palp formula IV-I-II-III-V. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern; forewing length 8 mm.

Male genitalia. Segment IX synsclerotized, the subdivided sternum with its posterior partially detached unit giving support to the phallobase by its sclerotized strips. Segment X (upper process of segment X) filiform with wrinkled apex. Cerci setose filiform, little shorter than segment X.

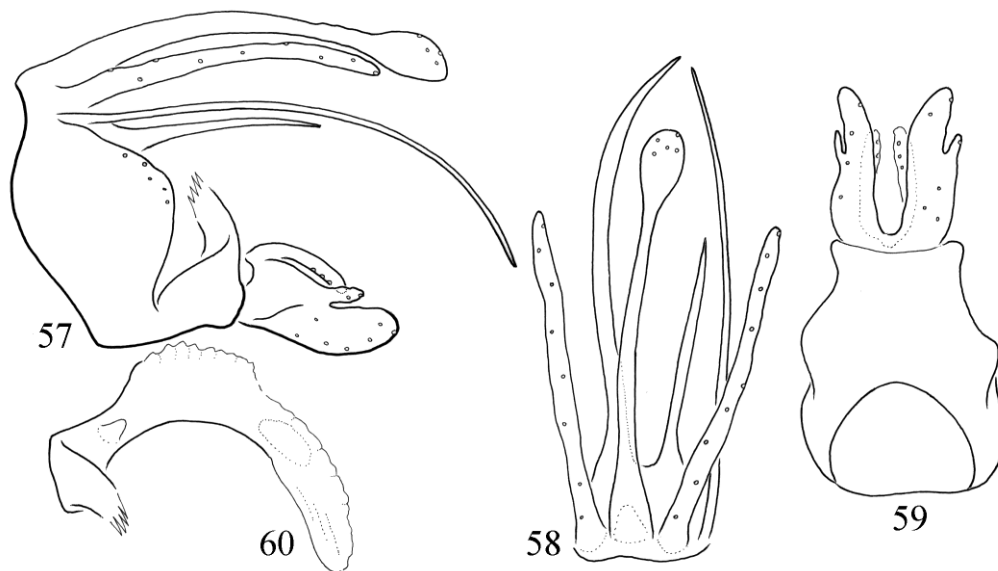
Paraproct (lower process of segment X) forming a pair of long filiform asymmetric spine-like processes, left process half as developed and long as the right side process. The single asymmetric spine like sclerotized pointed process attached to paraproct basement is more developed as long as the right-side paraproctal process. Gonopods bilobed, ventral lobe enlarged; mesal basodorsal process of the basal plate of gonopods ventrally flat and very broad. Phallic organ forming a downward arching tube with membranous apex and dorsum.

Etymology. *koba* from “kobak” head in Hungarian, refers to the short capitate apex of segment X.

***Triaenodes lemeza* sp. nov.**

(Figures 61–64)

Diagnosis. This small new species has resemblance to the *T. doryphora* complex of the *T. intricata* species group established by Neboiss & Wells (1998), especially to *T. empheira*, but differs by having paraproct fused, not paired as well as the gonopods and the mesal basodorsal process differently formed.



Figures 57–60. *Triaenodes koba* sp. nov. Male holotype, 57 = genitalia in left lateral view, without phallic organ, 58 = genitalia in dorsal view, 59 = genitalia in ventral view, 60 = phallic organ in left lateral view.

Material examined. Holotype. Indonesia, Papua Barat, Birdshead Peninsula, Snow Mountains, Baliem Resort, 1947m, 20 km from Wamena, 4°03.578'S 139°01.747'E, 23–28. 05. 2014, at light, leg. R. Horvath (1 male, OPC). *Paratype.* Locality same as of holotype (1 male, OPC).

Description. Male (in alcohol). Pale animal. Scape short as long as head; scent setae yellow short with upward curving apical third; pedicel short, third segment as long as scape. Maxillary palp formula I-IV-(II,III)-V. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern; forewing length 5 mm.

Male genitalia. Segment IX comprised of the synsclerotized basal ring and the subdivided sternum with its posterior partially detached unit giving support to the phallobase by its sclerotized strips. Segment X is represented by a single mesal long filiform process with slightly dilated apex. Cerci setose filiform, shorter than segment X. Paraprocts fused, not paired and composed of the short, less sclerotized pointed structure below segment X and of a single heavily sclerotized spine-like long downward curving process. Gonopods subtriangular in lateral view with a tapering apicoventral lobe bearing only a few apical setae and with an apicomasal lobe fully packed with short and strong setae on its mesal surface. The mesal basodorsal processes on the basal plate of

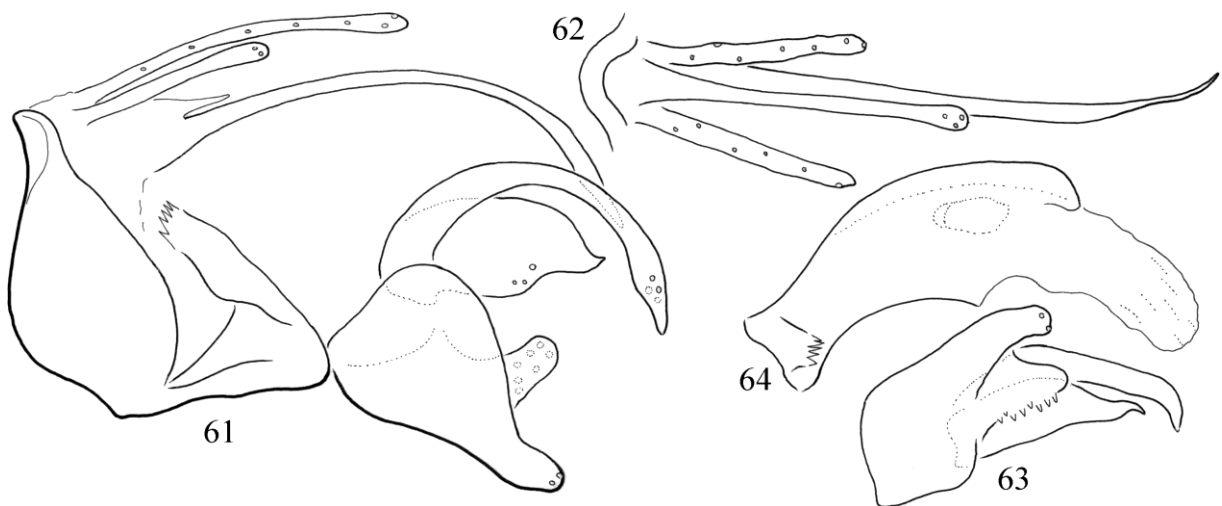
the gonopods composed of a sickle-shaped broad digitiform spine-like process and a vertical laminar plate pointed apicad. Phallic organ with short phallobase and the aedeagus with low lateral ridges; phallobase receives a pair of sclerotized strips, these strips arisen from the rather detached apical portion of sternite IX.

Etymolog. *lemeza* from “lemezes” laminar in Hungarian, refers to the platform (plate-shaped), laminar additional structure combined with the mesal basodorsal process on the basal plate of gonopods.

***Triaenodes marleorum* sp. nov.**

(Figures 65–68)

Diagnosis. Having a single paramere below the aedeagus this new species is similar to *T. tafana* Kimmins, *T. thespios* Malicky and *T. torpa* sp. nov., but differs from them by having paraproct almost truncate, only slightly excised apicad in dorsal view, lateral profile of gonopods different; lateral basoventral region of paraproct similar to *T. torpa* sp. nov. with very elaborated pattern of lobes and fingers, partially present at *T. tafana*, completely lacking at *T. thespios*, at least not recorded and not drawn. These four species form a rather similar complex with the presence of spine-shaped single paramere.



Figures 61–64. *Triaenodes lemeza* sp. nov. Male holotype, 61 = genitalia in left lateral view, without phallic organ, 62 = genitalia in dorsal view, 63 = left gonopod in ventral view, 64 = phallic organ in left lateral view.

Material examined. Holotype. Indonesia, Papua Barat, Batanta Island, Northern coast, Waridor River, 0°50'37.43"S, 130°31'28.45"E shippable endpoint, 9.09.2011, light trap, leg R. Horváth (1 male, OPC). *Paratype.* Papua Barat, Batanta Island, Kalijakut River, 0°52'52.0", 130°38'8.0", 16.02.2015, at light, leg. T. Kovács, P. Juhász (1 male, OPC).

Description. Male (in alcohol). Small, brown animal. Scape slightly enlarged, without dispensable scent organ; pedicel short, third segment long. Maxillary palp formula IV-I-II-III-V. Spur formula 1,2,2. Wing membrane pale yellowish, without any hyaline window; forewing length 4 mm.

Male genitalia. Segment IX fused with triangular sternum and short tergum, tergum visible as a more sclerotized vertical band. Segment X simplified into a single filiform median process with a few tiny emerged setae. Paraproct composed of a horizontal plate broadening laterad on basal half and hooding the phallic organ, a pair of lateral lobe with very slender filiform process. Cerci setose digitiform, shorter than segment X. Gonopods with upward curving apex and a small budding dorsal process middle; spine-like lateral basodorsal curving process. Middle located phallic organ asymmetric with more developed left lateral ridge; a unique single, well developed black spine-like paramere present; phallobase receives a pair of sclerotized strips, this strip runs on the

apical margin of sternite IX as a more pigmented darker band.

Etymology. This species is dedicated to Rodolfo Giusti de Marle and Iskandar F. Giusti de Marle, staff members of the Papua Paradise Eco-Resort (Birie Island). They have participated in caddisfly collection on Batanta Island.

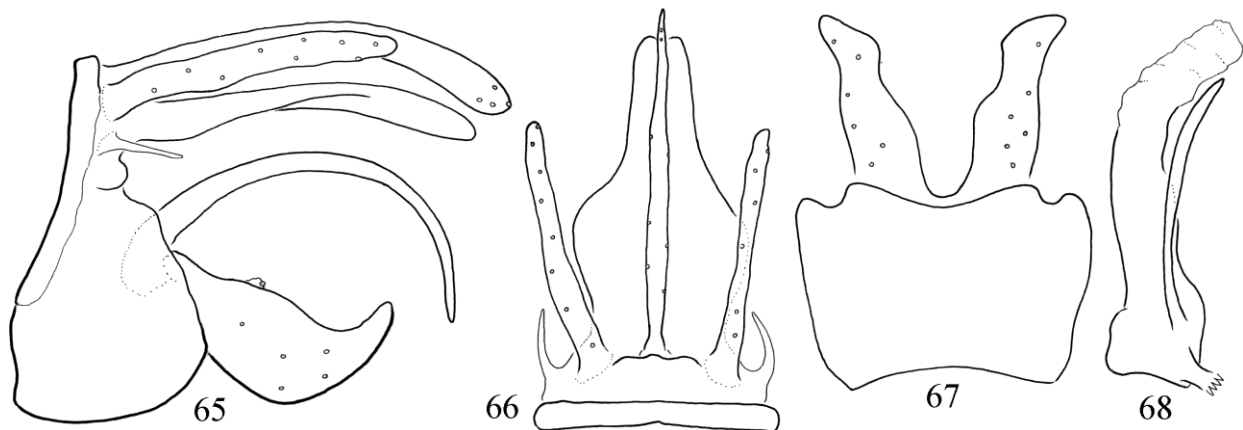
***Triaenodes nakla* sp. nov.**

(Figures 69–72)

Diagnosis. Most close to *T. fioka* sp. nov., but differs by having left arm of paraproct modified with apical third downward and mesad turning; paraproct basement without ventral process; apical margin of gonopods rounded in ventral view, not diverged laterad; mesal basodorsal process robust, not slender.

Material examined. Holotype. New Hebrides, Ridge E of South Bay, Malekula 1300 feet, 12.10.1971, leg. G. S. Robinson, Royal Soc. New Hebrides, 1971 (1 male, NHM). *Paratype.* New Hebrides, Santo, Mt Tabwemasana 4500 feet, 2.09.1971, leg. G. S. Robinson, Royal Soc. New Hebrides, 1971 (1 male, OPC).

Description. Male (in alcohol). Brown animal. Scape enlarged, without discernible scent organ; pedicel short, third segment long. Maxillary palp formula IV-I-II-III-V. Spur formula 1,2,2.



Figures 65–68. *Triaenodes marleorum* sp. nov. Male holotype, 65 = genitalia in left lateral view, without phallic organ, 66 = genitalia in dorsal view, 67 = genitalia in ventral view, 68 = phallic organ in left lateral view.

Wing membrane pale yellowish, without any pattern; forewing length 8 mm.

Male genitalia. Segment IX synsclerotized, the subdivided sternum with its posterior partially detached unit giving support to the phallobase by its sclerotized strips. Segment X (upper process of segment X) simple, shorter than cerci. Cerci setose filiform. Paraproct (lower process of segment X) forming a pair of long filiform spine-like processes, downward curving; left arm deformed: downward turning shallow C-shaped in lateral view and mesad directed shallow S-shaped in dorsal view. Gonopods with bilobed apex, ventroapical lobe large rounded, dorsal lobe small; mesal basodorsal process of the basal plate of gonopods short upward directed. Phallic organ forming a downward curving tube with membranous dorsal inflated lobes.

Etymology. *nakla* from “nyakla” a kind of collapse or crumple in Hungarian refers to the deformed shape of the left arm of the spine-like paraproct.

***Triaenodes nemaproka* sp. nov.**

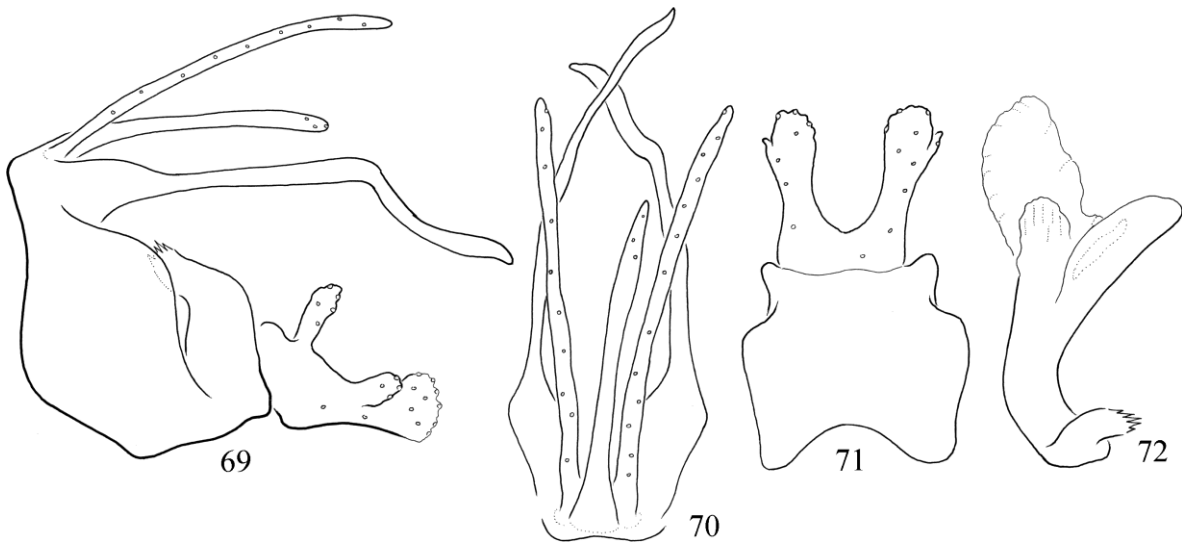
(Figures 73–74)

Diagnosis. The basic architecture of the genitalia, and particularly the dorsum of segment IX

with suture separated tergum, is similar to *T. aproka* sp. nov., *T. bala* sp. nov., *T. hasa* sp. nov., *T. jobba* sp. nov., *T. paratlan* Oláh & Mey, and *T. telefomicus* Kumanski. However, the left mesal basodorsal process is present not lost. Together with *T. aproka* this new species is probably the ancestral species of the lineage. Most close to *T. aproka* sp. nov., but differs by having tergum IX less framed by sutures; by segment X shorter with triangular apex, not with capitate apex; by differently shaped mesal basodorsal processes and gonopods.

Material examined. *Holotype.* Indonesia, Papua Barat, Batanta Island, Teluk Warai, stream, 0°50'51.0"S, 130°35'14,0"E, 11.02.2015, at light, leg. T. Kovács, P. Juhász (1 male, OPC). *Paratypes.* Locality same as of holotype (1 male, OPC). Papua Barat, Batanta Island, Kalijakut River, 0°52'49.1"S, 130°38'4.9"E, 16.02.2015, UV light-trap, leg. T. Kovács, P. Juhász, (1 male, OPC).

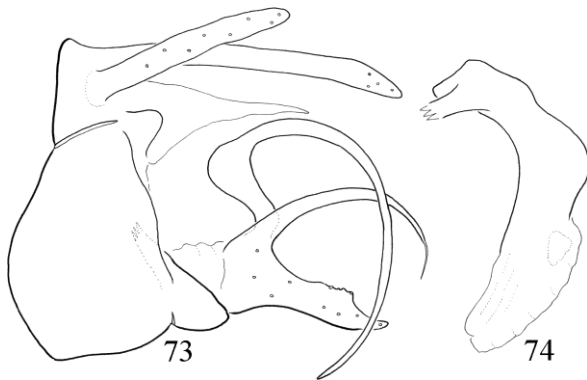
Description. Male (in alcohol). Brown animal, Scape slightly enlarged, with discernible scent organ present as a darker flap-covered area; pedicel short, third segment long. Maxillary palp formula IV-I-III-II-V. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern and without any scent setae; forewing length 7 mm.



Figures 69–72. *Triaenodes nakla* sp. nov. Male holotype, 69 = genitalia in left lateral view, without phallic organ, 70 = genitalia in dorsal view, 71 = genitalia in ventral view, 72 = phallic organ in left lateral view.

Male genitalia. Segment IX synsclerotized, subtriangular in lateral view; sclerotized frame of sutures encircles the very small tergite IX incomplete. Anterior suture lacking. Segment X comprising of digitiform mesal process (upper process of segment X) with triangular apex. Cerci setose filiform, two-thirds long of segment X. Paraproct (lower process of segment X) forming a less sclerotized long mesal process. Gonopods bilobed apicad; upper lobe long arching digitiform, lower lobe shorter; a pair of mesal basodorsal process present curving upward and downward. Phallic organ with dilated membranous apical portion of the aedeagus; phallobase connected with a pair of lateral sclerotized strips to sclerotized strips produced discontinuity in ventrum IX.

Etymology. *nemaproka*, from “nem apróka” not tiny in Hungarian, refers to similarity, but a recent contemporary divergence from *T. aproka* sp. nov.



Figures 73–74. *Triaenodes nemapraka* sp. nov. Male holotype, 73 = genitalia in left lateral view, without phallic organ, 74 = phallic organ in left lateral view.

***Triaenodes paratlan* Oláh & Mey, 2013**

(Figures 75–79)

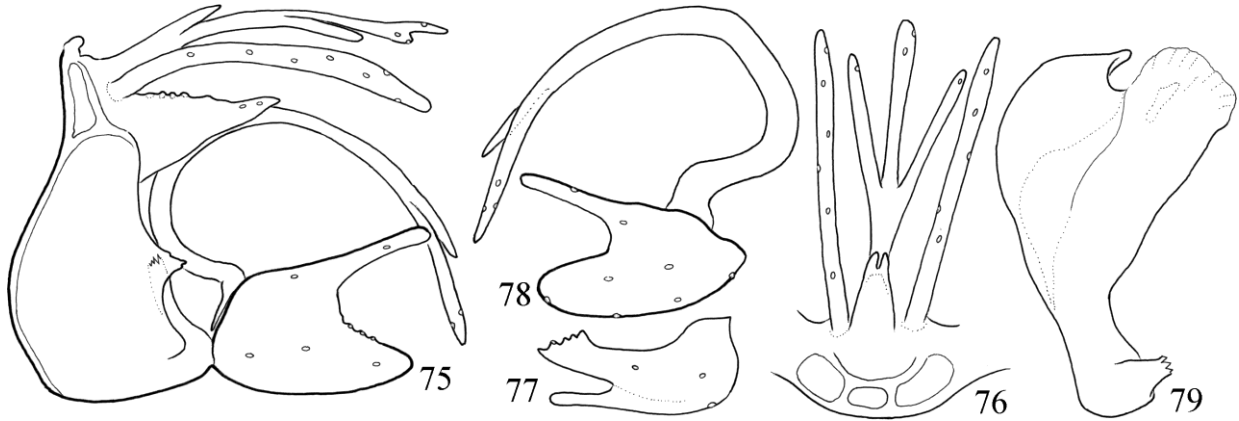
Remarks. In the original description we have compared *T. paratlan* described from Indonesia, Papua, Kecamatan Nipsan, Walmak, to *T. mondoana* Kimmins. It was a mistake. *T. paratlan* is more close to *T. telefominicus* Kumanski, 1979

described from the West Sepic Province of Papua New Guinea. Their basic genital architecture is very similar. Both species have paired mesal basodorsal process and its housing ridge on the aedeagus asymmetric. The left mesal basodorsal process revolved vestigial almost lost entirely. The paired lateral ridges or flanges of the aedeagus, housing the curved spiny mesal basodorsal process during rest or in action, also evolved asymmetric; the right ridge is less developed and the downward directed roofing is lost; the left ridge with well-developed roofing, serving its function, together with the less developed right ridge, to hold the paramere analogue in a dorsally fixed pulling or pushing direction.

Triaenodes paratlan and *T. telefominicus* are closely related incipient sibling species diverged and diverging in the fine structures of those traits that are directly involved in reproductive isolation. The paramere is lost in *Triaenodes*. In this sibling species pair the paramere function in copulation is taken over by the single mesal basodorsal process of the basal plate of the gonopods. Possible divergences in fine structures between the two species: (1) the internal additional spine-like process on the right mesal basodorsal process is smaller and located on one third subapicad, not long with middle location; (2) the internal additional spine-like process has fine spine-like setae on the tip and along its dorsomesal region, not recognised in *T. telefominicus*; this microspine row may have dramatic titillating or harming effect during copulation. (3) The shape of the functional right ridge on the aedeagus is differently formed, due probably to the diverged basodorsal process. However, as usual more specimens are required from both species to examine the extent and the stability of divergences.

***Triaenodes pellectus* Ulmer, 1908**

Material examined. Vietnam, Bach Thai Province, Quang Chu, 24–25.05.1987, light leg. J. Oláh (2 males, 2 females; OPC). Bac Thai Province, Phuluong, Dong Dat, 26.05.1987, light leg. J. Oláh (2 males, 1 female; OPC).



Figures 75–79. *Triaenodes paratlan* Oláh & Mey, 2013. Male holotype, 75 = genitalia in left lateral view, without phallic organ, 76 = genitalia in dorsal view, 77 = left gonopod in ventral view, 78 = right gonopod with the right mesal basodorsal process in right lateral view, 79 = phallic organ in left lateral view.

***Triaenodes pentheus* Malicky, 2005**

Material examined. Vietnam, Moc Chau, 25.10.1986, light, leg. J. Oláh (1 male, 1 female; OPC).

***Triaenodes picinka* sp. nov.**

(Figures 80–83)

Diagnosis. Having lobose mesal basodorsal process *picinka* is close to the speciose *T. bernaysae* complex of Neboiss & Wells, but differs by the plate-shaped fused paraproct hooding over the phallic organ.

Material examined. Holotype. Solomon Islands, San Jorge, Casuarina Forest, nr. Stream, vac. Collector, low herbage and litter, 26.09.1965, Royal Soc. Exped. B. M. 1966-1 (1 male, NHM). *Paratype.* Locality same as of holotype (1 male, OPC).

Description. Male (in alcohol). Brown animal, Scape slightly enlarged, without discernible scent organ; pedicel short, third segment long. Maxillary palp formula IV-I-II-III-V. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern; forewing length 3 mm.

Male genitalia. Segment IX synsclerotized, the subdivided sternum with its posterior partially detached unit giving support to the phallobase by

its sclerotized strips. Segment X (upper process of segment X) is a short blunt mesal process. Cerci broad, setose foliform, much longer than the abbreviated segment X. Paraproct (lower process of segment X) forming a mesal hooding plate over the phallic organ. Gonopods bilobed, apical margin rounded, dorsal lobe small; mesal basodorsal process of the basal plate of gonopods downward curving. Phallic organ forming a slightly curving tube with membranous apex.

Etymology. *picinka* from “picinyke” very small in Hungarian, refers to very small size.

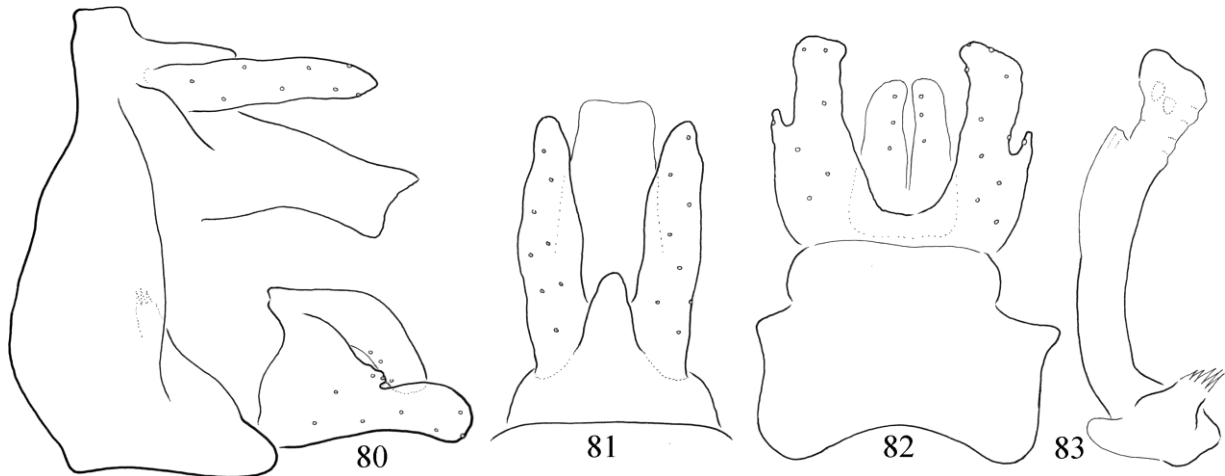
***Triaenodes qinglingensis* Yang & Morse, 2000**

Material examined. Vietnam, Tam Dao, 10.05.1987 light leg. J. Oláh (1 male, OPC). Bach Thai Province, Quang Chu, 24–25.05.1987, light leg. J. Oláh (4 males, OPC).

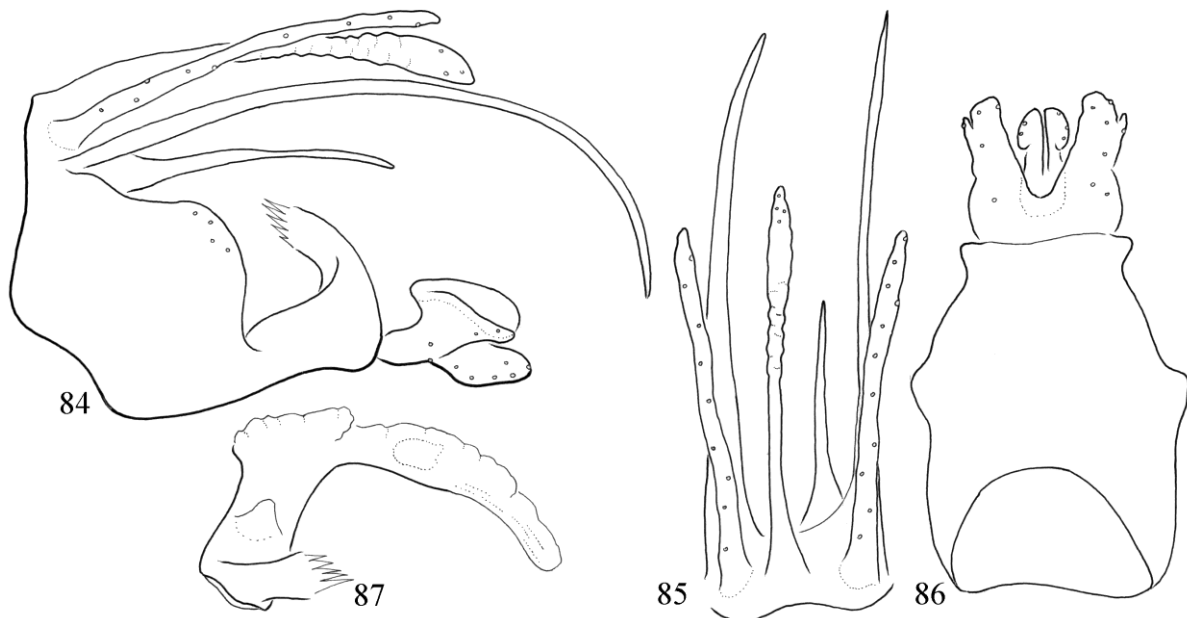
***Triaenodes ranca* sp. nov.**

(Figures 84–87)

Diagnosis. Most close to *T. buzoga* sp. nov., but differs by having segment X with wrinkled apex; gonopods short, apical lobes differently shaped; mesal basodorsal process differently shaped, vertically flat and very broad; membranous endotheca more elaborated, especially on dorsum.



