Opusc. Zool. Budapest, 2013, 44(2): 99–106

Millipedes (Diplopoda) of twelve caves in Western Mecsek, Southwest Hungary

D. ANGYAL & Z. KORSÓS

Dorottya Angyal and Dr. Zoltán Korsós, Department of Zoology, Hungarian Natural History Museum, H-1088 Budapest, Baross u. 13., E-mails: angyal.dorottya@zoo.nhmus.hu, korsos@nhmus.hu

Abstract. Twelve caves of Western Mecsek, Southwest Hungary were examined between September 2010 and April 2013 from the millipede (Diplopoda) faunistical point of view. Ten species were found in eight caves, which consisted eutroglophile and troglobiont elements as well. The cave with the most diverse fauna was the Törökpince Sinkhole, while the two previously also investigated caves, the Abaligeti Cave and the Mánfai-kőlyuk Cave provided less species, which could be related to their advanced touristic and industrial utilization.

Keywords. Diplopoda, Mecsek Mts., caves, faunistics

INTRODUCTION

Although more than 220 caves are known from the Mecsek Mts., our knowledge on the invertebrate fauna of the caves in the region is rather poor. Only two caves, the Abaligeti Cave and the Mánfai-kőlyuk Cave have previously been examined in speleozoological studies which includeed the investigation of the diplopod fauna as well (Bokor 1924, Verhoeff 1928, Gebhardt 1933a, 1933b, 1934, 1963, 1966, Farkas 1957).

These extensive investigations resulted in recording ten and six millipede species in the Abaligeti Cave and the Mánfai-kőlyuk Cave respecttively, including three species new to science at that time, too (Gebhardt 1966).

Brachydesmus troglobius Daday, 1889, *Hungarosoma bokori* Verhoeff, 1928 and *Haasea hungarica* (Verhoeff, 1928) were considered to be endemic for the Abaligeti Cave. However, later Loksa (1961) mentioned the Kovácsi Hill (Keszthelyi Mts.) as a second locality of *H. bokori*. *H. hungarica* was also found in other localities in forest litter in the Kőszegi Mts. (Szalay 1942), on the Kovácsi Hill (Loksa 1961), and in the Dráva Region (Korsós 1998). Although *B. troglobius* proved to be rather widespread in the karstic regions of the former Yugoslavia (Mršić 1998, 1994, Ćurčić & Makarov 1998), the species was not yet found in other Hungarian caves.

All the six millipede species of the Mánfai-kőlyuk Cave (*Polyxenus lagurus* (Linnaeus, 1758), *Glomeris hexasticha* Brandt, 1833, *Haploporatia* sp., *Polydesmus collaris* C. L. Koch, 1847, *Ommatoiulus sabulosus* (Linnaeus, 1758) and *Leptoiulus* sp.) were found in the entrance region in humid leaf litter (Gebhardt 1966). *Heteroporatia* (now *Mastigona*) *méhelyi* Verhoeff, 1897, *Craspedosoma transsylvanicum* Verhoeff, 1897, and *Polyzonium germanicum* Brandt, 1837 have been found in plant debris in the Törökpince Sinkhole, that was hidrologically connected with the Western-II collateral of the Abaligeti Cave in that time, and was handled as a branch of that (Gebhardt 1933a). Gebhardt (1966) had also found *Gervaisia noduligera* (now *Trachysphaera scmidtii* Heller, 1858) in the deeper parts of the Abaligeti Cave, where the specimens were fed on woody debris. The three *Polydesmus* species, *P. complanatus* (Linnaeus, 1761), *P. collaris* C. L. Koch, 1847, and *P. denticulatus* C. L. Koch, 1847 proved to be quite common at the entrance region of the Abaligeti Cave (Gebhardt 1966).

urn:lsid:zoobank.org:pub:14EB34F3-A492-4719-8966-08B124A563CC
HU ISSN2063-1588 (online), HU ISSN 0237-5419 (print)

More recently, Korsós (2000) has published a short paper on the millipede fauna of the Abaligeti Cave, enlisting altogether 8 species however, only one of them (*Brachydesmus troglobius*) was categorized as eutroglobiont element. The rare species, *Hungarosoma bokori* and *Haasea hungarica* have both been successfully recollected (in 1991, and 1999 respectively).

Following these investigations, the original conditions of the two caves have considerably been affected by human impact. The Abaligeti Cave has been developed for the public, capable to receive thousands of tourists every year, while the Mánfai-kőlyuk Cave has been utilized by waterworks and has completely lost its natural character. Considering that these changes could have influenced the diversity of the caves, a repeated sample collection was reasonable. Our additional aim was to explore the millipede fauna of other caves in the Mecsek Mts. which were so far biospeleologically uninvestigated.

The ecological classification of cave-dwelling animals was rather heterogeneous until the general acceptance of Sket's category system (2008). In this paper we give the categories of the millipede species of the investigated caves according to the new system. Troglobiont is a species with strong bounds to hypogean habitats. Eutroglophiles are essentially epigean species that are able to maintain a permanent subterranean population, while subtroglophiles are species inclined to perpetually or temporarily inhabit subterranean habitats, but are intimately associated with epigean habitats for some biological functions. Trogloxene is a species that only occurs sporadically in a hypogean habitat, and unable to establish subterranean population (Sket 2008).

MATERIAL AND METHODS

Between September 2010 and April 2013 we spent 22 collecting days in 12 caves of the Western Mecsek (Figure 1). We assigned different types of caves with various horizontal and vertical extensions (Table 1). The Törökpince Sinkhole was treated as an independent cave, as it has own cadastre number, and at present does not have active hidrological connection with the Abaligeti Cave.

Considering the vulnerability of the closed cave ecosystems and the relative low abundance of cave-dwelling animals, we did not use quantitative sampling methods which are generally not recommended. In most cases we did hand-collecting, but in the first year we also tried to set up pitfall traps in two occasions in the Törökpince Sinkhole and in the Abaligeti Cave, too.

Specimens were fixed and stored in 70 and 96% ethanol, and are deposited in the Myriapoda Collection of the Hungarian Natural History Museum. We used a Leica M125 stereo microscope, and the relevant publications (Blower 1985, Schubart 1934, Korsós 2008) for the identification of the samples. Gonopods, when it was necessary, were dissected and analysed under higher magnification.

RESULTS

GLOMERIDA

Doderiidae

Trachysphaera schmidtii Heller, 1858

Gervaisia noduligera Verhoeff, 1906
Trachysphaera noduligera: Strasser 1966
Trachysphaera schmidtii Heller, 1858: Sillaber 1987

Localities. Abaligeti Cave (23/11/2010, 08/06/2011), Törökpince Sinkhole (24/10/2010).

Remarks. Epigean populations from the Mecsek Mts. are well-known (Gebhardt 1966). Gebhardt (1933a) mentioned an observation of 90−100 specimens on wood debris in the Abaligeti Cave in July 1930. During our investigations we found the species in low abundance. A male specimen was found in the Eastern collateral and two females were collected feeding on the lamp flora of the entrance of the Western-II collateral, 380 m deep in the cave, where a permanent small population has been observed. We had a single record of a female specimen on the plain clay at the ending point (80 m deep) of the Törökpince Sinkhole.
Eutroglophile.

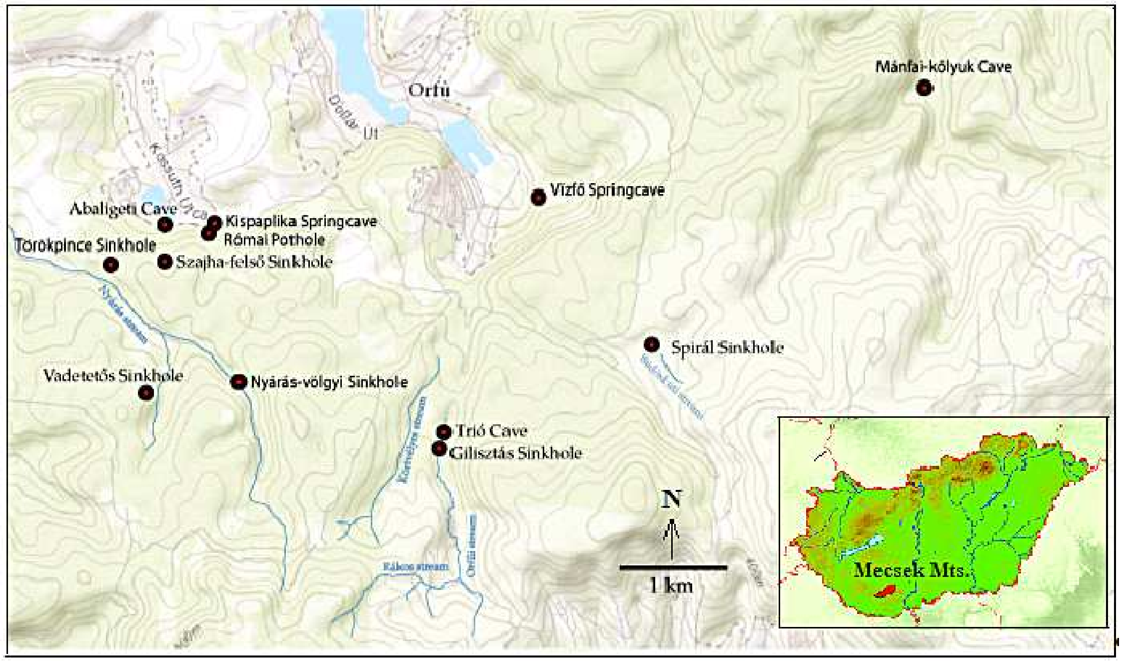


Figure 1. Location of the 12 examined caves in the Western Mecsek

Table 1. Basic data of the caves examined

Name of cave	Cadastre number	Settlement	Coordinates of entrance Y (Decimal degree)	Coordinates of entrance X (Decimal degree)	Entrance's altitude above sea level (m)	Horizontal extension of cave (m)	Vertical extension of cave (m)
Abaligeti Cave	4120-1	Abaliget	578,056.429	88,434.520	218,770	1764	49
Gilisztás Sinkhole	4120-70	Orfű	580,693.262	86,268.727	307,704	134	51
Kispaplika Springcave	4120-22	Abaliget	578,537.570	88,409.775	220,337	50	10
Mánfai-kőlyuk Cave	4120-2	Mánfa	585,324.364	89,720.420	240,121	360	12
Nyárás-völgyi Sinkhole	4120-31	Kővágószőlős	578,760.081	86,896.453	291,643	34	19
Római Pothole	4120-222	Abaliget	578,465.730	88,298.610	247,932	26	24
Spirál Sinkhole	4120-130	Pécs	582,719.925	87,242.072	350,280	1000	86
Szajha-felső Sinkhole	4120-16	Abaliget	578,056.137	88,041.665	283,508	125	42
Törökpince Sinkhole	4120-13	Abaliget	577,544.640	88,007.391	275,791	87	7
Trió Cave	4120-71	Orfű	580,722.262	86,347.182	301,035	250	58
Vadetetős Sinkhole	4120-27	Kővágótöttös	577,872.842	86,795.058	320,701	180	36
Vízfő Springcave	4120-3	Orfű	581,611.158	88,670.206	211,174	330	27

CHORDEUMATIDA

Haaseidae

Haasea hungarica (Verhoeff, 1928)

Orobainosoma hungaricum Verhoeff, 1928
Haasea hungarica: Hoffman 1980
Haasea hungarica: Korsós 2000

Locality. Kispaplika Springave (07/10/2010), Trió Cave (29/04/2013).

Remarks. There are some records of epigean populations from Tubes Hill and Dömörkapu (Mecsek Mts.), as well as from the Kőszegi Mts. (Szalay 1942), the Keszthelyi Mts. (Loksa 1961) and the Dráva Region (Korsós 1998). In the Abaligeti Cave *H. hungarica* was found in the deepest parts of the main passage and in a hall 300 m deep, called Karthago's Ruins, feeding on wood remains (Gebhardt 1933a). The first collection was made by Elemér Bokor in 1922, on which the original description by Verhoeff (1928) was based. Gebhardt (1933a) mentioned a specimen collected from the cave with reduced pigmentation of the ocelli. We have a single record of a female specimen from the entrance shaft of the Kispaplika Spring cave, and a small population − feeding on woody debris − was also found in a collateral of the Trió Cave. These were the first records in the Mecsek Mts. from other cave than the Abaligeti Cave.
Eutroglophile.

Mastigona bosniensis (Verhoeff, 1897)

Heteroporatia bosniense: Verhoeff, 1897b, Schubart 1934
Heteroporatia bosniensis: Attems 1899
Mastigona bosniensis: Jeekel 1970
Mastigona mehelyi Verhoeff, 1897: Lazányi & Korsós 2009

Locality. Nyárás-völgyi Sinkhole (14/01/2012).

Remarks. The species *Mastigona mehelyi* (Verhoeff, 1897), mentioned by Gebhardt (1966), has already been considered as a junior synonym of *M. bosniensis* (Korsós & Lazányi 2008, Lazányi & Korsós 2009). Up to now, only epigean records of this species were known from the Dráva Region (Korsós 1998) and the Keszthelyi Mts. (Kovácsi Hill) (Loksa 1961). A single female specimen was collected from 20 m deep from the vertical Nyárás-völgyi Sinkhole.
Trogloxene.

JULIDA

Julidae

Unciger foetidus (C. L. Koch, 1838)

Iulus foetidus C. L. Koch, 1838: Latzel 1884, Ortvay 1902
Julus foetidus: Chyzer 1886, Daday 1889, Petricskó 1891, 1892
Oncoiulus foetidus: Verhoeff 1928, 1941, Dudich 1958
Unciger foetidus: Schubart 1934, Blower 1985

Localities. Törökpince Sinkhole (21/08/2010).

Remarks. A widespread litter-dwelling species of the Mecsek and the Keszthelyi Mts., usually inhabiting undisturbed deciduous forests (Lazányi & Korsós 2009). A female specimen was found in the entrance region of the Törökpince Sinkhole.
Trogloxene.

Cylindroiulus luridus (C. L. Koch, 1847)

Julus luridus C. L. Koch, 1838: Latzel 1884, Ortvay 1902
Cylindroiulus luridus: Verhoeff 1907, Schubart 1934

Locality. Törökpince Sinkhole (21/08/2010).

Remarks. Similarly to the previous species, *C. luridus* is also a widespread forest-dwelling species. Its occurrence in the first 15 m of the Törökpince Sinkhole is probably by chance.
Trogloxene.

Blaniulidae

Blaniulus guttulatus (Fabricius, 1798)

Julus guttulatus Fabricius, 1798
Blaniulus guttulatus: C. L. Koch 1863, Daday 1889, Dudich 1958, Blower 1985

Locality. Törökpince Sinkhole (27/10/2010).

Remarks. A common forest species in Hungary. A single female specimen was collected in pitfall trap near the ending point of the Törökpince Sinkhole, 80 m deep in the cave.
Trogloxene.

Boreoiulus tenuis **(Bigler, 1913)**

Monocobates tenuis Bigler, 1913
Boreoiulus tenuis: Blower 1985

Localities. Törökpince Sinkhole (27/10/2010).

Remarks. Distributed in the Atlantic region. Due to its preference towards cool climate, the species frequently inhabits barks in Hungary. We have some records so far from Szenyér and Keszthely (Korsós *et al.* 2006), Somogy county. A single female individual was collected 80 m deep in the Törökpince Sinkhole with a pitfall trap. This is the first record from the Mecsek Mts.
Subtroglophile.

POLYDESMIDA

Polydesmidae

Brachydesmus troglobius **Daday, 1889**

Brachydesmus troglobius: Verhoeff 1928

Localities. Abaligeti Cave (22/09/2010, 04/11/2010, 23/11/2010, 25/11/2010, 09/12/2010, 07/08/2011, 23/08/2012), Törökpince Sinkhole (07/08/2011, 23/08/2012).

Remarks. The species had first been in the Abaligeti Cave by János Pável (date is not known), and then it had been described by Daday (1889) as an endemic species of the cave. Since then other records from the Abaligeti Cave were published by Bokor (1924), Gebhardt (1934, 1963, 1966), Korsós (2000) and Korsós *et al.* (2006). *B. troglobius* was collected in numerous caves from the Dinaric Karst, too (Mršić 1998, 1994, Ćurčić & Makarov 1998). Although Gebhardt (1966) mentioned an observation of an epigean population in winter 1956, found on plant debris covered by snow close to limestone rocks near Dömörkapu (Mecsek Mts.), this record should be treated with caution because of the lack of preserved specimen. Therefore *B. troglobius* is still considered to be an obligate cave-dwelling invertebrate.

During our investigations it proved to be the most frequently encountered millipede species of the Abaligeti Cave. We have collected altogether 14 specimens, including males, in seven occasions. They were distributed in the main passage, the Eastern collateral, and the Western-II collateral, too, feeding on the lamp flora or wood remains, or just walking on the clay or on the rocks. We found a population in the deeper zone of the Törökpince Sinkhole as well. Two male, three female, and one juvenile specimens were collected from that place. This is the first record in Hungary from another place than the Abaligeti Cave.
Troglobiont.

Polydesmus collaris **C. L. Koch, 1847**

Polydesmus collaris: Korsós 1994, Korsós *et al.* 1999

Localities. Vadetetős Sinkhole (08/12/2010), Törökpince Sinkhole (21/08/2010, 24/10/2010, 24/11/2010), Nyárás-völgyi Sinkhole (23/11/2010), Mánfai-kőlyuk Cave (11/12/2010), Abaligeti Cave (10/04/2013), Szajha-felső Sinkhole (10/09/2010).

Remarks. This attractive polydesmid is quite widespread in Southwest Hungary. It has records from Baranya (Daday 1889, Korsós et al. 2006), Tolna (Loksa 1954), Dráva (Korsós 1996, 1998), Somogy (Korsós 2001), and the Zselic region (Korsós et al. 2006). The species was also collected in the Bakony Mts. (Korsós et al. 2001). We have new records of two male, three female, and three juvenile individuals from the entrance aera of six caves from the Western Mecsek.
Trogloxene.

Polydesmus complanatus **(Linnaeus, 1761)**

Julus complanatus Linnaeus 1761
Polydesmus illyricus: Verhoeff 1893
Polydesmus complanatus Porat 1870, Lohmander 1925, Loksa 1954

Localities. Törökpince Sinkhole (21/08/2010, 24/10/2010), Mánfai-kőlyuk Cave (20/11/2011).

Remarks. One of the most common millipede species in Hungary occurring in almost every type of habitats (Lazányi & Korsós 2009). It has previously been mentioned by Gebhardt (1966) from several epigean localities of the Mecsek Mts., *e.g.* Mélyvölgy, Hidas Valley, Tubes and Misina Hills. We collected two male, two female, and one juvenile specimens in the first 10 m of the Törökpince Sinkhole. A female individual was found 15 m deep in the Mánfai-kőlyuk Cave as well.
Trogloxene.

DISCUSSION

Approximately 10% of the total Hungarian millipede fauna (of 103 species) was present in the investigated caves of the Mecsek Mts. Although 60% of these 10 species were epigean, the presence of subtroglophile, eutroglophile, and troglobiont elements prove that cavernicolous habitats have some obvious advantage for millipedes. Shear (1984) considered that many cave species are relics of old taxa searching for a better microhabitat during the last glacial period. Furthermore, due to the isolation of such habitats, a high degree of endemism could have developed in cave millipedes. It is also a well-known fact, that predation and competition for resources are less intensive in subterranean habitats then in epigean ones, due to the absence of higher trophic levels, to the low abundance of the species, and to the relatively constant environmental factors (Culver & Pipan 2008).

Among the 12 caves visited we had diplopod records from 8 caves. The one with the most diverse fauna was the Törökpince Sinkhole, where 6 species were found. The first few meters of this horizontal cave, situated in a deciduous woodland above Abaliget village, contain a massive amount of organic matter in all seasons, which explains the relative high number of trogloxene millipede species, like *U. foetidus*, *B. tenuis*, *P. collaris*, and *C. luridus*. The deeper parts of the cave with its constant temperature and humidity provide ideal shelter for the eutroglophile and troglobiont species, such as *T. schmidtii* and *B. troglobius*.

Among the three diplopod species, *B. troglobius*, *H. bokori*, and *H. hungarica* that were previously considered to be endemic to the Abaligeti Cave, only *B. troglobius* was now found, which seemingly maintains a rather stable population in the cave, using all types of vegetal organic material. Although the appearance of the lamp flora is both an aesthetic and a conservational problem in public caves like the Abaligeti Cave, the vegetation confined to them seemed to be a permanent energy source for not only *B. troglobius*, but also for *T. schmidtii*. Therefore we suggest careful protection against the lamp flora with the lowest disturbance towards the invertebrate fauna. The absence of the 7 previously recorded millipedes could also be related with the recent utilization of the cave and the surrounding area.

Similar comments can be made about the Mánfai-kőlyuk Cave, where the intrusive introduction of waterworks has led to the disappearance of the suitable microhabitats with their original inhabitants, and the introduction of epigean, urban-habitat dwelling species (Angyal 2012).

We have found two new localities of the rare eutroglophile species, *H. hungarica*, which means that the exploration of the millipede fauna in the Mecsek Mts. is required to extend to more caves, for getting a better knowledge about the distribution of the species in the area.

Acknowledgements – We are grateful to Eszter Lazányi (HNHM) for her assistance in species identification, and to Gergely Balázs (Eötvös Loránd University) for preparing the map of Western Mecsek. Our speleologist collegues, Andrea Illés, Zoltán Tegzes and Artúr Nyírő from the Pro Natura Karst and Cave Society are also gratefully acknowledged for their help during the sample collection.

REFERENCES

ANGYAL, D. (2012): Invertebrate fauna of the Mánfai-kőlyuk Cave in reflection of the utilization by waterwork – preliminary results. *Természetvédelmi Közlemények,* 18: 24−33. (In Hungarian).

BLOWER, J. G. (1985): *Millipedes*. Synopses of the British Fauna, N. S., No. 35, E. J. Brill, London, 242 pp.

BOKOR, E. (1924): Beitrage zur rezenten Fauna der Abaligeter Grotte. *Zoologischer Anzeiger*, 61: 111–121.

CULVER, D. & PIPAN, T. (2008): *The Biology of Caves and other Subterranean Habitats.* Oxford University Press, The Biology of Habitats Series, 254 pp.

ĆURČIĆ, B. P. M. & MAKAROV, S. E. (1998): Postembryotic development in *Brachydesmus troglobius* Daday (Diplopoda, Polydesmidae) from Yugoslavia. *Archives of Biological Science,* Belgrade, 50 (1): 9−10.

DADAY, J. (1889): *Monograph of the myriopods in Hungary.* Királyi Magyar Természettudományi Társulat, Budapest, 126 pp. + I-III. (In Hungarian with Latin descriptions)

FARKAS, H. (1957): Data to the knowledge of the fauna of the Abaligeti Cave. *Állattani Közlemények* 46: 67–69. (In Hungarian).

GEBHARDT, A. (1933a): *The fauna of the Abaligeti Cave.* Magyar Tudományos Akadémia, Budapest, 264 pp. (In Hungarian).

GEBHARDT, A. (1933b): Vergleichung der Tierwelt der Abaligeter – und Mánfaer Höhlen. *Állattani Közlemények,* 30 (1–2): 36–44. (In Hungarian)

GEBHARDT, A. (1934): Myriapoda in the Abaliget Cave. *Mathematikai és természettudományi közlemények.* 37: 132−138. (In Hungarian)

GEBHARDT, A. (1963): Biological research of the caves of the Mecsek Mountains. *A Janus Pannonius Múzeum Évkönyve*, 5−32. (In Hungarian).

GEBHARDT, A. (1966): Fauna of the Mecsek Mountains II. *A Janus Pannonius Múzeum Évkönyve*, 11: 7−15. (In Hungarian).

KORSÓS, Z. (1997): The millipede fauna of the Dráva Region, southern Hungary (Diplopoda). *Entomologica Scandinavica Supplement,* 51: 219−224.

KORSÓS, Z. (1998): Millipede fauna of the Dráva region (Diplopoda). *Dunántúli Dolgozatok Természettudományi sorozat*, 9: 81−96. (In Hungarian with English summary).

KORSÓS, Z. (2000): *Rare and endemic millipedes (Diplopoda) of the Abaliget Cave*. In. MOCK, A., KOVAC, L. & FULIN, M. (Eds.) Fauna Jaskyn (Cave Fauna), Kosice, p. 61−66.

KORSÓS, Z. (2001): Catalogue of the millipedes (Diplopoda) of Somogy county. *Natura Somogyiensis* 1: 49−56. (In Hungarian with English summary).

KORSÓS, Z., READ, H. J., BARBER, A. D., GREGORY, S. J., HORNUNG, E., JONES, R. E., KIME, R. D., LEWIS, J. G. E. & SELDEN, P. A. (2006): Report on a collecting trip of the British Myriapod Group to Hungary in 1994. *Bulletin of the British Myriapod & Isopod Group,* 21: 40−55.

KORSÓS, Z. (2008): *Diplopods of Hungary (Myriapoda: Diplopoda). Illustration tables and data sheets for the identification of the species.* Magyar Teméaszettudományi Múzeum, Budapest, 146 pp.

KORSÓS, Z. & LAZÁNYI, E. (2008): Millipedes (Diplopoda) of Maramures (Romania), *Studia Universitatis „vasile Goldis", Seria Stiintele Vietii (Life Sciences Series)*, 18: 199−209.

LAZÁNYI, E. & KORSÓS, Z. (2009): Millipedes (Diplopoda) of the Aggtelek National Park, Northeast Hungary. *Opuscula Zoologica Budapest,* 40(1): 35−46.

LOKSA, I. (1954): Die *Polydesmus*-Arten des Faunengebietes des Karpatenbeckens. *Annales historico-naturales Musei nationalis hungarici*, 5: 215−224.

LOKSA, I (1961): Die Arthropoden des Kovácsi-Berges. *Állattani Közlemények,* 48: 65−80. (In Hungarian with German summary)

MRŠIĆ, N. (1994): The Diplopoda (Myriapoda) of Croatia. *Razprave IV. Razreda SAZU, Ljubljana*, 35 (12): 219−296.

MRŠIĆ, N. (1998): Polydesmida (Diplopoda) of Yugoslavia, I. *Razprave IV. Razreda SAZU*, *Ljubljana*, 29 (3): 69−112.

SCHUBART, O. (1934): *Tausendfüssler oder Myriapoda I: Diplopoda*. In. DAHL, F. (Ed.) Die Tierwelt Deutschlands und der angrenzenden Meeresteile, Teil 28, Gustav Fischer Verlag, Jena, 318 pp.

SHEAR, W.A. (1984): Cave millipedes of the United

States. III. Two new species from the western states (Diplopoda: Polydesmida, Chordeumatida). *Myriapodologica*, 1: 95−104.

SKET, B. (2008): Can we agree on an ecological classification of subterranean animals? *Journal of Natural History,* 42 (21−22): 1549–1563.

SZALAY, L. (1942): Beiträge zur Kenntnis der Diplopoden-Fauna des Kôszeger Gebirges. *Mathematikai és természettudományi értesítő,* 61: 400−415.

VERHOEFF, K. W. (1928): Zur Kenntnis der Diplopodenfauna Ungarns. 109. Diplopoden-Aufsatz. *Állattani Közlemények,* 25: 124−126; 182−199.

Opusc. Zool. Budapest, 2013, 44(2): 107–127

The major megadrile families of the World reviewed again on their taxonomic types (Annelida: Oligochaeta: Megadrilacea)

R. J. BLAKEMORE

Robert J. Blakemore, C/- Biodiversity Lab., Dept. Natural Sciences, Hanyang University, Seoul, S. Korea
E-mail: rob.blakemore@gmail.com

Abstract. A critique of recent clado-molecular phylogenies notes shortcomings of starting materials, methods applied, and, therefore, their conclusions; hence this review. A new group, Exquisiclitellata, is newly defined as those 'non-crassiclitellate' members of the superorder Megadrilacea (*viz*., Moniligastridae Claus, 1880, plus Alluroididae Michaelsen, 1900 and Syngenodrilidae Smith & Green, 1919). Support for restitution and elevation of American Diplocardiinae Michaelsen, 1900 and Argilophilini Fender & McKey-Fender, 1990 are again raised. ICZN priority requires revival of *Typhoeus* Beddard, 1883 over synonym *Eutyphoeus* Michaelsen, 1900 and the sub-family Typhoeinae (corr. of Typhaeinae Benham, 1890) is re-established. Hoplochaetellinae sub-family nov. is proposed as a development of Octochaetidae s. lato in India. Wegeneriellinae sub-fam. nov. accommodates the holoic members of a restricted Neogastrini Csuzdi, 1996 from W. Africa and S. America. Caribbean family Exxidae Blakemore, 2000 and related Trigastrinae Michaelsen, 1900 are both retained. A contingency table of Megascolecidae s. stricto sub-families and types is presented with some revived and a few new sub-families proposed, particularly from Australasia. These are Diporochaetinae, Megascolidesinae, Celeriellinae, and Woodwardiellinae sub-fams. nov. Synonymy of Perichaetidae Claus, 1880 over Megascolecidae Rosa, 1891 is deferred for reasons of nomenclatural stability. For the large African family Eudrilidae Claus, 1880, a new sub-family, Polytoreutinae, is advanced and the status of abandoned Teleudrilini Michaelsen, 1891 and overlooked Hippoperidae Taylor, 1949 are noted.

Keywords. Earthworm family classification,taxonomic nomenclature, molecular phylogeny, primary types, synonyms.

INTRODUCTION

Megadrile oligochaetes now number about 7,000 named taxa (Csuzdi 2012, and pers. comm. June, 2013). Plus an estimate is of approximately 3,000 aquatic microdriles (exact figures are unavailable) to give a total for Class (or Order) Oligochaeta of *ca*. 10,000 taxa. Twenty years ago Reynolds & Cook (1993) listed 7,254 Oligochaeta species (terrestrial megadriles plus aquatic microdriles), in 780 genera and 36 families, since increased to *ca*. 40 families (Blakemore 2000, Plisko 2013). In comparison, totals for marine Polychaeta are of about 13,000 names – although only 8,000 of these were considered reasonably valid – in 1,000 genera and 82 families (these data from Dr Chris Glasby: http://www.ea.gov.au/biodiversity/abrs/online-resources/polikey/index.html#history accessed Dec. 2006). Thus the polychaete workers have allocated roughly the same number of species into more than twice the number of families with their median ratio of *ca*. 130:12:1. If these classifications are neither artefactual nor excessive, this may be due to the habitats of the earthworms imposing uniformity in external characters and their internal morphology differences being subtle. Nevertheless, a precedent is provided for a greater number of family level divisions in the Oligochaeta in order to match the Polychaeta ratio, as indeed suggested by Blakemore (2005). Whilst accepting that families and genera are useful (i.e., pragmatic) taxonomic 'convenience' constructs, it is assumed these can be validated nomenclaturally if not phylogenetically.

Under the ICZN (1999) code, *"Each nominal taxon in the family, genus or species groups has actually or potentially a name-bearing type"* that *"provides the objective standard of reference."* Often yet mistaken by novices as 'lumbricids = earthworms', Lumbricidae is just one of the twen-

urn:lsid:zoobank.org:pub:75A31729-7958-4C4C-9D61-92DEEBBC172F
HU ISSN 2063-1588 (online), HU ISSN 0237-5419 (print)

ty or so megadile earthworm families (Blakemore 2005: tab. 1, 2008a, c). And, whilst the important Oriental Moniligastridae gets overlooked by most Occidental researchers, a chronic problem with Pangean Megascolecoidea *sensu* Sims (1980) is that types are often ignored, especially by those (e.g. Sims 1980: 115, Csuzdi 1996: 365, 2010a, b, 2012) who follow Gates (1959: 240, 1972) in ascribing taxa with prostates *"racemose in structure of mesoblastic origin*" to a restrictive Megascolecidae whereas those with prostates *"tubular in structure of ectodermal origin*" are placed in an excessive Acanthodrilidae. Yet, as repeatedly shown by Blakemore (2005: 71, 2008a, 2012b), this syllogism is invalid and fatally flawed as the limited cases cited by Gates (*viz*. "*Stephenson & Ram, 1919 and Pickford, 1937*") referred to samples, none types, of the families Megascolecidae and Acanthodrilidae *sensu* Michaelsen (1900) as restored by Blakemore (2000) that were already differentiated on their male pores!

Stephenson (1930: 716) regarded Michaelsen's (1900) "*Das Tierreich*" review of the Oligochaeta as "*a triumph of arrangement which brought order into confusion and constituted a remarkable advance in our understanding of the group*". This stability remained until Gates (1959) proposed a revised scheme. Almost simultaneously, Lee (1959: 17, 32) mostly supported Stephenson's 'Classical System' as did Blakemore (2000) in reverting to an update of Michaelsen's system, in order to resolve the chronic family level chaos of intervening schemes. Slight refinements by Blakemore (2005, 2008a, 2012b) aimed to reduce residual confusion with family placement as exemplified with some Caribbean taxa described by James (2004: 277) citing "Acanthodrilidae" in the title, "Megascolecidae" on page 278 yet describeing *Dichogaster* species that belong in either Benhamiinae (that had been restored by Csuzdi, 1996) and/or in Octochaetidae.

Recent attempts to redefine some megadrile families based on moleculocladistics should be tempered within the constraints (and the starting points) of the taxa named under the current conventions of ICZN (1999) code. Seeking taxonomic solution from genetics may not always be appropriate thus the conclusions of a 'Molecular phylogeny' of some worms by James & Davidson (2012) must be treated with caution since biased sampling mostly avoided consideration of types and, without good reason, they 'sunk' meroic Octochaetidae that is especially dominant in India/New Zealand and is here revived. The weakness in their study was failure to follow ICZN (1999) whereby a family is defined on the basis of the characteristics of a representative type-genus implicit in the name of the family that is itself defined by the characteristics of its type and included species. Such essential samples of the type-genera were absent in their analyses of the major families, even though type-species of many of these are relatively common. Moreover, as already noted by Gates (1959: 241, 1972: 275), Lee (1959) and Sims (1980: 116), polyphyly has been apparent within Acanthodrilidae and Octochaetidae for some time, thus this same conclusion from James & Davidson (2012: 227) does little to actually resolve the 'problem' nor break the impasse to assist students properly place a species in the correct genus and correct family. Better if molecular cladists follow a PhyloCode instead of using Linnean taxonomy, as was independently suggested by Timm (2005: 57).

Compliance with a named genus or family is based on definitive characteristics that have traditionally been morphological and behavioural although molecular data are now also gaining ground starting with a study by Siddal *et al.* (2001). But conclusions from chemical/molecular work by non-taxonomist may often be incompatible with those from morphological/ecological studies by biologists depending on what questions we seek to answer and on what levels of division we apply under a particular system of classifycation. However, in the *ca*. 255 years use of Linnean scientific names it is realized that taxonomy is not necessarily the same as phylogeny: despite this ideal, Nature is not so accommodating. Moreover, classification and 'cladification' are not the same processes. Reconciling an evolutionnary/systematic Linnean taxonomy scheme with cladistic phylogenies is often impractical, if not impossible, due to different basic assumptions as noted in the Preface to the latest Code (ICZN, 1999) where it says: "*The conventional Linnaean hierarchy will not be able to survive alone: it will have to coexist with the ideas and terminology of phylogenetic (cladistic) systematics. From a cladistic perspective, our traditional nomenclature is often perceived as too prescriptive and too permissive at the same time. Too prescriptive, in so far as it forces all taxa (and their names) to fit into the arbitrary ranks of the hierarchy; too permissive, in so far* ***as it may be equally applied to paraphyletic as to monophyletic groups.***" [Bolding added for emphasis by the current author].

This argument is succinctly put on Alan Kazlev/Toby White's *Palaeos* website by Dr R.K. Brummitt (http://palaeos.com/phylogeny/cladistics/incompatible.html accessed July, 2005 and October, 2013):

"*Linnaean classification without paraphyletic taxa is a logical impossibility. Every monophyletic genus in a Linnaean classification must be descended from something (probably a species) in a different genus, which must be paraphyletic. Similarly every monotypic family must be descended from a species in a genus in a different family. If one denies paraphyletic taxa, where do genera and families come from? Ultimately, one would end up sinking everything into its ancestral taxon, and the whole classification would telescope into its original taxon...* " and...