Figures 80–83. *Triaenodes picinka* sp. nov. Male holotype, 80 = genitalia in left lateral view, without phallic organ, 81 = genitalia in dorsal view, 82 = genitalia in ventral view, 83 = phallic organ in left lateral view.



Figures 84–87. *Triaenodes ranca* sp. nov. Male holotype, 84 = genitalia in left lateral view, without phallic organ 85 = genitalia in dorsal view, 86 = genitalia in ventral view, 87 = phallic organ in left lateral view.

Material examined. *Holotype.* Fiji Islands, Vanua Levu, Savudvodro Dam, 10.02.1971, leg. G. S. Robinson (1 male, NHM). *Paratype.* Locality same as of holotype (1 male, OPC).

Description. Male (in alcohol). Brown animal, Scape enlarged, without discernible scent organ; pedicel short, third segment long. Maxillary palp formula IV-I-II-III-V. Spur formula 1,2,2. Wing

membrane pale yellowish, without any pattern; forewing length 8 mm.

Male genitalia. Segment IX synsclerotized, the subdivided sternum with its posterior partially detached unit giving support to the phallobase by its sclerotized strips. Segment X (upper process of segment X) filiform with wrinkled apex. Cerci setose filiform, little shorter than segment X. Paraproct (lower process of segment X) forming a

pair of long filiform spine-like processes. There is a single asymmetric spine like shorter sclerotized pointed process attached to paraproct basement. Gonopods bilobed, ventral lobe enlarged; mesal basodorsal process of the basal plate of gonopods ventrally flat and very broad. Phallic organ forming a downward arching tube with membranous apex and dorsum.

Etymology. *ranca* from “ránc” wrinkle in Hungarian, refers to the highly wrinkled apex of segment X.

***Trienodes sagodii* sp. nov.**

(Figures 88–90)

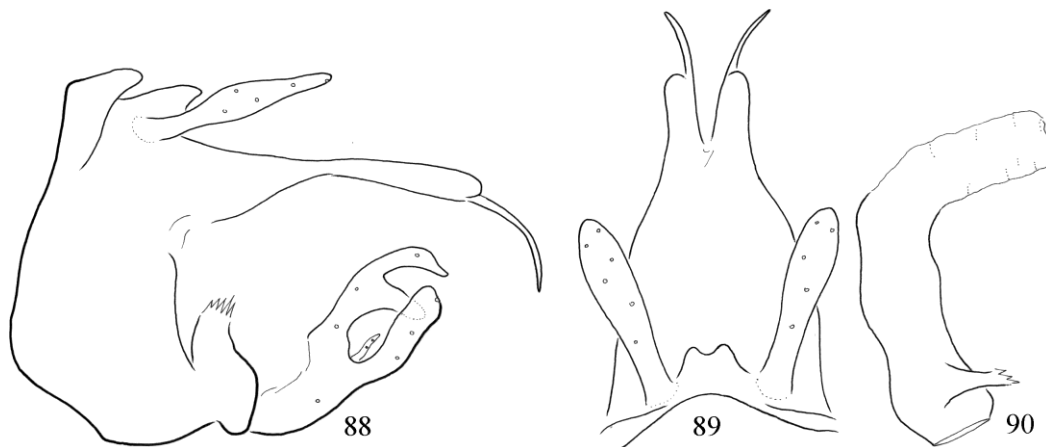
Diagnosis. Similarly to *T. triquetra* Neboiss & Wells the segment X is reduced to a short bifid hump. Basic architecture of the genitalia is also similar, but the construction of segment IX, paraproct and gonopods different.

Material examined. Holotype. Indonesia, Papua Barat, Batanta Island, Northern coast, Waridor River 0°51'53.71"S, 130°31'19.42"E, 18.01.2013, light trap, leg R. Horváth (1 male, OPC). *Paratypes.* Indonesia, Papua Barat, Batanta Island, Northern coast, Waridor River 0°52'6.24"S, 130°31'30.57"E, 18.01.2013, light trap, leg R. Horváth (1 male, OPC). Papua Barat, Batanta Island, Welebed, waterwork", valley of Kalijakut River, 0°53'22.85"S, 130°38'25.91"E, 105m, 23.01.2014, UV light-trap, leg. T. Kovács, P.

Juhász, R. Horváth (4 males, OPC). Papua Barat, Batanta Island, Welebed, valley of Kalijakut River, 0°53'12.88"S, 130°38'16.40"E, 138m, 23.01.2014, at light, leg. T. Kovács, P. Juhász, R. Horváth (6 males, OPC). Papua Barat, Batanta Island, valley of Waridor River, 0°52'09.66"S, 130°32'11.54"E, 46m, 18.01.2014, at light, leg. P. Juhász, T. Kovács, R. Horváth (4 males, OPC). Papua Barat, Batanta Island, valley of Waridor River, 0°51'51"S, 130°33'41"E, 04.02.2015, at light, T. Kovács, R. Horváth, P. Juhász (1 male, OPC).

Description. Male (in alcohol). Pale brown animal. Scape slightly enlarged, with a flap covering an internal cavity with some short yellowish emerging scent setae; pedicel short, third segment long. Maxillary palp formula IV-I-II-III-V. Spur formula 1,2,2. Wing membrane pale yellowish, hyaline window present along anastomosis cross-veins; forewing length 4 mm.

Male genitalia. Segment IX fused with shorter tergum, without any discernible suture or groove. Segment X reduced to a short hump with bifid apex. Paraproct plate deeply cleft apicomesad with additional downward curving terminal spines. Cerci setose digitiform in dorsal view, dilated middle in lateral view; half-length of paraproct. Gonopods with long basal stalk and tri-armed, plus a very thin filiform process between the two arms. Phallic organ composed of a more sclerotized basal horizontal and a less sclerotized membranous vertical part.



Figures 88–90. *Trienodes sagodii* sp. nov. Male holotype, 88 = genitalia in left lateral view, without phallic organ, 89 = genitalia in dorsal view, 90 = phallic organ in left lateral view.

Etymology. This species is dedicated to Zsolt Ságodi who, as the leader of the Papua Paradise EcoResort (Birie Island) has participated in the field collection on Batanta Island.

***Triaenodes sarla* sp. nov.**

(Figures 91–93)

Diagnosis. Habitus and genital architecture have similarity to *T. torpa* sp. nov., but wing apices falcate, paraproct with trifid apex in dorsal view and right mesal basodorsal process lost.

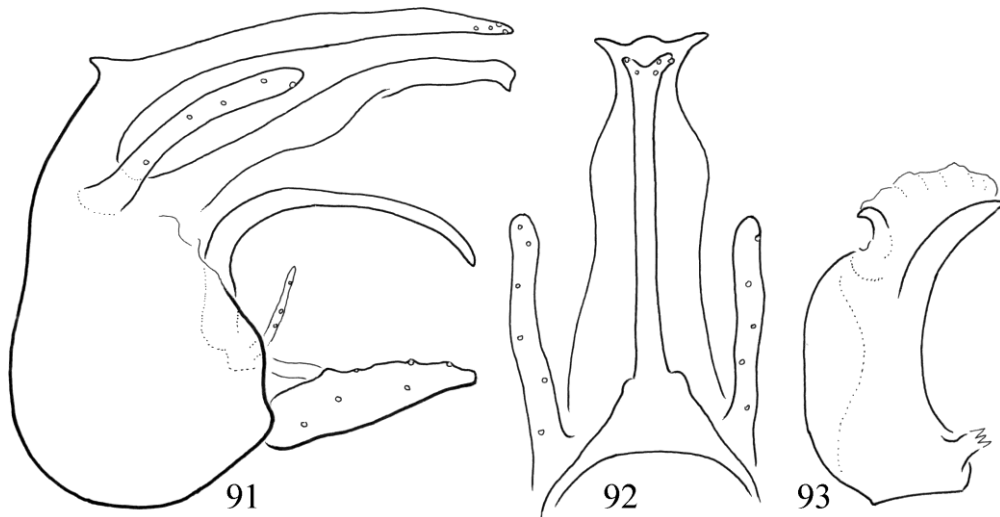
Material examined. Holotype. Indonesia, Papua Barat, Batanta Island, Northern coast, Waridor River 0°50'51.04"S, 130°31'10.85"E under great clearing, 18.01.2013, light trap, leg R. Horváth (1 male, OPC). *Paratypes.* Indonesia, Papua Barat, Batanta Island, valley of Weras Stream, 0°49' 51.2"S, 130°38'00.0"E, 300m, 8.02.2015, at light, T. Kovács, P. Juhász (1 male, OPC). Papua Barat, Batanta Island, Kalijakut River, 0°52'49.1"S, 130°38'4.9"E, 16.02.2015, UV light-trap, leg. T. Kovács, P. Juhász, (1 male, OPC). Papua Barat, Batanta Island, Kalijakut River, 0°52'52.0"S, 130°38'8.0"E, 16.02.2015, at light, leg. T. Kovács, P. Juhász (2 males, OPC).

Description. Male (in alcohol). Small, brown animal. Scape enlarged, scent organ without any

setae, the internal cavity of the scape is fully filled with an elongated membranous ovoid swollen structure emerging out through the dorsal longitudinal gap emarginated by more sclerotized longitudinal edges; surface of the swollen structure highly elaborated with fine pattern of densely packed minute granule and probably perforated elements; pedicel short, third segment long. Maxillary palp broken. Spur formula 1,2,2. Wing membrane pale yellowish, hyaline window present on lower anastomosis; forewing form with falcate apex, forewing length 4 mm.

Male genitalia. Segment IX fused with rounded subtriangular sternum and short tergum, without any discernible suture or groove. Segment X forms a single median process with bifid apex, the fork of bifid apex is more deep in paratype from the Kalijakut River. Paraproct a laterally bellied plate with trifid apex. Cerci setose digitiform, half-length of segment X. Gonopods tapering apicad; curving left mesal basodorsal process present, right process lost; a pair of very thin filiform processes developed on the basal plate of the gonopods. Phallic organ short and high with left ventral and right dorsal flaps; large U-shaped phallotremal sclerite with backward turning apices, located at the anterior border of the membranous endotheca.

Etymology. *sarla*, from “sarlós” falcate in Hungarian, refers to the falcate forewing apices.



Figures 91–93. *Triaenodes sarla* sp. nov. Male holotype, 91 = genitalia in left lateral view, without phallic organ, 92 = genitalia in dorsal view, 93 = phallic organ in left lateral view.

***Triaenodes sokaga* sp. nov.**

(Figures 94–97)

Diagnosis. Has similarity to *T. patroklos* Malicky from Thailand, but differs by much shorter paraproct and the differently shaped gonopods.

Material examined. Holotype. Vietnam, Moc Chau, 25.10.1986 light leg. J. Oláh (1 male, OPC). *Paratype.* Same as of holotype (1 male, OPC).

Description. Male (in alcohol). Brown animal, Scape slightly enlarged, without discernible scent organ; pedicel short, third segment long. Maxillary palp formula IV-I-II-III-V. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern; forewing length 7 mm.

Male genitalia. Segment IX synsclerotized, the subdivided sternum with its posterior partially detached unit giving support to the phallobase by its sclerotized strips. Segment X (upper process of segment X) is a filiform mesal process. Cerci setose filiform, slightly longer than segment X. Paraproct (lower process of segment X) forming a single spine-like sclerotized process located right side, accompanied by a small membranous process right side. Gonopods three-lobed; mesal basodorsal process of the basal plate of gonopods downward curving biarmed. Phallic organ form-

ing a slightly curving tube with lower left and higher right lateral flanges.

Etymology. *sokaga* from “sokágú” having many arms or branches in Hungarian, refers to the very complex structure of the gonopods.

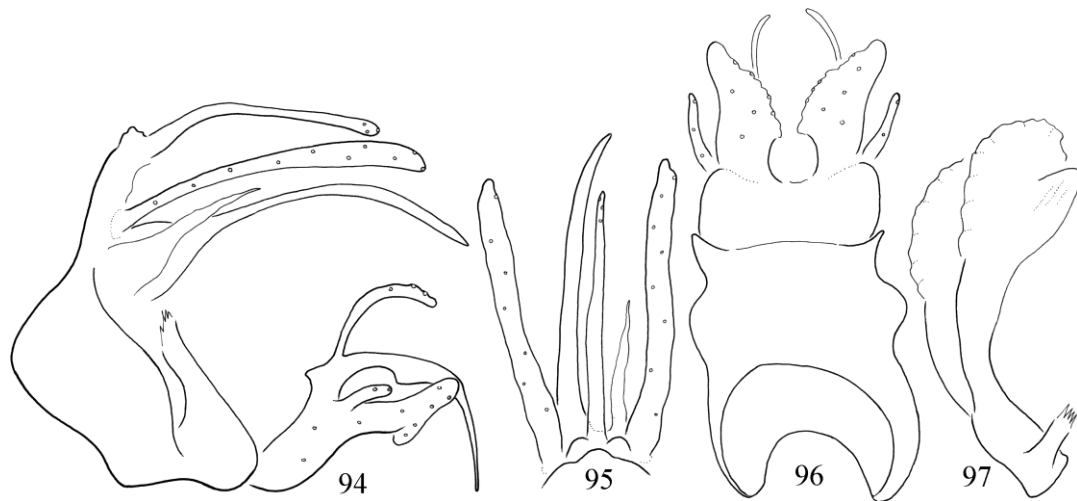
***Triaenodes sumbana* sp. nov.**

(Figures 98–101)

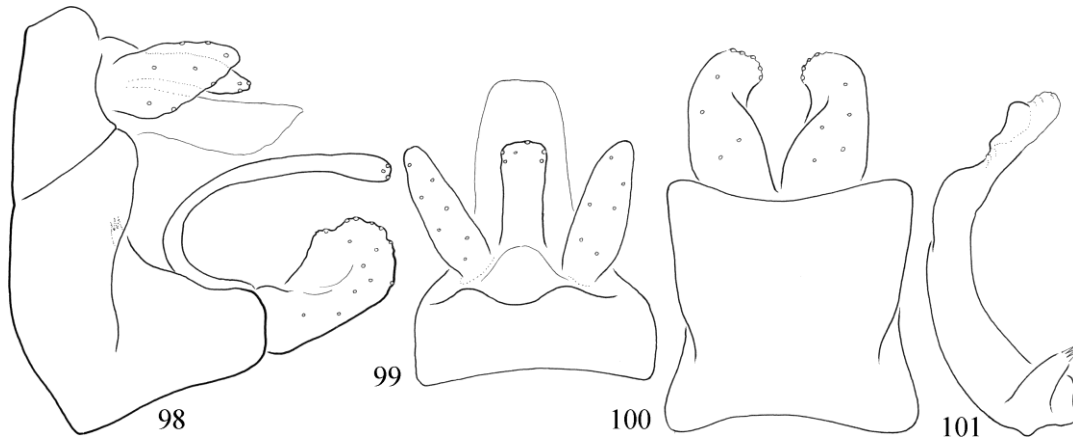
Diagnosis. Has similarity to *T. narkissos* Malicky, 2005 described from Thailand, but differs by having segment X short, broad, not broadened apicad; differently shaped gonopods and mesal basodorsal process medium long, not longer than gonopod.

Material examined. Holotype. Indonesia, Sumba, near Lewa, 300m, small stream with gallery forest, 17.08.2007, light, leg. Z. Ecsedi (1 male, OPC). *Paratypes.* Locality same as of holotype (2 males, OPC).

Description. Male (in alcohol). Brown animal. Scape enlarged, with discernible scent organ of longitudinal flap covering a longitudinal cavity filled with short setae; pedicel short, third segment long. Maxillary palp formula IV-I-II-III-V. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern; forewing length 7 mm.



Figures 94–97. *Triaenodes sokaga* sp. nov. Male holotype, 94 = genitalia in left lateral view, without phallic organ, 95 = genitalia in dorsal view, 96 = genitalia in ventral view, 97 = phallic organ in left lateral view.



Figures 98–101. *Triaenodes sumbana* sp. nov. Male holotype, 98 = genitalia in left lateral view, without phallic organ, 99 = genitalia in dorsal view, 100 = genitalia in ventral view, 101 = phallic organ in left lateral view.

Male genitalia. Segment IX synsclerotized with an oblique suture demarking ventrum of tergite IX; the subdivided sternum with its posterior partially detached unit giving support to the phallobase by its sclerotized strips. Segment X (upper process of segment X) short and truncated. Cerci short broad foliform. Paraproct (lower process of segment X) fused basally forming a short hood over the phallic organ with indiscernible apex. Apical lobe of gonopods blunt and mesad turning in ventral view. Mesal basodorsal process of the basal plate of gonopods arching. Phallic organ forming a downward curving tube with membranous apex.

Etymology. *sumbana*, named for the type locality.

***Triaenodes tarula* sp. nov.**

(Figures 102–105)

Diagnosis. Belongs to the *T. intricata* species complex and most close to *T. nigrolineata* Kimmins described from Kokoda, Papua New Guinea, but differs by having very pronounced mesal subapical process covered with stout setae and segment X without thickened, broad plate.

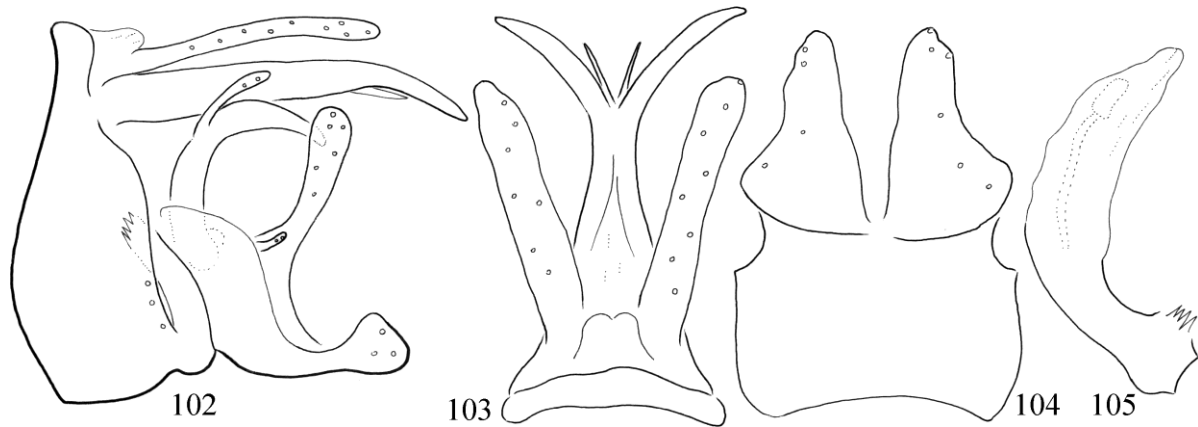
Material examined. Holotype. Indonesia, Papua Barat, Birdshead Peninsula, Arfak Mountains, Demaisi, 1637m, 1°10'S, 133°53'E, 14.11.2011,

at light PIF expedition (1 male, OPC).

Description. Male (in alcohol). Long, narrow, brown animal. Scape enlarged, 1.5 times longer than head; scent organ covered dorsally with a long flap; setae below the flap pale, not black; pedicel short, third segment long. Maxillary palp formula IV-I-(II, V)-III. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern; forewing length 9 mm.

Male genitalia. Segment IX short, long ventrad, short dorsad, with suture dividing sternum and separating the posterior sternal region of the sclerotized strip supporting the phallobase. Segment X and paraproct fused, deeply subdivided producing the terminal third directed laterad and a pair of small spines arisen from the bifurcation. Cerci setose horizontally flat, reaching the fork of segment X. Gonopods ending in a triangular capitate lobe in lateral view and characterized by a very long setose mesal subapical process. Mesal basodorsal process bifid. Phallic organ with short phallobase and the aedeagus with very low lateral ridges; phallobase receives a pair of sclerotized strips, this strip rather detached from the ventroapical region of sternite IX, endotheca with a pronounced U-shaped sclerite.

Etymology. *tarula*, from “tárul” opens in Hungarian, refers to apical region of segment X with spine-like apices directed laterad.



Figures 102–105. *Triaenodes tarula* sp. nov. Male holotype. 102 = genitalia in left lateral view, without phallic organ, 103 = genitalia in dorsal view, 104 = genitalia in ventral view, 105 = phallic organ in left lateral view.

***Triaenodes torpa* sp. nov.**

(Figures 106–109)

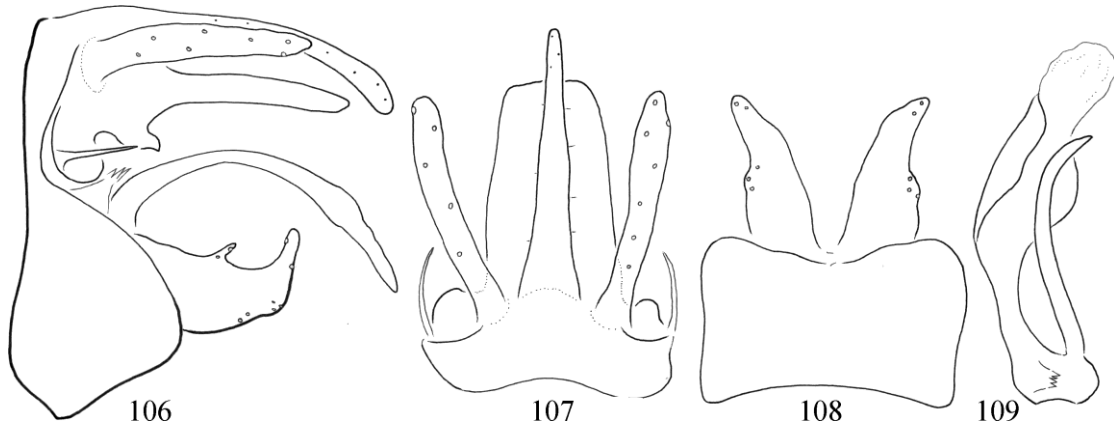
Diagnosis. Having a single paramere below the aedeagus this new species is similar to *T. tafana* Kimmins, *T. thespios* Malicky and *T. marleorum* sp. nov., but differs by having paraproct truncate, not excised apicad in dorsal view, lateral profile of gonopods different; lateral basoventral region of paraproct with very elaborated pattern of lobes and fingers, partially present at *T. tafana*, completely lacking at *T. thespios*, at least not recorded.

Material examined. Holotype. Indonesia, Papua Barat, Batanta Island, Northern coast, Warmon stream, 0°50'18.40''S, 130°42'41.91''E, above first waterfall, 24.09.2010 light trap, leg R. Horváth (1 male, OPC). *Paratypes.* Papua Barat, Batanta Island, Northern coast, Warmon stream, 0°50'04.03''S, 130°42'54.14''E, above first waterfall, 10.06.2010 light trap, leg R. Horváth (6 males, OPC). Papua Barat, Batanta Island, Northern coast, Warmon stream, 0°50'23.25''S, 130°42'35.18''E, below second waterfall, 25.10.2010 light trap, leg R. Horváth (19 males, OPC). Papua Barat, Batanta Island, Northern coast, Warmon stream, 0°50'29.47''S, 130°42'29.16''E, above second waterfall, 22.01.2013, light trap, leg R. Horváth (21 males, 3 females; OPC). Papua Barat, Batanta Island, Northern coast, Warmon stream,

0°50'8.52''S, 130°42'50.4''E, below first waterfall, 22.01.2013, light trap, leg R. Horváth (5 males, 1 female; OPC). Papua Barat, Batanta Island, Northern coast, Warmon stream, 0°50'18.40''S, 130°42'41.91''E, at fallen tree, 27.01.2012, light trap, leg R. Horváth (2 males, OPC). Papua Barat, Batanta Island, valley of Warmon stream, upper waterfall, 0°50'23.25''S, 130°42'35.18''E, 150m, 20.01.2014, at light, leg. T. Kovács, P. Juhász (3 males, OPC). Papua Barat, Batanta Island, Kalijakut River, 0°52'52.0''S, 130°38'8.0''E, 16.02.2015, at light, leg. T. Kovács, P. Juhász (2 males, OPC).

Description. Male (in alcohol). Small, brown animal. Scape enlarged, with scent organ covered with a long flap; not any setae discernible under the flap; pedicel short, third segment long. Maxillary palp formula I-IV-II-(III,V). Spur formula 1,2,2. Wing membrane pale yellowish, hyaline window present on lower anastomosis; forewing length 4.5 mm.

Male genitalia. Segment IX fused with triangular sternum and short tergum, without any discernible suture or groove. Segment X simplified into a single gradually tapering median process with a few tiny emerged setae. Paraproct composed of a quadrangular plate with a median rim hooding the phallic organ and of a pair of lateral lobe with very slender filiform process. Cerci setose digitiform, shorter than segment X. Gonopods with upward curving apex and a small



Figures 106–109. *Triaenodes torpa* sp. nov. Male holotype, 106 = genitalia in left lateral view, without phallic organ, 107 = genitalia in dorsal view, 108 = genitalia in ventral view, 109 = phallic organ in left lateral view.

digitiform dorsal process middle; spine-like lateral basodorsal process curving with aviform apex. Middle located phallic organ asymmetric with more developed left lateral ridge; a unique single, well developed black spine-like paramere present; (parameres typically lost at *Triaenodes*) phallobase receives a pair of sclerotized strips, this strip is rather detached from the ventroapical region of sternite IX.

Etymology. *torpa*, from “törpe” pygmy in Hungarian, refers to the small size of this interesting *Triaenodes* with paramere on the phallic organ.

***Triaenodes tudarda* sp. nov.**

(Figures 110–111)

Diagnosis. The basic architecture of the periphallic structures has resemblance to *T. costalis* Kimmins described from Papua (Kokoda), but differs by segment X short and tapering apicad, not long and widening; gonopod basodorsal branch bifid, not simple spine-like; gonopod ventroapical branch elongated pointed spine-like, not short and truncate. However most remarkable that *T. costalis* has a unique plesiomorphy, a pair of slender blade-like parameres present on the phallic organ. *T. tudarda* sp. nov., as diagnostic for the genus, has no any paramere.

Material examined. Holotype. Indonesia, Papua Barat, Batanta Island, Northern coast, Warmon

stream, 0°50'23.25''S, 130°42'35.18''E, below second waterfall, 25.10.2010 light trap, leg R. Horváth (1 male, OPC). Paratype: Papua Barat, Batanta Island, Northern coast, Warmon stream, 0°50'18.40''S, 130°42'41.91''E, at fallen tree, 27.01.2012, light trap, leg R. Horváth (1 male, OPC). Papua Barat, Batanta Island, Northern coast, Warmon stream, 0°50'29.47''S, 130°42'29.16''E, above second waterfall, 22.01.2013, light trap, leg R. Horváth (1 male, OPC). Papua Barat, Batanta Island, valley of Warmon stream, upper waterfall, 0°50'23.25''S, 130°42'35.18''E, 150m, 20.01.2014, at light, leg. T. Kovács, P. Juhász (1 male, OPC). Papua Barat, Batanta Island, Northern coast, small stream with dry mouth: 0°49'27.84''S, 130°38'45.02''E, 1000-1500m above dry mouth, 28.01.2012, light trap, leg R. Horváth (18 males, OPC). Papua Barat, Batanta Island, between Arefi and Teluk Warai, valley of „dried estuary of a stream”, 0°49'42.05''S, 130°38'12.23''E, 229m, 27.01.2014, at light, leg. T. Kovács, P. Juhász (16 male, OPC). Papua Barat, Batanta Island, Welebed, valley of Kalijakut River, 0°53'12.88''S, 130°38'16.40''E, 138m, 23.01.2014, at light, leg. T. Kovács, P. Juhász, R. Horváth (12 males, OPC). Papua Barat, Batanta Island, valley of Waridor River, 0°52'09.66''S, 130°32'11.54''E, 46m, 18.01.2014, at light, leg. P. Juhász, T. Kovács, R. Horváth (1 male, OPC). Papua Barat, Batanta Island, Teluk Warai, stream, 0°50'51.0''S, 130°35'14.0''E, 11.02.2015, at light, T. Kovács, P. Juhász (2 males, OPC). Indonesia, Papua Barat,

Batanta Island, valley of Weras Stream, 0°49' 51.2"S, 130°38'00.0"E, 300m, 08.02.2015, at light, T. Kovács, P. Juhász (1 male, OPC). Papua Barat, Batanta Island, Kalijakut River, 0°52' 49.1"S, 130°38'4.9"E, 16.02.2015, UV light-trap, leg. T. Kovács, P. Juhász, (1 male, OPC).

Description. Male (in alcohol). Brown animal. Scape enlarged, with scent organ covered with a flap; long scent tuft of brown setae originates from below the flap; pedicel short, third segment long. A pair of vertically elongated hump present on pronotum with laterad directed scent setae. Maxillary palp formula is IV-I-II-III-V. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern; forewing length 7 mm; hind wing with a very long scent pencil of black setae hold together basally by a strong jugal fold forming a scent pouch by folding the jugal region below.