"*The theory of a Linnaean classification without paraphyletic taxa is nonsensical. Hennig's proposal to eliminate paraphyletic taxa* [from Cladistic studies] *was based on a failure to see the difference between the Linnaean hierarchy in which all taxa are nested in the next higher taxon, and a phylogenetic hierarchy which is not so nested, the lower levels of the hierarchy being not equivalent to the higher levels.* ***Put another way, all the species of a genus together equal the genus but all the offspring of a parent do not equal the parent.***" [Bolding added for emphasis].

The fundamental incongruity between the approaches of "*Hennigian Cladistics*" vs. "*Darwinian Classification*" is detailed by Mayr (1998), Grant (2003) and by Mayr & Bock (2002) who, in favouring a combination of morphological and molecular studies using Linnaean systematics (as per Blakemore *et al*. 2010 and as advocated here), said:

"When the molecular methods were first introduced, some authors thought that these were automatically superior to morphological characters based on subjective evaluations. But different molecular methods also often led to different results, and it was eventually realized that different molecules may have different rates of change (mosaic evolution) and that morphological characters, the product of large numbers of genes, are usually quite reliable."

Mayr & Bock's (2002) distinctions are for Darwinian Classification: – "*A classification based on two criteria – similarity and common descent*", plus we might add 'and often proximity' with "*...almost any method of weighing is preferable to using unweighed characters*"; and for Hennigian Cladification: – "*An ordering system ... arranged with reference to the sequence of the branching points ... based on the principle of holophyly*" with 'holophyly' used in its restricted Cladist sense.

Particulars of the current issue are that specimens and species of genera that are acanthodriline but have meroic nephridia derived from the 'primitive' holoic state are properly allocated under ICZN priority to the currently defined meroic family Octochaetidae and its sibling or sub-families. In each case the precursor to this development of meroic nephridia may reasonably be accepted as an erstwhile member of Acanthodrilidae, regardless of when or where this development occurred. In addition, the derived taxa will, of necessity, indeed be similar to their precursors in many if not most of their features. This last fact – that taxa at the boundaries of transition we set will be similar – is tautological and even if the process is not often directly observable we can readily deduce this outcome in the specimens of our concern, assuming they are correctly characterized and identified. The similarity of Octochaetidae to Acanthodrilidae species was recognized by Lee (1959: 32) although additional information has somewhat eroded his argument for their combination. Thus the current and relatively stable working model for earthworm systematics has yet to be conclusively and definitively refuted, and, even when weaknesses were identified, few workable alternatives were suggested. This issue is treated further in the Results and Revision section below.

Here it is necessary to again restate and refine taxonomic families with the realization that not all the components of an ordered earthworm phylogeny may be available due to extinction and lack of funding support for soil eco-taxonomy such that terrestrial surveys are far from complete and that some taxa remain misdescribed pending revision, ideally based on primary types or neotype specimens (see Blakemore 2008a, Blakemore *et al*. 2010). Earlier, Blakemore (2000, 2005, 2006b) had discussed the key issues and problems of previous family level classification and noted that Michaelsen (1900) disassociated his Megascolecidae subfamilies Acanthodrilinae (on page 122) and Diplocardiinae (on page 324) using a key to megascolecoids from Michaelsen (1900: 121), similar to the following that is still applicable today:

1. Calciferous gland or oesophageal pouches in 9, 10 (last hearts in 11)..**Ocnerodrilinae**
– Calcifrous glands/pouches absent or not in 9, 10 (last hearts after 11) **2**

2. (Acanthodriline male pores and) two or three gizzards in front of first testes **3**
– Not such an arrangement of (male pores and) gizzards... **4**

3. Holoic nephridia (two per segment) .... **Diplocardiinae**
– Meroic nephridia (more than two) ....
....................**Trigastrinae** (*cf.* Benhamiinae and Exxidae)

4. Spermathecal pores behind 8/9 often fused with female pore .... **Eudrilinae**
– Spermathecal pores on or before 8/9, or absent............... **5**

5. Vasa deferentia combined with prostatic pores exit on 18
.... **Megascolecinae**
– Vasa deferentia not so combined with prostatic pores on 18 .... **6**

6. Holoic .... **Acanthodrilinae**
– Meroic.. **Octochaetinae**

Michaelsen's divisions seem remarkably insightful and phylogenetically valid based on contemporary knowledge, except that Eudrilidae is now separated off and most other sub-families merit elevation to family level plus addition of Exxidae – perhaps a local derivation of Trigastrinae Michaelsen, 1900 (cf. Benhamiinae Michaelsen 1895) as discussed herein. An 'ideal' phylogenetic arrangement for these megascolecoid taxa based on weighted morphology of their primary types is shown in Fig. 1.

Any family review without consideration of types is meaningless; however, if monophyly is strictly employed then each type deserves its own unique family or else all families may telescope into the earlier taxon. Clearly a rational moderation is required.

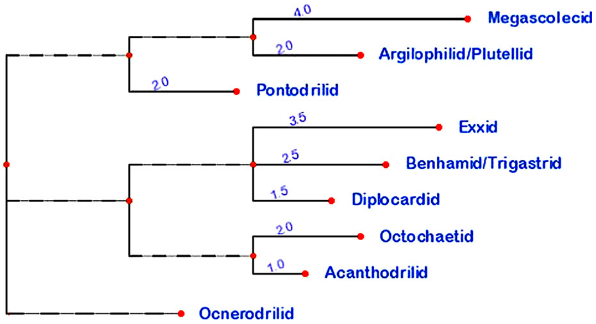


Figure. 1. Phylogeny of the Megascolecoidea taxa constructed on weighted morphology of their types after Blakemore (2008: fig. 3 corresponding to an actual molecular phylogram presented in Blakemore 2005: fig. 2, 2008: fig. 1).

TAXONOMIC RESULTS AND REVIEW

Annelida Lamarck, 1802: Oligochaeta Grube, 1850 suborder Lumbricina De Blainville, 1828, was classed as Terricolae Örsted, 1843 (part.) or, most appropriately, as Megadrili Benham, 1890, now constructed as Superorder Megadrilacea when used by Gates (1972, 1982), Sims (1978, 1980), Easton (1981: 33) and Righi (1984) to described Stephenson's (1930) megadriles, *i.e.*, mainly 'true' terrestrial earthworm as opposed to smaller, aquatic microdriles that lack capillaries on their nephridia (Beddard 1895: 157) and other features noted by Gates (1972: 28). Megadriles comprise the Moniligastrida (for Moniligastridae Claus, 1880) + Lumbricina or Haplotaxida from Easton (1981: 35) "*After Sims, in press*". Megadrilacea seems to have priority to later non-inclusive names and includes the very important Oriental terrestrial family Moniligastridae and some lesser families. Although theoretical or 'higher' taxa are unregulated by ICZN code, henceforth the Megadrilacea is composed of what some authors insist on calling 'Crassiclitellata' (= Lumbricina or Haplotaxida) plus the Exquisiclitellata that is newly defined for those non-crassiclitellate members of the Megadrilacea, (viz. families Moniligastridae and Alluroididae Michaelsen, 1900 along with monotypic Syngenodrilidae Smith & Green*,* 1919) characterized by their delicate or thin (single-cell) clitella and concomitant large ova. Aside from phylogenetic merit, this term avoids the inexactitude of what James & Davidson (2012: 213) call in part "*the non-crassiclitellate 'earthworms'*" and what Pop *et al.* (2005: 143) tag as "*Alluroidina and Moniligastrida*" that they properly include under megadrile oligochaetes in their molecular studies.

Review and revision of Ocnerodrilidae, Acanthodrilidae and Octochaetidae

Classically seen as closest to the root-genus in the phylogenic 'tree' of all megascolecoid worms (Stephenson 1930), the tropical Afro-American Ocnerodrilidae Beddard, 1891 currently includes Indian sub-family Malabariinae Gates, 1966 the members of which, however, lack 'ocnerodriline diverticula' and thus may have different origins, possibly meriting elevation to separate family status. As Gates (1942: 66, 1979: 162) initially suggested, the Ocnerodrilidae are considered a more primitive sibling group of the Megascolecoidea, closest to ancestral forms, an idea that has gained support from preliminary molecular data (Blakemore, 2005: figs. 1–2, 2008; Pop *et al.*, 2005; Christoffersen, 2008: 97).

For Acanthodrilinae Claus, 1880, Michaelsen (1910: 53), in a paper seemingly often overlooked, subdivided the family into several 'sectio' or tribes that should be reconsidered: *viz*. Acanthodrilacea that presently includes his Diplotremacea (syn. Eodrilacea Michaelsen, 1910), Neodrilacea (syn. Maoridrilacea Michaelsen, 1928), Chilotacea [type Chilean *Chilota* Michaelsen, 1899 (non Aubertin, 1930 Diptera), type *Mandane littoralis* Kinberg, 1867: 100 (et *litoralis* = *Mandane patagonica* Kinberg, 1867)], and Maheinacea [types *Maheina* Michaelsen, 1899 for monotypic *Acanthodrilus braueri* Michaelsen, 1897 from Mahé, Seychelles that Cs. Csuzdi (pers. comm. 13th May, 2008) says is probably an Ocnerodrilidae], plus meroic Howascolacea belonging in, or allied with Octochaetidae. This latter, perhaps the most primitive of the octochaetids, is now monotypic for Malagasy *Howascolex madagascariensis* Michaelsen, 1901 as remarked on by Stephenson (1930: 819, 843) with removal of similar species garnered in the genus from China (now in *Ramiella* Stephenson, 1921), India (now in *Konkadrilus* Julka, 1988 or *Wahoscolex* Julka, 1988) and America (now in *Ramiellona* Michaelsen, 1935 and *Graceevelynia* Graff 1957).

Following Pickford's (1937) extensive revision, Lee (1959) maintained two tribes of his concept of Acanthodrilinae, one equivalent to Neodrilacea Michaelsen, 1910 having regular alternation of holoic nephropores much like in strictly megascolecid Plutellinae members with type-genus *Plutellus* Perrier, 1873 presently restricted to a few species from central coastal New South Wales (see Blakemore 1994b).

Csuzdi (1996: 350-351) redefined Acanthodrilidae to accept either the holoic (Acanthodrilinae s. Csuzdi) or meroic (Octochaetinae Michaelsen, 1900) states, but this was soon confounded by a rather contrived tribe Neogastrini Csuzdi, 1996: 363 that allowed either state and was unacceptably heterogeneous, consequently its genera were re-allocated by Blakemore (2005: 72): holoic genera to Acathodrilidae and meroic genera to Octochaetidae. Futhermore, it was noted that Csuzdi's (1996: 365) definition of Megascolecidae with only racemose prostates separated from Acanthodrilidae s. Csuzdi with tubular prostates (and holoic or meroic nephridia) is superceded by the redefinitions by Blakemore (2000, 2005, 2008a) as repeated herein. Revisions by Csuzdi (1995, 1996, 1997, 2010a, b) had re-established "Benhamiinae Michaelsen, 1897" for meroic species with 2–3 pairs of extramural calciferous glands beginning in or after segment 14 but its relationships to other sub-families were unclear. Blakemore (2005, 2008a) accepted a reduced Benhamiinae and considered revision and restoration of Diplocardiinae Michaelsen, 1900 (but with meroic components removed to Octochaetidae as per Michaelsen 1933) and of Trigastrinae, which seems to be gaining support. Moreover, Benhamiinae may be elevated having an independent lineage possibly with no relation to Indian/NZ octochaetids (Blakemore 2005: tab. 2, fig. 2; Csuzdi pers comm. Aug. 2013) nor to the other two American taxa.

Monotypic West African genus *Monogaster* Michaelsen, 1915 (type-species *M. bidjumensis* Michaelsen, 1915 from Cameroon) according to Csuzdi (1996: 358) belongs in (Acanthodrilidae: Benhamiinae) tribe Benhamiini as defined by Csuzdi (1996: 351) with two large gizzards before segment 10, three extramural calciferous glands in 14–17 and meroic nephridia with meganephridia caudally. This genus *Monogaster* is unusual in having a single, combined gizzard in 5–6, calciferous glands in 15–17 and saccular meroic nephridia, thus it should possibly be separated off into a new sub-family (as Monogastrinae) leaving a restricted definition of Benhamiini.

The other tribe, Neogastrini, was newly defined by Csuzdi (1996: 363) with a single gizzard in 5 (sometimes rudimentary), calciferous glands in 14–15 and holoic or meroic nephridia. Csuzdi (2010b: 105) retained this diagnosis (but with gizzard in 6 sometimes vestigial or absent), yet having holoic taxa in this group is still problematic.

Csuzdi (1996: 365, 2010b) included holoic West African genera *Wegeneriella* Michaelsen, 1933 and *Pickfordia* Omodeo, 1958 in subfamily Benhamiinae that was originally as Sippe (German = clan or tribe) Benhamiacea Michaelsen, 1895: 23 and later as Benhamini (Michaelsen, 1897: 3, 7, 25) then Benhaminae (Eisen, 1900: 208) – as reported in Michaelsen (1900: 330) where it was included in synonymy of his subsequent Trigastrinae Michaelsen, 1900: 330 perhaps because Benham (1890: 231) had made *Benhamia* Michaelsen, 1889 a junior synonym of his prior *Trigaster* Benham, 1886, but this genus was later restored, as Benham (1890: 281) indeed proposed; see also Stephenson (1923: 469; 1930), Gates (1959: 256). Thus it seems the correct date and orthography is Benhaminae Michaelsen, 1895 rather than "Benhamiinae Michaelsen, 1897". Nevertheless, these holoic taxa belonging in Acanthodrilidae as redefined by Blakemore (2000, 2005, 2008a) are here revisited (Table 1).

Table 1. Characters distinguishing 'Neogastrini' genera after Csuzdi (2010b: tab. 1)

Genus	Distribution	Nephridia	Gizzard	Ca glands	Spermathecae
Wegeneriella Mich., 1933	W. Africa	Holoic	Present	Common duct	Unpaired
**Neogaster* Čern., 1934	S. America	Meroic*	Present	Common duct	Paired
**Wegeneriona* Čern., 1939	S. America	Meroic*	Present	Common duct	Unpaired
Pickfordia Omod, 1958	W. Africa	Holoic	Absent	Separate duct	Paired (and diverticulate)
Omodeoscolex Csuzdi, 1993	S. America	Holoic	Absent	Separate duct	Paired (adiverticulate)
Afrogaster Csuzdi, 2010	W. Africa	Holoic	Absent	Common duct	Paired (adiverticulate)
Pickfordiella Csuzdi, 2010	W. Africa	Holoic	Present	Common duct	Paired (and diverticulate)

*The two meroic genera comply with Octochaetidae/Benhamiinae/Neogastrini; all other holoic genera returned or newly transferred to Acanthodrilidae and now Wegeneriellinae (details in body of text).

Table 1 reproduces information provided by Csuzdi (2010b: tab. 1) of characteristics of the Neogastrini sorted chronologically. Retention of genera separated only on their unpaired male and/or spermathecal pores is tenuous as several other genera (e.g. *Amynthas* Kinberg, 1867) include both paired and unpaired states, although some other genera, e.g. megascolecid *Fletcherodrilus* Michaelsen, 1891 and eudrilids such as *Libyodrilus* Beddard, 1891, are primarily defined by the unpaired state. Thus *Pickfordiella* Csuzdi, 2010 may be derived from *Wegeneriella* Michaelsen, 1933, and *Wegeneriona* Černosvitov, 1939 from *Neogaster* Černosvitov, 1934. These latter two meroic genera comply with Neogastrini Csuzdi, 1996 *s. strict* (types *Neogaster* Černosvitov, 1934 and *Neogaster americanus* Černosvitov, 1934) and both are from South America.

However, the other holoic genera in the table do not comply and should be returned to Acanthodrilidae and possibly to a restored Diplocardiinae but, since they lack the required duplication of gizzards, they qualify for a new sub-family as here proposed:

Family Acanthodrilidae Claus, 1880

Sub-family Wegeneriellinae sub-fam. nov.

Diagnosis. Acanthodriline male pores, holoic nephridia, presence of a single gizzard in 5 or 6 sometimes vestigial or absent, calciferous glands in segments 14–15 and with lumbricine setae.

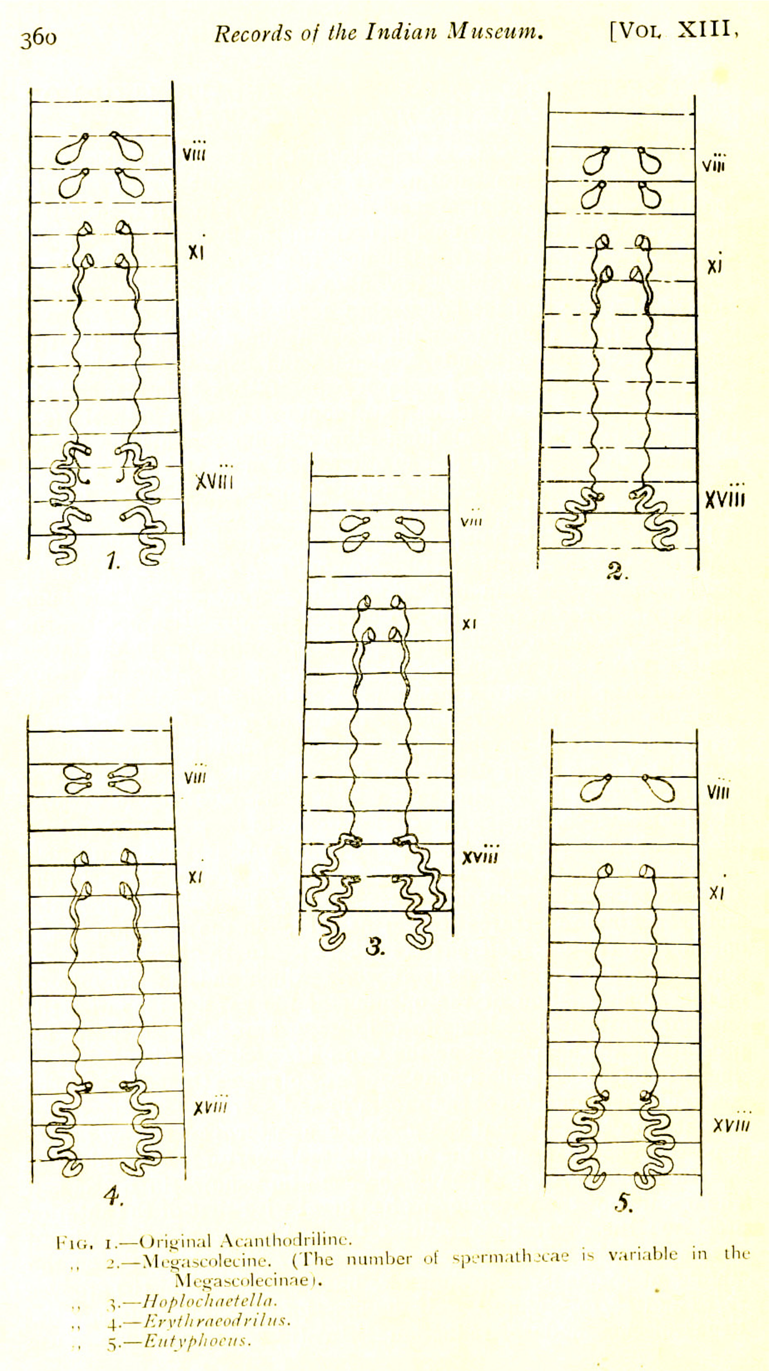
Types. *Wegeneriella* Michaelsen, 1933 and *Notiodrilus valdiviae* Michaelsen, 1903.