Male genitalia. Segment IX triangular, long ventrad, short dorsad, subdivided sternum with its posterior partially detached unit giving support to the phallobase by its sclerotized strips. Segment X composed of the mesal filiform upper part as long as the cerci and of the less sclerotized lower part. Cerci setose, filiform. Paraproct forms a pair of long downward arching spine-like process. Gono

pods triangular in lateral view with elongated dorsal and apical branches; dorsal branch bifid; apical branch slender pointed, a pair of mesal subapical irregular setose process present. Phallic organ with short phallobase and the aedeagus with low lateral ridges; phallobase receives a pair of sclerotized strips rather detached from the ventro-apical region of sternite IX.

Etymology. *tudarda*, from “tű dárda” pin-pointed lance in Hungarian, refers to the slender pin-pointed shape of the apical process on the gonopods.

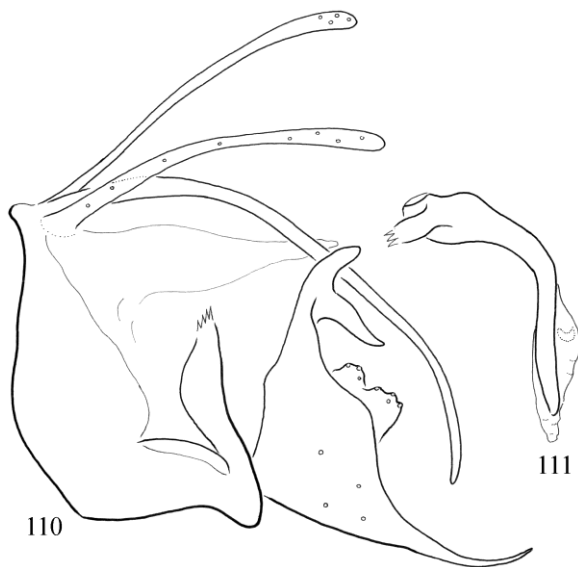
***Triaenodes zicsii* sp. nov.**

(Figures 112–115)

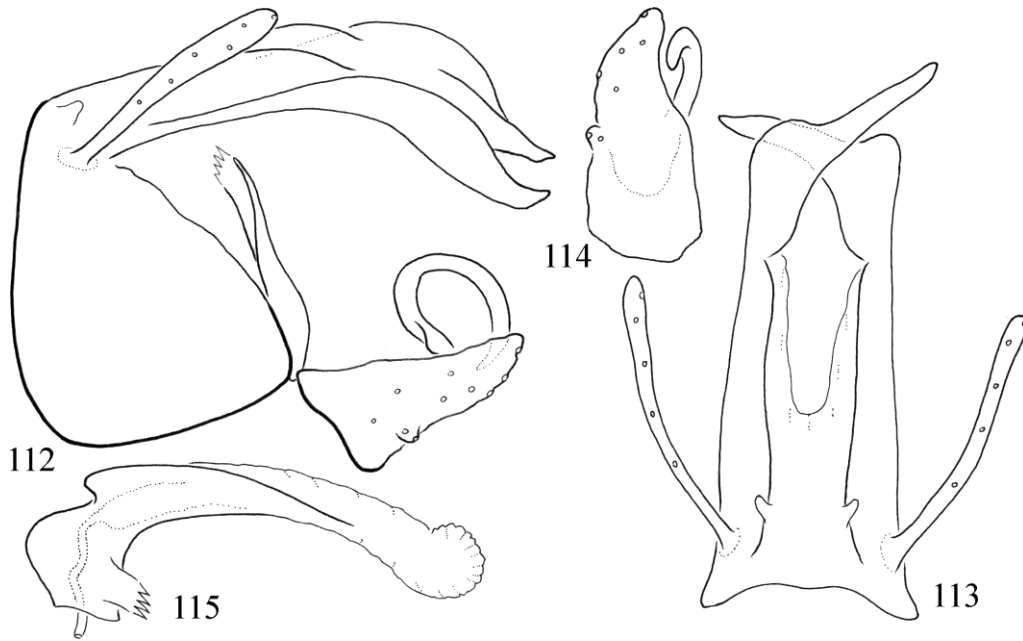
Diagnosis. The genitalic structures do not conform to any of the typical arrangement listed by Neboiss & Wells for Australian species complexes. Similarly to *Triaenodes dubia* Mosely described from Fiji Island, the segment X (upper part of X) and the paraproct (lower part of X) are fused forming an entirely amalgamated single structure. The new species differs from it by having apices of the fused structures crossed, not parallel-sided long and blade-shaped, the genitalia without any downward curving, centrally situated slender spine, present on *T. dubia*; gonopods apex monolobed, not bifid.

Material examined. *Holotype.* Indonesia, Papua Barat, Birdshead Peninsula, Arfak Mountains, Mokwam, 1510m, 1°06'S, 133°54'E, 6–10.11.2011, at light PIF expedition (1 male, NBC-ZMAN). *Paratype.* Indonesia, Papua Barat, Birdshead Peninsula, Arfak Mountains, Demaisi, 1637m, 1°10'S, 133°53'E, 14.11.2011, at light PIF expedition (1 male, OPC).

Description. Male (in alcohol). Brown animal. Scape enlarged, with scent organ covered with a long flap; below the closed flap a long black longitudinal structure visible, probably the compressed scent setae; pedicel short, third segment long. Maxillary palp fomula IV-I-V-II-III. Spur formula 1,2,2. Wing membrane pale yellowish, without any pattern; forewing length 7 mm.



Figures 110-111. *Triaenodes tudarda* sp. nov. Male holotype, 110 = genitalia in left lateral view, without phallic organ, 111 = phallic organ in left lateral view.



Figures 112–115. *Triaenodes zicsii* sp. nov. Male holotype, 112 = genitalia in left lateral view, without phallic organ, 113 = genitalia in dorsal view, 114 = left gonopod in ventral view, 115 = phallic organ in left lateral view.

Male genitalia. Segment IX triangular, long ventrad, short dorsad, without any discernible suture or groove. Segment X and paraproct fused, deeply subdivided with aviform crossing apices; in the amalgamated complex the segment X is represented by a pair of vertical dorsal ridges bearing a pair of small gemmiform basal process, the possible vestigium of the lateral processes; the paraproct is represented by the ventral heavily sclerotized pair of long processes with crossing apices. Cerci setose filiform, half as long as the fused segment X and paraproct. Gonopods triangular in lateral view with a pair of small mesal basodorsal spine-like process curving into a circular shape. Phallic organ with short phallobase and the aedeagus with low lateral ridges; phallobase receives a pair of sclerotized strips rather detached from the ventroapical region of sternite IX.

Etymology. The new species is dedicated to the memory of the late Prof. Dr. András Zicsi the renowned Hungarian soil zoologist and earthworm taxonomist.

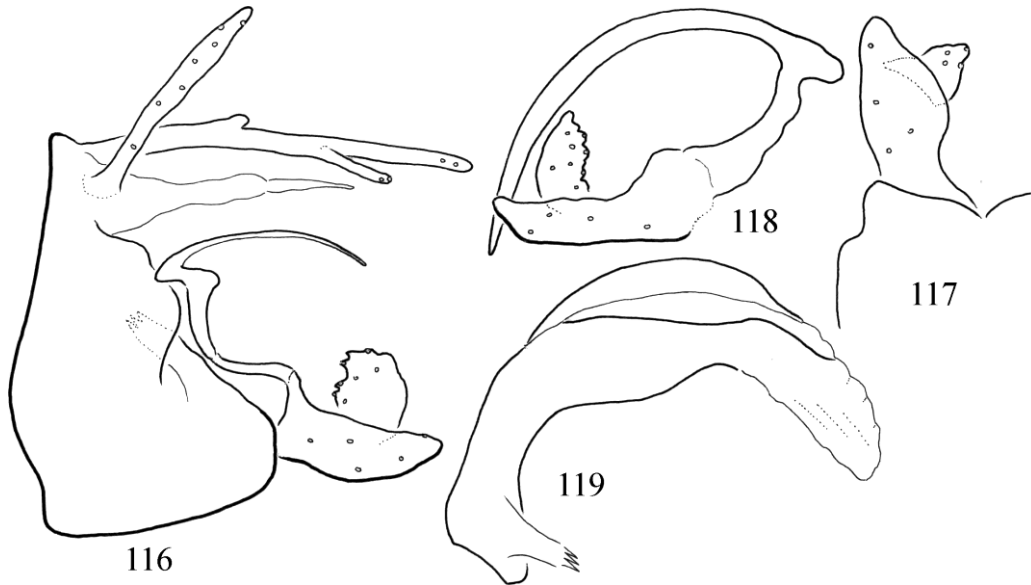
***Triaenodes zugora* sp. nov.**

(Figures 116–119)

Diagnosis. The basic architecture of the genitalia similar to *K. kalija* sp. nov., *T. marleorum* sp. nov., *T. sarla* sp. nov., *T. tafana* Kimmins, *T. thespios* Malicky, *T. torpa* sp. nov., but differs by having simple paraproct with narrowing pointed apex; by the presence of large mesal subapical lobe on the gonopod; paramere lacking similarly to *T. sarla* sp. nov. and *T. kalija* sp. nov. Has unique miniaturized left mesal basodorsal process.

Material examined. *Holotype.* Indonesia, Papua Barat, Batanta Island, Teluk Warai, stream, 0°50'51.0"S, 130°35'14.0"E, 11.02.2015, at light, leg. T. Kovács, P. Juhász (1 male, OPC).

Description. Male (in alcohol). Brown animal. Scape enlarged and elongated, almost triple long than head; brown tuft of long scent setae nested on the basodorsal area and recumbent along the entire length of the scape; pedicel short, and third



Figures 116–119. *Triaenodes zugora* sp. nov. Male holotype. 116 = genitalia in left lateral view, without phallic organ, 117 = left gonopod in ventral view, 118 = right gonopod with mesal basodorsal process originates on basal plate, 119 = phallic organ in left lateral view.

segment long. Maxillary palp formula IV-I-II-III-V. Spur formula 1,2,2. Wing membrane brown, hyaline window present along crossveins of the anastomosis; forewing length 5 mm.

Male genitalia. Segment IX fused with triangular sternum and short tergum, without any discernible suture or groove. Segment X present as a single mesal process with a short bifid dorsal arm midway and a pair of little longer lateral process at two thirds. Paraproct forming a broad based plate hooding the phallic organ, with tapering apex. Cerci setose digitiform, shorter than segment X. Gonopods subtriangular in lateral view with large mesal subapical setose lobe; a pair of spine-like mesal basodorsal process originates on basal plate of gonopods with vertical stalk than curving posterad enforced by a short anterior knot; left process miniaturized. The phallosome of the middle located phallic organ produced a pair of laterad than downward directed dorsolateral rim housing the mesal basodorsal processes; left low, and longer housing the miniaturized left process; right more developed, high housing the right process; phallobase receives a pair of sclerotized strips from the ventroapical region of segment IX.

Etymology. *zugora*, from “zsugor” shrink in Hungarian, refers to the reduced, vestigial size of the left mesal basodorsal process on the basal plate of the gonopods.

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A new *Fridericia* species (Clitellata, Enchytraeidae) and the enchytraeid fauna of the Őrség National Park (Hungary)

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Abstract. The enchytraeid fauna of the Őrség National Park (Western Hungary), hitherto unknown, was investigated in this study. 14 enchytraeid genera including 47 species and one other annelid worm (*Hrabeiella periglandulata*) were identified. One enchytraeid species was found to be new to science and is described in this paper as *Fridericia zicsii* sp. nov. The new species is distinguishable based on both morphological characters and molecular data (mitochondrial cytochrome c oxidase subunit I, nuclear histone 3 genes and nuclear ribosomal ITS region sequences) from similar species. The enchytraeid fauna of Őrség NP indicated well the subalpine nature of this area. The most species-rich site was the hay meadow (32 species) and interestingly, the species number in the *Sphagnum* bog of Szóce was unusually high (19 species).

Keywords. *Fridericia*, new species, Enchytraeidae, fauna, Őrség National Park

INTRODUCTION

An intensive investigation of the Hungarian enchytraeid fauna was launched in 2001 with support from the Hungarian Scientific Research Fund (OTKA), and so far resulted in publication of three comprehensive works on the enchytraeid fauna of Hungary. First, the enchytraeid fauna of the Northern Hungarian Mountains (Bükk, Mátra, Zemplén, Börzsöny Mts.) was investigated resulting in recording of 77 species belonging to 14 genera including five species new to science (*Mari-onina sexdiverticulata* Dózsa-Farkas, 2002, *Achaeta unibulba* Graefe, Dózsa-Farkas & Christensen, 2005, *Fridericia eiseni* Dózsa-Farkas, 2005, *F. schmelzi* Cech & Dózsa-Farkas, 2005 and *F. crassiductata* Dózsa-Farkas & Cech, 2006 (Dózsa-Farkas 2002, Dózsa-Farkas 2005, Cech & Dózsa-Farkas 2005, Graefe, Dózsa-Farkas & Christensen 2005, Dózsa-Farkas & Cech 2006, Dózsa-Farkas 2007). Between 2005–2009 the fauna of the Vértes Mts. (belonging to the Transdanubian Mountains) was investigated. From this

area 41 species and one subspecies distributed in 11 genera were identified including a new species and also a new subspecies (*Fridericia mahunkai* and *Fridericia gamotheca hungarica*) (Dózsa-Farkas 2013). As third region, the exploration of the Danube–Dráva National Park was carried out in 2011–2014 and a total of 14 enchytraeid genera including 49 species and two other annelid worms were identified of which four species were new to science (*Fridericia connatififormis*, *F. phaeostriata*, *F. longiducta*, and *Cernovitiella buekkhathi*) (Dózsa-Farkas *et al.* 2015).

Within the last project in 2014 and 2015, the Őrség National Park was investigated and the faunistic results of this study and description of a new species *Fridericia zicsii* sp. nov. are herewith presented. The morphological studies were supplemented with molecular-taxonomic analyses targeting the nuclear ribosomal ITS region, the mitochondrial cytochrome c oxidase subunit I (COI) gene and the nuclear histone 3 (H3) gene.

MATERIAL AND METHODS

Study area. The Órség National Park is situated in Western Hungary (46° 51'–55°N, 16° 06'–24'E). The yearly average precipitation is 700–800 mm, the mean annual temperature is 9.0–9.5 °C. The elevation range of the area is approximately 250–350 m above sea level, and the landscape is divided into hills and valleys (Dövényi 2010). The bedrock consists of alluvial gravel and loess, the most frequent soil types are pseudogleyic and lessivaged brown forest soils, which are nutrient poor. The pH of the soil is acidic, ranging from 4.0 to 4.8 (mean 4.3) (Juhász *et al.* 2011). Forests cover an area of ca. 350 km², which represents 80% of the Órség NP. Stands are dominated by *Fagus sylvatica*, *Quercus petraea*, *Q. robur*, *Carpinus betulus*, *Pinus sylvestris* and *Picea abies*. Mixed stands with great compositional diversity are frequent, but some are dominated by a single tree species. The most frequent non-dominant tree species are *Betula pendula*, *Populus tremula*, *Castanea sativa*, *Prunus avium*, *Tilia* spp., and *Acer* spp. Most of the original forests of the region were cut in the middle ages and in the regrown secondary forest the proportion of pioneer tree species (such as *Pinus sylvestris* and *Betula pendula*) and the cover of acidofrequent herbs, bryophytes and lichens increased (Gyöngyössy 2008, Tímár *et al.* 2002).

Collection sites. In total, 16 macro- and microhabitats were sampled at 9 localities (Appendix 1).

Morphological methods. The animals were extracted from the soil by the wet funnel method (O'Connor 1962). Worms were first studied and measured alive, and subsequently preserved in 70% ethanol. Later, a part of the adult *F. zicsii* specimens was stained with borax-carmine, then passed through an ethanol (70% to absolute) dehydration series, mounted temporarily in clove oil, and later mounted in Euparal in a slide between two coverslips. The important morphological structures were recorded *in vivo*, drawn, and photographed using an Axio Imager.A2 microscope with DIC (differential interference contrast) il-

lumination and an AxioCam MRc 5 (Zeiss) digital camera with Axiovision software. The whole-mounted specimens were reinvestigated and also photographed. Holotype and paratypes of the new species are deposited in the collection of the Department of Systematic Zoology and Ecology, Eötvös Loránd University (Budapest, Hungary).

Methods of molecular analysis. From the individuals subjected to molecular taxonomic analysis, genomic DNA was extracted with the DNeasy Blood & Tissue Kit (Qiagen) following the instructions given by the manufacturer. The mitochondrial cytochrome c oxidase subunit I (CO1) gene, the nuclear histon 3 (H3) gene and the nuclear ribosomal ITS region were amplified using the primers HCO2198 (5'-TAA ACT TCA GGG TGA CCA AAA AAT CA-3') and LCO1490 (5'-GGT CAA CAA ATC ATA AAG ATA TTG G-3') (Folmer *et al.* 1994), H3a-F (5'-ATG GCT CGT ACC AAG CAG ACV GC-3') and H3a-R (5'-ATA TCC TTR GGC ATR ATR GTG AC-3') (Colgan *et al.* 1998), and ETTS1 (5'-TGC TTA AGT TCA GCG GGT-3') and ETTS2 (5'-TAA CAA GGT TTC CGT AGG TGA A-3') (Kane & Rollinson 1994), respectively. PCRs were performed applying the parameters given by Dózsa-Farkas & Felföldi (2015). Purification and sequencing of PCR products were carried out by LGC Genomics GmbH (Berlin, Germany). Removal of primer sequences and manual correction of automatic base calling on chromatograms were performed using the Chromas software v. 1.45 (Technelysium). Phylogenetic analyses (which included the search for the best-fit models) were conducted with the MEGA 6.0 software (Tamura *et al.* 2013). Sequences determined in this study were deposited in GenBank under the following accession numbers: KU586612-KU586627 (ITS), KU586582-KU586595 (CO1) and KU586596-KU586611 (H3).

RESULTS

Results of morphological analysis

In total 47 species were recorded belonging to 14 enchytraeid genera, moreover a terrestrial po-

lychaete, *Hrabeiella periglandulata*, was also collected (Appendix 2). All species represent new records for the Órség National Park. The status of one *Fridericia* species (*Fridericia* sp. 1) has not been ascertained yet. This probably also represents a new species for science, but further investigations are needed to clarify its status. A list of species recorded in individual samples, representing microhabitats sampled at the individual sites, is given in Appendix 2.

DESCRIPTION OF THE NEW SPECIES

Fridericia zicsii sp. nov.

(Figures 1–5)

Material examined. Holotype. F.25 slide No. 2078, adult, stained whole mounted specimen. *Type locality.* Órség, Gödörházi rétek (specially protected area) on the edge of alder carr with *Hemerocallis lilio-asphodelus*, 46°44.782N 16°21.227E, 229 m a.s.l., leg. K. Dózsa-Farkas, J. Farkas, Z. Tóth & F. Hoc, 31.03.2014 (site 3b in Table 1). *Paratypes* (in total, 30 specimens). P.108.1.1–6 slide No. 1007–1009, 1066–1067, 2077. Six specimens from type locality, leg. K. Dózsa-Farkas, J. Farkas, Z. Tóth & F. Hoc, 31.03.2014. P.108.2.1–3 slide No. 2059–2060, 2076. Three specimens from Gödörházi rétek, hay meadow with *Salix rosmarinifolia*, 46°44.931N 16°21.177E, 229 m a.s.l., leg. K. Dózsa-Farkas, J. Farkas, Z. Tóth & F. Hoc, 31.03.2014. P.108.3.1–4 slide No. 2103–2106. Four specimens from Gödörházi rétek, hay meadow with *Salix rosmarinifolia*, 46°44.931N 16°21.177E, 229 m a.s.l., leg. Z. Tóth, 09.11.2014. P.108.4.1. Four specimens in ethanol from type locality, leg. K. Dózsa-Farkas, J. Farkas, Z. Tóth & F. Hoc, 31.03.2014. P.108.4.2. Ten specimens in ethanol Órség, Gödörházi rétek, hay meadow with *Salix rosmarinifolia*, 46°44.931N 16°21.177E, 229 m a.s.l., leg. Z. Tóth, 09.11.2014. P.108.4.3. Three specimens in ethanol from Órség, Gödörházi rétek, hay meadow with *Salix rosmarinifolia*, 46°44.931N 16°21.177E, 229 m a.s.l., leg. Z. Tóth, 26.10.2015.

Further material examined. 16 specimens from both localities (sites 3b and 4 in Table 1).

Diagnosis. The new species can be recognized by the following combination of characters: (1) large size (14–20 mm long and about 400 wide *in vivo*), but the cuticle thin (maximum 1.5 μm), segments 48–65; (2) maximum 4–5 chaetae per bundle; (3) clitellum girdle-shaped, gland cells arranged in transverse, dense rows, gland cells absent between the bursal slits but area glareaosa developed instead; (4) five preclitellar pairs of nephridia; (5) dorsal blood vessel originating in XVII–XX, blood light pink; (6) coelomo-mucocytes with hyaline globulose matrix, lenticytes scarce; (7) chylus cells in XII–XIV (2 segments); (8) seminal vesicle large; (9) subneural glands absent; (10) sperm funnel cylindrical, about the same length or 2/3 as long as body diameter; (11) spermathecae with short ectal duct, with 2 (3) very large ectal glands, the spherical ampulla with two oval or bean-shaped, large diverticula (diameter 60–90 μm *in vivo*), separate openings into oesophagus.

Description. Large species, holotype 17.5 mm long, 420 μm wide at VIII and 550 μm at clitellum *in vivo*, 11.8 mm long, 490 μm wide at VIII and 570 μm at clitellum (fixed), segments 59. Body length of paratypes 14–20 mm, width 350–450 μm at VIII and 370–580 μm at clitellum *in vivo*, length of fixed specimens 8–13 mm, width 360–500 μm at VIII and 450–590 μm at clitellum, segments 48–65. Chaetal formula: 3,4–4,3,(1),2 : 3,4,5–4,3,2. The chaetae within a bundle arranged in pairs with the outer being longer and thicker than the inner (40–50 \times 5 μm vs. 45–35 \times 4 μm , in preclitellar ventral bundles), the length of the chaetae in the lateral bundles somewhat longer (54 and 40 μm , respectively). Chaetal lengths about the same in postclitellar segments. From about XXV–XXXII, only two chaetae per bundle, these 60–70 μm long in terminal segments. Head pore a longitudinal slit at 0/I (Fig. 2A). Dorsal vessel from XVII–XX, blood light pink (Fig. 2D). Epidermal gland cells inconspicuous. Clitellum in XII–1/3XIII, girdle-shaped, hyalocytes and granulocytes arranged in dense rows dorsally (Fig. 2F), sometimes irregularly, around the male copulatory organs only granulocytes (Fig. 2E), but between the bursal slits the glandular cells absent (Fig. 2H)

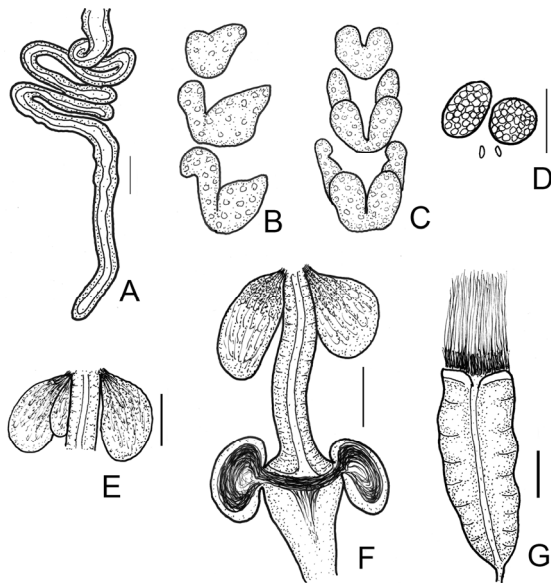


Figure 1. *Fridericia zicsii* sp. nov. A = oesophageal appendage, B = pharyngeal glands in lateral view (schematic), C = pharyngeal glands in dorsal view (schematic), D = coelomocytes, E = three ectal glands of spermatheca, F = spermatheca, G = sperm funnel; scale bars = 50 μ m (except G = 100 μ m).

while here an area glareosa well developed (Fig. 2G). Body wall about 25–40 μ m thick, cuticula thin, 1–1.5 μ m *in vivo*.

Brain (Fig. 2B, C) about 200 μ m long and 1.8 times longer than wide *in vivo*, anterior and posterior margin with slight convexity. Oesophageal appendages (Fig. 1A) long, coiled, unbranched, type b (rarely two short branches at the end). All pairs of pharyngeal glands united dorsally and with ventral lobes in V and VI (Fig. 1B, C). Chloragocytes from V, 23–26 μ m long, brown *in vivo*. Midgut pars tumida in XXX–XLIV (in 7–10 segments) [but in two specimens in XXV–XXXI (8 segments)] the height of cells 63–65 μ m (Fig. 3A–B). Five pairs of preclitellar nephridia from 6/7 to 10/11; length ratio anteseptale : post-septale about 1 : 1.5, medial origin of efferent duct (Fig. 3H). Coelomo-mucocytes with characteristic hyaline globulose matrix (Fig. 1D, 3C–E), but in aggregations dark grey, length mostly 30–45 μ m, lenticytes scarce, 7–10 μ m long, *in vivo*. Chylus cells (Fig. 3F–G) between XII–XIV, occupying 2 segments. Seminal vesicle large (X–XI). Sperm funnels cylindrical (Figs. 1G, 4A–B), 320–500 μ m long *in vivo*, 2.5–4 times longer than

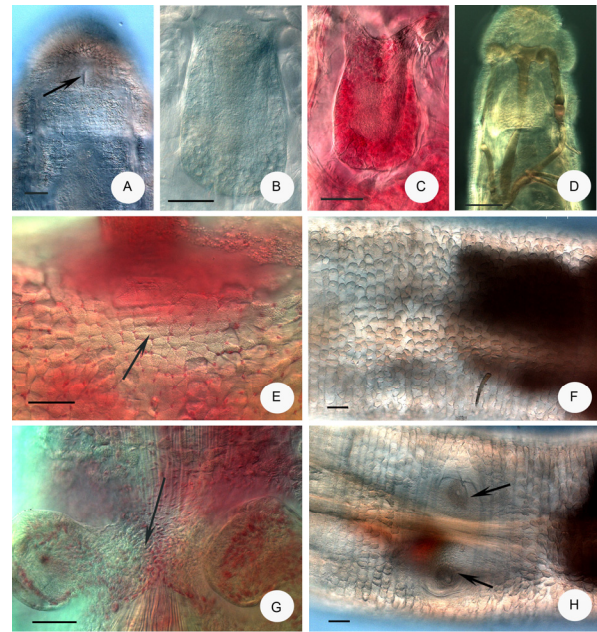


Figure 2. Micrograph of *Fridericia zicsii* sp. nov. A = head-pore (marked with arrow), B–C = brain, D = dorsal blood vessel anteriorly (blood pink), E = clitellar gland cells near to the male copulatory organ, laterally only granulocytes (marked with arrow), F = clitellar gland cells dorsally (hyalocytes and granulocytes in dense transverse rows), G = between the two bursal slits the glands absent, but area glareosa well developed (marked with arrow), H = clitellum in ventral view (the two male copulatory organs are marked with arrows). A, B, D, F, H *in vivo*, C, E, G fixed, stained; scale bars = 50 μ m.

wide, but in fixed specimens the length of funnels 230–330 μ m, and about 1.5–3 times longer than wide. Collar slightly narrower than funnel body. Length of spermatozoa 190–250 μ m, heads 60–80 μ m, *in vivo*. Diameter of sperm ducts about 10 μ m, *in vivo*. Male copulatory organs large (Fig. 4C–D), 250–300 μ m long, 140–160 μ m wide and 110–130 μ m high, *in vivo* (200–285, 120–160 and 95–130 μ m, fixed, respectively), the modiolus and area glareosa well developed, and covering the medial surface of the bursa (Fig. 4C). The bursal slits are T-shaped (Fig. 4E). No subneural glands. Ectal ducts of spermathecae short, length 180–260 μ m and width 26–30 μ m (130–170 μ m long and 25–28 μ m wide, fixed), the canal of duct 5–6 μ m wide *in vivo*. Two very large brownish glands at the ectal openings of the spermathecal ducts (but in size different, 80–160 μ m long *in vivo* and fixed alike). Rarely, there is a third smaller gland

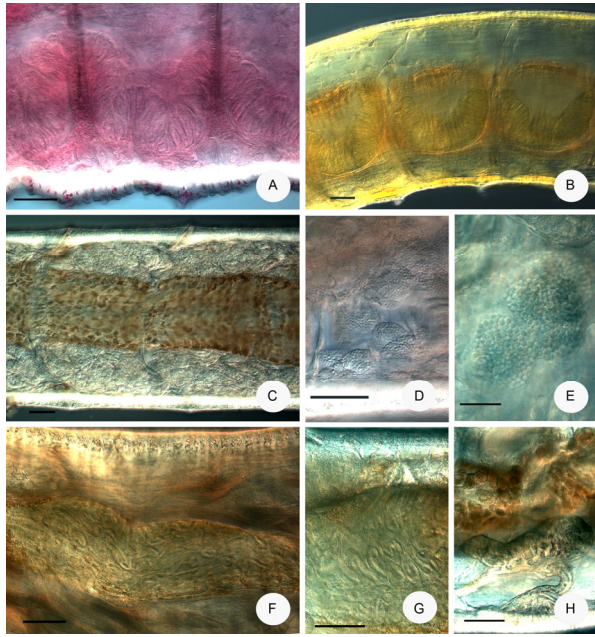


Figure 3. Micrograph of *Fridericia zicsii* sp. nov. A = pars tumida in XXVI-XXVII (fixed and stained), B = pars tumida in XXXVI-XXXVIII (fixed but not stained), C-E coelomocytes, F-G = chylus cells in XIII-XIV, H = second anteclellular nephridium. C-H *in vivo*; scale bars = 50 µm (except E = 20 µm).

(Fig. 1E-F, 4F, 5A-C). The glands consist of a complex of many gland cells, which open one by one to the surface (Fig. 5F). Ampullae onion-shaped, diameter 75–85 µm *in vivo* (fixed 50–80 µm), with two sessile oval, bean-shaped or rounded thin-walled diverticula about 70–90 µm long and 60–70 µm wide when fixed, mostly filled with sperm (Fig. 1F, 4A-C). In one case, three diverticula were present in one of the two spermathecae (Fig. 5E). The ectal duct projecting into the lumina of ampullae, ental bulbs 40–50 µm wide, fixed (Figs. 5B). Distal and proximal parts of ampullae mostly not set off by a constriction, separate openings into oesophagus. One to four mature eggs at a time.

Distribution and habitat. Only in the specially protected area Gödörházi rétek of Órség National Park: on the edge of alder carr with *Hemerocallis lilio-asphodelus* and a hay meadow with *Salix rosmarinifolia*.

Etymology. Named in honour of my late colleague, the excellent earthworm taxonomist, Prof. Dr. András Zicsi.

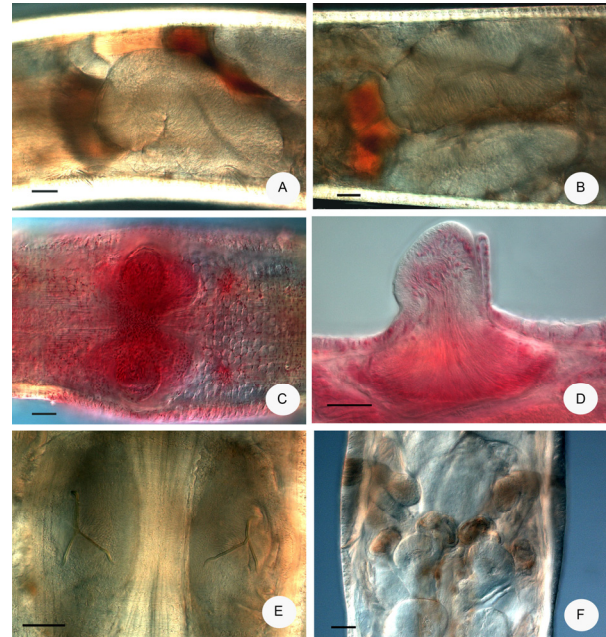


Figure 4. Micrograph of *Fridericia zicsii* sp. nov. A-B = sperm funnels, C = male copulatory organs and the clitellar region ventrally, D = bursa everted, E = bursal slits, F = the two spermathecae. A, B, E, F *in vivo*, C-D stained; scale bars = 50 µm.

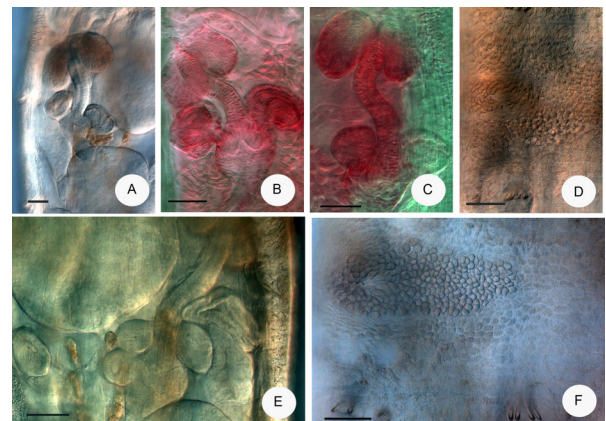


Figure 5. Micrograph of *Fridericia zicsii* sp. nov. A-C = spermathecae with two diverticula and large ectal glands, E = spermatheca exceptionally with three diverticula, D, F = gland openings of the complex spermathecal ectal glands. A, D, E, F *in vivo*, B-C fixed, stained; scale bars = 50 µm.

Remarks. Among the previously described *Fridericia* species with oval or bean-shaped spermathecal diverticula and separate openings into oesophagus, five species (*F. strenua* Rota, 1995; *F. aurita* Issel, 1905; *F. auritoides* Schmelz, 2003; *F.*

longiducta Dózsa-Farkas, 2015; and *F. phaeostriata* Dózsa-Farkas, 2015) are similar to the new species (Issel 1905, Schmelz 2003, Rota 1995, Dózsa-Farkas *et al.* 2015). The main differences that distinguish the new species from all the above-mentioned ones are the blood colour (in the new species light pink, in the others colourless) and the very large spermathecal ectal glands. Another species, *F. magna* Friend, 1899, has red blood and similar spermathecae with two large ectal glands. However, *F. zicsii* sp. nov. can be easily distinguished from *F. magna* by the following characters: 1) smaller size (14–20 mm long and 48–64 segments vs. 30–50 mm and 70–96 segments); 2) more chaetae: mostly 4–5 in preclitellar bundles both ventrally and laterally (2 or 3, only very rarely 4 in *F. magna*); 3) oesophageal appendages type b (type c in *F. magna*); 4) coelomo-mucocytes with a characteristic texture, the nucleoli are not visible (nucleoli conspicuous in *F. magna*); 5) seminal vesicle large (in *F. magna* absent). For descriptions of *F. magna* see Friend (1899) and Schmelz (2003).

Results of molecular analysis

Results of molecular analyses are shown in Fig. 6. In total, 16, 14 and 16 sequences were determined from various *Fridericia* specimens in the case of ITS, CO1 and H3, respectively. In addition to two *F. zicsii* sp. nov. individuals, specimens of five other, morphologically similar species (*F. phaeostriata*, *F. longiducta*, *F. connatifformis*, *F. bisetosa* and *F. connata*, all collected from woodland habitats in Hungary; Appendix 3) were also sequenced. The results of molecular analyses confirmed our morphological results, since the sequences of the three studied taxonomic markers for *F. zicsii* sp. nov. were clearly separated from those of all similar *Fridericia* species.

DISCUSSION

The enchytraeid fauna (47 species of 14 genera) of this area is quite diverse, and consists mostly of species typical to the Hungarian or wider

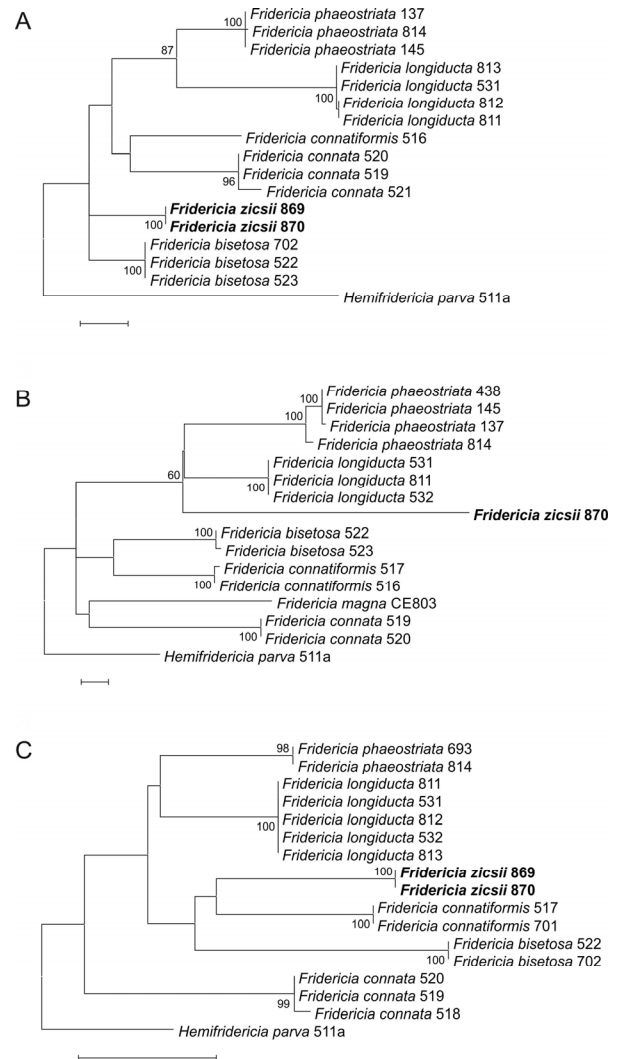


Figure 6. Maximum likelihood (ML) phylogenetic trees of selected *Fridericia* species based on the ITS region (A), CO1 (B) and H3 genes (C). Bootstrap values greater than 50 are shown at the nodes. Sequences from the new species described here appear in bold. A = ML tree of the ITS region based on 425 nucleotide positions using the K2+G nucleotide substitution model. B = ML tree of the CO1 gene based on 405 nucleotide positions using the TN93+G+I substitution model. C = ML tree of the H3 gene based on 175 nucleotide positions using the K2+G substitution model. Scale bars = 0.05 substitutions per nucleotide position. Sequences from the new species are highlighted with bold letters.

Central European fauna (Schmelz & Collado 2010). In terms of species numbers recorded in the investigated sites, the hay meadow of Gödörházi rétek (site 5 in Appendix 1) showed with 32 species the highest value. The species compo-

sition of this site reflects best the mountain or subalpine character of the area. Moreover only here (and at the neighbouring site 4, the edge of an alder carr), specimens of *F. zicsii* sp. nov. were found. This new species was clearly distinguishable from other *Fridericia* species based on morphological characters and molecular taxonomical analyses.

Of all other studied Hungarian mountain ranges, the fauna of Őrség NP is most similar to the fauna of Zemplén Mts. (Dózsa-Farkas 2007). *Mesenchytraeus armatus*, *Mesenchytraeus glandulosus* and *Marionina simillima* are North European or subalpine fauna elements. Comparing the two *Sphagnum* mires studied here (sites 8 and 9a) with the four other *Sphagnum* mires in the north-eastern part of Hungary investigated earlier (Dózsa-Farkas 1990, 1991), it is worth noting that the enchytraeid fauna of the mire in Farkasfa (site 8) was poor in species (4 species) while the mire in Szőce (site 9) with its 20 recorded species widely differed from these. Interestingly, this species-rich sampling site was located in the middle of the mire (site 9a), while at its edge (sites 9b and c) only seven species were recorded. We expected an opposite trend. The reason for this can be the higher pH value measured (6.8–6.9) in the mire in Szőce, the site was not as nutrient-poor as in case of the other mires (Pócs *et al.* 1958) and furthermore, besides *Sphagnum* spp. other moss species were also present.

Chamaedrillus (= *Cognettia*) *chalupskyi* is a new species for the Hungarian fauna. It should be noted that almost all *Cognettia* species were recently revised and relegated to the genus *Chamaedrillus* Friend, 1913 (Martinsson *et al.* 2015), but this nomenclatural act was questioned and a case has been submitted to the International Commission on Zoological Nomenclature (Schmelz *et al.* 2015), therefore both genus names appear throughout this article.

Acknowledgements – Our thanks are due to Dr. János Farkas and Dr. Zoltán Tóth for their assistance in sampling. This research was financed by the Hungarian Scientific Research Fund (OTKA K77999). Tamás Felföldi was supported by the János Bolyai Research Scholarship of the Hungarian Academy of Sciences.

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Online supporting material: Appendix 1–3 (http://opuscula.elte.hu/PDF/Tomus47_1/DFK_Appendix1-3.pdf)

Appendix 1. Investigated localities and habitats (with sampling dates) of the Órség National Park with the recorded enchytraeid and *Hrabeiella* species.

1. **Szentgyörgyvölgy, mixed forest** with *Quercus petraea*, *Carpinus betulus* and some *Pinus silvestris*, 46°45.180N 16°25.031E, 223 m a.s.l., 31.03.2014. **11 + 1 species** (*Achaeta danica*, *Chamaedrillus* (=Cognettia) *glandulosus*, *Ch.* (=C.) *chlorophilus*, *Ch.* (=C.) *chalupskyi*, *Enchytraeus buchholzi*, *Enchytronia parva*, *Fridericia benti*, *F. bisetosa*, *F. sohlenii*, *Marionina simillima*, *Stercutus niveus*, *Hrabeiella periglandulata*).
2. **Szentgyörgyvölgy, hay meadow**, 46°45.188N 16°24.917E, 232 m a.s.l., 31.03.2014. **12 species** (*Achaeta bohemica sensu stricto*, *A. danica*, *Chamaedrillus* (=Cognettia) *glandulosus*, *Enchytraeus buchholzi sensu lato*, *Enchytronia parva*, *Fridericia bisetosa*, *F. connata*, *F. connatiformis*, *F. nemoralis*, *F. dura*, *F. sohlenii*, *Marionina simillima*).
3. **Gödörházi rétek (specially protected area), alder carr**, 46°44.782N 16°21.227E, 229 m a.s.l.
 - a.) waterlogged area under *Alnus glutinosa* trees, 31.03.2014. **10 species** (*Buchholzia fallax*, *Chamaedrillus* (=Cognettia) *glandulosus*, *Enchytraeus buchholzi sensu lato*, *Enchytronia parva*, *Fridericia benti*, *F. maculata*, *F. perrieri*, *F. sohlenii*, *Marionina simillima*, *Mesenchytraeus armatus*).
 - b.) on the edge of an alder carr, drier area with *Hemerocallis lilioasphodelus*, 31.03.2014, 09.11.2014, 26.10.2015. **10 species** (*Achaeta danica*, *Buchholzia appendiculata*, *Chamaedrillus* (=Cognettia) *chlorophilus*, *Ch.* (=C.) *glandulosa*, *Enchytraeus buchholzi sensu lato*, *Fridericia benti*, *F. connata*, **F. zicsii sp. n.**, *F. dura*, *Mesenchytraeus pelicensis*).
4. **Gödörházi rétek (specially protected area) hay meadow** with *Salix rosmarinifolia*, 46°44.931N 16°21.177E, 229 m a.s.l., 31.03.2014, 09.11.2014, 16.05.2015, 26.10.2015. **32 species** (*Achaeta danica*, *A. unibulba*, *Buchholzia appendiculata*, *Cernosvitoviella aggtelekiensis*, *C. minor*, *Chamaedrillus* (=Cognettia) *cognettii*, *Enchytraeus buchholzi*, *E. buchholzi sensu lato*, *E. christenseni*, *Enchytronia parva*, *E. baloghi*, *Fridericia benti*, *F. bisetosa*, *F. bulboides*, *F. connata*, *F. dura*, *F. lenta*, *F. maculata*, *F. maculatiformis*, *F. perrieri*, *F. ratzeli*, *F. schmelzi*, *F. sohlenii*, **F. zicsii sp. n.**, *Fridericia sp. 1*, *Henlea perpusilla*, *H. ventriculosa*, *Marionina argentea sensu lato*, *M. communis*, *M. vesiculata*, *Mesenchytraeus armatus*, *Mes. pelicensis*).
5. **Kercaszomor, under old oak trees**, 46.78527N 16.31639E, 252 m a.s.l., 31.03.2014. **12+1 species** (*Achaeta danica*, *Buchholzia appendiculata*, *Cernosvitoviella minor*, *Chamaedrillus* (=Cognettia) *chlorophilus*, *Enchytronia parva*, *Fridericia connata*, *F. galba/1-2*, *F. maculatiformis*, *F. paroniana*, *Fridericia sp. 1*, *Henlea perpusilla*, *Marionina simillima*, *Stercutus niveus*, *Hrabeiella periglandulata*).
6. **Szalfő**, 46°52.492N 16°18.158E, 325 m a.s.l.
 - a.) spruce (*Picea abies*) forest, 31.03.2014. **5+1 species** (*Achaeta danica*, *Chamaedrillus* (=Cognettia) *chlorophilus*, *Enchytronia parva*, *Fridericia dura*, *F. sohlenii*, *Hrabeiella periglandulata*).
 - b.) near to site 6a, a pine forest (*Pinus silvestris*), 31.03.2014. **7+1 species** (*Achaeta danica*, *Chamaedrillus* (=Cognettia) *chlorophilus*, *Ch.* (=C.) *glandulosus*, *Enchytraeus norvegicus*, *Enchytronia parva*, *Fridericia connata*, *Mesenchytraeus pelicensis*, *Hrabeiella periglandulata*).
7. **Szalfő Forest reserve** with *Quercus robur*, *Carpinus betulus*, 46°52.227N 16°18.356E, 333 m a.s.l., 31.03.2014. **5+1 species** (*Achaeta danica*, *Buchholzia appendiculata*, *Chamaedrillus* (=Cognettia) *chlorophilus*, *Fridericia connata*, *F. miraflores*, *Hrabeiella periglandulata*).
8. **Szentgotthárd-Farkasfa, Sphagnum mire**, 46°54.112N 16°19.188E, 253 m a.s.l., 31.03.2014. **4 species** (*Cernosvitoviella atrata*, *C. minor*, *Chamaedrillus* (=Cognettia) *glandulosus*, *Fridericia sohlenii*)
9. **Szóce, Sphagnum mire**, 46°53.983N 16°34.382E, 229 m a.s.l.
 - a.) *Sphagnum* and other moss, 31.03.2014, 16.05.2015. **20 species** (*Achaeta affinis*, *Buchholzia fallax*, *Cernosvitoviella atrata*, *C. aggtelekiensis*, *C. minor*, *C. microtheca*, *Chamaedrillus* (=Cognettia) *glandulosus*,

Ch. (=C.) chalupskyi, *Enchytraeus buchholzi sensu lato*, *E. christenseni*, *Enchytronia parva*, *En. baloghi*, *Fridericia benti*, *F. bisetosa*, *F. connatiformis*, *F. perrieri*, *F. ratzeli*, *Hemifridericia parva*, *Marionina argentea sensu lato*, *Mesenchytraeus armatus*).

- b.) on the edge of the mire with *Anemone nemorosa*, 31.03.2014. **7 species** (*Cernosvitoviella aggtelekiensis*, *Chamaedrillus (=Cognettia) cognettii*, *Ch. (=C.) glandulosus*, *Enchytraeus buchholzi sensu lato*, *Fridericia sohlenii*, *Hemifridericia parva*, *Marionina simillima*).
- c.) meadow with *Lamium amplexicaule* on the edge of the mire 31.03.2014. **7 species** (*Buchholzia appendiculata*, *B. fallax*, *Enchytraeus christenseni*, *Fridericia bisetosa*, *F. connata*, *Henlea perpusilla*, *H. ventriculosa*).
- d.) woodland on the edge of the mire with *Quercus robur*, *Alnus glutinosa* and *Betula pendula*, 31.03.2014. **11 species** (*Buchholzia fallax*, *Cernosvitoviella atrata*, *Chamaedrillus (=Cognettia) cognettii*, *Ch. (=C.) chlorophilus*, *Enchytraeus buchholzi sensu lato*, *Enchytronia parva*, *Marionina argentea sensu lato*, *M. simillima*, *Mesenchytraeus armatus*, *Mes. glandulosus*, *Mes. pelicensis*).

Appendix 2. List of the species of Enchytraeidae and Hrabieillidae recorded in the Órség National Park.

- Achaeta affinis* Nielsen & Christensen, 1959
Achaeta bohemica (Vejdovský, 1879) *sensu stricto*
Achaeta danica Nielsen & Christensen, 1959
Achaeta unibulba Graefe, Christensen & Dózsa-Farkas, 2005
Buchholzia appendiculata (Buchholz, 1862)
Buchholzia fallax Michelsen, 1887
Cernosvitoviella aggtelekiensis Dózsa-Farkas, 1970
Cernosvitoviella atrata (Bretscher, 1903)
Cernosvitoviella microtheca (Rota & Healy, 1999)
Cernosvitoviella minor Dózsa-Farkas, 1990
Chamaedrillus (Cognettia) glandulosus (Michelsen, 1888)
Chamaedrillus (Cognettia) chlorophilus Friend, 1913
Chamaedrillus (Cognettia) chalupskyi Martinson, Rota & Erséus, 2014
Chamaedrillus (Cognettia) cognettii (Issel, 1905)
Enchytraeus buchholzi Vejdovský, 1879
Enchytraeus buchholzi Vejdovský, 1879 *sensu lato*
Enchytraeus christenseni Dózsa-Farkas, 1992
Enchytronia baloghi Dózsa-Farkas, 1988
Enchytronia parva Nielsen & Christensen, 1959
Fridericia benti Schmelz, 2003
Fridericia bisetosa (Levinsen, 1884)
Fridericia bulboides Nielsen & Christensen, 1959
Fridericia connata Bretscher, 1902
Fridericia connatiformis Dózsa-Farkas, 2015
Fridericia dura (Eisen, 1879) (= *F. ratzeli* Dózsa-Farkas, 2005)
Fridericia galba (Hoffm, 1843) (/1=with 2–4 diverticula, /2= with 5–8 diverticula)
Fridericia lenta Schmelz, 2003
Fridericia maculata Issel, 1905
Fridericia maculatiformis Dózsa-Farkas, 1972
Fridericia nemoralis Nurminen, 1970
Fridericia paroniana Issel, 1904
Fridericia perrieri (Vejdovský, 1878)
Fridericia ratzeli (Eisen, 1872) (*sensu F. eiseni* Dózsa-Farkas, 2005)
Fridericia sohlenii Rota et al., 1998
***Fridericia zicsii* sp.n.**
Fridericia sp. 1
Hemifridericia parva Nielsen & Christensen, 1959
Henlea perpusilla Friend, 1911
Henlea ventriculosa (d'Udekem, 1854)
Marionina argentea (Michelsen, 1889) *sensu lato*
Marionina communis Nielsen & Christensen, 1959
Marionina simillima Nielsen & Christensen, 1959
Marionina vesiculata Nielsen & Christensen, 1959
Mesenchytraeus armatus (Levinsen, 1884)
Mesenchytraeus glandulosus (Levinsen, 1884)
Mesenchytraeus pelicensis Issel, 1905
Stercutus niveus Michelsen, 1888
- Hrabieilla periglandulata* Pižl & Chalupský, 1984

Appendix 3. List of *Fridericia* specimens used for molecular taxonomic analyses with collection data and GenBank accession numbers (sequences determined in this study appear in bold)

Species	Collection source and collection date	Specimen ID	GenBank accession numbers		
			ITS	CO1	H3
<i>F. bisetosa</i>	Máttra Mts., Markaz, Turkey oak woodland, 47°50.257N 20°03.260E, 324 m a.s.l., leg. K. Dózsa-Farkas & J. Farkas, 10.05.2013.	522	KU586623	KU586588	KU586604
	Nyírség, Egyek-Félhalom, closed lowland steppe oak woodlands, 47°36.349N 20°51.368E, 91 m a.s.l., leg. K. Dózsa-Farkas & J. Farkas, 13.05.2011.	523	KU586624	KU586589	-
		702	KU586622	-	KU586603
<i>F. connata</i>	Danube-Dráva NP, between Sellye and Bogdása, meadow with young oak plantation, 45°52.246N 17°48.011E, 104 m a.s.l., leg. K. Dózsa-Farkas, J. Farkas & Z. Tóth, 28.03.2011	518	-	-	KU586609
	Máttra Mts., Markaz, fir forest, 47°50.257N 20°03.260E, 324 m a.s.l., leg. K. Dózsa-Farkas & J. Farkas, 10.05.2013.	519	KU586625	KU586594	KU586610
	Máttra Mts., near Recsk, hornbeam woodlands with beech, 47°53.233N 20°05.461E, 482 m a.s.l., leg. K. Dózsa-Farkas & J. Farkas, 10.05.2013.	520	KU586626	KU586595	KU586611
	Nyírség, Újszentmargita, oak woodland, 47°44.373N 21°05.573E, 1491 m a.s.l., leg. K. Dózsa-Farkas & J. Farkas, 13.05.2011.	521	KU586627	-	-
<i>F. connatiformis</i>	Danube-Dráva NP, Páprád, Bükkhát Forest Reserve, riverine oak-elm-ash woodlands, wet soil patch, 45°52.194N 18°00.474E, 109 m a.s.l., leg. A. Ortmann-Ajkai, 08.12.2012.	516	KU586621	KU586591	-
	Danube-Dráva NP, between Sellye and Bogdása, meadow with young oak plantation, 45°52.246N 17°48.011E, 104 m a.s.l., leg. K. Dózsa-Farkas, J. Farkas & Z. Tóth, 28.03.2011.	517	-	KU586590	KU586607
	Danube-Dráva NP, Páprád, Bükkhát Forest Reserve, riverine oak-elm-ash woodlands, wet soil patch, 45°52.194N 18°00.474E, 109 m a.s.l., leg. A. Ortmann-Ajkai, 21.10.2011.	701	-	-	KU586608
<i>F. longiducta</i>	Danube-Dráva NP, Páprád, Bükkhát Forest Reserve, riverine oak-elm-ash woodlands, wet soil patch, 45°52.194N 18°00.474E, 109 m a.s.l., leg. A. Ortmann-Ajkai, 08.12.2012.	531	KU586615	KU586585	KU586600
		532	-	KU586593	KU586597
	Danube-Dráva NP, Páprád, Bükkhát Forest Reserve, riverine oak-elm-ash woodlands, wet soil patch, 45°52.194N 18°00.474E, 109 m a.s.l., leg. A. Ortmann-Ajkai, 20.10.2014.	811	KU586616	KU586586	KU586599
		812	KU586617	-	KU586598
		813	KU586618	-	KU586596
<i>F. magna</i>	(see reference Erséus <i>et al.</i> 2010)	CE803	-	GU902066	-
<i>F. phaeostriata</i>	Villány Mts., Kistótfalu, old oak woodland, 45°90.139N, 18°30.889E, 119 m a.s.l., leg. K. Dózsa-Farkas, J. Farkas & G. Boros, 04.04.2006.	137	KU586612	KU586582	-
		145	KU586613	KU586592	-
	Danube-Dráva NP, between Lakócsa and Potony, lowland pedunculate oak-hornbeam woodlands, 45°54.473N 17°40.204E 120 m a.s.l., leg. K. Dózsa-Farkas & J. Farkas, 28.03.2011.	438	-	KU586583	-
	Danube-Dráva NP, Páprád, Bükkhát Forest Reserve, lowland pedunculate oak-hornbeam woodlands, under <i>Ruscus aculeatus</i> shrubs, 45°52.352N 18°00.413E, 127 m a.s.l., leg. K. Dózsa-Farkas, J. Farkas & Z. Tóth, 28.03.2011.	693	-	-	KU586602
	Közseg Mts., Közseg, ash-alder woodlands along a stream, 47°24.055N 16°26.527E, 478 m a.s.l., leg. K. Dózsa-Farkas, J. Farkas & Z.	814	KU586614	KU586584	KU586601

Dózsa-Farkas & Felföldi: A new Fridericia species and the enchytraeid fauna of the Őrség National Park

	Tóth, 13.10. 2014.				
<i>F. zicsii</i>	Őrség, Gödörházi rétek, on the edge of alder carr with <i>Hemerocallis lilio-asphodelus</i> , 46°44.782N 16°21.227E, 229 m a.s.l., leg. K. Dózsa-Farkas, J. Farkas, Z. Tóth & F. Hoc, 31.03.2014.	869	KU586619	-	KU586605
		870	KU586620	KU586587	KU586606
<i>Hemifridericia parva</i> (outgroup)	(see reference Dózsa-Farkas & Felföldi 2015)	511a	KM591939	KM591923	KM591931

Re-description of eight species described by Luigi Balzan from South America (Argentina, Brazil, Paraguay) (Pseudoscorpiones: Chernetidae)*

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Abstract. Lectotypes are designated for *Chelifer brevifemoratus*, *Chelifer communis*, *Chelifer crassimanus*, *Chelifer foliosus*, *Chelifer germainii*, *Chelifer robustus*, *Chelifer (Lamprochernes) cervus*, *Chelifer (Lamprochernes) ovatus*; the species are re-described and their generic placement is discussed. *Gomphochernes depressimanus* (With, 1908) and *Gomphochernes perproximus* Beier, 1932 are considered as subjective junior synonyms of *G. robustus*. *Chelifer ovatus* is transferred to the genus *Americhernes* Muchmore (nov. comb.). *Chelifer brevifemoratus* is removed from synonymy of *Lamprochernes savignyi* (E. Simon) and transferred to the genus *Parachernes* (nov. comb.).

Keywords. taxonomy, lectotypes, new combinations, new synonyms.