Distribution. Africa and South America as show in Csuzdi (2010b: fig. 1 although this differs somewhat to Csuzdi, 1996: fig. 7 especially for *Pickfordia* and *Wegeneriella*) for genera *Wegeneriella*, *Pickfordia*, *Omodeoscolex*, *Afrogaster* and *Pickfordiella* but excluding the two remaining Neogastrini *s. stricto* genera (*Neogaster* and *Wegeneriona*).

Remarks. Wegeneriellinae currently complies with Acanthodrilidae. It is possible that different phylogenic origins apply to African and American taxa (e.g. Diplocardiidae, Benhamiidae and Exxidae) compared to the Australasian taxa (Acanthodrilidae, Octochaetidae, Megascolecidae) as keyed from Michaelsen (1900) in the Introduction above (see Fig. 1). Moreover, the retention of some previous sub-families and proposal of new ones may be appropriate (see later sections).

Benhaminae and related groups are shown by Csuzdi (1996, 2010a) to occur in the tropics, in Africa and South America. The mystery remains of why Octochaetinae is more prevalent in India whereas Acanthodrilidae, that occurs mostly in southern lands, is absent from both India and Asia [with possible extinctions from Gondwanan India except for a single dubious species, *Diplocardia* (?) *indica* Stephenson, 1924]. This may have been partly explained >60 years ago by Bahl (1947) when he talks of certain anatomical novelties (e.g. enteronephry) for moisture conservation in monsoonal regions. Thus we may speculate that adaptation of meronephry as a means of water conservation has favoured meroic Octochaetidae in these regions subjected to seasonal but regular floods.

In contrast, the native holoic Acanthodrilidae in Australia (e.g. *Diplotrema* spp.) endure periodic and sometimes extended drought, surviving by diapause as discovered by Blakemore (1994a) e.g. for *Diplotrema narayensis* Blakemore, 1997; whereas only a few native 'missing link' Octochaetidae species are currently know from there, although the massive Northern Territory is currently unsurveyed. Compared to random droughts, seasonal monsoons are more regular and probably survivable for earthworms, with such a climate more conducive to meroic adaptation rather than conservation of an ancestral holoic state. For these meroic octochaetids abundant in India, their most advanced genera are those with development of multiple male pores for which a new Octochaetidae division is here proposed.



360 *Records of the Indian Museum.* [Vol. XIII,

Fig. 1.—Original Acanthodriline.
,, 2.—Megascolecine. (The number of spermathecae is variable in the Megascolecinae).
,, 3.—*Hoplochaetella*.
,, 4.—*Erythraeodrilus*.
,, 5.—*Eutyphoeus*.

Figure 2. Schema of male fields and of hoplochaetellid earthworms from Stephenson (1917).

Family Octochaetidae Michaelsen, 1900

Sub-family Hoplochaetellinae sub-fam. nov.

Diagnosis. Octochaetidae with perichaetine setae. Male field similar to the acanthodriline with prostatic pores on both 17 and 19 with male pores closely aligned with those either on 17 or with both 17 and 19, a condition termed 'hoplochaetelline' after Gates (1972: 329). Single oesophageal gizzard before testes. Nephridia meroic.

Types. *Hoplochaetella* Michaelsen, 1900: 321 and *Perichaeta stuarti* Bourne, 1886: 667 (?syn. *Erythraeodrilus* Stephenson, 1915 with type *E. kinneari* Stephenson, 1915). See Fig. 2.

Distribution. East India (that now involves Sri Lanka and Myanmar) with type plus eighteen species listed by Csuzdi (2012).

Remarks. *Hoplochaetella* type and Stephenson's (1917) species have male pores co-incident near those of the anterior pair of prostates on 17 whereas other species, such as *H. anomala* Stephenson, 1920 have two pairs of male pores near both sets of prostates in 17 and 19. Stephenson (1920: 226) remarked that a similar situation pertained to lumbricine *Eutyphoeus* Michaelsen, 1900: 322 (Octochaetinae) species but that the male pore combined only with the single pair of prostates on 17 (i.e., no prostates on segment 19, similar to the microscolecine reduction with male and prostatic pores closely converged). Gates (1959: 247) notes that these pores are not co-incident in *Eutyphoeus* contrary to earlier assertions

Questions now raised are whether the type of *Hoplochaetella* is representative of all other included members, or should *Erythraeodrilus* be restored and established as the type of a sub-family similar to the one proposed here. Another question concerns the closeness of relationship of perichaetine *Hoplochaetella* to lumbricine *Eutyphoeus*. As only the setae separate them, is it more appropriate to re-establish the existing sub-family Typhaeinae Benham, 1890: 220? Whatever the final outcome, this latter sub-family is corrected to Typhoeinae for type *Typhoeus orientalis* Beddard, 1883 for the following reasons.

Regarding ICZN priority of *Typhoeus* Beddard, 1883: 219, it was given a replacement name *Eutyphoeus* Michaelsen, 1900: 322 (n. n. pro *Typhoeus* Beddard, 1883) seemingly invalidly since the preoccupying Coleoptera genus having type *Scarabaeus typhoeus* Linnaeus, 1785 [itself later un-necessarily renamed *Typhoeus* Boucomont, 1911 (n. n. pro *Typhaeus* Leach, 1815)] was *Typhaeus* Leach, 1815 (with an "a" rather than an "o"). "*Typhaeus* Beddard, 1888: 111" is also listed for *Typhaeus gammii* Beddard, 1888: 111 (http://jcs.biologists.org/content/s2-29/114/101.full.pdf) although it is a *lapsus* for *Typhoeus* Beddard, 1883. This information is from Michaelsen (1900), Beddard (1901: 195), and from Airey-Neave's Nomenclator Zoologicus (http://uio.mbl.edu/ NomenclatorZoologicus/ accessed 30th Sept. 2013). Thus it seems the name *Typhoeus* Beddard, 1883 should strictly be restored with junior synonym *Eutyphoeus* Michaelsen, 1900; under current ICZN (1999: art. 23.9.1.1) prevailing usage should be set aside since Beddard (1901) vehemently re-establishes the name. This name restoration affects the *ca.* 50 *Eutyphoeus* taxa accumulated in the last 140 years as provided in the database of Csuzdi (2012).

Typhoeinae (and/or 'Erythraeodrilinae') may in time legitimately replace proposed Hoplochaetellinae; alternatively, all three may be maintained as sub-families of Octochaetidae (at the same time with elevation of Benhamiinae to separate family level?).

As Stephenson (1920: 184) keenly observed: "*The new* Hoplochaetella *raises some interesting points of morphology and phylogeny, and helps to show, – what is illustrated by other parts of the paper also, and indeed, I suppose, by the experience of systematists in general, – that the smaller our material, the more precise and satisfactory is our systematic work. Here as elsewhere increase of knowledge brings sorrow and trouble, and where before we walked confidently as in the daylight, we hesitate and feel befogged.*"

Revival of Trigastrinae Michaelsen, 1900 and retention of Exxidae Blakemore, 2000

Genus *Exxus* Gates, 1959 was defined on its non-tubular prostates, and Blakemore (2000, 2006a, 2007a) had argued for merger of *Neotrigaster* James, 1991 from Puerto Rico, as the type-species *Neotrigaster rufa* (Gates, 1962), initially poorly characterized but re-described on new material by several authors with 'racemose' prostates in 17 and 19, differs substantially from *Exxus* only by having three gizzards [in 5–7 (James, 1991: 348) or 6–8 (Borges & Moreno, 1992)]. Of the other two species included in *Neotrigaster* by James (1991) only *N. complutensis* (Borges & Moreno, 1991) belongs in this family. The third species, *Trigaster yukiyui* Borges & Moreno, 1991, with tubular prostates required returning to its original genus in the family Octochaetidae.

However, since the meroic genus *Trigaster* was formerly representative of sub-family Trigastrinae Michaelsen, 1900, this taxon is provisionally restored for consideration as origin of (and/or alternative to) Benhamiinae and/or Octochaetidae Michaelsen, 1900 in the Neotropical region of Central America and the Caribbean. Michaelsen (1900: 330) defined his Trigastrinae either with calciferous glands after ovarial segment 13 (*Dichogaster*) or without these (*Trigaster*); the former condition is characteristic of the prior Benhamiinae leaving the boundaries of a restored Trigastrinae *s. stricto* as redefined below.

(Family Octochaetidae Michaelsen, 1900)?

Sub-family Trigastrinae Michaelsen, 1900 (part.)

Diagnosis. Acanthodrile male pores with tubular prostates and meroic nephridia (as in Octochaetidae); lumbricine setae; two or three oesophageal gizzards; calciferous glands absent.

Types. *Trigaster* Benham, 1886 and *Trigaster lankesteri* Benham, 1886.

Distribution. Mexico and the Caribbean (mostly).

Remarks. Michaelsen (1900: 332) included eight taxa, but those three from India that had calciferous glands (before segment 14) were since reallocated to Indian *Eudichogaster* Michaelsen, 1903 having calciferous glands uniquely in the region of 10–13; and whereas Csuzdi (2012) lists ten *Trigaster* taxa inadvertently included are *Benhamia lankesteri* Michaelsen, 1889 and *Trigaster rufa* Gates, 1962 that was moved to *Neotrigaster* and then to *Exxus* in family Exxidae. The database also omits *T. yukiyui* noted above. Thus just ten or so species belong in this subfamily, including *Trigaster minima* Friend, 1911 and *T. setarmata* (?auct.) *species inquirendae*, both of which appear to have been overlooked and for which further work is required (see also Stephenson 1923: 362, 469; 1930; Gates, 1959: 256).

Family Exxidae Blakemore, 2000

The family Exxidae Blakemore, 2000 was revised by Blakemore (2006a, 2007a) to have the following characteristics.

Diagnosis. Acanthodrile male pores and meroic nephridia (as in Octochaetidae) but with non-tubular prostates; lumbricine setae; two or more oesophageal gizzards; intestinal modification possible but calciferous glands not recorded.

Types. *Exxus* Gates, 1959 and *Exxus wyensis* Gates, 1959 (?syn. *Neotrigaster* James, 1991 with type *Trigaster rufa* Gates, 1962 differing mainly in its three gizzards, although either two or three gizzards are permissible in some other genera, such as *Digaster* Perrier, 1872).

Distribution. Neotropical, Central America/Caribbean (viz. Puerto Rico, Cuba); no longer considered ‘Australasian’ (despite two doubtful Australian records). Eight or nine confirmed species transferred from three or four genera. Closest relationships are clearly with fauna in the region of Mexico, Cuba, Hispaniola, and Antilles. Other included species – but not types – come from these genera: *Zapatadrilus* James, 1991, *Trigaster* Benham, 1886, *Cubadrilus* Rodriguez & Fragoso, 2002 (and, doubtfully, *Torresiella* Dyne, 1997).

Remarks. The family as augmented by Blakemore (2007a) includes *Exxus barroi, E. cubitasensis, E. righii* (all comb. novs. from *Cubadrilus* Rodriguez and Fragoso, 2002), plus *E. taina* (Rodriguez and Fragoso, 1995) that comply with *Exxus* type, with *Neotrigaster complutensis* (Borges and Moreno, 1991) and with *N. rufa* (Gates, 1962), the latter type-species of synonymic, heterogeneous genus *Neotrigaster* James, 1991.

Further refinement of subfamilies of Megascolecidae

The diversity within the large family Megascolecidae Rosa, 1891 *s. stricto* is such that a case is put forward for resurrection of some, and proposal of several new, sub-families under ICZN (1999: art. 26) as summarized in Table 2.

Re-analysis again shows the Megascolecidae diagnosed only by its derived megascolecine male field (male and prostatic pores combined on segment 18 or its homeotic equivalent) as opposed to an acanthodriline male field, irrespective of any other character (Tab. 2; Fig. 2). Moreover, it is newly resolved into sub-families mostly from the numerous Australasian taxa comprising ca. 715 species from Australia (Blakemore & Paoletti, 2006, Blakemore, 2008b) and 228 from NZ (Blakemore, 2012a).

Megascolecid species with tubular prostates (and holoic nephridia) are placeable in Vejdovsky's (1884: 63) resurrected families Plutellinae (with objective junior synonym Plutellini Eisen 1894: 55) and Pontodrilinae [types Indo-australasian *Pontodrilus marionis* Perrier, 1874 (= *litoralis* Grube, 1855) – see Blakemore (2007c) and Australian *Plutellus heteroporus* Perrier, 1873 – see Blakemore (1994b), respectively]. Note that the name Plutellinae is a senior homonym of a large lepidopteran family of *Plutella* Schrank 1802 (diamondback moths) that requires replacement. Whether Nearctic sub-family Argilophilinae Fender & McKey-Fender, 1990 (type American *Argilophilus marmoratus ornatus* Eisen, 1893: 253) should be merged or separated from Plutellinae, as was suggested by Blakemore (2008), remains to be resolved. Heterogeneously meroic *Driloleirus* Fender & McKey-Fender, 1990 should be excluded from both Plutellinae and Argilophilini (and possibly it too merits a new tribal or sub-family status as Driloleirinae?) – but see Megascolidesinae below.

Table 2. Contingency table of Megascolecidae s. stricto sub-families and type of representative type-genus (loosely based on "*Bestimmungstabelle der Megascolecinen-Gattungen*" (Identification Table of the Megascolecid genera) from Michaelsen (1907: 160) and Blakemore's (2000: 47) table of Tasmanian genera.

Prostates	Nephridia	Setae	Sub-family	Genus
Tubular	Holoic (absent from anterior)	8	**Pontodrilinae** Vejdovsky, 1884	*Pontodrilus marionis* Perrier, 1874
Tubular	Holoic	8	**Plutellinae** Vejdovsky, 1884	*Plutellus heteroporus* Perrier, 1873
Tubular	Holoic	8	**Argilophilinae** Fender & McKey-Fender, 1990 (for USA)	*Argilophilus marmoratus ornatus* Eisen, 1893
Tubular	Holoic	>8	**Diporochaetinae***	*Perichaeta intermedia* Beddard, 1889: 380
Tubular	Meroic	8	**Megascolidesinae***	*Megascolides australis* McCoy, 1878
Tubular	Meroic	>8	**Celeriellinae***	*Spenceriella duodecimalis* Michaelsen, 1907
Non-tubular	Holoic	8	**Woodwardiellinae***	*Woodwardia callichaeta* Michaelsen, 1907
Non-tubular	Holoic	>8	**Perionycinae** Benham, 1890: 221	*Perionyx excavatus* Perrier, 1872
Non-tubular	Meroic	8	**Cryptodrilinae** Beddard, 1890: 236 / 1891: 256	*Cryptodrilus rusticus* Fletcher, 1886
Non-tubular	Meroic	>8	**Megascolecinae** Rosa, 1891	*Megascolex caeruleus* Templeton, 1844

* Sub-family nov.

Megascolecidae Rosa, 1891

Sub-family Diporochaetinae sub-fam. nov.

Diagnosis. Megascolecidae with tubular prostates, holoic nephridia and non-lumbricine setae.

Types. *Diporochaeta* Beddard, 1890 and *Perichaeta intermedia* Beddard, 1889 syn. *Perichaeta novae-zelandiae* Beddard, 1888: 434 (nomen nudum) – see Blakemore (2012a: 130).

Remarks. Included genera are those such as *Diporochaeta* and *Provescus* Blakemore, 2000 that comply with the diagnosis above. Note that Reynolds & Cook (1993: 4) cited family "*Diporochaetidae*" (actually a lapsus for Lumbricidae (sub-)family Diporodrilidae Bouché, 1970) – see Blakemore (2008c).

Sub-family Megascolidesinae sub-fam. nov.

Diagnosis. Megascolecidae with tubular prostates, non-holoic nephridia and lumbricine setae.

Types. *Megascolides* M'Coy, 1878 and *Megascolides australis* M'Coy, 1878.

Remarks. Included are Indian species of *Megascolides* that were transferred to *Scolioscolides*, *Barogaster* and *Travoscolides* by Gates (1940) leaving the original genus confined to Australian and New Zealand (North Island). North American species of *Megascolides* transferred to *Driloleirus* by Fender & McKey-Fender (1990) may possibly be included or should be retained separately as noted above. Based on contemporary knowledge Benham (1890: 220) had included *Megascolides* in his family Typhoeidae Benham, 1890 (corr. of Typhaeidae) that was (in part) in synonymy of Michaelsen's Octochaetinae its type-genus being *Typhoeus* Beddard, 1883 that, however, had already been (invalidly) renamed *Eutyphoeus* Michaelsen, 1900 as discussed above under the proposed Hoplochaetellinae sub-fam. nov.

Sub-family Celeriellinae sub-fam. nov.

Diagnosis. Megascolecidae with tubular prostates, non-holoic nephridia and non-lumbricine setae.

Types. *Celeriella* Gates, 1959 and *Spenceriella duodecimalis* Michaelsen, 1907

Remarks. The new sub-family is proposed to accept the residue of perichaetine, meroic taxa with tubular prostates, since *Spenceriella* Michaelsen, 1907 type was synonymized following supposed discovery of non-tubular prostates in the type species, *Diporochaeta notabilis* Spencer, 1900 that made it comply with prior *Anisochaeta* Beddard, 1890, (see Blakemore, 2000: 455; 2008b) in sub-family Megascolecinae. However, this requires re-evaluation on better preserved material as the prostates of this species may in fact be tubular in which case *Spenceriella* and 'Spenceriellinae' could be restored as priority replacements for Celeriellinae. Transfer of Australian species (and the four New Zealand species with tubular prostates that were formerly placed in *Spenceriella* in Lee, 1959) to the primarily Indian genus *Celeriella* was thought a probable temporary taxonomic 'convenience', pending further review of constituent species, by Blakemore (2000).

Sub-family Woodwardiellinae sub-fam. nov.

Diagnosis. Megascolecidae with non-tubular prostates, holoic nephridia and lumbricine setae.

Types. *Woodwardiella* Stephenson, 1925 and *Woodwardia callichaeta* Michaelsen, 1907.

Remarks. Diagnosed as in the table (Tab. 2) and redescription by Blakemore (2000: 283) with component taxa in Australia and New Zealand, including *Zacharius* Blakemore, 1997, as per Blakemore (2008b, 2011, 2012a). Note that Sri Lankan and Indian taxa formerly in *Woodwardiella* such as *W. uzeli* Michaelsen, 1903 and *W. kayankulamensis* Aiyer, 1929 were removed by Gates (1960: 240) to meroic *Notoscolex* Fletcher, 1886 and/or to *Lennoscolex* Gates, 1960 and thus belong in other sub-families.

Table 2 shows Cryptodrilinae Beddard, 1890 and Perionycidae Benham, 1890 provisionally restored for megascolecids with non-tubular prostates, meroic nephridia and setae that are lumbricine or perichaetine, respectively, as originally comprised but with compliant genera updated and provided in Blakemore (2000: 46, 2008b, 2012b). The residue of megascolecid species are most derived with their non-tubular prostates, meroic (i.e. non holoic) nephridia and perichaetine (i.e., non lumbricine) setae in sub-family Megascolecinae Rosa, 1891 *s. stricto*; examples of member genera are such as Indian *Megascolex* and Australasian *Anisochaeta* Beddard, 1890 plus Oriental pheretimoids – the *Pheretima* auct. of Sims & Easton (1972).

Michaelsen (1900: 161) included prior Pleurochaetidae Vejdovsky, 1888 in synonymy of Megascolecinae since its type-genus, *Pleurochaeta* Beddard, 1883 was found a synonym of *Megascolex*. Another claimed synonym (Michaelsen, 1900: 120) was Perichaetidae Claus, 1880 for *Perichaeta leucocycla* Schmarda, 1861 that, although probably still an available name, should be avoided for nomenclatural stability. Homonymy of *Perichaeta* Schmarda 1861 with *Pericheta* Rondani, 1859 (Diptera) was due to confusion of an extra "*a*". cf. Airey-Neave (http://www.ubio.org/NZ/) and Sabrosky (1999 http://www.sel.barc.usda.gov/Diptera/people/FCT_pdf/FGNAMES.pdf) for Dipteran homonyms in which it is stated:

> "*Pericheta Rondani 1859: 152 (unjustified new name for Policheta Rondani). Type, Tachina unicolor Fallen 1820 (aut.) = Policheta unicolor (Fallén). Tachinidae. Senior synonym (not the basis of a family-group name): Policheta Rondani 1856: 67. Type, Tachina unicolor Fallén 1820 (orig. des.) = Policheta unicolor (Fallén). Tachinidae.*
>
> *Perichaeta (error) Brauer & Bergensta 1889: 99 (31). Perichaetidae Brauer & Bergensta 1889: 82, 99 (14, 31). Note. Herting (1984: 23) adopted Perichaeta on the ground that Policheta was the "misspelled homonym of Polychaeta Macquart 1851." The "homonym" was repeated in Herting & Dely-Draskovits (1993: 153). However, Policheta and Polychaeta are distinct names (Code, Art. 56b), not homonymous.*"

Although there may be rare citations after 1899, Michaelsen (1900: 212) reported the last species named was *Perichaeta schmardae macrochaeta* Michaelsen, 1899 (= *Duplodicodrilus schmardae*) from Japan and China. Since "*Perichaeta paeta* Gates, 1935: 13" is a mistake for *Pheretima paeta* (= *Metaphire paeta*) from China, thus, the requirements for ICZN (1999: Art. 23.9) reversal of precedence are met and as Sims & Easton (1972: 176) explain: "*Michaelsen made* Perichaeta *Schmarda, 1861 a junior syn. of* Megascolex *which it has remained ever since and perhaps should continue to do so for reasons of nomenclatural stability, although non-occupied and still available*".

Eudrilidae revision and division to sub-families

African Eudrilidae Claus, 1880 is perhaps the most developed family with special euprostates receiving the sperm ducts and with ovaries closely connected to modified spermathecal openings that allow possibility of direct, internal fertilization of eggs (e.g. Sims 1969). Current sub-families are Eudrilinae Claus, 1880 with calciferous glands and testes enclosed in sperm reservoirs or Pareudrilinae Beddard, 1894 that has calciferous glands absent or modified from the usual and free testes. Taxa that have lapsed or been overlooked are Tribe Teleudrilini Michaelsen, 1891: 57 (type *Teleudrilus ragazzii* Rosa, 1888) plus monospecific Hippoperidae Taylor, 1949 that was erected for *Hippopera nigeriae* Taylor, 1949, supposedly distinguished by a second pair of male pores and mostly ignored since (cf. Gates 1959). Here a new sub-family is advanced.

Eudrilidae Claus, 1880

Sub-family Polytoreutinae sub-fam. nov.

Diagnosis. Eudrilidae with lumbricine setae, holoic nephridia, oesophageal gizzard and calciferous glands present. Male pores with euprostates opening midventrally in or near segment 17. Spermathecal pores also midventral, typically behind the male pores.

Types. *Polytoreutus* Michaelsen, 1890 and *Polytoreutus coeruleus* Michaelsen, 1890: 24 (genus misspelled ‘Polytoreutes’ by Benham, 1890). See Fig. 3.

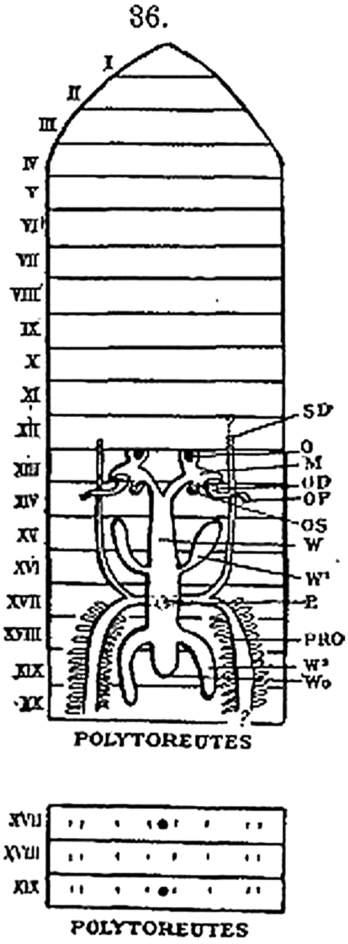


Figure. 3. *Polytoreutus* diagram (misspelt POLYTOREUTES) from Benham (1890: fig. 36)

Distribution. East and Central Africa. Csuzdi (2012) databases *ca.* 40 species of *Polytoreutus*. Compliance of similar genera will be considered on their particulars.

Remarks. This sub-family belongs to the section of the family characterized by unpaired, midventral male (and spermathecal pores) grouped under the name “Teleudrilinen” by Michaelsen (1891: 41) that he defined (according to Beddard: 265 as tribe Teleudrilini) thus: “*Die Teleudrilinen sind meganephridische, mit 4 Borsten-paar Reihen ausgestattete Terricolen, die eine einzige ventral-mediane männliche Geschlechtsöffnung auf oder am 17 Segment und eine einzige ventral-mediane Samentaschenöffnung hinter der Intersegmentalfurche 10/11 besitzen”*. Although he included *Polytoreutus* in his list of genera (Michaelsen, 1891: 55), he later abandoned the group and, moreover, the type-genus definitions of *Teleudrilus* (from Michaelsen, 1900: 411) has male pore in 19 preceded by spermathecal pore in 13/14.

Especially unique in Polytoreutinae and *Polytoreutus* is having the spermathecal pore behind the male pores, possibly as the most advanced development from the usual paired situation and with the spermathecal pores in front of the male pores. Whether all other eudrilids having midventral reproductive pores should be included at this time is uncertain as, for example, in *Buettneriodrilus* Michaelsen, 1897 like in *Teleudrilus* these typically precede the male pores. Other similar genera are reviewed by Owa (1998).

A similar genus is *Hyperiodrilus* Beddard, 1890: 563 that has intestinal as well as or instead of the usual oesophageal gizzard; it has about a dozen species (plus other species of synonyms *Heliodrilus* Beddard, 1890: 627; *Alvania* Beddard, 1893 and *Iridodrilus* Beddard, 1897) with erstwhile synonym *Segunia* Sims, 1985. Inclusion of these latter two genera, plus those of Segun (1980) [*viz. Parapolytoreutus* and *Digitodrilus* (= *Tubiscolex* Michaelsen, 1935) see also Owa (1998)] is also uncertain at present despite them sharing midventral male and spermathecal pores as indeed do the Pareudrilin *Eudriloides* Michaelsen, 1890 and *Libyodrilus* Beddard, 1891, etc., to mention just a few genera. Genus *Keffia* Clausen, 1963 sometimes has spermathecal pores behind male pores but this location may be independently acquired and, since these are paired, it is thus non compliant.

The question of restoration of the prior Teleudrilinae in place of Polytoreutinae remains uncertain and further family refinement is obviously required, although some support for this new sub-family is provided by preliminary molecular studies. Pop *et al.* (2005: fig. 3) showed some separation of *Polytoreutus* spp. from *Polytoreutus montsikenyae* Beddard, 1902 and James & Davidson's (2012: fig. 4 cf. Fig. 3) Eudrilidae groupings had one composed of *Polytoreutus finni* Beddard, 1893 plus an "*Hyperiodrilus* sp." separate from an "*Eudriloides* sp.", although the other *Hyperiodrilus* specimen (*H. africanus*) appeared unresolved, possibly due to misidentification of specimens. Unfortunately, the types were not tested for Eudrilidae [type: *Eudrilus decipiens* Kinberg, 1867 a junior synonym of the common 'African Night Crawler' *Eudrilus eugeniae* Kinberg, 1867 that is readily available globally as a vermicomposting species, e.g. Blakemore (1994a) provides its first Australian records, and full characterization and distribution are in Blakemore, 2012b] nor for *Polytoreutus coeruleus* type of Polytoreutinae. James & Davidson (2012: 225) incorrectly state suboesophageal sacs are always unpaired in Eudrilidae (cf. Segun, 1980).

Evaluation of James & Davidson's (2012) molecular phylogeny

Whilst acknowledging the research supported in part by US National Science Foundation Awards (DEB- 0516439 and 0516520) funded collection trips "*in the USA, France, Spain, Andorra, Romania, Hungary, Gabon, Kenya, South Africa, Madagascar, Thailand, the Philippines, Brazil, Fiji, the Antilles, Japan, and Australia*", despite this travel, a major difficulty with the study by James & Davidson (2012) is a general lack of representative material and the non-identification of many of the specimens providing the samples: these merely being categorized to a genus or to a presumably *a priori* family allocation (e.g. "Ocnerodrilidae sp", "A-canthodrilidae sp.", "Almidae sp."). Giving the impression of progressing revision of the major families they yet failed to test the key type-genera, admitting (James & Davidson, 2012: page 226) that "*we did not have material from the diverse 'Octochaetidae' of the Indian subcontinent*", and "*we did not have them represented in the taxon sample* " [referring to holoic genera excluded from Benhamiinae *vide infra* but they mistakenly include meroic *Wegeneriona* as an holoic taxon], and "*leave the status of the Exxidae until such a time as* someone *actually finds a specimen of* Exxus…", and (on page 227) a "*lack of material from South Asia, where there are many Megascolecidae, including the type genus* Megascolex". For Acanthodrilidae (page 226) they accept their "*lack of data*" and only give two examples for their analysis. However, neither of these two samples may be reliable as one is identified only as "*0828 Acanthodrilidae sp. Madagascar*" and the other as "*0904 Diplotrema sp. Australia*". Whilst Malagasy Acanthodrilidae are not particularly well represented and are far from the New Caledonian type-locality, some of those few species known there are reported in Razafindrakoto *et al.* (2010) and Blakemore (2012b). But by being unidentified, not even to genus, this specimen must be suspect since all other specimens in their study labelled "*Acanthodrilidae*" actually belong to Octochaetidae/Banhamiinae or to Exxidae. As for their "*Diplotrema* sp.", this is an Australian/New Zealand genus frequently misidentified in the past from America and/or Africa (often as its junior synonym *Eodrilus* Michaelsen, 1907) – it is again unfortunate that the specimen was not identified to species at least, since some supposed Australian members were actually octochaetids.

For example, several native *Diplotrema* spp. described from Queensland were subsequently found to belong to *Octochaetus*, e.g. *Octochaetus ambrosensis* (Blakemore 1997) and those formerly in *Neodiplotrema* Dyne, 1997 (nom. preocc. Yamaguchi, 1938 = *Adroitplema* Blakemore, 2006 nom. nov.) are all now in synonymy of *Octochaetus* Beddard, 1893. The preoccupied genus *Neodiplotrema* had been used in molecular phylogeny (quoted for instance by Csuzdi, 2010a), as evidence that Acanthodrilidae was separate from Octochaetidae although this genus was recognized (by Blakemore, 2000: 46; 2004: 175; 2008b, 2009, 2012a: 129) as a junior synonym of *Octochaetus* – the type-genus of the family – and may be more properly used in such limited phylograms to defend retaining the Octochaetidae.

James & Davidson (2012: 227) also misinform on Australasian taxonomy when they mention New Zealand *Megascolides* and *Spenceriella* having "*tongue-shaped prostates*" because, firstly, *Spenceriella* Michaelsen, 1907 was determined by Blakemore (2000) to be a junior synonym of *Anisochaeta* Beddard, 1890 and, secondly, *Megascolides* M'Coy, 1878 members just have tubular prostates. Those taxa from New Zealand described with "*tongue-shaped*" prostates properly belong in a restored genus *Tokea* Benham, 1904, which was recently resolved by Blakemore (2012a: 120). They also recited "*Terriswalkerius* sp." (sic - mispelling) that actually belongs in either of prior *Diporochaeta* Beddard, 1890 or *Perionychella* Michaelsen, 1907 or in *Reflechtodrilus* Blakemore, 2005 as demonstrated by Blakemore (2000, 2008b, 2011, 2012a). Many similar problems in the previous molecular phylogeny by Buckley *et al.* (2011) – oft cited by James & Davidson (2012) for support – were already addressed in Blakemore (2011: 25, 42–43) where it was noted "*Thus, rather than clarity we get further confusion and, as with several previous molecular phylogenetic works, the only errors in their otherwise informative study are the names.*"

Species of polygicierate Exxidae Blakemore, 2000 that share the type's meroic nephridia plus 'non-tubular' prostates (rather than *"racemose"* as misrepresented by James & Davidson, 2012: 215, 226) are here restored as noted above even though they left this problem for "*someone*" else to fix. Their sample, identified with *Neotrigaster rufa* (= *Exxus*?), was found to be most closely related molecularly to a *Diplocardia* sp. (*D. conoyeri* Murchie, 1961). This in no way detracts from the inclusion of the former taxon in the family Exxidae since its acquisition of non-tubular prostates and meronephy is probably via precursors that would be attributable to a restored Diplocardi-inae/-idae as Blakemore (2005, 2008a) indeed proposed that gains some support from the study by Pop *et al.* (2005). James & Davidson (2012: 215, 222) prelabel and conclude these two taxa (i.e., non-type representatives of Diplocardiinae and of Exxidae) as "*ACANTHODRILIDAE*".

Surprisingly for an authority who claims familiarity with the debate, James (1991) seemed to have missed the essential similarity of *Trigaster rufa* Gates, 1962 (mislabelled as "*T. rufa Gates, 1954*" www.jstor.org/stable/3226771), the type-species of his *Neotrigaster* James, 1991, that was placed by Blakemore (2005) as a probable junior synonym to the genus *Exxus* Gates 1959 – the establishment of which was the reason for Gates's (1959) revision of Megascolecoidea families that of itself caused so much unnecessary confusion since. James & Davidson (2012), as with James (1991), fail to even cite Gates (1959).

Their only novel contribution was erection of Pontoscolecidae James & Davidson, 2012: 227 that, unfortunately, is an objective junior synonym with same type as Urochaetidae Beddard, 1891 – long since combined, along with Geoscolecidae Rosa, 1888 and Rhinodrilidae Benham, 1890, under Glossoscolecidae Michaelsen, 1900: 420.

It is of note that Beddard's papers were "*Read 19th February and 19th March 1890*" and if he had distributed separates ('preprints') at that time it would take precedence under ICZN (1999: art. 21.8.1), and although date for Rhinodrilidae Benham, 1890 is not obvious, on page 280 Benham adds a postscript dated "*April 30th*". Furthermore, Geoscolecidae Rosa, 1888 (corr. Geoscolicidae Beddard, 1895: 622) has overall priority over Glossoscolecidae Michaelsen, 1900 although *Geoscolex* Leuckart, 1841 is now held a junior synonym of *Glossoscolex* Leuckart, 1835. Unless the breaking up of the classical Glossoscolecidae Michaelsen, 1900 is not warranted, there may then be an argument for restoration of reconstituted (sub-)families: Urochaetidae, Geoscolicidae and Rhinodrilidae as by Benham (1890: 221) and Beddard (1891, 1895: 626). Possibly another sub-family is merited for perichaetine *Periscolex* Cognetti, 1905 (as 'Periscolicinae'). Shuffling of these groups has been unnecessary in the century following Michaelsen's (1900) excellent review that admirably provided an ideal for ICZN aims of "*Standards, sense and stability for animal names*". Work is yet required to fully resettle this important family group from the Neotropics.