INTRODUCTION

Luigi Balzan was born in 1865 in Badia (Italy) and moved to Paraguay in 1886, obtaining there the chair of Professor of Natural History at the National Institute. He started exploring the country and collected intensively different animal groups and published, first in a private edition (1887, 1888), then in 1890 in Italy, the pseudoscorpion fauna of Paraguay, describing 27 new species. He died in 1893 at the age of only 28 years in Padua (Italy). Several of his species have subsequently been recorded from many parts of South and Central America. Balzan's pseudoscorpion collection was untraceable, and With (1908) redefined some of Balzan's species without having seen the original specimens. His detailed descriptions were taken over by Beier (1932b) for his monumental synopsis of the pseudoscorpions. One century later fortunately, I could trace, with the help of Italian colleagues, an important part of Balzan's collection in the Museo La Specola at Florence and thanks to the helpful collaboration

of the responsible at this time, Dr Sarah Mascherini, I was finally able to study many species described by Balzan from Paraguay and adjacent regions. Several species have already been re-described and lectotypes designated (Mahnert 1985, 2013, Mahnert & Aguiar 1986), and I take the occasion here to precise the taxonomic position of eight Chernetid species for which a good definition was lacking and which had been therefore confused or partly misplaced. This might enable a new discussion on affinities between genera and species based on precise morphological data.

MATERIAL AND METHODS

Measurements are given in mm; proportions and measurements of pedipalps and carapace correspond to length/breadth, those of legs to length/depth. Terminology follows mainly Chamberlin (1931) and Harvey (1992), measurements follow Beier (1932a). The species are arranged in alphabetic order of their name, in the synonyms'

urn: lsid:zoobank.org:pub:4B24832F-560F-492D-A37E-9374F9BC4DC3

HU ISSN 2063-1588 (online), HU ISSN 0237-5419 (print) <http://dx.doi.org/10.18348/opzool.2016.1.73>

*This paper is dedicated to Andras Zicsi, in memory of our common field and collecting trips.

list are only mentioned the original name, the generic placement by Beier (1932b) and (if different) the current placement indicated by Harvey (2013) where complete synonymies are listed. Due to the bad conservation status of most specimens, drawings are concentrating on the most important characters, vestitural setae *e.g.* had been omitted on pedipalps and chela; furthermore, these details are well figured by Balzan (1887, 1888).

All specimens studied here are housed in the collections of the Museo Zoologico La Specola, Florence (Italy).

TAXONOMY

Parachernes brevifemoratus (Balzan) **comb. nov.**

(Figures 1–3)

Chelifera brevifemoratus (Balzan, 1887): no pagination, figs.

Pycnochernes brevifemoratus (Balzan): Beier 1932b: 137.

Material examined. Paraguay, Asuncion, sotto base foglie di *Cocos* (coll. no. 30); *Lectotype* ♂ (designated here, designation label dates from 1983) (type series consisting of 1♂, 2♀ 10 nymphal stades; badly conserved, broken, and partly incomplete). *Paralectotypes*; remaining specimens.

Balzan (1887) mentioned a total of 13 specimens (one from Resistencia, 12 from Asuncion). Balzan (1890) cited one specimen from Resistencia ("sotto la corteccia d'un tronco morto"), this specimen probably has been mixed up with those from Asuncion.

Description of lectotype. Carapace granular, the granula regular and separated by their diameter, surface between eye-spots smooth, tergites excepted XI divided, anterior ones granular, the last ones scaly sculptured; pedipalps coarsely granular, setae on carapace and tergites clavodentate, being longer on the posterior tergites;

setae on pedipalps relatively long and clavodentate, on hand dentate. Carapace 1.2 times longer than broad, two indistinct eye-spots present, with two narrow transversal granular furrows, subbasal one indistinctly nearer to posterior margin than to median one; 4 setae on anterior, 10 setae on posterior margin; half-tergites I–III with 6–7 marginal setae, IV–X with about 5–6 setae on posterior margin, 1 lateral and 1 median anterior seta, XI 10 setae (4 median discal setae, tactile broken or absent). Manducatory process with 3 marginal and 1 discal setae; genital operculum with about 30 long and smooth setae, genital opening with 3/3 acute internal setae; chaetotaxy of half-sternites III–XI: 5+3/5+2/8/9/7/5/5/3, on VII–X biserial setation (1 or 2 lateral, median and discal setae), sternite XI 8 (2 median discal setae, 2 lateral tactile setae). Spermatheca of female (Fig. 3) paired, the short ducts with apical bulge.

Chelicera. 5 setae on hand, basal one finely dentate, movable finger with tooth-like subapical lobus, serrula exterior 17 blades, galea short, acute, with 1–2 tiny teeth, galea of female longer, with apical fork and 4 lateral branchlets, rallum 3 setae.

Pedipalps (Fig. 1). Trochanter with broad dorsal hump, 1.3 times longer than broad, femur abruptly enlarged, 2.0 (♀ 2.2) times, patella 2.2 (♀ 2.0) times, hand with pedicel 1.6 (♀ 1.6) times, chela with pedicel 2.8 (♀ 2.7–2.8) times, without pedicel 2.6 times longer than broad, hand with pedicel 1.1 (♀ 1.2) longer than finger; both fingers (♂♀) with 29–34 small partly cusped teeth, on fixed finger 6–9, on movable finger 6–7 antiaxial accessory teeth and 2/1 paraxial accessory teeth.

Trichobothria (Fig. 2). *et* in distal finger third, *it/ist/est* grouped in middle of finger, *eb/esb/ib/isb* at finger base on fixed finger, *st* on movable finger halfway between *sb* and *t*; a long venom duct present in movable finger, nodus ramosus at level of trichobothrium *t*.

Leg IV. Femur+patella 4.3 times, tibia 3.7 times, tarsus 4.8 times longer than deep, tibia 1.1 times longer than tarsus; tarsus with a tactile seta (broken) in the middle of tarsus (TS=0.48) arolia undivided, shorter than simple claws, subterminal seta strongly curved.

Measurements of ♂ (2♀). Body length 1.52; carapace 0.59/0.47. Pedipalps: trochanter 0.25/0.19, femur 0.37/0.18 (0.40–0.42/0.18–0.19), patella 0.40/0.18 (0.42–0.43/0.20–0.22), length of pedicel 0.11, hand with pedicel 0.39/0.25 (0.45–0.46/0.28–0.29), length of pedicel 0.06, length of finger 0.37 (0.38–0.39), of chela with pedicel 0.71 (0.78–0.79), without pedicel 0.65; leg IV: femur+patella 0.38/0.09, tibia 0.27/0.07, tarsus 0.25/0.05.

Remarks. Harvey (1987) proposed the synonymy of *Ch. brevifemoratus* with *Lamprochernes savignyi* (E. Simon), but he had ignored the existence of the type specimens. The bad conservation of the type specimens does not allow a definitive generic placement of the species, but it is evident that it does not belong to Lamprochernetinae, but has to be placed in Chernetinae, and putatively into the genus *Parachernes*. Differences between the close genera *Rhopalochernes* and *Parachernes* should be re-discussed. The trichobothrial pattern (*ist-it*) in middle of finger or proximal of and near *ib-isb*, the presence of a tactile seta on tarsus IV and particularly the paired spermatheca are the main arguments for this generic placement.

***Odontochernes cervus* (Balzan)**

(Figures 4–7)

Chelifera cervus Balzan, 1888: no pagination, figs.
Odontochernes cervus (Balzan): Beier 1932b.

Material examined. Lectotype ♂. Brasil, Matto-grosso (coll.no.129) (designated here, designation label is dated 1983). Paralectotype ♀. Same data (both specimens in bad condition, many setae fallen off or broken).

Balzan (1888) clearly states "Possideo exemp. 2 ex provincia Matto-grosso", but not in 1890: "Ne posseggo un solo esemplare proveniente dalla provincia brasiliana del Matto-grosso".

Description of lectotype (paralectotype ♀). Carapace 1.2 times longer than broad, laterally finely and densely granular, median transverse

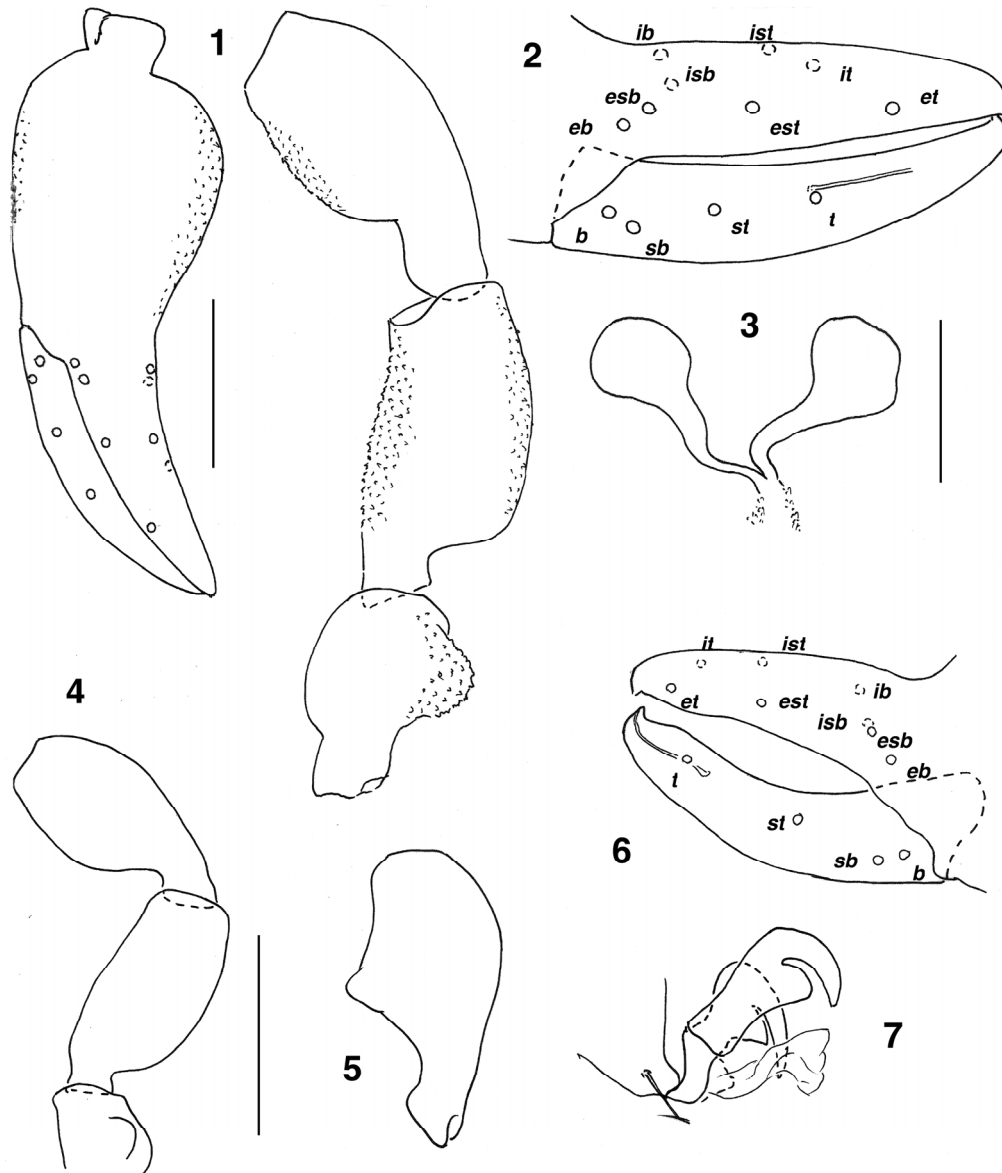
furrow distinct, 2 eye-spots present, 4 setae on anterior, about 15 on posterior margin, setae thin and finely dentate; tergites I–III and XI undivided, the other ones divided, with about 8 marginal, 1–2 lateral and median anterior setae and 2 discal setae; manducatory process with 3 marginal and 2 discal setae; coxae and sternites, genital organs unstudied. Chelicera with 5 setae (broken in ♂), two basal ones finely dentate in ♀; fixed finger with 8 retrorse teeth, movable finger with long cone-like subapical tooth and 3 small marginal teeth, galea broken in ♂, long with at least 4 lateral (one near base) and 2–3 apical branchlets, serrula exterior 18 blades, rallum 3 setae (distal one detate).

Pedipalps (Figs. 4–5). All segments finely granular, trochanter with high and rounded dorsal hump, femur smoothly enlarged, 2.4 (2.1) times longer than broad, patella 1.9 (2.1) times, club with a distinct hump on median face (much less pronounced in ♀), hand with pedicel 1.5 (1.7) times, chela with pedicel 2.4 (2.6) times, without pedicel 2.3 (-) times longer than broad, hand with pedicel 1.3 (1.4) times longer than finger; finger strongly gaping (less pronounced in ♀), fixed finger with 43 small cusped teeth, 11 anti-axial and 9 paraxial accessory teeth, movable finger with 48 marginal teeth, 10 anti-axial and 10 paraxial accessory teeth, short venom canal present in movable finger, nodus ramosus proximal of trichobothrium *t* in distal third of finger.

Trichobothria (Fig. 6). *et* near finger tip, *it* slightly proximal, *ist-est* at same level distal of finger middle, *it* distinctly nearer to finger tip than distance between *ist-isb*; *st* on movable finger slightly nearer to *sb* than to *t*.

Leg IV. Femur+ patella 3.5 (3.1) times, tibia 5.1 (4.2) times, tarsus 5.4 (4.7) times longer than deep, tibia 1.5 (1.4) times longer than tarsus; tibia probably with a tactile seta in middle (TS=0.52–0.54), tarsus with a basal tactile seta (TS=0.23) (enlarged alveoles present); claws of legs I–IV with big ventral tooth (♂♀) (Fig. 7).

Measurements of lectotype (paralectotype ♀, when measured). Carapace 1.47/1.23. Pedipalps: femur 1.40/0.59 (1.11/0.53), patella 1.48/0.78 (1.19/0.56), hand with pedicel 1.65/1.12 (1.42/0.86), length of pedicel 0.16, of finger 1.28



Figures 1–3. *Parachernes brevifemoratus* (Balzan), lectotype; 1 = pedipalp, 2 = trichobothrial pattern, 3 = spermatheca; scale bar Fig. 1 = 0.2 mm; Fig. 3 = 0.1 mm.

Figures 4–7. *Odontochernes cervus* (Balzan), lectotype; 4 = pedipalp ♀ (without chela), 5 = patella ♂ (paralectotype), 6 = trichobothrial pattern, 7 = claws of tarsus IV; scale bar Figs. 4,5 = 1.0 mm:

(1.01), of chela with pedicel 2.67 (2.28), without pedicel 2.51. Leg IV: femur+patella 1.42/0.41 (3.13/0.39), tibia 1.18/0.23 (0.93/0.22), tarsus 0.77/0.14 (0.65/0.14).

Remarks. Descriptions given by With (1908) and Beier (1932b) correspond well to the type

specimen from Mato-Grosso, adding some indications on individual variation of several taxonomic characters (measurements, proportions). This monotypic genus is known from a few localities in Brazil (Mato-Grosso, Amazonas) and from Suriname.

***Gomphochernes communis* (Balzan)**

(Figures 8–11)

Chelifera communis Balzan, 1888: no pagination, figs.
Lustrochernes communis (Balzan): Beier 1932b: 90–91.
Gomphochernes communis (Balzan): Mahnert 1985.
Gomphochernes depressimanus (With, 1908) **syn. nov.**
Gomphochernes perproximus Beier, 1932 **syn. nov.**

Material examined. Argentina, Chaco, Resistencia, sotto cortecchie umide (coll. no. 33): ♀, *lectotype* (designated here, designation label dates from 1983). *Paralectotypes*, 5♂, 3♀, same data. Paraguay, Rio Apa, sotto cortecchie umide, *paralectotypes*, several specimens, not labelled "tipo", corresponding in morphological data to the series from Resistencia.

Balzan (1888) noted "Collegi exemp. 130 in colonia Resistencia, 13 in Asuncion, ac 69 in colonia Risso (in Apa fluminis territorio), in putrescente detrito sub arborum corticibus; possideo 4 ex. provincia Matto-grosso), and in 1890 "Raccolsi moltissime esemplari di questa specie assai commune in Resistencia, in Asuncion ed al Rio Apa, nel detrito putrefatto sotto cortecchie dei tronchi morti": I did not see specimens from Asuncion.

Description of lectotype (*paralectotypes*). Carapace 1.2 times longer than broad; with 2 indistinct eye-spots, surface smooth, with a distinct median transverse furrow, posterior margin irregularly desclerotized, setae of carapace and tergites acute and thin, apically finely dentate, 4 on anterior, 11 (10) on posterior margin; tergites divided (excepted I,II,XI), half-tergites mostly with 6–8 marginal setae (I–III 6), on IV–IX with 1 lateral and 1 median anterior setae, IX–XI also with a median discal seta, XI (entire) 14 setae (2 lateral and 2 submedian tactile setae, 2 median discal setae). Manducatory process: 3 marginal and 2 discal setae, pedipalpal coxae smooth, about 21 setae, coxa I 12, II 13, III 14, IV numerous setae; genital operculum with 4/4 median marginal setae and 14 setae in a central group, spermatheca (Fig. 10) paired, with egg-shaped distal

part; sternites divided, III 4+3 suprastigmal setae/4+1/8/8/8/7/8/7/, XI (entire) 16 setae, VI–X with 2–3 anteriorly set setae. Pleural membran striate.

Chelicera. Hand with 5 setae, three basal ones finely dentate, fixed finger with 4 retrorse teeth and 3 apical granula, movable finger with tooth-like subapical lobe, galea long, with 6 (5–6) apical/subapical branchlets; rallum with 3 setae, the distal one anteriorly dentate, serrula exterior with 18 (17–18) blades.

Pedipalps (Fig. 8). Femur and patella finely and densely granular, chelal hand smooth; trochanter with pronounced and rounded dorsal hump, granular, 1.7 (1.6) times longer than broad, femur abruptly enlarged, 2.2 (2.1–2.2) times, patella 2.1 (2.0–2.1) times, hand with pedicel 1.8 (1.8–1.9) times, chela with pedicel 2.8 (2.9–3.0) times, without pedicel 2.6 (2.7–2.8) times longer than broad, hand with pedicel 1.6 (1.5) times longer than hand breadth and indistinctly gaping; fixed finger with 29 cusped teeth, 5 anti-axial and 3 paraxial accessory teeth, movable finger with 32 teeth, accessory teeth 6/2; long venom duct present in movable finger, nodus ramosus proximal of trichobothrium *t*.

Trichobothria (Fig. 9). *est* in proximal third of fixed finger, *ist-it* in finger middle, *et* near finger tip; distance *it*-finger tip distinctly longer than distance between *ist/isb*; *st* on movable finger nearer to *sb* than to *t*, which is situated distal of the finger middle.

Leg IV. Femur+patella 2.6 (2.4–2.6) times, tibia 3.6 (3.2–3.5) times, tarsus 3.8 (3.5–3.8) times longer than deep, tactile seta on tarsus in basal third (TS=0.25); subterminal seta smooth, curved; arolia undivided, as long as claws; internal claw with distinct and broad tooth on inferior margin (Fig. 11).

Measurements of lectotype (*paralectotypes* ♂ ♀). Body length - (2.2–2.6); carapace 0.81/0.68 (0.68–0.85/0.55–0.71). Pedipalps: trochanter 0.44/0.25 (0.33–0.39/0.21–0.25), femur 0.69/0.32 (0.51–0.62/0.25–0.29), patella 0.70/0.34 (0.53–0.63/0.26–0.31), length of pedicel 0.18 (0.14–0.18), hand with pedicel 0.80/0.44 (0.60–0.71/0.33–0.38), length of pedicel 0.10 (0.07–0.09), of finger 0.50 (0.40–0.47), of chela with pedicel 1.21

(0.95–1.10), without pedicel 1.12 (0.89–1.01). Leg IV: femur+patella 0.66/0.26 (0.51–0.62/0.20–0.25), tibia 0.50/0.14 (0.38–0.48/0.12–0.14), tarsus 0.33/0.09 (0.26–0.31/0.08).

Supplementary specimens. Specimens collected during the expedition 1979 of the Geneva Museum of Natural History to Paraguay correspond perfectly to the above given description of the lecto- and paralectotypes. They were collected in the following localities (leg. V. Mahnert): Paraguay, prov. Concepcion, Rio Apa, south of Estancia Estrellas, under bark, 18.X.1979; prov. Concepcion, Rio Apa, between Estancia Estrellas and Estancia Primavera, under bark of fallen tree trunks, 18.X.1979; prov. Amambay, 12 km south Bella Vista, sieving of litter and rotten wood, 23.X.1979; prov. Canendiyu, near mouth of Rio Carapa, sieving of dead leaves and rotten wood, 3.XI.1979.

Remarks. The species *Chelifer communis* Balzan has been transferred to the genus *Gomphochernes* by Mahnert (1985), but without giving detailed information on it and without official designation of a lectotype. The species *Lustrochernes communis* (Balzan) *sensu* Beier (1932b) had been identified as being identical with *Lustrochernes intermedius* (Balzan), with designation and description of a lectotype (Mahnert 1985).

The transfer of *communis* invites to the comparison with the two hitherto known species in *Gomphochernes*; *depressimanus* (With, 1908) and *perproximus* Beier, 1932 (type species of the genus). Based on the descriptions of those two species, both species can be considered identical with *communis* and therefore should be considered as junior subjective synonyms of *communis*. Specimens of *perproximus* (original description) show slightly smaller size in pedipalpal measurements, compared to *communis*, e.g. length of femur ♂ 0.47 mm/♀ 0.56 mm vs. ♂ 0.56–0.62 mm/♀ 0.51–0.59 mm, of patella ♂ 0.48/♀ 0.56 mm vs. ♂ 0.55–0.63/♀ 0.53–0.70, length of chela with pedicel ♂ 0.89 mm/♀ 1.04 mm vs. ♂ 1.00–1.08 mm/♀ 0.95–1.21 mm.

These small differences seem to be not significant to maintain them as different species. The three species had still been differentiated by Mahnert *et al.* (2011), based on published descriptions and on the lectotype only, without taking in account variability of characters.

Parachernes crassimanus (Balzan)

(Figures 12–13)

Chelifer crassimanus Balzan, 1887: no pagination, figs.

Parachernes (Argentochernes) crassimanus (Balzan): Beier 1932b: 121–122.

Material examined. Argentina, Chaco, Resistencia, sotto corteccie secche (coll.45), *lectotype*, 1♀ (designated here, designation label dates from 1983) (Balzan 1887: "Collegi sub truncorum corticis exemp. 1 in colonia Resistencia").

The specimens from Asuncion (Balzan 1890: sotto corteccie secche (coll.no.45): 1♂ 10T 1P) belong without doubt to another *Parachernes* species, probably *P. plumosus* (With).

Balzan (1887) noted "possideo exemp. 9 ex. provincia Matto-grosso", en affirmant (1890) "ne posseggo pure parecchi del Matto-grosso".

Description of the lectotype. Colouration not discernable, but pedipalpal hand apparently darker than other segments. Carapace and pedipalps coarsely granular, granula on carapace regular, separate by one diameter from each other, setae short, dentate and slightly clavate, those on hand dorsum finely dentate, but not clavate; tergites except XI divided, I–VI scaly, the others smooth, setae slender, longer on the posterior ones, dentate and slightly clavate. Carapace 1.1 times longer than broad, 2 indistinct eye-spots present, prozone between eyes smooth, 4 setae on anterior, 10 on posterior margin; chaetotaxy of half-tergites I–X: 6/5/6/7/6/6/4/5/5/5, on III–X one lateral anterior seta, tergite XI 8 (2 median discal setae, tactile setae, ?broken). Manducatory process with 3 marginal and 1 discal setae; genital operculum

with 3/4 median marginal and about 25 central discal setae; spermatheca not observed; half-sternites III–X: 5+3 suprastigmal setae/4+1/6/8/7/8/9/8, entire sternite XI 8 setae (tactile setae, ?broken). Pleural membran granular.

Chelicera. 5 setae on hand, at least one basal one finely dentate, movable finger with tooth-like subapical lobe, galea long with 6 apical and subapical curved branchlets, serrula exterior 22 blades, rallum 3 setae, distal one dentate.

Pedipalps (Fig. 12). Trochanter with prominent rounded dorsal hump, 1.6 times longer than broad, femur abruptly enlarged, 2.4 times, patella 2.3 times, hand with pedicel 1.6 times, chela with pedicel 3.1 times, without pedicel 2.8 times longer than broad, finger as long as hand with pedicel, distinctly gaping (movable finger curved); fixed finger with 41, movable finger with 47 small teeth, accessory teeth 6/5 on antiaxial side, 3/2 on paraxial side; venom duct present in movable finger, nodus ramosus at level of trichobothrium *t*.

Trichobothria (Fig. 13). *et* in distal third of fixed finger, *it-ist-est* near finger base, quite close to *eb-esb-ib-isb*.

Leg III (IV lacking). Femur+patella 2.5 times, tibia 3.6 times, tarsus 4.0 times longer than deep, tarsus with a (broken) tactile seta in distal third (TS=0.70).

Measurements. Carapace 0.83/0.75. Pedipalps: trochanter 0.37/0.22, femur 0.57/0.24, patella 0.61/0.27, length of pedicel 0.19, hand with pedicel 0.57/0.35, length of pedicel 0.11, of finger 0.58, of chela with pedicel 1.08, without pedicel 0.98; leg III: femur+patella 0.49/0.20, tibia 0.51/0.11, tarsus 0.31/0.08.

Remarks. Morphological details given by With (1908) and by Beier (1932b) are based on two ♀ from Venezuela (La Moka) and do not correspond to those of the lectotype from Argentina (Resistencia) (Mahnert *et al.* 2011): bigger size (*e.g.* length of pedipalpal femur 0.80 mm *vs.* 0.57 mm, of patella 0.83 mm *vs.* 0.61 mm, of hand with pedicel 0.83 mm *vs.* 0.57 mm; chelal fingers not gaping *vs.* distinctly gaping, a different trichobothrial pattern (*est* in distal finger half near *et*, *it-ist* in distal half of fixed finger *vs.* *it-ist* grouped with *est* near base of fixed finger).

The status of the species described by With (1908) (and Beier 1932b) is uncertain (With, *l.c.*: "It is with greatest hesitation that I have referred...to *Ch. crassimanus*..") and cannot be clarified here. The differences between *P. crassimanus* as defined here and *P. melanopygus* Beier, 1959 are subtle (Mahnert *et al.* 2011), new specimens of *crassimanus* are necessary to settle a possible synonymy between both species.

***Pseudopilanus foliosus* (Balzan)**

(Figures 14–17)

Chelifera foliosus Balzan, 1887: no pagination, figs.

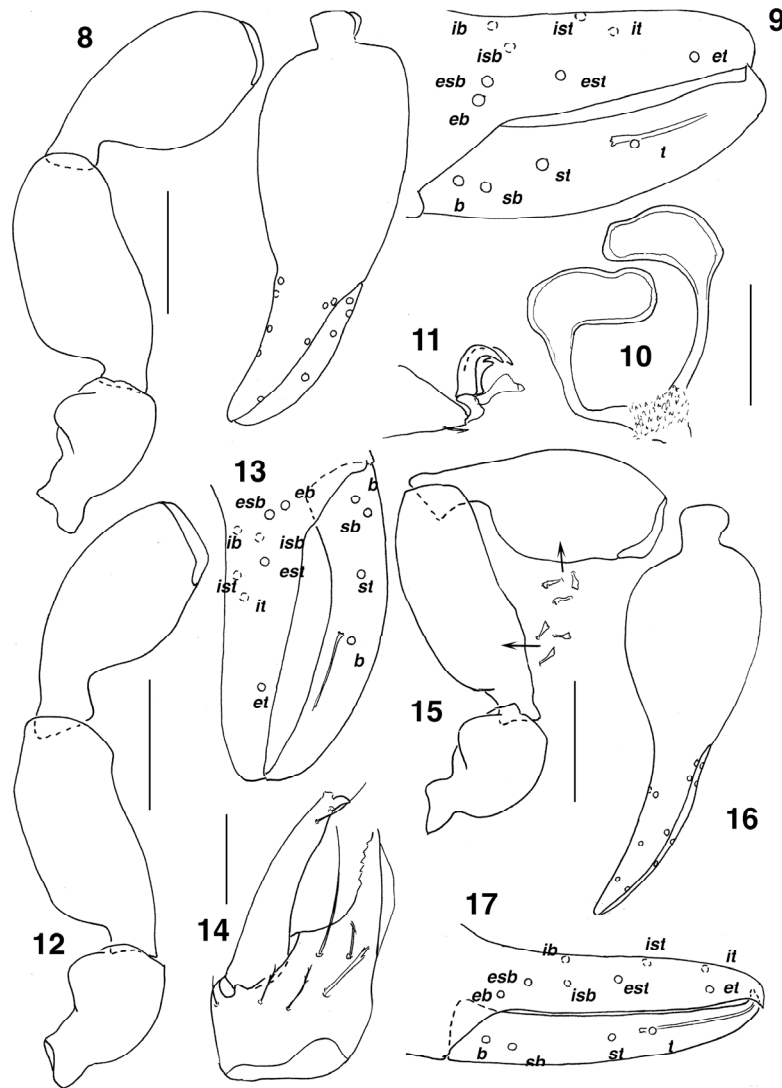
Rhopalochernes foliosus (Balzan): Beier 1932b.

Pseudopilanus foliosus (Balzan): Beier 1977.