Despite their conclusion of separation of *Biwadrilus bathybates* (Stephenson, 1917) from Criodrilidae, only partial sequence data (James & Davidson, 2012: 225) was presented for the widespread and common type-species of the family, *Criodrilus lacuum* Hoffmeister, 1845, and no morphological differentiation was provided at all. Blakemore (2007b) dismissed the distinguishing characteristic of Biwadrilidae of a supposed 'lateral line' as found in a fish, leaving only its distinctive male pores in 13. The lateral line was a figment and having male pores varying from segment 13 to 15 is entirely permissible in genus Lumbricidae. As Blakemore (2007b) stated: "*Justification for separation off of Biwadrilidae (or* Biwadrilus*) on this character now seems invalid (cf. Sims, 1980). Moreover, Stephenson (1930: 911) remarking on his* Criodrilus bathybates *under Criodrilinae further says: "the forward shifting of the male pores is paralleled in Eiseniella.""* DNA barcode data (COI gene) from topotypes of *Biwadrilus bathybates* are provided in the Appendix to help confirm identity of this species and thus the resolution of the family.

Regarding Benhaminae revision as noted above, James & Davidson (2012: 226) further say: "*Blakemore (2005) considers this inclusion* [of meroic genera in an holoic Acanthodrilidae] *by Csuzdi 'unacceptable' but gives no reasons for preferring the condition of the nephridia over the condition of the calciferous glands as indicators of phylogeny*." To clarify, the rather obvious reason is that when we follow the ICZN code it is the condition found in the representative type of the type-genus that defines the family and it is a fundamental flaw to consider or report otherwise. Thus only holoic species strictly belong in holoic genera and only holoic genera belong in Acanthodrilidae; meroic genera belong elsewhere (in present or proposed families) albeit nephridia are secondary to the condition of the reproductive organization as is consistently shown by Michaelsen (1900, 1907) and by Blakemore (2000, 2005) (and intuitively in Plisko, 2013: tab. 2). Also, the presence or absence of gizzards and calciferous glands has long been recognized as of lesser importance since they may be more adaptive due to the "*well known dependence of the conformation of the alimentary tract on food and environment*" accorded by Stephenson (1930: 720).

As further justification, a recent new African family Tritogeniidae Plisko, 2013 is separated from Microchaetidae Beddard, 1895 by virtue of its meroic nephridia, although she defines it (Plisko, 2013: 79) as "*meroic; two or more small nephridia per segment*" meaning probably 'meroic: two or more *pairs of* small nephridia per segment'. Having non-holoic nephridia is the same reason why (Indo-Australasian?) Octochaetidae is separated from Acanthodrilidae, again giving support to the reasonable separation of the latter two families with the proviso, as proposed by Blakemore (2005, 2008a) that polygiceriate Diplocardi-inae/idea be restored for North American acanthodrilids as per Michaelsen (1900). If this were the case, then relationship and origin of the American octochaetids (cf. Trigastrinae) is likely with this group as, in its turn, would be the Caribbean Exxidae Blakemore, 2000.

James & Davidson (2012: 226) conclude "*The problematic Acanthodrilidae, Megascolecidae and Octochaetidae*" with the speculation that: "*It seems simpler to afford racemose prostates less weight, in recognition that evolution of complex prostates from simple ones* [which they, like Gates and Sims before, misconstrue as "*non-racemose*"] *has taken place several times in the history of megascolecoid earthworms*." Albeit this particular argument relates more to Exxidae (see Blakemore, 2005, Introduction and Fig. 1 above), James & Davidson (2012: 227) did finally agree with Blakemore's (2000) classification of the Acanthodrilidae and Megascolecidae. Consistently, Blakemore (2000, 2005, 2008a) had explained that the morphological division is not between tubular and racemose prostates, rather it is between tubular and *non-tubular*, i.e., any derivation from the ancestral (plesiomorphic) tubular prostate form. Thus, Blakemore's (2000) revision was well founded since it endorsed the views of Johann Wilhelm Michaelsen (1860–1937) and John Stephenson (1871–1933), the two pillars of Classical earthworm studies, when

Michaelsen (1907a: 160) divided his Megascolecinae *s. stricto* primarily on the basis firstly of either tubular or non-tubular prostates, and secondly on holoic or meroic nephridia, and Stephenson (1923: 7, 316) when he said: "*The sexual organs are the most important of all for systematic purposes*", and "*..one of the great features in the evolution of the Megascolecinae has been the change in the prostate; and if this in not to be marked in our scheme of classification, the scheme will be comparatively useless; it will certainly fail to indicate what it ought*".

REFERENCES

BAHL, K. N. (1949): Structure, development and physiology of the nephridia of Oligochaeta. Part VIII. *Biological reviews of the Cambridge Philosophical Society*, 22(2): 109–147.

BEDDARD, F. E. (1891): The classification and distribution of earthworms. *Proceedings of the Royal Physical Society of Edinburgh*, 10: 325–290.

BEDDARD, F. E. (1894): A Contribution to our Knowledge of the Oligochæta of Tropical Eastern Africa. *Quarterly Journal of Microscopical Science*, 1894: 201–270.

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

BEDDARD, F. E. (1901): Contributions to the knowledge of the structure and systematic arrangement of earthworms. *Proceedings of the Zoological Society of London*, 70(2): 187–206.

BENHAM, W. B. (1890): An attempt to classify earthworms. *Quarterly Journal of Microscopical Science*, 31(2): 201–315.

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

BLAKEMORE, R. J. (1994b): A review of *Heteroporodrilus* from south-east Queensland (Megascolecidae: Oligochaeta). *Memoirs of the Queensland Museum*, 37(1): 19–39.

BLAKEMORE, R. J. (1997): Two new genera and some new species of Australian earthworms (Acanthodrilidae, Megascolecidae: Oligochaeta). *Journal of Natural History*, 31: 1785–1848.

BLAKEMORE, R. J. (2000): *Tasmanian Earthworms*. CD-ROM Monograph with Review of World Families. 'VermEcology', PO BOX 414 Kippax 2615. Canberra, 800 pp.

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

BLAKEMORE, R. J. (2005): Whither Octochaetidae? – A review of its family status (Annelida: Oligochaeta). In. POP, A. A. & POP V. V. (Eds.) *Advances in Earthworm Taxonomy II*. Proceedings IOTM2, Cluj University Press, Romania, p. 63–84.

BLAKEMORE, R. J. (2006a): Revised checklist of the Family Exxidae Blakemore, 2000. In. KANEKO, N & ITO, M. (Eds.) *A Series of Searchable Texts on Earthworm Exo-taxonomy.* CD-ROM published by YNU in accordance with ICZN (1999).

BLAKEMORE, R.J. (2006b): Revised Key to Worldwide Earthworm Families from Blakemore (2000). In. KANEKO, N & ITO, M. (Eds.) *A Series of Searchable Texts on Earthworm Exo-taxonomy.* CD-ROM published by YNU in accordance with ICZN (1999).

BLAKEMORE, R. J. (2007a): Checklist and phylogeny of Exxidae Blakemore, 2000 (Oligochaeta). *European Journal of Soil Biology*. 43: s9–s11.

BLAKEMORE, R. J. (2007b): Review of Criodrilidae (Annelida: Oligochaeta) including *Biwadrilus* from Japan. *Opuscula Zoologica, Budapest,* 37: 11–22.

BLAKEMORE, R. J. (2007c): Origin and means of dispersal of cosmopolitan *Pontodrilus litoralis* (Oligochaeta: Megascolecidae). *European Journal of Soil Biology*, 43: s3–s8.

BLAKEMORE, R. J. (2008a): Phylogeny of Megascolecoidea revisited with recourse to non-molecular means. In. PAVLÍČEK, T & CARDET, P. (Eds.) *Advances in Earthworm Taxonomy III. Proceedings IOTM3*. Ministry of Agriculture, Natural Resources and Environment of the Republic of Cyprus, Nicosia, p. 11–22.

BLAKEMORE, R. J. (2008b): A definitive checklist of Australian earthworms. 72 pp. http://www.annelida.net/earthworm/Australasian%20Earthworms/Aussie%20Earthworms.pdf. (accessed 18. October, 2013)

BLAKEMORE, R. J. (2008c): An updated list of valid, invalid and synonymous names of Criodriloidea (Criodrilidae) and Lumbricoidea (Annelida : Oligochaeta : Sparganophilidae, Ailoscolecidae, Hormogastridae, Lumbricidae, and Lutodrilidae). 80 pp. http://www.annelida.net/earthworm/Lumbricidae.pdf). (accessed 18. October, 2013)

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

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

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

BLAKEMORE, R. J. & PAOLETTI, M. G. (2006): Australian Earthworms as a natural agroecological resource. *Annals of Arid Zone*, 45: 309–330.

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

BORGES, S. & MORENO, A. G. (1991): Nuevas especies del genero *Trigaster* Benham, 1886 (Oligochaeta: Octochaetidae) para Puerto Rico. *Bollettino del Museo di Scienze Naturali,* 9: 39–54.

BORGES, S. & MORENO, A. G. (1992): Redescripción de *Trigaster rufa* Gates, 1962 (Oligochaeta: Octochaetidae. *Caribbean Journal of Science*, 28: 47–50.

CHRISTOFFERSEN, M. L. (2008): A catalogue of the Ocnerodrilidae (Annelida, Oligochaeta) from South America. *Italian Journal of Zoology,* 75(1): 97–107.

CSUZDI, Cs. (1995): A catalogue of Benhamiinae species (Oligochaeta: Acanthodrilidae). *Annalen des Naturhistorischen Museums in Wien*, 97B: 99–123.

CSUZDI, Cs., (1996): Revision der Unterfamilie Benhamiinae Michaelsen, 1897 (Oligochaeta: Acanthodrilidae). *Mitteilungen aus dem Zoologischen Museum in Berlin*, 72: 347–367.

CSUZDI, Cs., (2000): A review of the Benhamiinae collection of the Natural History Museum, London (Oligochaeta: Acanthodrilidae). *Opuscula Zoologica, Budapest*, 32: 51–80.

CSUZDI, Cs. (2010a): *A monograph of the Paleotropical Benhamiinae earthworms (Annelida: Oligochaeta, Acanthodrilidae)*. Pedozoologica Hungarica 6, Hungarian Natural History Museum, Budapest, 348 pp.

CSUZDI, Cs. (2010b): Review of the Paleotropical Neogastrini earthworms (Oligochaeta, Acanthodrilidae, Benhamiinae) with description of two new genera. *Acta Zoologica Academiae Scientiarum Hungaricae*, 56: 103–118.

CSUZDI, Cs. (2012): Earthworm species, a searchable database. *Opuscula Zoologica, Budapest*, 43: 97–99.

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

EISEN, G. (1894): On California Eudrilidae. *Memoirs of the California Academy of Sciences*, 2(3): 21–62.

FRIEND, H. (1911). New annelids. *The Zoologist (Series 4)*, 15: 273–275.

GATES, G. E. (1942): Notes on various peregrine earthworms. *Bulletin of the Museum of Comparative Zoology*, 89(3): 61–144.

GATES, G. E. (1959): On a taxonomic puzzle and the classification of the earthworms. *Bulletin of the Museum of Comparative Zoology, Harvard* 121(6), 229–261.

GATES, G. E. (1960): On Burmese earthworms of the Family Megascolecidae. *Bulletin of the Museum of Comparative Zoology,* 123(6): 204–282.

GATES, G. E. (1962): On a new species of the earthworm genus *Trigaster* Benham, 1886 (Octochaetidae). *Brevoria*. 178: 1–4.

GATES, G. E. (1972): Burmese Earthworms: An Introduction to the Systematics and Biology of Megadrile Oligochaetes with Special Reference to Southeast Asia. *Transactions of the American Philosophical Society*, 62(7): 1–326.

GATES, G. E. (1979): A new genus of larger ocnerodrilid earthworms in the American hemisphere. *Megadrilogica*, 3: 162–164.

GRANT, V. (2003): Incongruence between cladistic and taxonomic systems. *American Journal of Botany*, 90(9): 1263–1270.

ICZN, (1999): International Code of Zoological Nomenclature. 4th edn. Published by the International Trust for Zoological Nomenclature, c/o Natural History Museum, Cromwell Road, London, SW7 5BD, UK, 306 pp.

JAMES, S. W. (1991): New species of earthworms from Puerto Rico, with a redefinition of the genus *Trigaster*. *Transactions of American Microscopical Society*, 110(4): 337–353.

JAMES, S. W. (2004) Earthworms (Clitellata, Acanthodrilidae) of the mountains of Eastern Jamaica. *Organisms, Diversity & Evolution*, 4: 277–294.

JAMES, S. W. & DAVIDSON, S. (2012): Molecular phylogeny of earthworms (Annelida : Crassiclitellata) based on 28S, 18S and 16S gene sequences. *Invertebrate Systematics*, 26(2): 213–229.

LEE, K. E. (1959). *The Earthworm Fauna of New Zealand.* New Zealand Department of Scientific and Industrial Research Bulletin No. 130, Wellington, 486 pp.

MAYR, E. (1998): Two empires or three? *Proceedings of the National Academy of Sciences of the United States of America*, 95(7): 9720–9723.

MAYR, E. & BOCK, W. J. (2002): Classifications and Other Ordering Systems. *Journal of Zoological Systematics and Evolutionary Research*, 40: 1–25.

MICHAELSEN, W. (1891): Beschreibung der von Herrn Dr. Fr. Stuhlmann auf Sansibar und dem gegenüberleigenden Festlandes gesammelten Terricolen. I. Übersicht über die Teleudrilinen. II. Die Terricolen-Fauna Afrikas. *Mitteilungen aus dem Naturhistorischen Museum in Hamburg*, 9: 3–72.

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

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

MICHAELSEN, W. (1910): Oligochäten von verschiedenen Gebieten. *Mitteilungen aus dem Naturhistorischen Museum in Hamburg,* 27: 47–169.

MICHAELSEN, W. (1933): Die Oligochätenfauna Surinames, mit Erörterung der verwandschaftlichen und geographischen Beziehungen der Octochätinen. *Tijdschrift der Nederlandsch Dierkunde Vereeniging, Leiden*, 3(3): 112-131.

OWA, S. O. (1998): Taxonomy of five polytoreutoid earthworm genera and three new species from Nigeria. *Durban Museum Novitates*, 23: 29–38.

PICKFORD, G. E. (1937): *A monograph of the acanthodriline earthworms of South Africa*. Cambridge, W. Heffer &. Sons, 612 pp.

PLISKO, J. D. (2013): A new family Tititogeniidae for the genera *Tritogenia* and *Michalakus*, earlier accredited to the composite Microchaetidae (Annelida: Oligochaeta). *African Invertebrates*, 54: 69–92.

POP, A. A., CSUZDI, CS. & WINCK, M. (2005): Remarks on the molecular phylogeny of Crassiclitellata families using the mitochondrial 16S rDNA gene (Oligochaeta, Opisthopora). In. POP, V. V. & POP, A. A. (Eds.) *Advances in earthworm taxonomy II, (Annelida: Oligochaeta)*, Cluj-Napoca, Romania: Cluj University Press, p. 143–154.

RAZAFINDRAKOTO M., CSUZDI CS., RAKOTOFIRINGA S. & BLANCHART E. (2010): New records of earthworms (Oligochaeta) from Madagascar. *Opuscula Zoologica, Budapest*, 41(2): 231–236.

REYNOLDS, J. W. & COOK, D. G. (1993): *Nomenclatura Oligochaetologica: Supplementum Tertium.* Lindsey, Blewett Press, 37 pp.

RIGHI, G. (1984): On a collection of Neotropical Megadrili Oligochaeta I. Ocnerodrilidae, Acanthodrilidae, Octochaetidae, Megascolecidae. *Studies on Neotropical Fauna and Environment,* 19(1): 9–31.

SEGUN, A. O. (1980): More eudriline earthworms from eastern Nigeria. *Journal of Natural History*. 14(2): 271–281.

SIDDALL, M. E., APAKUPAKUL, K, BURRESON, E. M., COATES, K. A., ERSÉUS, C, GELDER, S. R., KÄLLERSJÖ, M, & TRAPIDO-ROSENTHAL, H. (2001): Validating Livanow's Hypothesis: Molecular Data Agree that Leeches, Branchiobdellidans and *Acanthobdella peledina* form a Monophyletic Group of Oligochaetes. *Molecular Phylogenetics and Evolution*, 21: 346–351.

SIMS, R. W. (1969): Internal fertilization in Eudrilid earthworms with the description of a new Pareudriline genus and species (Oligochaeta) from Ghana. *Journal of Zoology London*, 157: 437–447.

SIMS, R. W. (1978): Megadrilacea (Oligochaeta). *Monographiae Biologicae*, 31: 661–676.

SIMS, R. W. (1980): A Classification and the distribution of earthworms, suborder Lumbricina (Haplotaxida: Oligochaeta). *Bulletin of the British Museum (Natural History) Zoology,* 39: 103–124.

SIMS, R. W. & EASTON, E. G. (1972): A numerical revision of the earthworm genus *Pheretima* auct. (Megascolecidae: Oligochaeta) with the recognition of new genera and an appendix on the earthworms collected by the Royal Society North Borneo Expedition. *Biological Journal of the Linnean Society*, 4: 169–268.

STEPHENSON, J. (1917): On a collection of Oligochaeta from various parts of India and further India. *Records of the Indian Museum*, 13: 353–416.

STEPHENSON, J. (1920): On a collection of Oligochaeta from the lesser known parts of India and from Eastern Persia. *Memoirs of the Indian Museum*, 7(3): 191–262.

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

STEPHENSON, J. (1930): *The Oligochaeta*. Clarendon Press, Oxford, 978 pp.

TAYLOR, A. G. (1949): A West African earthworm, *Hippopera nigeriae*, belonging to a new family Hippoperidae. *Proceedings of the Zoological Society, London*, 119: 703–710.

TIMM, T. (2005): Some misused names in aquatic Oligochaeta. In. POP, V.V. & POP, A.A. (Eds.) *Advances in earthworm taxonomy II*, *(Annelida: Oligochaeta)*, Cluj-Napoca, Romania: Cluj University Press, p. 53–60.

Appendix.

DNA COI barcode of *Biwadrilus bathybates* (Stephenson, 1917)

Data courtesy of S. Prosser, N. Ivanova and P. Hebert of Guelph University, Canada with donor specimens now in Tokyo Museum under curatorial care of Dr T. Kuramochi.

BLAST analysis is from http://www.ncbi.nlm.nih.gov/genbank/.

>JET096 |Tokyo specimen An-414.1|Criodrilus_bathybates|COI-5P
AACACTATATTTATTCTTGGCGTATGAGCGGGAATAATTGGGGCTGGAATAAGCCTTCTAATTCGAATTGAGCTAAG
ACAGCCTGGTGCCTTTTTAGGAAGAGACCAACTTTACAATACCATTGTCACAGCCCATGCTTTCATTATAATTTTCTTT
TTAGTGATACCAGTATTTATCGGGGGATTTGGAAATTGATTACTACCTTTAATACTGGGGGCACCTGACATAGCTTTCC
CACGATTAAACAATATAAGATTTTGGCTACTACCCCCATCCCTAATTCTTTTAGTATCTTCAGCTGCAGTTGAGAAGGG
GGCTGGGACTGGATGAACTGTATATCCTCCACTTGCCAGAAACTTAGCCCACGGAGGGCCCTCCGTGGATTTAGCAA
TTTTTTCACTTCACTTGGCTGGAGCCTCCTCCATTTTAGGGGCTATCAATTTTATTACAACTGTAATTAATATACGATGA
AACGGGCTACGCCTAGAGCGAATCCCATTATTTGTTTGAGCCGTAACCATTACAGTTGTTCTGCTACTTCTATCCCTTC
CTGTTCTAGCTGGAGCCATTACTATGCTATTAACAGACCGAAATCTAAATACATCATTTTTTGACCCTGCTGGCGGCG
GTGACCCTGTTCTATACCAACACCTATTT

megaBLAST Max Id. 82% GU014166 Glossoscolecidae sp. [sic] from Brazil (DPEW86596 voucher EW-SJ-867).

>JET098|Tokyo specimen An-414.3|Criodrilus_bathybates|COI-5P
AACACTATATTTATTCTTGGCGTATGAGCAGGAATAATTGGGGCTGGAATAAGCCTTCTAATTCGAATTGAGCTAAG
ACAACCTGGTGCCTTTTTAGGAAGAGACCAACTTTACAATACCATTGTCACAGCCCATGCTTTCATCATAATTTTCTTT
TTAGTGATACCAGTGTTTATCGGGGGATTTGGAAATTGATTACTACCTTTAATACTGGGGGCACCTGACATAGCTTTCC
CACGATTAAACAATATAAGATTTTGGCTACTGCCCCCATCCCTAATTCTTTTAGTATCTTCAGCTGCAGTTGAGAAGGG
GGCTGGGACTGGGTGAACTGTATATCCTCCACTTGCCAGAAACTTAGCCCACGGAGGACCCTCCGTGGATTTAGCAA
TTTTTTCACTTCACTTAGCTGGAGCCTCCTCCATTTTAGGGGCTATCAATTTTATTACAACTGTAATTAATATACGATGA
AACGGGCTACGCCTAGAGCGAATCCCATTATTTGTTTGAGCCGTAACCATTACGGTTGTTCTGCTACTTCTATCCCTTC
CTGTTCTAGCTGGAGCCATTACTATGCTATTAACAGACCGAAATCTAAATACATCATTCTTTGACCCGGCTGGTGGCG
GTGACCCTGTTCTATACCAACACCTATTT

BLASTn comparison JET096 vs. JET098 Id. 646/658 (98%), i.e., slight difference from two samples of topotypic Lake Biwako specimens collected and identified by RJB.

Note. Genbank voucher samples HQ728920 HQ728949 and JF267906 of *B. bathybates* were reported in James & Davidson (2012) for 16S, 18S and 28S genes possibly based on samples sent by the author to Dr S. James in 2006 (see Blakemore, 2007b: 20) although I cannot find their particulars online via GenBank (http://www.ncbi.nlm.nih.gov/genbank/).

Opusc. Zool. Budapest, 2013, 44(2): 129–135

Supplementary description of *Dolicheremaeus distinctus* Aoki, 1982 (Acari: Oribatida: Tetracondylidae) on the basis of Indian specimens

S.G. ERMILOV[1] and S. KALÚZ[2]

[1]*Dr. Sergey G. Ermilov, Tyumen State University, Tyumen 625003, Russia. E-mail: ermilovacari@yandex.ru*

[2]*Dr. Stanislav Kalúz, Section of Ecology, Institute of Zoology, Slovak Academy of Sciences, Bratislava 845 06, Slovakia. E-mail: stanislav.kaluz@savba.sk*

Abstract. The oribatid mite species, *Dolicheremaeus distinctus* Aoki, 1982, is redescribed in details, on the basis of specimens from India. This species is recorded for the first time from India and the Oriental region. An identification key to the Indian *Dolicheremaeus* is given.

Keywords. Oribatida, *Dolicheremaeus*, *D. distinctus*, redescription, key, India

INTRODUCTION

In the course of taxonomic identification of Indian oribatid mites (Acari: Oribatida), we have found three females and one male of the species *Dolicheremaeus distinctus* Aoki, 1982 (Tetracondylidae). This species was described by Aoki (1982) from Southern Japan. Earlier, *D. distinctus* has only been reported from the type locality, consequently this is the first record from India as well as from the Oriental region.

The original description of *D. distinctus* was based on a single holotype, and hence it is incomplete and brief (lacking information on the measurements of morphological structures, leg setation and solenidia, morphology of gnathosoma; only dorsal view of idiosoma and sensillus were illustrated). The main goal of our work is to present a detailed description and illustration of *D. distinctus* on the basis of the Indian specimens found. The second goal of our paper is to present an identification key to the 14 so far recorded Indian *Dolicheremaeus* species (Haq 1978; Chakrabarti *et al.* 1981; Mondal & Kundu 1986; Sanyal & Bhaduri 1986; Sanyal 1990, 1992, 2000; Sengupta *et al.* 1997; Mondal *et al.* 1999; Subías 2004).

MATERIALS AND METHODS

Material examined. Four adult specimens (three females, one male): India, 28°19′32″N 95°57′31″E, Arunachal Pradesh, Hunli vicinity, 1300 m a.s.l., soil, collected by L. Dembický and O. Šauša in 01.06.2012.

Specimens were studied in lactic acid, mounted in temporary cavity slides for the duration of the study, and then stored in 70% alcohol in vials. All body measurements are presented in micrometers. Body length was measured in lateral view, from the tip of rostrum to the posterior edge of ventral plate. Notogastral width refers to the maximum width in dorsal aspect. Formulae of leg setation are given according to the sequence trochanter–femur–genu–tibia–tarsus (famulus included). Formulae of leg solenidia are given (in square brackets) according to the sequence genu–tibia–tarsus.

urn:lsid:zoobank.org:pub:E4C36A59-F917-42B5-91B6-1220C8E83B57
HU ISSN2063-1588 (online), HU ISSN 0237-5419 (print)

Terminology used in this paper follows that of Aoki (1965a, 1967), Wallwork (1962a), Norton & Behan-Pelletier (2009).

TAXONOMY

Genus *Dolicheremaeus* Jacot, 1938

Dolicheremaeus distinctus Aoki, 1982

(Figures 1–19)

Diagnosis. Body size: 498–564 × 265–282. Body surface microgranulate; genital and anal plates with large granules. Rostrum truncated. Prodorsum with longitudinal medial ridge. Interlamellar and notogastral setae of medium length. Sensilli clavate; sensillar head weakly lanceolate. All prodorsal and notogastral condyles present. Apodemes 1 developed. Distance between adanal setae ad_3–ad_3 shorter than ad_2–ad_2. Lyrifissures *iad* located in paraanal position. Formula for leg setae *u*: L–S–S–S.

Measurements. Body length: 498–564 (four specimens). Notogaster width: 265–282 (four specimens).

Integument. Body color yellow-brownish. Surface of body with microgranules (diameter less than 1). Genital and anal plates with larger granules (diameter up to 2). Surface of notogaster and anogenital region foveolate (diameter up to 10).

Prodorsum. Rostrum narrowly truncated (visible in dorso-anterior and ventral views). Anterior part of prodorsum with strong, longitudinal medial ridge (*r*). Rostral (*ro*) and lamellar (*le*) setae long, similar in length (82–90), setiform, thickened, barbed unilaterally. Interlamellar setae (*in*) shorter (32–36), thinner than rostral and lamellar setae, slightly barbed, inserted between bothridia (*bo*). Sensilli (*ss*, 69–77) with bacilliform stalk and weakly lanceolate, indistinctly barbed head. Exobothridial setae (*ex*) shortest on prodorsum (10), straight, thin, smooth, inserted on tubercles antero-laterally to bothridial openings. Medial (*co.pm*) and lateral (*co.pl*) prodorsal condyles rounded distally, located separately.

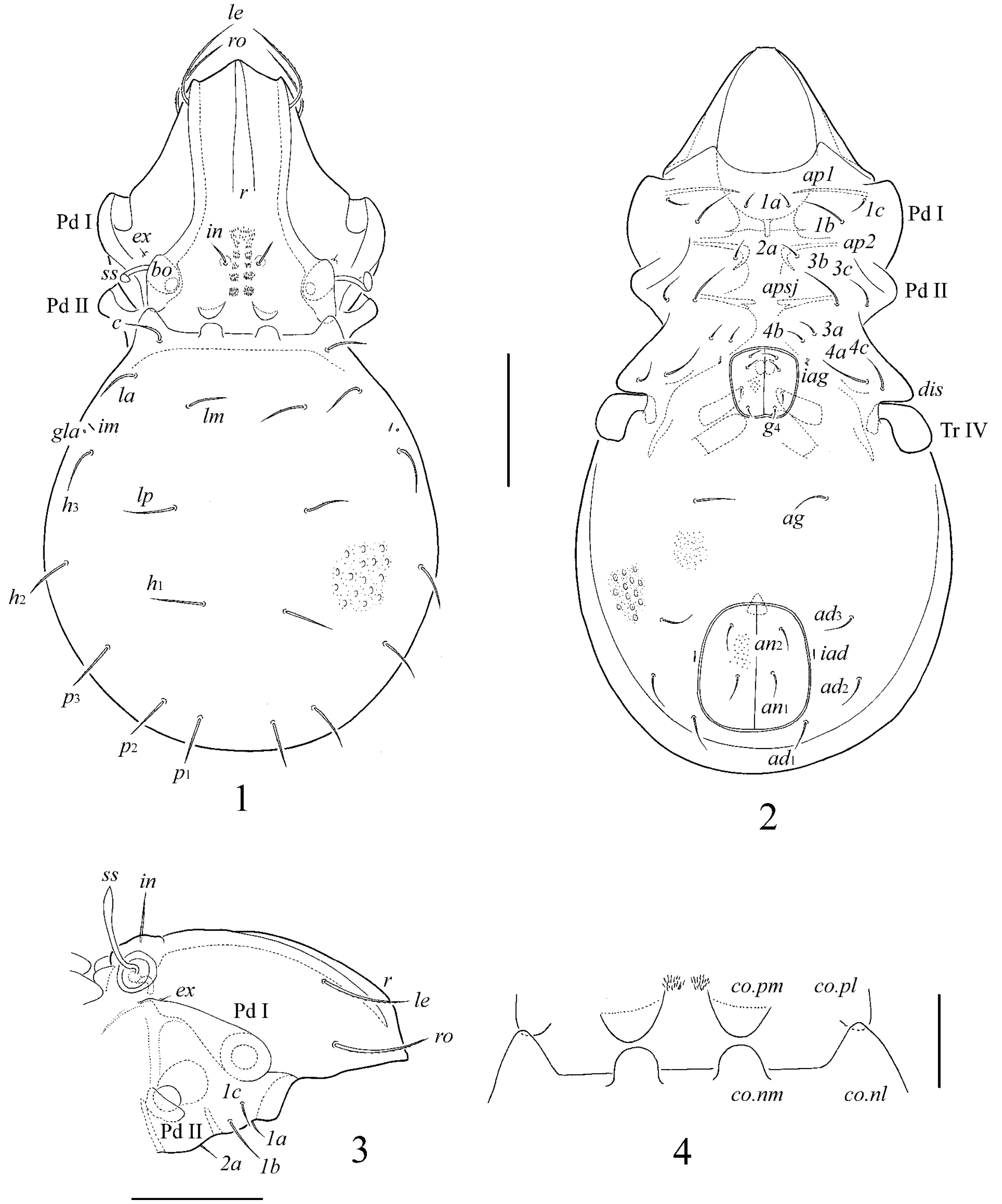
Notogaster. Medial notogastral condyles (*co.nm*) rectangular, weakly rounded distally, located separately. Lateral notogastral condyles (*co.nl*) triangular, blunt-ended. Notogaster with 10 pairs of setae of medium length (102–110), setiform, slightly barbed (visible under high magnification). Distance between setae p_1–p_2 shorter than p_2–p_3. Lyrifissures (*ia*, *im*, *ip*, *ih*, *ips*) and opisthonotal gland openings (*gla*) developed in typical arrangement for *Dolicheremaeus* (see Aoki 1967; Ermilov *et al.* 2010).

Gnathosoma. Subcapitulum longer than wide (102 × 86). Subcapitular setae (*h*, *m*, *a*) similar in length (20), setiform, smooth. Adoral setae and their alveoli not evident. Palps (61) with setation 0–2–0–3–8(+1ω). Solenidion pressed to the palptarsus surface in basal part and distal seta in medio-distal part. Chelicerae (106) with dorsal tooth (*t*) and two barbed setae; *cha* (32) longer than *chb* (16). Trägårdh's organ (Tg) short, conical.

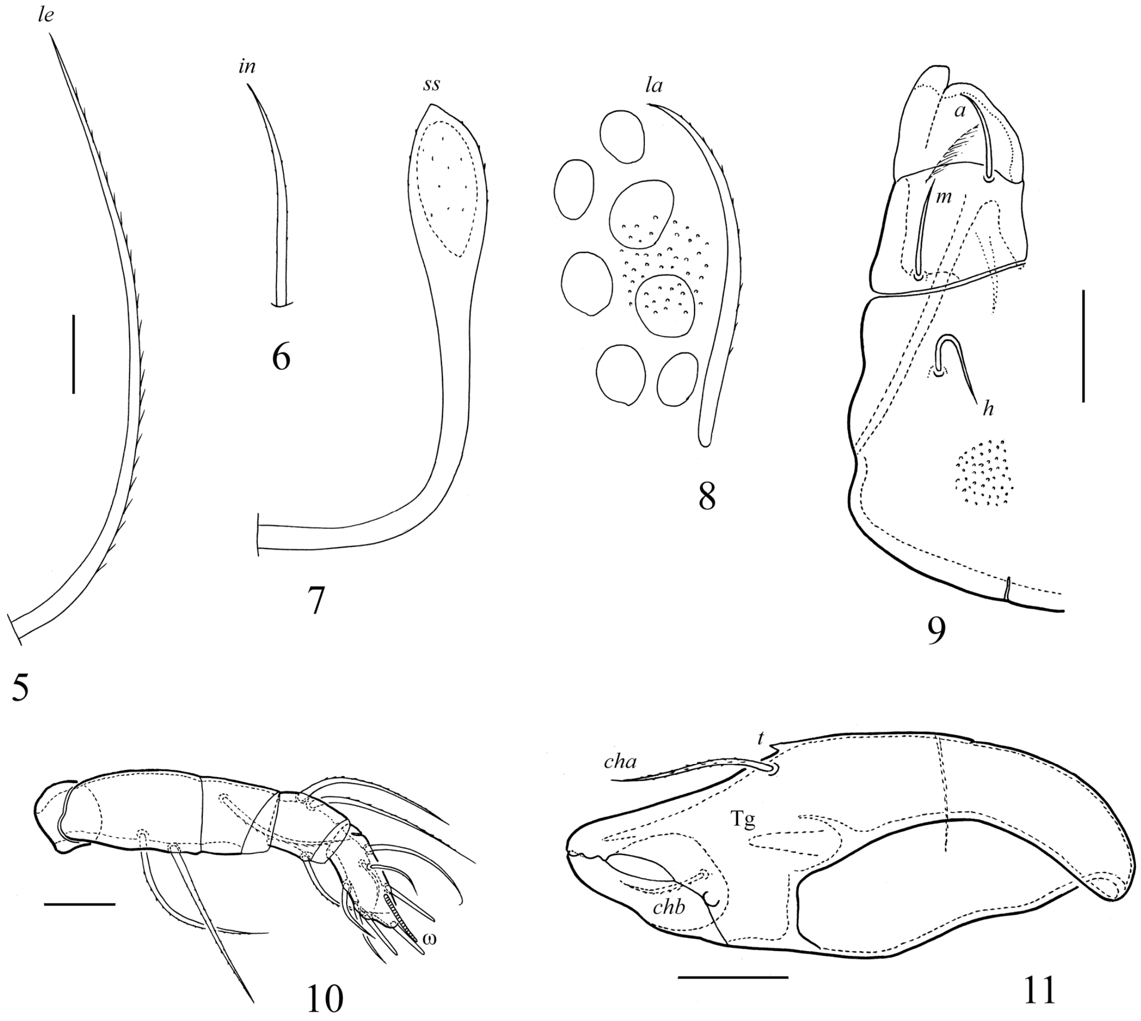
Epimeral and lateral podosomal regions. Apodemes 1 (*ap1*), 2 (*ap2*) and sejugal (*apsj*) distinct, transversally developed. Apodemes 3 absent. Epimeral setal formula: 3–1–3–3. All setae setiform, slightly barbed. Setae *1a*, *1c*, *2a*, *3a*, *4b* (20) shorter than *3c*, *4c* (26–28) and *1b*, *3b*, *4a* (41–45). Pedotecta I (Pd I) and II (Pd II) developed typically for *Dolicheremaeus* (see Wallwork 1962a, Aoki 1967). Discidia (*dis*) triangular, widely blunt-ended.

Anogenital region. Four pairs of genital (g_1–g_4, 8–12), one pair of aggenital (*ag*, 24–28), three pairs of adanal (ad_1–ad_3, 22–26) and two pairs of anal (an_1, an_2, 16–20) setae setiform, slightly barbed. Aggenital lyrifissures (*iag*) clearly visible. Adanal setae ad_1 inserted postero-laterally to the anal plates. Distance between setae ad_3–ad_3 shorter than ad_2–ad_2. Lyrifissures *iad* short, located in paraanal position nearly to anal aperture. Ovipositor (126 × 49) with three lobes (57) and cylindrical distal part (69). Four setae of each lobe setae similar in length (18), thorn-like, smooth. Six coronal setae minute (4).