Material examined. Argentina, Chaco, Resistencia, sotto corteccie secche, "Tipo": ♂ *Lectotype* (designated here, designation label dates from 1983) (bad condition; leg I, right chelicera missing, most setae broken off).

Balzan had two specimens, one from Resistencia, and one from Asuncion ("che è giovane") but this latter was not present in the collection studied.

Description. Carapace as long as broad, nearly pave-stone-like sculptured, prozone on lateral sides finely granular, surface nearly smooth, two distinct smooth transverse furrows, subbasal furrow nearly halfway between median furrow and posterior margin, two big lensed eyes present, setae (as those of tergites) strongly clavate, 4 on anterior, 11 on posterior margin. Tergites divided, except I and XI, scaly ctenoid sculptured, mostly 6–8 marginal setae, III–X also with a lateral and a median anterior seta, XI (entire) with 13 setae (no tactile setae, but 4 discal ones). Manducatory process with 3 marginal and 2 discal setae, coxae not examined; genital operculum with about 50 setae in semicircular arrangement; genital organ not examined; half-sternites with about 76–80 marginal setae, about 1 suprastigmal seta on each side, IX–X with one lateral anterior seta, XI not examined. Pleural membran granular (granula nearly star-like).



Figures 8–11. *Gomphochernes communis* (Balzan), lectotype; 8 = pedipalp, 9 = trichobothrial pattern, 10 = spermatheca, 11 = claws of tarsus IV; scale line Fig. 8 = 0.3 mm, Fig. 10 = 0.1 mm.

Figures 12–13. *Parachernes crassimanus* (Balzan), lectotype; 12 = pedipalp (without chela), 13 = trichobothrial pattern; scale line Fig. 12 = 0.3 mm.

Figures 14–17. *Pseudopilanus foliosus* (Balzan), lectotype; 14 = left chelicera, 15–16 = pedipalp and chela, 17 = trichobothrial pattern; scale line Fig. 14 = 0.1 mm, Figs. 15–16 = 0.4 mm.

Chelicera (Fig. 14). With 6 setae, three basal ones dentate, fixed finger with 6 retrorse and 3 apical tiny teeth, movable finger with a small tooth-like subapical lobe, galea broken, serrula exterior 19 blades, rallum 3 setae.

Pedipalps (Figs. 15–16). Densely granular, setae clavodentate, trochanter with high rounded dorsal hump, 1.7 times longer than broad, femur abruptly enlarged, 2.8 times, patella 2.2 times,

hand with pedicel 1.8 times, chela with pedicel 3.1, without pedicel 2.8 times longer than broad, hand with pedicel 1.15 times longer than finger; fixed finger with 38 marginal teeth, 6 antiaxial and 3 paraxial accessory teeth, movable finger with 44 marginal teeth, accessory teeth 3/3, venom duct present in movable finger, nodus ramosus proximal of trichobothrium *t*.

Trichobothria (Fig. 17). *et-it* near finger tip,

ist distal of *est* (both in finger middle), *est* distinctly nearer to *ist* than to *isb*, *st* on movable finger close to *t*.

Leg IV. Femur+patella 3.4 times, tibia 3.6 times, tarsus 5.3 times longer than deep, tarsal tactile setae apparently absent, claws smooth, subterminal seta curved and smooth.

Measurements. Carapace 1.04/1.03. Pedipalps: trochanter 0.57/0.34, femur 0.92/0.33, patella 0.93/0.42, length of pedicel 0.30, hand with pedicel 0.88/0.50, length of pedicel 0.16, of finger 0.77, of chela with pedicel 1.58, without pedicel 1.42. *Leg IV:* femur+patella 0.83/0.24, tibia 0.68/0.19, tarsus 0.55/0.10.

Remarks. The species *foliosus* had been placed for long years in the genus *Rhopalochernes*, but in 1977 Beier transferred it to the genus *Pseudopilanus* Beier, 1957, without argumentation. *Pseudopilanus* (type species *fernandezianus* Beier from the Juan-Fernandez-Islands) is characterized mainly by the following characters: rallum with 3 setae, vestitural setae strongly clavate, hand with paraxial spine-like setae, chelal fingers without accessory teeth, trichobothria *et-it* near finger tip and nearly at same level, tarsus of leg IV without tactile seta. Eight species are currently placed in this genus, some without spine-like setae on pedipalps, some with accessory teeth on chelal fingers, but all sharing the absence of a tactile seta on tarsus IV and the distal position of trichobothrium *it* at level of *et* (as emphasized by Beier 1964).

Feio (1945) described *Neochernes melloleitao* from Argentina (Santiago del Estero) and according to the main taxonomic characters it represents probably a synonym of *foliosus*, but its type specimens have not been checked.

Rhopalochernes germainii (Balzan)

(Figures 18–20)

Chelifera germainii Balzan, 1887: no pagination, figs.
Rhopalochernes germainii (Balzan): Beier 1932b.

Material examined. Lectotype ♂, Brasil, Matto-grosso (coll. no. 46) (designated here, designa-

tion label dates from 1983). *Paralectotypes*, 1♂ 1♀, same data (all specimens in bad condition, partly in fragments).

Description. Carapace finely granular, granula separated by one diameter, median prozone smooth, setae of carapace and tergites clavo-clavate, setae of pedipalps short, on femur and patella clavodentate (the lateral ones finer), on hand merely clavate, those on fingers acute. Carapace with 2 indistinct eye-spots, two narrow transverse furrows present, the median one curved laterally cephalad, the subbasal one nearer to posterior margin than to median furrow, both granular at bottom, 4 setae on anterior, 8 on posterior margin; tergites (except I, XI) divided, with mainly 5–7 marginal setae, one lateral and one median anterior seta on IV–X, XI (entire) with 12 setae (4 discal setae). Manducatory process with 3 marginal setae, one discal seta present(?); chaetotaxy of coxae unstudied; genital operculum with about 50 long and acute setae (arranged in several rows); male genital organ not studied, spermatheca paired (Fig. 20); half-sternites with about 6–8 marginal acute and thin setae, on X one lateral seta clavodentate. Pleural membrane striate.

Chelicera with 5 acute long setae on hand (chelicerae missing in lectotype and ♀ paralectotype), movable finger with a small tooth-like subapical lobe, serrula exterior 17 blades, rallum 3 setae, the distal one serrate.

Pedipalps (Fig. 18). Distinctly granular, trochanter with a distinct rounded dorsal hump, femur basally gently enlarged, 3.3 times, patella 2.6 times, hand with pedicel 2.0 times longer than broad, finger 1.2 times, chela with pedicel 3.3 times, without pedicel 3.1 times longer than broad; both chelal fingers with 40 cusped marginal teeth, 4 (3) antiaxial and 2 (2) paraxial accessory teeth; venom duct present in movable finger, nodus ramosus proximal of trichobothrium *t*.

Trichobothria (Fig. 19). *et* in distal finger half, *it* distinctly distal of *ist*, *est* halfway between *ist* and *isb* in proximal third of finger; *st* on movable finger nearer to *sb* than to *t*.

Leg IV. Femur+patella 3.0 times, tibia 4.4 times, tarsus 4.6 times longer than deep, tarsus without (?) tactile seta, claws simple, arolia undivided, subterminal seta smooth, curved.

Measurements of lectotype. Carapace 0.66/0.60. Pedipalps: trochanter 0.32/0.18, femur 0.55/0.17, patella 0.51/0.20, length of pedicel 0.14, hand with pedicel 0.54/0.28, length of pedicel 0.06, of finger 0.44, of chela with pedicel 0.92, without pedicel 0.87. Leg IV: femur+patella 0.50/0.17, tibia 0.37/0.08, tarsus 0.28/0.06.

Remarks. The description given by Beier (1932b) is quite concordant with that of the type specimens studied. To complete iconographie of this species, figures of pedipalps and spermatheca are given.

***Americhernes ovatus* (Balzan, 1892) comb. nov.**

(Figure 21)

Chelifer (*Lamprochernes*) *ovatus* Balzan, 1892: 519, fig. 10, 10a.

Lustrochernes ovatus (Balzan): Beier 1932b.

Material examined. Holotype ♀, Brazil, Caracá, Minas (coll. no. 130) "Tipo" (Balzan had one specimen at disposition... in unico exemplo..).

Description. Carapace 1.2 times longer than broad, smooth, basally lightened, with a flat median transverse furrow, 2 big but not well marked eye-spots, with 4 setae on anterior and 8 on posterior margin, setae of carapace and tergites long, thin and finely dentate near apex, setae of pedipalps finely dentate; tergites except XI divided, half-tergites I–III with 3–5 marginal setae, IV–X with 6–8 on posterior margin and one lateral and median anterior setae, XI (entire) with 16 setae (4 tactile setae?). Manducatory process with 3 marginal and 1–2 discal setae, pedipalpal coxa smooth, 21 setae, coxa I 13, II 14, III 14, IV numerous. Genital operculum with a median oval group of 12 setae and 7 marginal setae, spermatheca not observed; sternites divided, chaetotaxy of half-sternites: 5+2 suprastigmal setae/3+?/7/7–9/7–8/6–8/8–9/6–7; V–X with 1–2 additional anterior setae on lateral and median margin; entire sternite XI 16 seta (2 lateral tactile, 2 median discal tactile setae). Pleural membran striate.

Chelicera. 5 long setae, 3 basal ones finely dentate, galea broken (right chelicera lacking),

rallum probably with 3 setae, distal one dentate, serrula exterior with 21 blades.

Pedipalps. Trochanter finely granular, femur indistinctly and finely granular medially, patella and hand smooth, trochanter with prominent rounded dorsal hump, 1.7 times longer than broad, femur abruptly enlarged, lateral face strongly rounded, 2.0 times, hand with pedicel 1.8 times, chela with pedicel 2.8 times, without pedicel 2.7 times longer than broad, hand with pedicel 1.6 times longer than finger; finger not gaping; fixed finger with 40 small, uniform and cusped teeth, 11 antiaxial, 3 paraxial accessory teeth, movable finger with about 41 mostly cusped teeth, 9 antiaxial and 3 paraxial accessory teeth, venom duct present in movable finger, nodus ramosus slightly proximal of *t*.

Trichobothria (Fig. 21). *it* halfway between *et* and *est*, *est*–*ist* on same level in proximal finger half, distance between finger tip and *it* longer than distance between *ist* and *isb*; *st* of movable finger nearer to *sb* than to *t*.

Remarks. The trichobothrial pattern of the species corresponds to the definition of *Americhernes* Muchmore, 1976 (distance between finger tip and trichobothrium *it* distinctly longer than distance between *ist* and *isb*). This character (and the generic placement) should be verified on more specimens.

***Pachychernes robustus* (Balzan)**

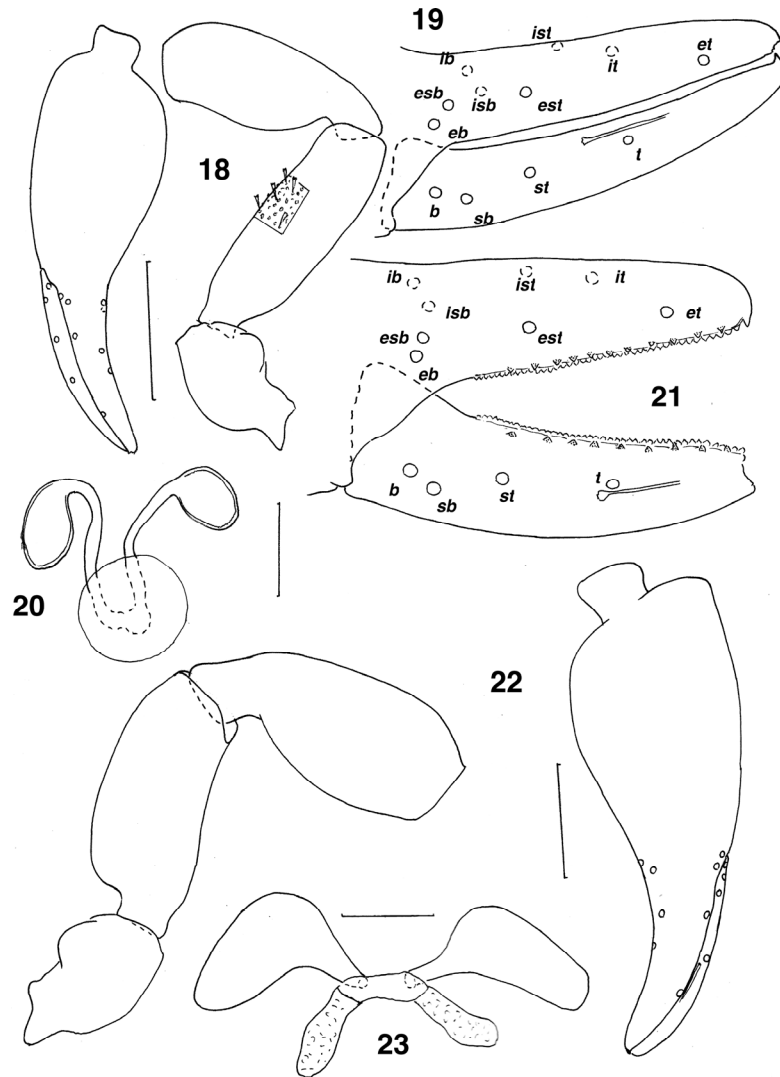
(Figures 22–23)

Chelifer robustus Balzan, 1888: no pagination, figs.

Pachychernes robustus (Balzan): Beier 1932b.

Material examined. Brasil, Mato-Grosso, coll. no. 35: Lectotype ♀ (designated here, designation label dates from 1983). Paralectotypes, 2♀, same data (all in bad condition, many fragments).

Description of lectotype (paralectotypes). Carapace fine and densely granular, indistinctly longer than broad, median transverse furrow present, 2 eye-spots, 4 setae on anterior, 11 setae on posterior margin; tergites divided excepted XI, mostly with 5–7 marginal setae, one lateral and



Figures 18–20. *Rhopalochernes germainii* (Balzan), lectotype; 18 = pedipalp, 19 = trichobothrial pattern, 20 = spermatheca; scale line Fig. 18 = 0.3mm, Fig. 20 = 0.1 mm.

Figure 21. *Americhernes ovatus* (Balzan), lectotype; trichobothrial pattern.

Figures 22–23. *Pachychernes robustus* (Balzan), lectotype; 22 = pedipalp, 23 = spermatheca; scale line Fig. 22 = 0.5 mm, Fig. 23 = 0.1 mm.

one median anterior seta, XI (entire) 12 setae (2 median discal setae); manducatory process with 3 marginal and 2 discal setae, pedipalpal coxa smooth, about 25 setae (long and acute), coxa I 16, II 12, III 23, IV numerous; genital operculum with about 40 setae; spermatheca paired (Fig. 23), sternites divided, mostly with 7 marginal setae, one lateral and one median anterior seta.

Chelicera. With 5 setae on hand, two basal ones dentate, *vt* long and smooth; subapical lobe on movable finger small, tooth-like, galea broken, serrula exterior 26–27 blades, rallum 3 setae, the distal one serrate.

Pedipalps (Fig. 22). All segments finely granular on median side, trochanter with large dorsal hump, 1.7 times longer than broad, femur

abruptly enlarged, 2.4 (2.4–2.6) times, patella 2.3 (2.2–2.4) times, hand with pedicel 1.85 (1.8) times, chela with pedicel 2.9 (2.8–3.0) times, without pedicel 2.7 times longer than broad, hand with pedicel 1.45 times longer than finger; fixed finger with 64 small cusped teeth, 10 antiaxial and 2 paraxial accessory teeth, movable finger with 69 marginal, 11 antiaxial and 0 paraxial accessory teeth; venom duct present in movable finger, nodus ramosus slightly distal of trichobothrium *t*.

Trichobothria. *et* on fixed finger halfway between finger tip and *it*, *ist–est* on same level distinctly proximal *it* and indistinctly nearer to *it* than to *ib/isb*; *st* on movable finger close to *sb*, *t* isolated in distal finger half.

Leg IV. Femur+patella 2.5 times, tibia 4.3 times, tarsus 4.3 times longer than deep, tibia 1.48 times longer than tarsus; tarsus with tactile seta in basal third (TS=0.26), claws simple and smooth, arolium shorter than claws.

Measurements of lectotype (paralectotypes, when measured). Carapace 1.33/1.31. Pedipalps: trochanter 0.71/0.43, femur 1.10/0.46 (1.04–1.07/0.42–0.44), patella 1.27/0.54 (1.18–1.20/0.50–0.55), length of pedicel 0.34, hand with pedicel 1.37/0.74 (1.28–1.29/0.70–0.73), length of pedicel 0.16 (0.11), of finger 0.94 (0.91–0.94), of chela with pedicel 2.13 (2.02–2.07), without pedicel 2.00; leg IV: femur+patella 1.22/0.48, tibia 0.91/0.21, tarsus 0.61/0.14.

Remarks. The species has been characterized in a satisfactory way by Beier (1932b), the description of the type specimens brings up some more indications on variability of taxonomic characters and enables figures of exact trichobothrial pattern and spermatheca.

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The *Allolobophora sturanyi* species group revisited: Integrated taxonomy and new taxa (Clitellata: Megadrili)

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Abstract. The *Allolobophora sturanyi* Rosa, 1895 species group is revisited using DNA barcoding and morphology. Barcoding results corroborated the previous treatment of the *Allolobophora sturanyi* subspecies and furthermore proved that the morphologically similar *Allolobophora gestroides* Zicsi, 1970 species belong to this species group. Elaboration of new samples from the Apuseni Mts resulted in discovery of a new subspecies *A. sturanyi biharica* ssp. nov. from the summit of the Bihor range, and a new species *A. zicsica* from the Vladeasa range similar to *A. gestroides* described from Northern Hungary.

Keywords. Earthworms, barcoding, COI, Carpathian Basin, new species

INTRODUCTION

The *Allolobophora sturanyi* species group was first recognized by Csuzdi & Pop (2008) through morphometric and biogeographic analysis of the species distributed in the Balkan and the Carpathian Basin and previously thought to be related to the Franco-Iberian *Allolobophora dugesi* (Rosa, 1886). The non-metric multidimensional scaling (MDS) and cluster analysis (CA) resulted in four well separated groups which showed distinct biogeographical patterns as well (Csuzdi & Pop 2008). On the basis of the somewhat variable positions of the clitellum and tubercles, and furthermore the varying number of spermathecae, three lineages were treated as *Allolobophora sturanyi* subspecies, namely *A. s. sturanyi* Rosa, 1895, *A. s. dacica* (Pop, 1938) and *A. s. dacidoides* Bouché, 1973. The fourth clade differing markedly in the position of the clitellum from *A. sturanyi*, was described as a new species *Allolobophora prosellodacica* Csuzdi & Pop, 2008.

In the recent years new samples were collected in the Apuseni Mts and the Carpathians including a specimen, in habitus resembling the *A. sturanyi* subspecies, but its clitellum begins much backwards, on segment 32 and therefore taxonomically similar to *Allolobophora gestroides* Zicsi, 1970 which was described from Northern Hungary.

Another sample, collected on and around the highest peak of the Bihor Mts (Cucurbăta Mare) contained also a strange species seemingly similar to *A. sturanyi* but it was not identical to any of the previously described subspecies.

To clear the positions of the newly discovered specimens and the species/subspecies in the *A. sturanyi* species group, in addition to the morphological investigation, we have carried out a molecular phylogenetic analysis using barcode sequences (COI) from all *A. sturanyi* subspecies and also *A. gestroides*. Unfortunately we were not able to collect fresh material from *A. prosellodacica* suitable for DNA extraction.

MATERIALS AND METHODS

Earthworms were collected by the diluted formaldehyde method (Raw 1959) supplemented with digging and hand-sorting and also looking under stones and fallen logs. The worms were killed in 96% ethanol and preserved in 75% ethanol. For molecular studies, some specimens were placed into 96% ethanol. The identified material is deposited in the Soil Zoology Collection of the Hungarian Natural History Museum (HNHM).

DNA extraction, amplification and sequencing were carried out in the Molecular Taxonomic Laboratory of HNHM according to the protocol described by Szederjesi & Csuzdi (2015). In addition to the newly got barcodes several sequences were downloaded from the GenBank (Online [Appendix 1](#)).

DNA sequences were aligned with ClustalW implemented in MEGA 6.06 (Tamura *et al.* 2013) using the default settings.

Maximum Likelihood (ML) analysis was carried out using the online tool on Phylogeny.fr (Dereeper *et al.* 2008) with GTR G+I substitution model selected by the model selection process implemented in MEGA 6.06 (Tamura *et al.* 2013) and 100 bootstrap replication.

Bayesian inference was performed using the BEAST 1.8.2 software (Drummond *et al.* 2012) with the best fitting GTR G+I substitution model. The analysis was run for 10 millions of generations, sampling trees at every 1000th generation. The first 2000 trees were discarded as “burn in” in TreeAnnotator v.1.8.2. The resulted tree was visualized with FigTree 1.4.2 (Rambaut 2014).

RESULTS

The *A. sturanyi* species group proved to be monophyletic in both (Bayesian and ML) analyses (Fig. 1) however, with moderate support (79% and 61% respectively). The new species *A. zicsica* sp. nov. forms a quite well supported clade (88%

and 87%) with *A. gestroides* and this clade is basal to the *A. sturanyi* subspecies. The relationships between the *A. sturanyi* subspecies are not quite clear and the Bayesian and ML analyses resulted in two different topologies. In the ML tree *A. s. sturanyi* is basal to the other subspecies and *A. s. biharica* is close to *A. s. dacica* however, in the Bayesian tree (Fig. 1B) *A. s. biharica* forms a moderately supported clade with *A. s. dacidoides*. The morphological characters support this latter hypothesis, because with 2/3 pairs of spermathecae *A. s. biharica* from the summit of the Bihor Mts resembles *A. s. dacidoides* distributed in higher elevations of the Carpathians and characterized by 3/4 pairs of spermathecae (Table 2).

According to the thorough analysis by Chang & James (2011) the K2P distances lower than 9% and higher than 15% can unambiguously be assigned to the same species or two different species, respectively. Between these two values there is an ambiguous range requires further considerations. The K2P genetic distances in the *A. sturanyi* species group (Table 1) vary between 10.6% and 14.1% which corroborate the previous taxonomic conclusion of Csuzdi & Pop (2008) that *dacica*, *dacidoides* and also *biharica* ssp. nov. represent different subspecies of *A. sturanyi*.

The genetic distance (K2P) between *A. gestroides* and *A. zicsica* is 16.1% which proves their different specific statuses on molecular level too. It is worth noting that the genetic distance between *A. gestroides* and *A. s. dacidoides* is 14.6% however, the large morphological differences (Table 2) verify that they represent different species.

Table 1. K2P genetic distances between the *A. sturanyi* species group taxa. Intraspecific distances are in bold.

	1	2	3	4	5
<i>A. s. dacica</i>	0.064				
<i>A. s. dacidoides</i>	0.141	0.076			
<i>A. s. biharica</i>	0.124	0.106	-		
<i>A. s. sturanyi</i>	0.137	0.139	0.115	-	
<i>A. gestroides</i>	0.169	0.146	0.157	0.171	-
<i>A. zicsica</i>	0.179	0.176	0.169	0.182	0.161

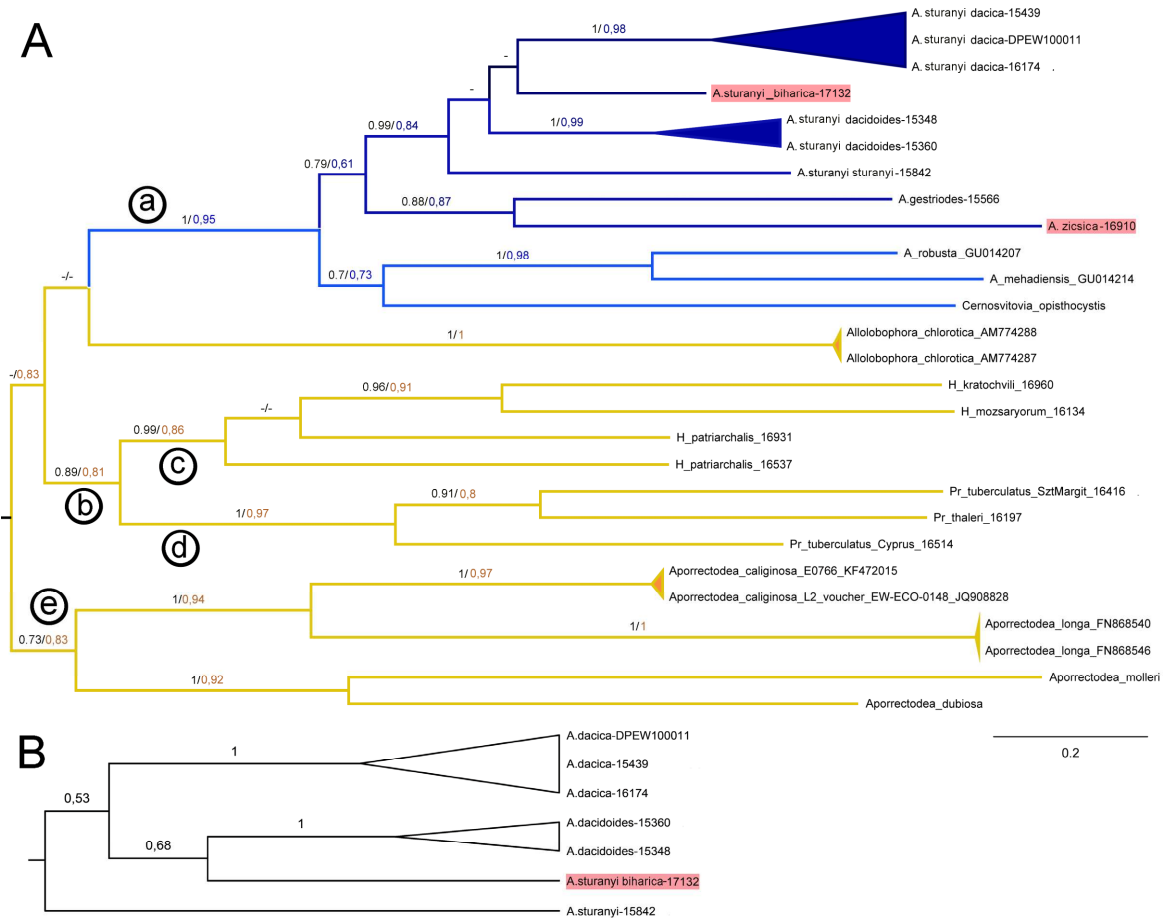


Figure 1. Phylogenetic reconstruction of the *A. sturanyi* species group (dark blue). Yellow clades represent outgroup species. Numbers above clades are Bayesian posterior probabilities/ bootstrap supports. A = ML tree, B = Bayesian tree.

TAXONOMY

Allolobophora zicsica Szederjesi, Pop & Csuzdi sp. nov.

(Figures 2–3)

Material examined. Holotype. HNHM/16910, Romania, Săcuieu, Vf. Bogdanului, 46.81°N 22.92°E, mixed pine-beech-oak forest, leg. J. Novák, T. Szederjesi, 19.04.2014.

Diagnosis. Length 45 mm, diameter 3.5 mm, setae closely paired. Pigmentation lacking. First dorsal pore on 8/9. Clitellum on 32–40, tubercles on ½35–½40. Male pore on 15, large (Fig. 2). Nephridial pores invisible. Two pairs of vesicles

in 11, 12; spermathecae three pairs in 9/10–11/12 in *cd*. Calciferous glands with well-developed diverticula in 10. Hearts in segments 6–11, nephridial bladders proclinate, J-shaped.

External characters. Holotype 45 mm long and 3.5 mm wide. Number of segments 125. Colour pale, pigmentation lacking. Prostomium epilobous ½ closed. First dorsal pore at intersegmental furrow 8/9. Setae closely paired. Setal arrangement behind clitellum: *aa:ab:bc:cd:dd* = 16.3:1.3:6.3:1:23.6 (Fig. 3). Male pores on segment 15, surrounded by glandular crescents. Nephridial pores invisible. Clitellum on segments 32–40. Tubercula pubertatis on segments ½35–½40. Genital papillae on segments 13, 14, 16, 29, 30, 36–40 *ab*.

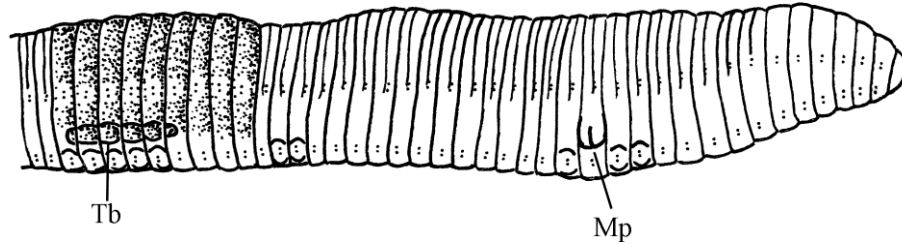


Figure 2. *A. zicsica* sp. nov. Ventrolateral view of the clitellar region. Mp = male pore, Tb = tubercle.

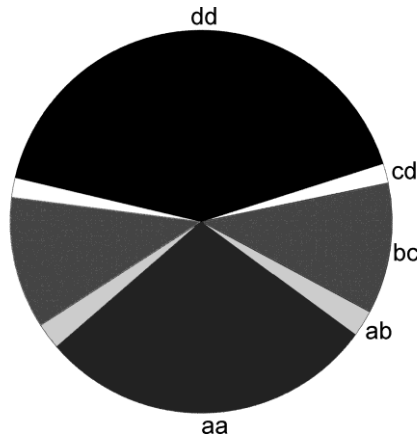


Figure 3. *A. zicsica* sp. nov. Setal arrangement.

Internal characters. Dissepiments 5/6–8/9 strongly thickened, 9/10 slightly thickened. Testes and funnels in segments 10–11, covered by perioesophageal testis sacs. Seminal vesicles in 11, 12. Spermathecae three pairs in 9/10, 10/11, 11/12 with external openings near the setal line *cd*. Calciferous glands with well-developed diverticula in segment 10. Paired hearts appear in segments 6–11, with a pair of small extraesophageal vessels in 12. Nephridial bladders J-shaped with short proclinate ental part. Crop in segments 15–16, and gizzard in segments 17–18. Typhlosolis trifid, longitudinal musculature is of fasciculated type.

Etymology. The new species is named in honour of the late Prof. Dr. András Zicsi, the renowned earthworm taxonomist.

Remarks. *A. zicsica* sp. nov. is close to *A. gestroides* but differs in the position of the clitellum (32–40 vs. 29, 30–40, 41), smaller biometry (45 x 3.5 mm vs. 55–98 x 4.3–5.2 mm) and 16.1% K2P genetic distance.

***Allolobophora sturanyi biharica* Szederjesi, Pop & Csuzdi ssp. nov.**

Figures (4–5)

Material examined. *Holotype.* HNHM/17133, Romania, Bihor Mts., before the peak of Curcubăta Mare, 1810–1685 m, 46°26.126'N 22°42.761'E, leg. Csuzdi Cs., 19.06.2015. *Paratypes.* HNHM/17151, 8 ex., locality and date same as of *Holotype*.

Diagnosis. Length 79–91 mm, diameter 3–3.5 mm, setae closely paired. Pigmentation lacking. First dorsal pore on 9/10. Clitellum on 27–38, tubercles on 28–½37. Male pore on 15, small (Fig. 4). Nephridial pores irregularly alternate between setal line *b–d*. Two pairs of vesicles in 11, 12; spermathecae two or three pairs in 9/10–10/11(11/12) in *cd*. Calciferous glands with well-developed diverticula in 10. Hearts in segments 6–11, nephridial bladders proclinate, J-shaped.

External characters. *Holotype.* 84 mm long and 3 mm wide. Number of segments 205. *Paratypes.* 79–91 mm long and 3–3.5 mm wide, number of segments 179–182. Colour pale, pigmentation lacking. Prostomium epilobous 1/3 closed. First dorsal pore at intersegmental furrow 9/10. Setae closely paired. Setal arrangement behind clitellum: *aa:ab:bc:cd:dd* = 24:1.5:13:1:48 (Fig. 5). Male pores on segment 15, small. Nephridial pores irregularly alternate between setal line *b–d*. Clitellum on segments 27–38. Tubercula pubertatis on segments 28–½37. Genital papillae on segments 11, 13–16, 23, 24, 27, 28, 36 *ab*.

Internal characters. Dissepiments 5/6–8/9 strongly thickened, 9/10 slightly thickened. Testes

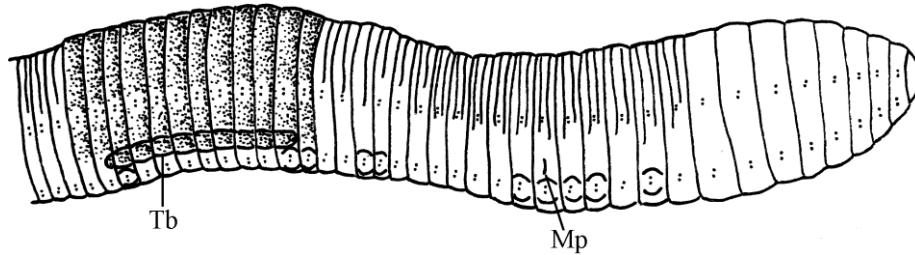


Figure 4. *A. sturanyi biharica* ssp. nov. Ventrolateral view of the clitellar region. Mp = male pore, Tb = tubercle.

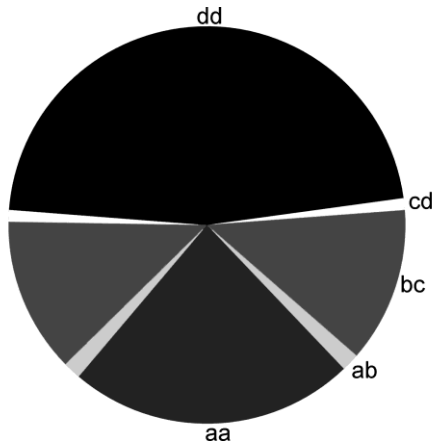


Figure 5. *A. sturanyi biharica* ssp. nov. Setal arrangement.

and funnels paired in segments 10–11, covered by perioesophageal testis sac. Seminal vesicles in 11, 12. Spermathecae two or three pairs in 9/10–10/11(11/12) with external openings near the setal line *cd*. Calciferous glands with well-developed diverticula in segment 10. Paired hearts appear in segments 6–11, with a pair of small extraesophageal vessels in 12. Nephridial bladders J-shaped with proclinate ental part. Crop in segments 15–16, and gizzard in segments 17–18.

Typhlosolis bifid, longitudinal musculature is of fasciculated type.

Etymology. The species name refers to the type locality.

Remarks. *A. s. biharica* ssp. nov. is similar to *A. s. sturanyi* and *A. s. dacidoides* in having 2/3 pairs of spermathecae but differs from both in the position of the clitellum and tubercles (Table 3) and also 11.5% and 10.6% K2P genetic distances respectively.

DISCUSSION

Integrated taxonomy proved to be highly efficient in recognizing and expanding the previously defined *Allolobophora sturanyi* species group (Csuzdi & Pop 2008). Both molecular taxonomic methods applied (Bayesian and ML analysis) highly supported the clade of the *A. sturanyi* subspecies (99% and 84% respectively) and also there is a moderate support for inclusion of the *A. gestroides* and *A. zicsica* species pair into the *sturanyi* species group. This inclusion is supported by morphology as well (Table 2).

Table 2. Distinguishing characters of the species in the *A. sturanyi* species group.

Species/subspecies	Clitellum	Tubercles	Receptacles	Segments
<i>A. sturanyi sturanyi</i>	27, 28–1/n 39, 39	29–38, 1/n39	3, 9/10–11/12	170–210
<i>A. sturanyi dacica</i>	28, 29–37, 38, 39	30–37, 1/n38	5, (4) 9/10–12/13, 13/14	165–182
<i>A. sturanyi dacidoides</i>	1/n27, 27–36, 37	1/n28, 28–36, 37	3,4, 9/10–11/12, 12/13	119–152
<i>A. sturanyi biharica</i> ssp. nov.	1/n27, 27–38	28–½37, 37	2,3, 9/10–10/11, 11/12	205
<i>A. prosellodacica</i>	1/n24, 25–½36, 36	30–½35, 35	3 9/10–11/12	160–170
<i>A. gestroides</i>	29, 30–40, 41	35–40, 41	3, 9/10–11/12	163–201
<i>A. zicsica</i> sp. nov.	32–40	½35 –½40	3, 9/10–11/12	125

It is interesting to note that the other Dacian species analysed (*Cernosvitovia opisthocystis*, *A. robusta* and *A. mehadiensis*) formed a well-supported (100% and 0.95) clade with the *sturanyi* species group (clade *a* in Fig. 1). This Balkanic-Central European clade of the *Allolobophora* species has already been recognized by Pop *et al.* (2005) and more recently in Domínguez *et al.* (2015). This clade (*a* here, and *c* in Domínguez *et al.* 2015) contains species relegated previously into different genera by Mršić (1991) i.e. *Cernosvitovia* (*opisthocystis*, *rebeli*, *dudichi*), *Karpato-dinariona* (*dacica*, *dacidoides*, *sturanyi*), *Serbi-ona* (*mehadiensis*, *robusta*) and *Alpodinaridella* (*gestroides*, *gestroi*). According to the accumulating morphological and molecular results it seems that these species form a well separated Balkanic-Central European genus, different from *Allolobophora* proper. As the type species of the senior synonym of *Cernosvitovia* is also involved (*C. rebeli* (Rosa, 1897)) the valid name of this genus should be *Cernosvitovia*.

It is also remarkable that the *Helodrilus* and *Proctodrilus* species also formed a monophyletic clade (*b*) with quite high Bayesian and bootstrap support (89% and 81% respectively) and *Helodrilus* (clade *c*) and *Proctodrilus* (clade *d*) proved to be exclusively monophyletic.

The closer relationship of *Aporrectodea dubiosa* (Örley, 1881) and *Aporrectodea molleri* (Rosa, 1889) was yet observed (Pop *et al.* 2005) and here they grouped together with the other *Aporrectodea* species (clade *e*) unlike to the trees in Domínguez *et al.* (2015) where they formed a clade with *Allolobophora chlorotica* (Savigny, 1826) (type species of the genus). *Ap. dubiosa* and *Ap. molleri* seems to be close also morphologically, both species are relatively large-bodied (120–150 mm), greenish, possess fasciculated musculature and backward shifted clitellum terminating after segment 45.

Qiu & Bouché (1998) separated *Ap. molleri*, *Ap. dubiosa* and several other large-bodied greenish Franco-Iberian species into the newly erected *Heraclescolex*. If further molecular studies with more complete taxon sampling and wider gene selection prove their distinctness, the valid genus name would be *Archeodrilus* Szűts, 1913 with

type species *Criodrilus dubiosus* Örley, 1881 by priority.

Acknowledgements – The study was supported by the Hungarian Scientific Research Fund (OTKA No. K100369).

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Appendix1. Data of the sequenced specimens

<i>Species</i>	<i>Locality</i>	<i>Reference</i>	<i>Accession No.</i>
<i>Allolobophora sturanyi dacica</i>	Hungary, Mezöhegyes.	HNHM/15439	KX009563
<i>Allolobophora sturanyi dacica</i>	Romania, Arad county, Lipova area, forest reserve above a flood control dam.	-	GU013841
<i>Allolobophora sturanyi dacica</i>	Romania, Transylvania, Micestii de Campie.	HNHM/16174	KX009564
<i>Allolobophora sturanyi biharica</i>	Romania, Apuseni Mts. Curcubăta Mare.	HNHM/17132	KX009568
<i>Allolobophora sturanyi dacidoides</i>	Romania, Maramures county, Rodnei Mts.	HNHM/15348	KX009570
<i>Allolobophora sturanyi dacidoides</i>	Romania, Maramures, Oaş Mts.	HNHM/15360	KX009569
<i>Allolobophora sturanyi sturanyi</i>	Croatia, Dinara Mts.	HNHM/15842	KX009567
<i>Allolobophora gestroides</i>	Hungary, Szendehegy.	HNHM/15566	KX009565
<i>Allolobophora zicsica</i>	Romania, Săcuieu, Vf. Bogdanului.	HNHM/16910	KX009566
<i>Allolobophora robusta</i>	Romania, Caras-Severin County, North of Baile Herculane on slopes above Cerna river.	-	GU014207
<i>Allolobophora mehadiensis</i>	Romania, Arad county, Lipova area, forest reserve above a flood control dam.	-	GU014214
<i>Cernosvitovia opisthocystis</i>	Romania, Caras-Severin County, North of Baile Herculane, on slopes above Bedina river.	ICB386	KX009580
<i>Allolobophora chlorotica</i>	Switzerland, Zolikoffen, garden.	-	AM774287
<i>Allolobophora chlorotica</i>	Switzerland, Zolikoffen, garden.	-	AM774288
<i>Helodrilus kratochvili</i>	Žira Cave, Bosnia and Herzegovina.	HNHM/16960	KX009573
<i>Helodrilus mozsaryorum</i>	Hungary, Aggteleki Cave.	HNHM/16134	KX009571
<i>Helodrilus patriarchalis</i>	Turkey,	HNHM/16931	KX009572
<i>Helodrilus patriarchalis</i>	Turkey,	HNHM/16537	KX009574
<i>Proctodrilus tuberculatus</i>	Hungary, Szentmargitfalva.	HNHM/16416	KX009577
<i>Proctodrilus tuberculatus</i>	Cyprus	HNHM/16514	KX009575
<i>Proctodrilus thaleri</i>	Romania, Oltenia, near Runcu, beech forest.	HNHM/16197	KX009576
<i>Aporrectodea caliginosa</i>	Russia, Orenburg oblast.	-	KF472015
<i>Aporrectodea caliginosa</i>	France: Seine Maritime, Mont Saint Aignan, Prairie Bois du Cotillet.	-	JQ908828
<i>Aporrectodea longa</i>		-	FN868546
<i>Aporrectodea longa</i>		-	FN868540
<i>Aporrectodea molleri</i>	Portugal, Azores, St. Marie.	ICB445	KX009579
<i>Aporrectodea dubiosa</i>	Romania, Danube delta, Sulina.	ICB374	KX009578

Uropodina mites (Acari: Mesostigmata) from agricultural areas of Ecuador

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Abstract. Soil and leaf-litter samples of several agroecosystems (banana, cacao, coffee, and Monterey pine plantations) in Ecuador were investigated regarding soil dwelling Uropodina. Short notes are given on the plantations and on the recorded mite species with description of a species new to science; *Clivosurella zicsii* sp. nov. Furthermore, diagnosis of the genus *Clivosurella* Hirschmann, 1979 is presented with a new key to the known species.

Keywords. Acari, Uropodina, new species, agroecosystems, Ecuador.

INTRODUCTION

The renown earthworm taxonomist and soil biologist András Zicsi organized numerous collection trips together with Imre Loksa and later with Csaba Csuzdi to Ecuador (Zicsi & Csuzdi 2008). These trips resulted in many scientific contributions to the knowledge of the Ecuadorian soil dwelling animals, like nematodes (Andrássy 1997) and earthworms (Zicsi 1989, 2002, 2007). In addition, several papers were focused on the soil dwelling mites, especially on the members of the suborder Uropodina (*e.g.* Kotschán 2008a, b, 2012).

Uropodina or turtle-mites are one of the characteristic groups of the soil dwelling Acari which reaches its highest diversity in the tropical soils (Lingquist *et al.* 2009). Hirschmann and his co-authors discovered and described 54 Uropodina species from Ecuador (including the Galapagos Archipelago) mostly based on the collections of the Hungarian soil zoologists (see the summary list in Wiśniewski 1993). Beside Hirschmann, Elzinga (1981, 1982, 1995) and Elzinga & Rettenmeyer (1970, 1975) described eight new Uropodina species collected from the body of the Ecuadorian army ants. Subsequently Kotschán

(2008a,b, 2010, 2011, 2012) and Kotschán & Starý (2013) presented new species from Ecuador.

All these studies focused on natural habitats (mostly rain forests), but we did not get any information about the Uropodina fauna of agricultural soils in South- and Central-America.

Here, I would like to complete these deficiencies reporting on the soil dwelling mites collected in Ecuadorian agricultural fields.

MATERIAL AND METHODS

Specimens were cleared in lactic acid and drawings were made with the aid of a drawing tube attached to a Leica DM 1000 scientific microscope. All specimens are stored in ethanol and deposited in the Hungarian Natural History Museum in Budapest (HNHM) and the Natural History Museum in Geneva (MHNG).

Setal nomenclature follows that of Kranzt & Walter (2009). Abbreviations: h = hypostomal setae, St = sternal setae, V = ventral setae. All measurements and the scales in the figures are given in micrometers (μm).

RESULTS

1. Cocoa

Background. Cocoa trees have been cultivated firstly in Central America, but nowadays are planted in Africa and in Asia as well. In the humid tropical areas it is an important cultivated plant, currently about 6.5 million hectares are planted in more than 50 countries (Wood & Laas 2001). Cocoa plantations have a significant role in tropical biodiversity conservation; the cocoa agroforestry can be important refuge for several plant and animal species (Schrot & Harvay 2007).

Material examined. Ecuador, (Ecu.1990. B. 13.) Prov. Manabi. 7 km after Flavio Alfaro 300 m., 20. IV. 1990, leaf litter from Cocoa plantation, leg. Zicsi, A. & Csuzdi, Cs.

Uropodina species. Three already described and named Uropodina were found in this sample: *Ungulaturopoda ungulata* (Hirschmann & Hiramatsu, 1977), *Kaszabjaloghi kaszabi* Hirschmann, 1973 and *Clivosurella porosa* (Hirschmann, 1972). The species *Ungulaturopoda ungulata* belongs to the family Cillibidae (Kontschán 2012), which usually occurs in natural habitats of Ecuador (Kontschán 2012) similarly to the species *Kaszabjaloghi kaszabi*. The third species, *Clivosurella porosa* was collected only in Brazilian rain forests so far. This is the first Ecuadorian record of the species.

2. Coffee

Background. The coffee bush is of Ethiopian origin, widely introduced in the old and new world tropics (Perfecto *et al.* 1996). The coffee production has an important economical role in the Neotropical countries (Gobbi 2000), for example in El Salvador coffee is the most important agricultural export commodity representing 30% of the country's total exports. Beside the economic importance, the coffee plantations have significant role in the preservation of the tropical biodiversity (Perfecto *et al.* 1996).

Material examined. Ecuador, (Ecu. B. 38.) Prov. Napo. 12 km before Loreto, coffee plantation, 450 m. 2. V. 1990, leaf litter, leg. Zicsi, A. & Csuzdi, Cs.

Uropodina species. A single Uropodina species is recorded from this sample; *Clivosurella porosa* (Hirschmann, 1972).

3. Monterey pine (*Pinus radiata* D. Don)

Background. The Monterey pine is one of the most often planted pine species in the world. The largest plantations are cultivated in Australia, New Zealand, Chile, Spain South-Africa, but smaller forests can be found in other countries (*e.g.* Kenya) as well (Mead 2013). The soil dwelling mites of the *Pinus radiata* plantations have already been summarized by Kontschán (2015), with description of two new species furthermore, in the very same year the third species of the Afrotropical endemic genus, *Bloszykiella* Kontschán, 2010 was discovered and described from leaf litter of Monterey pine plantation in Kenya (Kontschán & Starý 2015).

Material Examined. Ecuador, (Ecu. 1986 Berl. 123.), on the way to Pujili, *Pinus radiata* plantation (about 40 years old), 2800 m, 16. II. 1986, mossy litter and soil from below trees, leg. Loksa, I. & Zicsi, A.

Uropodina species. Numerous specimens of *Rotundabaloghia* (*Circobaloghia*) *ecuadorensis* Hirschmann, 1992 were found in this sample. This mite seems to be common in natural habitats of Ecuador (Kontschán 2008), and this is its first record from an agricultural area.

4. Banana

Background. Banana is one of the most important agricultural plants, which occurs in the equatorial zones of the world. Banana fruit is an important and cheap food, while other parts of the plant can be used as building materials (Hallam 1995). The investigated sample was not taken in a

typical agricultural area; it is originated from a forest where some banana trees were found, and the trees were probably cultivated.

Material examined. Ecuador, (Ecu. Berl. 178. Saloya (Prov. Pichincha), 1450 m, 20. II.1986, litter and soil from forest edge with banana plants.

Uropodina species. The banana leaf litter material contained two species, the herein described new one: *Clivosurella zicsii* sp. nov. and the Neotropical *Uroobovella faceta* Hiramatsu & Hirschmann 1978, which was listed earlier from Ecuador and Costa-Rica (Kontschán 2009).

Descriptions

Genus *Clivosurella* Hirschmann, 1979

Clivosurella Hirschmann, 1979: 59.

Clivosurella: Kontschán 2010: 332, Halliday 2015: 109.

Diagnosis. Idiosoma pentagonal, marginal shield forms a trapezoid pygidial shield on caudal area of dorsal body. Central part of dorsal shield elevated from the neighboring regions. Genital shield of female scutiform. Internal malae apically or marginally pilose, setae h1 long and smooth. Chelicerae with internal sclerotized node.

Type species. *Discourella clivosa* Hirschmann, 1972: 34, by original designation.

Distribution. All described *Clivosurella* species occur in the Neotropical area, in Brazil, Venezuela and Ecuador (Kontschán 2010).

Notes. Originally, the genus *Clivosurella* was a species group (*clivosa* species group) of the genus *Discourella* and was elevated to generic rank by Hirschmann (1979). Although this newly described genus differs by several characters from the genus *Discourella*, later Hirschmann (1993) and his co-workers (Wiśniewski 1993, Wiśniewski & Hirschmann 1993) placed it back again into the genus *Discourella*, as the *clivosa* species group. Subsequently, Kontschán (2010) mentioned again this name and elevated it to generic rank.

Clivosurella zicsii sp. nov.

(Figures 1–14)

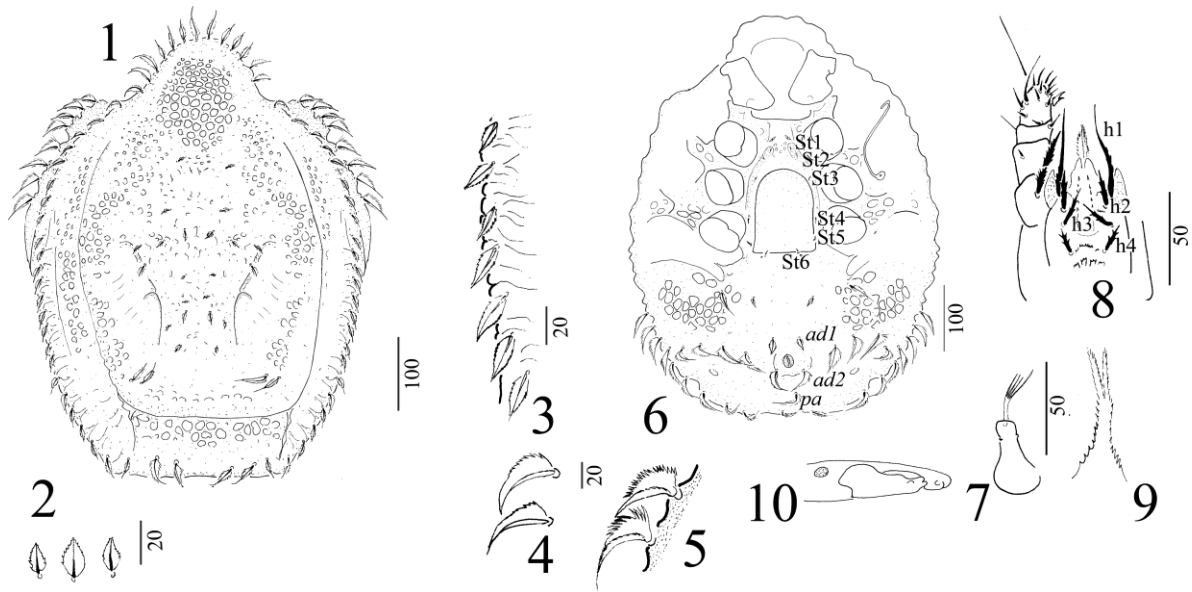
Material examined. Holotype. Female (HN HM), Ecuador, (Ecu. Berl. 178.) Saloya (Prov. Pichincha), 1450 m, 20. II.1986, litter and soil from forest edge with banana plants. *Paratype.* Female (NHMG), locality and date same as of holotype.

Diagnosis. All marginal setae phylliform and marginally finely serrate. Majority of dorsal setae short, phylliform and marginally serrate. Pygidial shield fused to marginal shield on caudal part. All body covered by irregular pits. One pair of supplementary sternal setae present, genital shield of female linguliform and its surface smooth.

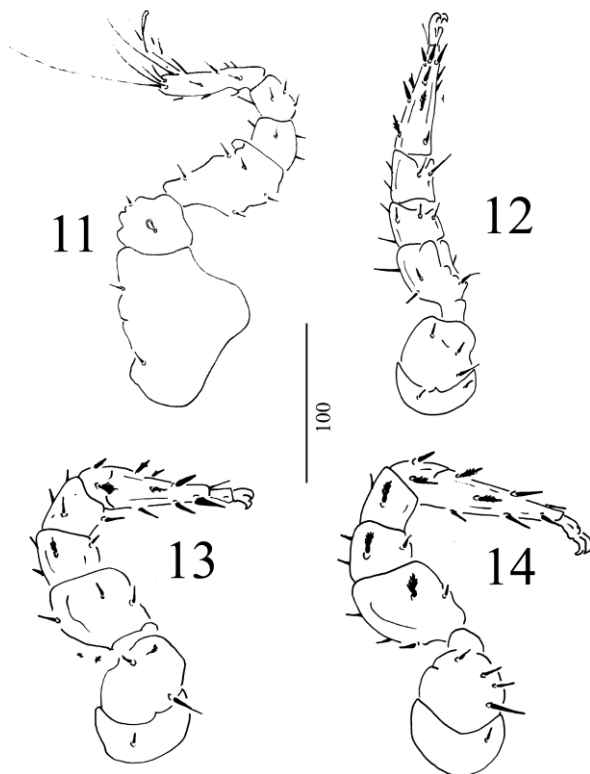
Description of female. Length of idiosoma 600–620 μm , width 440–450 μm (n=2). Shape pentagonal, color reddish brown.

Dorsal idiosoma (Fig. 1). Marginal and dorsal shields fused anteriorly. Setae on dorsal shield, wide, phylliform and marginally serrate (Fig. 2) majority of dorsal setae short (*ca.* 18–22 μm), except two pairs of longer setae (*ca.* 45–48 μm) situated close to caudal edges of dorsal shield. Surface of dorsal shield with numerous large irregular pits on anterior area and smaller oval pits on other parts of dorsal shield. Central part elevated from the neighboring area, lateral margins of elevated area strongly sclerotized and forming C-shaped parts. Marginal shield covered by irregular pits and bearing large, phylliform, marginally serrate setae (*ca.* 25–27 μm) (Fig. 3), on anterior area of marginal part of body bearing larger (*ca.* 50–55 μm) phylliform, marginally serrate setae (Figs. 4–5). Pygidial shield trapezoid, covered by irregular pits, bearing three pairs of marginally serrate phylliform setae (*ca.* 43–45 μm) and caudally fused to marginal shields.

Ventral idiosoma (Fig. 6). Majority of surface of sternal shield smooth, but some oval pits situated between coxae I. Sternal (St1–St6) setae short (*ca.* 8–10 μm), smooth and needle-like. St1 and St2 situated at level of central area of coxae II, St3 at level of central area of coxae III, St4 at level of central area of coxae IV, St5 at level of



Figures 1–10. *Clivosurella zicsii* sp. nov. female, holotype, 1 = body in dorsal view; 2 = dorsal setae; 3 = marginal setae, 4 and 5 = setae on anterior margins; 6 = body in ventral view; 7 = tritosternum; 8 = ventral view of gnathosoma and palp; 9 = epistome; 10: lateroventral view of chelicera.



Figures 11–14. *Clivosurella zicsii* sp. nov. female, holotype, 11 = ventral view of leg I; 12 = ventral view of leg II; 13 = ventral view of leg III; 14 = ventral view of leg IV.

posterior margin of coxae IV, St6 close to basal line of genital shield. St1–St4 situated on strongly sclerotized area around anterior part of genital opening. All setae on ventral idisoma phylliform, marginally serrate, first pair short (ca. 17–18 μm), others long (ca. 44–48 μm). Adanal setae *ad1* shorter (ca. 22–23 μm) than *ad2* and postanal seta (*pa*) (ca. 37–38 μm), but same shape as of ventral setae. Irregular pits situated posterior to pedofossae IV and close to outer part of coxae II and III. One pair of lyrifissures situated anterior to St1 and one pair of poroid close to St6. Stigmata situated close to coxae III. Prestigmatid part of peritremes hook-shaped, poststigmatid part absent. Genital shield linguliform, anterior margin rounded its surface smooth. Pedofossae deep, their surface smooth, separated furrows for tarsi IV absent. Base of tritosternum pear-like with one pair of lateral spines, tritosternal laciniae subdivided into four smooth branches (Fig. 7).

Gnathosoma (Fig. 5). Corniculi horn-like, internal malae smooth and longer than corniculi. All hypostomal setae marginally serrate, h1 long (ca. 50–52 μm), h2, h3 and h4 shorter (ca. 17–20 μm). Apical part of laprum marginally pilose. One pair of row of denticles situated on the ventral

part of gnathosoma and internal malae from h2 till at level of corniculi. Palp tochanter with two long and robust marginally serrate setae, other setae on palp smooth and needle-like. Epistome marginally serrate and apically divided into two marginally pilose branches (Fig. 9). Chelicerae with internal sclerotized node, fixed digit longer than movable digit, movable digit with two apical and one lateral tooth, apical part of fixed digit with a pit-like sensory organ (Fig. 10).

Legs (Figs. 11–14). Leg I without claws on tip of tarsi. Marginally serrate and needle-like setae situated on each leg.

Male, larva and nymphs unknown.

Etymology. I dedicate the new species to the memory of Prof András Zicsi, the noted earth-worm specialist, who collected soil samples all across Ecuador.

**Key to the known females of the genus
Clivosurella (after Kontschán 2010, modified)**

- 1. Genital shield bearing ornamentation..... 2
- Genital shield without ornamentation..... 4
- 2. Whole surface of genital shield ornamented..... 3
- Genital shield ornamented anteriorly.....
- *C. brasiliica* Kontschán, 2010
- 3. Depression on ventral shield near anterior region of anal opening with irregular pits..... *C. venezuelensis* (Huțu, 1987)
- Depression on ventral shield near anterior region of anal opening without pits..... *C. simonbolivari* (Huțu, 1987)
- 4. Genital shield linguliform 5
- Genital shield scutiform 6
- 5. Setae on marginal shields smooth and needle-like *C. frondosa* (Hirschmann, 1972)
- Setae on marginal shields phylliform and marginally *C. zicsii* sp. nov.
- 6. Ventral shield with alveolar pits..... *C. deraiophoroides* (Hirschmann, 1972)
- Ventral shield without alveolar pits..... *C. porosa* (Hirschmann, 1972)

Notes to the key. Only male specimens are known of *C. brasiliensis* (Hirschmann, 1972), *C. clivosa* (Hirschmann, 1972) and *C. spumans* (Hirschmann, 1972). All the three species have smooth and needle-like dorsal setae therefore they are easy to separate from the new species on the basis of this character.

DISCUSSION

All the Uropodina species found were listed earlier only from natural habitats of the Neotropical region. These species usually belong to the more common Neotropical Uropodina, but there is very few information about their habitat preferences. Maybe it can be true also for soil dwelling Uropodina that some tropical agricultural areas are good refuges for these species and thus these areas contribute significantly to biodiversity (Gobbi 2000, Perfecto *et al.* 1996, Schrot & Harvay 2007).

Four of the species found belong to the endemic Neotropical genera *Ungulaturopoda*, *Kaszabjbaloghia* and *Clivosurella*, which are known only from Ecuador, Brazil, Costa-Rica and Columbia. The subgenus *Rotundabaloghia* (*Circobaloghia*) has a circumtropical distribution type; members of this subgenus can be found in all tropical regions. The *Uroobovella* species found is an extremity. This species belongs to the *Uroobovella elengans*-group, the members of this group occur only in South-East Asia and Austral-Asia (Wiśniewski 1993), except a single species *U. faceta* that lives in the Neotropical region therefore it can be an example of the amphipacific distribution type.

Acknowledgements – This study was supported by the Hungarian Scientific Research Fund (OTKA 108663). I am grateful for Dr. Balázs Kiss for the linguistic corrections of the text and the anonymous reviewers for their valuable comments.

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Current distribution of the invasive earthworm *Pontoscolex corethrurus* (Müller, 1857) after a century of its first report from Kerala state, India

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Abstract. *Pontoscolex corethrurus* (Müller, 1857) is an important peregrine earthworm species in the humid tropics and is found in land disturbed by human activities. Its presence in Kerala state was first reported by Michaelsen in 1910. So far the occurrence of 14 exotic earthworm species has been reported from Kerala state. However present distribution status of any of these exotic species is not yet thoroughly studied. Now *P. corethrurus* is naturalized in forests, degraded areas, and agroecosystems from the higher altitude areas to the coastal zones. Here, the current distribution pattern of *P. corethrurus* in the state after a period of 100 years is highlighted.

Keywords. *Pontoscolex corethrurus*, exotic, earthworm, naturalized

INTRODUCTION

Earthworms are one of the important soil macro invertebrates and they function as consumers, decomposers, soil modulators, and food resources for other animals (Lee 1985, Lavelle *et al.* 1994, Edwards 2004, Zhang *et al.* 2007). At present more than 6000 species have been described, among these around 3000–3,500 are valid (Csuzdi 2012) and about 150 species are considered as peregrine on a global scale (Blakemore 2002, 2009, 2012). When an exotic earthworm is naturalized in a new area it can seriously alter the structural properties of the soil, organic matter and nutrient dynamics, as well as plant and animal communities above and below ground (Hendrix *et al.* 2008). But the effects and implications of invasive species in below ground terrestrial ecosystems are not well known as compared to above ground terrestrial and marine ecosystems (Gonzalez *et al.* 2006). At present, peregrines are found to occur in every continent including Antarctica, on oceanic islands, every biogeographic

region and in nearly all types of ecosystems including desert oases. Most importantly, this spread mainly happened through human activities (Blakemore 2002, Hendrix *et al.* 2008). As per Blakemore (2008) and Julka (2014), there are 505 earthworms in India and 51 are exotic species. *Eisenia fetida* (Savigny, 1826), *Pontoscolex corethrurus* (Müller, 1857), *Eudrilus eugeniae* (Kinberg, 1867), *Nematogena panamaensis* (Eisen, 1900), *Metaphire houleiti* (Perrier, 1872), *Polypheretima elongata* (Perrier, 1872), *Polypheretima taprobanae* (Beddard, 1892), *Ocnodrilus occidentalis* (Eisen, 1878), *Pontodrilus litoralis* (Grube, 1855), *Dichogaster affinis* (Michaelsen, 1890), *Dichogaster annae* (Horst, 1893), *Dichogaster bolau* (Michaelsen, 1891), *Gordiodrilus elegans* (Beddard, 1892), and *Pithemera bicincta* (Perrier, 1875) are the exotic earthworms so far reported from Kerala state (Stephenson 1923, Aiyer 1929, Julka & Paliwal 1990, Kathireswari *et al.* 2005, Narayanan *et al.* 2012). However, the entire diversity and distribution pattern of alien earthworm species of Kerala state is still not fully understood.

Pontoscolex corethrurus (Müller, 1857) of the Rhinodrilidae family (James & Davidson 2012; James 2012) is one of the peregrine and invasive species of earthworms found in the state. But it can be easily identified by the following characters; setae lumbricine, usually present from segments 1-2 in which they are very closely paired, AB and CD gradually wider from 3, one rank after another becoming more and more irregular until the quincunx arrangement is attained, towards the posterior end enlarged and ornamented ectally by transverse rows of fine teeth, one or both setae of ventral couples in some of 14–22 genital and ornamented ectally with longitudinal rows of gouges; clitellum saddle-shaped; male pores and tubercula pubertatis in clitellar region; septa all present at least from segments 5/6; digestive system with paired solid calciferous glands in 7–9, a well developed typhlosole but without intestinal caeca and supra-intestinal glands; metandric; spermathecae 3 pairs, pores are present on the intersegmental furrows of 6/7–8/9; seminal vesicles long, extending from 12 back through several segments; metagynous. It is an endogeic and meso-humic species, which has a highly efficient digestion system and exceptional demographic traits, and has colonized in various habitats and also in secondary forests due to its great tolerance for different habitats and wide range of soil conditions (edaphic plasticity) especially in the tropics (Lavelle *et al.* 1987, Lavelle & Pashanasi 1989, Lavelle *et al.* 1992, Tapia-Coral *et al.* 2006). *P. corethrurus* was first described by the German naturalist Fritz Müller in 1857 from individuals collected from Itajaí (now Blumenau) in Santa Catarina state of Brazil (Brown *et al.* 2006). The centre of origin of the genus *Pontoscolex* is the Guyana Shield region, including northern Brazil and the southern portions of Venezuela, Guyana, Surinam and French Guyana (Righi 1984). As per Lavelle *et al.* (1987), its expansion seems to be limited only by temperature and soil moisture values.

Michaelsen (1910) was the first person mentioning the occurrence of *P. corethrurus* in Kerala, he recorded it from Calicut (now Kozhikode), Cheyayur, Kerumaadi (Karumadi), Pallode (Palo-

de), Quilon (Kollam), Shasthancottah (Sasthamkotta), Tiruvallur and Trivandrum (Thiruvananthapuram). Later Cognetti (1911) mentioned about its presence in Travancore; Michaelsen (1913) and Stephenson (1916) reported its presence from Neyyattinkara (7 July 1911), Vellany (Vellayani), on 8 June 1911, Chimunga (Chemmunji) on 26 December 1911 and Bonaccord (Bonacaud) on 28 December 1911, based on the specimens collected by the taxidermist Shunkara Narayanan Pilley of the Trivandrum Museum. Even at that time a good number of specimens were collected from Vellayani and Neyyattinkara (Stephenson 1916). The two sites Kozhikode and Tiruvallur mentioned above are located in northern Kerala while rests of the sites are in southern Kerala. Later, Aiyer (1929) did an extensive survey on the Oligochaetes of the Travancore Kingdom. As part of this, he covered different forested regions as well as human inhabited areas like Kottayam, Thiruvalla, Kayamkulam etc., but he didn't find any individual of *P. corethrurus* from Travancore. He made a list of the earthworm species recorded from Travancore region by him and by former workers, but interestingly, *P. corethrurus* is not mentioned in that list. Nath and Chaudhari (2010) studied human induced biological invasion of *P. corethrurus* in rubber plantations of Tripura state of India. But information on the basic distribution pattern of *P. corethrurus* in Kerala is absent. This paper is aimed to address the current distribution pattern of *P. corethrurus* in the state, based on the data generated from the collections carried out as part of our ongoing study on the earthworm diversity of Kerala state.

MATERIALS AND METHODS

Kerala can be physiographically subdivided into lowlands (<75m above msl), midlands (75–500m above msl) and highlands (>750m above msl) (Balakrishna Pillai *et al.* 1991). Since 2010, as part of the ongoing taxonomical study on the earthworms of Kerala state, we have collected earthworm samples from all the districts, with various habitats like agricultural fields, various types of natural forests, plantations, homestead, grasslands, etc., of the state using the digging and

hand sorting method (Senapati & Sahu 1993). Being a part of the taxonomical studies on the earthworms of the state, physical attributes such as soil temperature, moisture content, pH and chemical characteristics of soil were not evaluated. *P. corethrurus* collected were identified using the key prepared by Julka (2008) and specimens examined were deposited in the earthworm laboratory of the Advanced Centre of Environmental Studies and Sustainable Development, Mahatma Gandhi University, Kottayam, Kerala, India.

RESULTS

In the present study a sizeable number of *P. corethrurus* were collected from 129 sites from all the 14 districts of the state (Figure 1). The name of the collection locality with altitude is given in Appendix 1. Interestingly, it has been recorded from various Wildlife Sanctuaries of the state such as Neyyar, Peppara, Shendurney, Chinnar, Malabar, Aralam and Periyar Tiger Reserve (Appendix 1). It has also been recorded from various sacred groves of northern Kerala. Collection sites ranged from high altitude Lockhart Marsh (1533m) near Munnar to low land areas like Kuttanad wetlands (below mean sea level). It is found that *P. corethrurus* thrives in various edaphic conditions like sandy coastal, alluvial wetlands, laterite formations and forest soils of the state.

DISCUSSION

From the present study it is clear that *P. corethrurus* has naturalized and invaded almost all disturbed areas of the state within a time span of 100 years. After independence, there were only a handful of records of this species available from Kerala. The reported places were Alappuzha (Gates 1973), Kanjikode (Kathireswari *et al.* 2005), Thiruvananthapuram (Killipalam, Vanchiyoor and Vellayambalam) (Nair *et al.* 2007), Silent Valley National Park and Wayanad Wildlife Sanctuary (Mohan *et al.* 2011). It is assumed that the species would have come to the state

either through the introduction of cassava (*Manihot esculenta*) or rubber (*Hevea brasiliensis*) plantation activities. Cassava is a popular root crop of Kerala and it was introduced into India by the Portuguese merchants in the 17th century. Later King Visakhama Thirunal Rama Varma of Travancore introduced and popularized cassava in Kerala during his time of reign from 1880 to 1885 (George *et al.* 2000). The first commercial rubber plantation of India was established at Thattekkadu in 1902. But Michaelsen's (1910) specimens were from all over the state; hence the mode of introduction appears to be more through cassava rather than rubber cultivation.

Aiyer (1929) has collected samples from 14 locations within the present day boundary of the state. Of these 14 locations, we have resurveyed eight sites, viz., Kumily, Peerumedu, Vandiperiyar, Kottayam, Thiruvalla, Chengannur, Kayamkulam and Ponnudi and collected *P. corethrurus*. The presence of this species in Thiruvananthapuram was already confirmed by Nair *et al.* (2007). Hence, it is clear that *P. corethrurus* has established itself in the above mentioned localities mainly after 1930's. All the recorded places of *P. corethrurus* in the 20th century were from midlands except Bonacaud of Thiruvananthapuram district, which is in the high lands. But now it is found to have spread over all the physiographical subdivisions of the state from the high altitude Munnar regions of Idukki district to the coastal regions. Change of land use pattern for agricultural purposes consequent to increased population pressure and migration has led to large scale deforestation, especially after World War II, in response to famine (Govindaru 1994). A major portion of the original forest land was also cleared for plantation crops such as teak, eucalyptus and cashew in the earlier years (Govindaru 1994). All these activities would have created a perfect niche for *P. corethrurus* for invasion and naturalizing in the new areas. Present study revealed its presence in five protected areas of the state. Before this, Wayanad Wildlife Sanctuary was the only protected area in the state from where its presence was confirmed (Mohan *et al.* 2011).

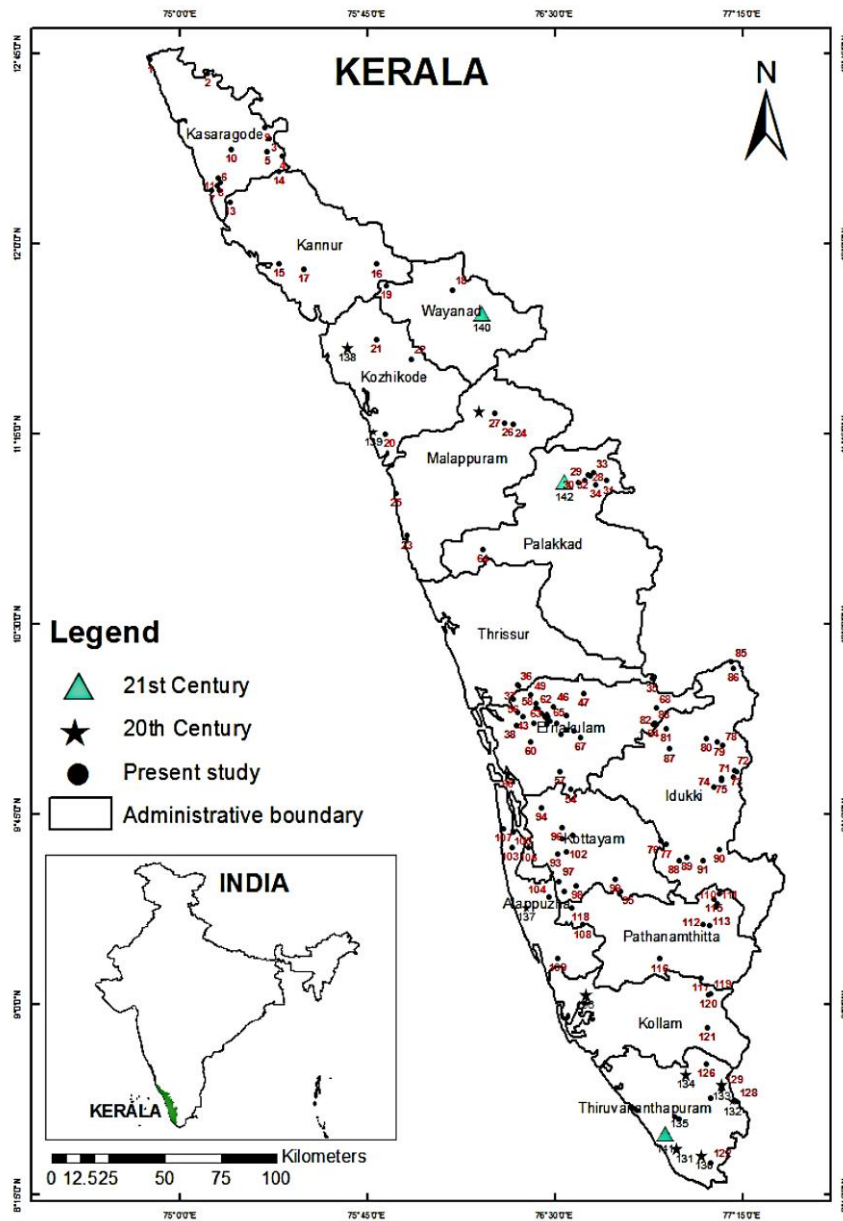


Figure 1. Distribution of *Pontoscolex corethrurus* in the Kerala state

As per Julka (2008), *P. corethrurus* is frequently found in human influenced habitats like cultivated land, garden soils, coconut and rubber plantations, manure and compost heaps, under rotten tree trunks and disturbed forest. This species has high edaphic plasticity, which also helped them to widely colonize in various habitats which we have surveyed. Now, it has been collected from various soil conditions such as sandy

coastal regions, alluvial wetlands, laterite formations, and higher altitude forest soils. Lavelle (1987) stated that *P. corethrurus* has narrow microclimatic requirements and because of this, it is tolerant to a wide range of soil conditions. It was found principally in pastures and fallows, and rarely in natural forests (Kathireswari et al. 2005). The species has a strong association with man-made ecosystems (Lavelle & Pashanasi 1989,

Barros et al. 2003, Marichal et al. 2010, Rossi et al. 2010). The present study revealed the presence of *P. corethrurus* in various forested regions of the state, but all those regions are disturbed areas due to anthropogenic activities. Tapia-Coral et al. (2006) reported the conspicuous presence of *P. corethrurus* in plant residue-rich tropical soils and Marichal et al. (2010) mentioned that land use may determine its occurrence and coexistence with other species.

Authors have reported that *P. corethrurus* has the ability to enhance nutrient release in soil (Lavelle et al. 1987, Lopez-Hernandez et al. 1993, Chapuis-Lardy et al. 1998), promoting plant growth and tolerance to phyto-parasitic nematodes (Pashanasi et al. 1996, Lafont et al. 2007). It has also been recorded that when this species is established in an area it can affect soil physical properties (soil compaction) (Hallaire et al. 2000, Chauvel et al. 1999), modify biogeochemical processes (Gonzales & Zou, 1999, Barros et al. 2001, Liu & Zou 2002), and affect plant (Zou 1993) and microbial communities (McLean et al. 2006).

Acknowledgements – We would like to thank Mr. K. Sreedharan, Mr. M. Ramesan, Mr. S. Arun Sasi, Mr. Dinu Kuriakose, Mr. T.K. Subash and Mr. Toms Augutsine for the helps offered during the fieldwork from various parts of the state and also to V.G. Gopikrishna for preparing the map. We are extending our sincere thanks to Dr. P.J. George for correcting the language of the manuscript. We are grateful to the Department of Forest and Wildlife Kerala, for providing the sanction and necessary facilities. We would also like to thank the anonymous referees for their constructive criticism and help which enabled us to upgrade the manuscript.

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Online supporting material: Appendix 1 (http://opuscula.elte.hu/PDF/Tomus47_1/Narayanan_Appendix1.PDF)

Appendix 1. *Pontoscolex corethrurus* (Müller, 1857) collection sites along with districts in the present study, during the 20th and 21st centuries

Sl. No.	Place	District	Habitat	Altitude (m)	No of specimens*
1	Manjeshwar	Kasaragode	Garden land	8	6
2	Adakasthala	Kasaragode	Agriculture field	77	4
3	Ranipuram	Kasaragode	Coffee plantation	735	2
4	Kottencheri	Kasaragode	Evergreen forest	801	1
5	Vallikadavu	Kasaragode	Plantation	98	7
6	Veeramalakunnu Hillock	Kasaragode	Scrub land	13	14
7	Nellikathuruthi Temple	Kasaragode	Coastal sacred grove	5	14
8	Melerippukavu	Kasaragode	Sacred grove	19	2
9	Panathoor	Kasaragode	Agriculture Field	98	4
10	Malom	Kasaragode	Home stead	117	2
11	Kayyur	Kasaragode	Homestead	21	2
12	Kuttamathu Temple	Kasaragode	Coastal sacred grove	1	11
13	Palathra	Kannur	River bank	4	3
14	Pulingom	Kannur	Homestead	28	6
15	Sree Poongottukavu	Kannur	Evergreen sacred gove	58	1
16	Valayamchal- Aralam WLS	Kannur	River bank	94	14
17	Choryamkundu	Kannur	Home stead	68	5
18	Kuruvadweep	Wayanad	River bank	737	4
19	Periya	Wayanad	Between forest and plantation	447	25
20	Bhayamkavu	Kozhikode	Sacred grove	34	3
21	Janakikkadu	Kozhikode	Semi evergreen forest	26	1
22	Shankaranpuzha - Malabar WLS	Kozhikode	Disturbed everreen forest	677	1
23	Mangalam	Malappuram	Home stead	16	3
24	Nedumgayam	Malappuram	Teak Plantation	46	1
25	Poorappuzha between Parappanangadi and Thanoor	Malappuram	River bank	4	3
26	Karulai	Malappuram	River bank	18	2
27	Chungathara	Malappuram	River bank	14	6
28	Karara Road - Agali	Palakkad	Moist deciduous forest	653	2
29	Gudayoor	Palakkad	Agriculture field	760	7
30	Jellippara	Palakkad	Agriculture field	734	2
31	Varagampady	Palakkad	Scrub land	806	1
32	Nellipathi	Palakkad	Grass land	537	9
33	Nellipathi Checkpost	Palakkad	Grass land	529	7
34	Pettickal	Palakkad	Mixed plantation	792	4

35	Malakkapara	Thrissur	Evergreen forest	833	6
36	Koratty	Thrissur	Home stead	14	30
37	Vazhichal	Ernakulam	Home stead	19	35
38	Aluva	Ernakulam	Home stead	17	1
39	Kalady	Ernakulam	Home stead	14	10
40	Marampilly	Ernakulam	Home stead	14	27
41	Kanjirakkadu	Ernakulam	Home stead	19	22
42	Vengoor	Ernakulam	Agriculture field	64	19
43	Neduvannoor	Ernakulam	Agriculture field	12	47
44	Athani	Ernakulam	Home stead	11	26
45	Aimury	Ernakulam	Home stead	24	19
46	Kurichilakodu	Ernakulam	Home stead	16	2
47	Ayyampuzha	Ernakulam	Home stead	460	38
48	Erumalappady	Ernakulam	Agriculture field	38	12
49	Mookannoor	Ernakulam	Agriculture field	30	6
50	Methala	Ernakulam	Agriculture field	75	15
51	Kuruppampady	Ernakulam	Home stead	30	12
52	Vattakkanam	Ernakulam	Agriculture field	16	3
53	Marottikadavu	Ernakulam	Home stead	61	3
54	Kakkoor	Ernakulam	Agriculture field	38	1
55	East Okkal	Ernakulam	Agriculture field	15	9
56	Parakkadavu	Ernakulam	Home stead	21	19
57	Pampakuda	Ernakulam	Agriculture field	40	1
58	Sivajipuram	Ernakulam	Home stead	23	10
59	Perumbavoor	Ernakulam	Home stead	11	56
60	Kizhakambalam	Ernakulam	Home stead	7	9
61	Mavelippady	Ernakulam	Agriculture field	27	2
62	Kalady	Ernakulam	College campus	14	13
63	Chellamattam	Ernakulam	Agriculture field	12	6
64	Parappuram,	Ernakulam	Agriculture field	19	37
65	Pattal, Perumbavoor	Ernakulam	Agriculture field	32	32
66	KUFOS	Ernakulam	University campus	7	2
67	Venduvazhy, Kothamangalam	Ernakulam	Home stead	39	4
68	Chuttukulam Oru	Ernakulam	Home stead	321	2
69	Mayiladumpara	Idukki	Cardamom plantation	1106	4
70	Chathurangapara	Idukki	Forest	1105	4
71	Chaturangapara stream side	Idukki	Forest	1107	27
72	Parakkal Estate, Rajappara	Idukki	Cardamom plantation	1150	14
73	Thondamankotta	Idukki	Mixed plantation	1181	7
74	Manjapetti	Idukki	Home stead	1048	3
75	Megha Plantation	Idukki	Cardamom plantation	1109	5

76	Kolahalamedu	Idukki	Grass land	1112	2
77	Bonami Division II	Idukki	Grass land	1120	12
78	Periyakanal	Idukki	Tea plantation	1337	7
79	Periyakanal Power House	Idukki	Tea plantation	1614	18
80	Lockhart Marsh	Idukki	Marsh land	1533	2
81	Viripara	Idukki	Forest	914	16
82	Moothassery streamside	Idukki	Coffee plantation	860	14
83	Moothassery abandonad plantation area	Idukki	Disturbed forest	902	14
84	Moothassery Tribal settlement	Idukki	Tribal settlement	892	5
85	Manalthura, Chinnar WLS	Idukki	Scrub land	440	3
86	Chambakkadu Kudi, Chinnar WLS	Idukki	Tribal settlement	514	15
87	Karimkulam	Idukki	Disturbed area	565	1
88	Vandiperiyar	Idukki	Homestead	817	2
89	Peerumedu	Idukki	Tea plantation	1001	13
90	Pambanar	Idukki	Disturbed road side	1067	5
91	Kumili	Idukki	Abandoned paddy field	884	8
92	Mahatma Gandhi University	Kottayam	University campus	12	14
93	Chalukunnu – Kottayam	Kottayam	Home stead	18	1
94	Vadakara - Thalayolaparambu	Kottayam	Home stead	8	1
95	Oottupara - Ponthanpuzha	Kottayam	Deciduous forest	162	1
96	Kanakkary	Kottayam	Home stead	36	23
97	Thuruthy	Kottayam	Home stead	3	1
98	Madappally	Kottayam	Home stead	18	10
99	Manimala	Kottayam	Home stead	53	1
100	Changanacherry	Kottayam	Home stead	19	3
101	Punnathura West	Kottayam	Home stead	27	6
102	Ponpally	Kottayam	Home stead	45	6
103	S N college, Cherthala	Alappuzha	College campus	4	3
104	Ramankary	Alappuzha	Home stead	0	3
105	Cherthala	Alappuzha	Home stead	9	8
106	Pathiramanal	Alappuzha	Island within river	0	2
107	Kadakkappally Cherthala	Alappuzha	Home stead	7	5
108	Chengannur	Alappuzha	Home stead	13	3
109	Kayamkulam	Alappuzha	Home stead	10	2
110	Gavi	Pathanamthitta	Cardamom plantation	856	8
111	Kochupamba Reservoir	Pathanamthitta	River bank	923	7
112	Moozhiyar KSEB Office	Pathanamthitta	Road side within forest	855	16
113	Aranamoozhi &	Pathanamthitta	Road side within	1056	3

	Ilampampa		evergreen forest		
114	Pachakkanam	Pathanamthitta	Road side within evergreen forest	1037	2
115	Chenthamara Kokka - Gavi	Pathanamthitta	Forest	947	2
116	Vayakkara	Pathanamthitta	Home stead	31	6
117	Kallar	Pathanamthitta	Riverine forest	60	4
118	Thiruvalla	Pathanamthitta	Home stead	13	3
119	Priya Estate	Kollam	Tea plantation	486	1
120	Near to Ambanad Estate	Kollam	Evergreen forest	795	1
121	Kattalapara - Shendurney WLS	Kollam	Myristica swamp	194	2
122	Udhiyankulangara	Thiruvananthapuram	Agriculture Field	41.5	19
123	Karakulam	Thiruvananthapuram	Home stead	44	12
124	Irumba	Thiruvananthapuram	Homestead and Rubber plantation	79	12
125	Near Peppara Dam site	Thiruvananthapuram	Disturbed Evergreen Forest	143	8
126	Ponmudi Hill Top	Thiruvananthapuram	Shola Forest	1009	8
127	Muttidichantheri - Peppara WLS	Thiruvananthapuram	Grass land	737	3
128	Athirumala - Neyyar WLS	Thiruvananthapuram	Human settlement inside Evergreen forest	1011	8
129	Bonacaud	Thiruvananthapuram	Human settlement	589	3
	20th Century	District	Reference		
1	Neyattinkara	Thiruvananthapuram	Stephenson (1916)		
2	Vellayani	Thiruvananthapuram	Stephenson (1916)		
3	Chemmunji	Thiruvananthapuram	Michaelsen (1913)		
4	Bonacaud	Thiruvananthapuram	Michaelsen (1913)		
5	Palode	Thiruvananthapuram	Michelsen (1910), Stephenson (1916)		
6	Thiruvananthapuram	Thiruvananthapuram	Michelsen (1910), Stephenson (1916)		
7	Shasthamkotta	Kollam	Michelsen (1910)		
8	Karumadi	Alappuzha	Michelsen (1910)		
9	Tiruvallur	Kozhikode	Michelsen (1910)		
10	Kozhikode	Kozhikode	Michelsen (1910)		
	21st Century	District	Reference		
1	Thiruvananthapuram		Nair <i>et al.</i> (2007)		
2	Wayanad Wildlife Sanctuary	Wayanad	Mohan <i>et al.</i> (2011)		
3	Silent Valley National Park	Palakkad	Mohan <i>et al.</i> (2011)		

* - specimens include juveniles, a clitellates and clitellates.