Legs. Claw of each tarsus smooth. Tarsi without teeth. Morphology of leg segments typical for many *Dolicheremaeus* (see Ermilov *et al.*



Figures 1–4. *Dolicheremaeus distinctus* Aoki, 1982. 1 = Body dorsally (legs not illustrated), 2 = body ventrally (gnathosoma and legs except trochanters IV not illustrated), 3 = prodorsum laterally (gnathosoma and legs I, II not illustrated), 4 = condyles. Scale bar (1–3) 100 µm, (4) 50 µm.



Figures 5–11. *Dolicheremaeus distinctus* Aoki, 1982. 5 = Lamellar seta, 6 = interlamellar seta, 7 = sensillus, 8 = notogastral seta *la*, 9 = subcapitulum ventrally, right half, 10 = palp, 11= chelicera. Scale bar (5–8, 10) 10 µm, (9, 11) 20 µm.

Table 1. Leg setation and solenidia of *Dolicheremaeus distinctus* Aoki, 1982.

Leg	Trochanter	Femur	Genu	Tibia	Tarsus
I	*v′*	*d*, *(l)*, *bv″*	*(l)*, *v′*, σ	*(l)*, *(v)*, φ_1, φ_2	*(ft)*, *(tc)*, *(it)*, *(p)*, *(u)*, *(a)*, *s*, *(pv)*, *e*, ω_1, ω_2
II	*v′*	*d*, *(l)*, *bv″*	*(l)*, *v′*, σ	*l′*, *(v)*, φ	*(ft)*, *(tc)*, *(it)*, *(p)*, *(u)*, *(a)*, *s*, *(pv)*, ω_1, ω_2
III	*l′*, *v′*	*d*, *l′*, *ev′*	*l′*, σ	*(v)*, φ	*(ft)*, *(tc)*, *(it)*, *(p)*, *(u)*, *(a)*, *s*, *(pv)*
IV	*v′*	*d*, *ev′*	*d*, *l′*	*(v)*, φ	*ft″*, *(tc)*, *(p)*, *(u)*, *(a)*, *s*, *(pv)*

Roman letters refer to normal setae (*e* – famulus), Greek letters refer to solenidia. One apostrophe (′) marks setae on anterior and double apostrophe (″) setae on posterior side of the given leg segment. Parentheses refer to a pair of setae.

2010). Formulae of leg setation and solenidia: I (1–4–3–4–16) [1–2–2], II (1–4–3–3–15) [1–1–2], III (2–3–1–2–15) [1–1–0], IV (1–2–2–2–12) [0–1–0]; homology of setae and solenidia indicated in Table 1. Setae and solenidia simple. Famulus (*e*) straight, blunt-ended. Leg setae *u* setiform (L-type) on tarsi I and thorn-like (S-type) on tarsi II–IV.

Remarks. The present Indian specimens of *D. distinctus* are morphologically and in general appearance similar to the Japanese specimens (Aoki 1982). The only slight difference is in the notogastral setae which are poorly barbed in the Indian specimens (versus smooth in Japanese specimens). We believe these differences represent intraspecific (perhaps geographical) variability.

Key to the Indian species of *Dolicheremaeus**

1. Medial prodorsal condyles absent -------------------------- 2
– Medial prodorsal condyles present ------------------------- 3

2. Medial notogastral condyles present; notogastral setae p_1 shorter than p_2; body length: 877–981; distribution: India ---------------------------- **D. geminus** Mondal & Kundu, 1986
– Medial notogastral condyles absent; notogastral setae p_1 and p_2 of same length; body length: 1050; distribution: India ------------------------------------ **D. bengalensis** Sanyal, 1992

3. Medial notogastral condyles absent or very small, poorly visible --- 4
– Medial notogastral condyles present, well developed ----- 6

4. Notogaster with 14 pairs of setae; sensilli rod-like; body length: 940–1060; distribution: Himalaya ---**D. nepalensis** Aoki, 1967 (see Aoki 1967)
– Notogaster with 10 pairs of notogastral setae; sensilli with distinctly developed head --------------------------------------- 5

5. Sensillar head rounded distally; medial notogastral condyles absent; body length: 550; distribution: Malaysia, India----**D. bruneiensis** Aoki, 1967 (see also Mahunka 1991)
– Sensillar head pointed distally; medial notogastral condyles very small, poorly visible; body length: 445–518; distribution: Malaysia, India----**D. sabahnus** Mahunka, 1988

6. Interlamellar and notogastral setae short, *lm* considerably shorter than distance between insertions of *lm* and *lp*-------- 7
– Interlamellar and notogastral setae long or of medium size, *lm* longer or little shorter than distance between insertions of *lm* and *lp* --- 8

7. Prodorsum with longitudinal medial ridge; distance between insertions of the adanal setae ad_3–ad_3 shorter than ad_2–ad_2; body length: 498–564; distribution: Japan, India-- **D. distinctus** Aoki, 1982
– Prodorsum without longitudinal medial ridge; distance between insertions of the adanal setae ad_3–ad_3 longer than ad_2–ad_2; body length: 456–476; distribution: India---------------------- **D. coronarius** Chakrabarti, Bhaduri & Kundu, 1981

8. Sensillar head bifurcate, with two long branches; anterio-medial part of notogaster with two short longitudinal ridges; body length: 809; distribution: India---**D. renukae** Sanyal, 1990
– Sensillar head of other morphology; anterio-medial part of notogaster without ridges-- 9

9. Sensilli spindle-form, with elongate, pointed apex -------10
– Sensilli clavate, without elongate, pointed apex -----------12

10. Notogastral setae h_1 and p_2 with flagellate tip; insertions of notogastral setae *lm* and h_3 located nearly to each other; body length: 945; distribution: India-- **D. keralensis** Sanyal, 1990
– Notogastral setae h_1 and p_2 without flagellate tip; insertions of notogastral setae *lm* and h_3 removed from each other----11

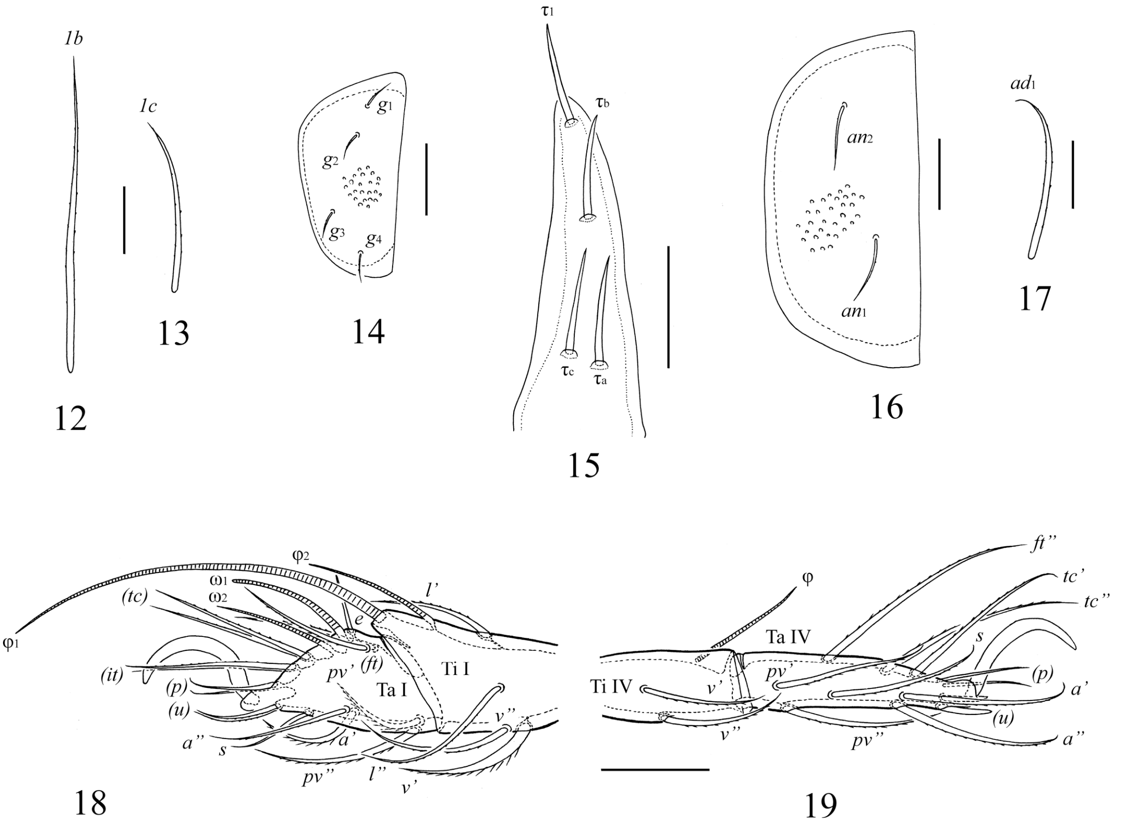
11. Notogastral setae p_1 shorter than p_2; body length: 770–986; distribution: Ghana, India --**D. cuspidatus** (Wallwork, 1962)
– Notogastral setae p_1 and p_2 of same length; body length: 780–884; distribution: India -----------**D. indicus** Haq, 1978)

12. Medial notogastral condyles located postero-laterally to medial prodorsal condyles; body length: 540–560; distribution: India----------- **D. russiae** Mondal, Kundu & Roy, 1999
– Medial notogastral condyles located posteriorly to medial prodorsal condyles ---13

13. Formula for leg setae *u*: L–S–S–S; genital plates striate; body length: 770; distribution: Indonesia, India ---------------
D. hammerae Corpuz-Raros, 2000 (=*D. lineolatus* Hammer, 1981)
– Formula for leg setae *u*: L–L–L–L; genital plates not striate; body length: 1067–1088; distribution: India------------------- **D. himalayensis** Chakrabarti, Bhaduri & Kundu, 1981

*Two species of *Dolicheremaeus*, which also were found in India, *D. auritus* (Aoki, 1965) and *D. speciosus* (Pearce, 1906) are not included in this key, because both have the large pedotectae II (see Aoki 1965b and Pearce 1906), which is not a typical character for *Dolicheremaeus*. In our opinion, further research is needed to establish the taxonomical position of these species.

Acknowledgements – We cordially thank Prof. Dr. Badamdorj Bayartogtokh (National University of Mongolia, Ulaanbaatar, Mongolia) for valuable comments. We gratefully acknowledge L. Dembický and O. Šauša for help in oribatid mite material gathering. We cordially thank Dr. Umukusum Ya. Shtanchaeva (Universidad Complutense de Madrid, Madrid, Spain), Prof. Dr. Luis S. Subías (Universidad Complutense de Madrid, Madrid, Spain) and Prof. Dr. Roy A. Norton (USA) for help with collecting of literature.



Figures 12–19. *Dolicheremaeus distinctus* Aoki, 1982. 12 = Epimeral seta *1b*, 13 = epimeral seta *1c*, 14 = genital plate, right, 15 = lobe of ovipositor, 16 = anal plate, right, 17 = adanal seta ad_1, 18 = tarsus and anterior part of tibia of leg I, left, antiaxial view, 19 = tarsus and anterior part of tibia of leg IV, left, antiaxial view.
Scale bar (12, 13, 17) 10 µm, (14–16, 18, 19) 20 µm.

REFERENCES

AOKI, J. (1965a): A preliminary revision of the family Otocepheidae (Acari, Cryptostigmata). I. Subfamily Otocepheinae. *Bulletin of the National Museum of Natural Science, Tokyo*, 8(3): 259–341.

AOKI, J. (1965b): Oribatiden (Acarina) Thailands. I. *Nature and Life in Southeast Asia*, 4, 129–193.

AOKI, J. (1967): A preliminary revision of the family Otocepheidae (Acari, Cryptostigmata). II. Subfamily Tetracondylinae. *Bulletin of the National Museum of Natural Science, Tokyo*, 10(3): 297–359.

AOKI, J. (1982): New species of oribatid mites from the southern island of Japan. *Bulletin Institute of Environmental Science and Technology, Yokohama National University*, 8: 173–188.

CHAKRABARTI, D. K., BHADURI, A. K. & KUNDU, B. G. (1981): Two new species of the genus *Dolicheremaeus* Jacot (Acari: Oribatei) from West Bengal, India. *Mitteilungen aus dem Zoologischen Museum in Berlin*, 57(1): 15–21.

ERMILOV, S. G., SIDORCHUK, E. A. & RYBALOV, L. B. (2010): A new species of *Dolicheremaeus* (Acari: Oribatida: Tetracondylidae) from Ethiopia. *Systematic and Applied Acarology*, 15(3): 235–243.

HAQ, M. A. (1978): *Some aspects of the taxonomy of oribatid mites from the soil of Kerala*. In. EDWARDS, C. A. & VEERESH, G. K. (eds.) Soil biology and ecology in India. University of Agricultural Sciences, Hebbal, Bangalore, Technical series 22, p. 117–134.

HAMMER, M. (1981): On some oribatid mites from Java. Part I. *Acarologia*, 22(1): 81–99.

MAHUNKA, S. (1988): New and interesting mites from the Geneva Museum LXI. Oribatids from Sabah (East Malaysia) III (Acari: Oribatida). *Revue suisse de Zoologie*, 95(3): 817–888.

MAHUNKA, S. (1991): New and interesting mites from the Geneva Museum LXVIII. Oribatids from Sabah (East Malaysia) IV (Acari: Oribatida). *Revue suisse de Zoologie*, 98(1): 185–206.

MONDAL, B. K. & KUNDU, B. G. (1986): A new species of Otocepheidae (Acari: Oribatei) from Darjeeling, India. *Records of the Zoological Survey of India*, 83(1–2): 91–96.

MONDAL, B. K., KUNDU, B. G. & ROY, S. (1999): A new species of *Dolicheremaeus* (Acari: Oribatei: Otocepheidae) from Darjeeling, India. *Records of the Zoological Survey of India*, 97(1): 187–194.

NORTON, R. A. & BEHAN-PELLETIER, V. M. (2009): *Oribatida*. Chapter 15. In. KRANTZ, G. W. & WALTER, D. E. (eds.) A Manual of Acarology. Texas Tech University Press, Lubbock, p. 430–564.

PEARCE, N. D. F. (1906): On some Oribatidae from the Sikkim Hymalaya. *Journal of the Royal Microscopical Society*, 26: 269–273.

SANYAL, A. K. (1990): On a collection of Oribatei (Acari: Cryptostigmata) from Silent Valley, Kerala (India) with descriptions of six new species. *Records of the Zoological Survey of India*, 86(3–4): 467–483.

SANYAL, A. K. (1992): *Oribatid Mites (Acari)*. In. GHOSH, A. K. (ed.). Fauna of West Bengal. Part 3 (Arachnida and Acari). Zoological Survey of India, Calcutta, p. 213–356.

SANYAL, A. K. (2000): Oribatid mites (Acari: Oribatei*). Zoological Survey of India, State Fauna Series 7: Fauna of Tripura*, 2: 33–112.

SANYAL, A. K. & BHADURI, A. K. (1986): Checklist of oribatid mites (Acari) of India. *Records of the Zoological Survey of India*, 83: 1–79.

SENGUPTA, D., SANYAL, A. K. & CHAKRABARTI, S. (1997): List of oribatid (Acari, Oribatei) mites from the Indian Hymalaya along with some notes. *Hexapoda*, 8(1): 19–35.

SUBÍAS, L. S. (2004): Listado sistemático, sinonímico y biogeográfico de los ácaros oribátidos (Acariformes: Oribatida) del mundo (excepto fósiles). *Graellsia*, 60(número extraordinario): 3–305.

WALLWORK, J. A. (1962a): Some Oribatei from Ghana VIII. The genus *Tetracondyla* Newell 1956 (1st series). *Acarologia*, 4(2): 274–291.

WALLWORK, J. A. (1962b): Some Oribatei from Ghana IX. The genus *Tetracondyla* Newell 1956 (2nd series). *Acarologia*, 4(3): 440–456.

Opusc. Zool. Budapest, 2013, 44(2): 137–159

Collecting sites of soil zoological trips by the Hungarian Natural History Museum and the Hungarian Academy of Sciences to Greece, between 2006 and 2013

D. MURÁNYI[1] & J. KONTSCHÁN[2]

[1]*Dr. Dávid Murányi, Department of Zoology, Hungarian Natural History Museum, H-1088 Budapest, Baross u. 13, Hungary, E-mail: muranyi@zool.nhmus.hu*

[2]*Dr. Jenő Kontschán, Plant Protection Institute, Centre for Agricultural Research, Hungarian Academy of Sciences, H-1525 Budapest, P.O. Boksz 102, Hungary and Department of Zoology and Animal Ecology, Szent István University, Gödöllő, Páter Károly str. 1, H-2100, Hungary.*
E-mail: kontschan.jeno@agrar.mta.hu

Abstract. The Greek locality data of soil zoological collecting sites by the Hungarian Natural History Museum and the Hungarian Academy of Sciences during 8 trips to the Balkans between 2006 and 2013 are enumerated. The localities are given in chronological order. Methods of collectings, and literature where the materials were published given after the locality data; the localities are depicted on the map of Greece. New taxa described on the basis of these materials are also reported.

Keywords. Greece, Balkans, faunistics, collections, localities, type localities, list

INTRODUCTION

Being one of the most complex and species rich area in the Mediterranean, the fauna of Greece is continouosly studied by many nations in most animal groups (Malicky 2005). Traditions of the Hungarian Natural History Museum and the Hungarian Academy of Sciences in exploration of the Greek fauna dates back to the turn of the Twentieth Century, when the first collecting tour by Lajos Bíró was led to Crete (Kuthy 1907). During the last eight years, we continued this research with extensive soil zoological collectings in different part of mainland Greece and the Greek Islands. Of the material gathered during our recent trips, the following groups were hitherto partly or entirely published: Oligochaeta: Lumbricidae (Szederjesi & Csuzdi 2012), Mollusca: Gastropoda (Erőss *et al.* 2011, Fehér *et al.* 2010), Diplopoda (Lazányi *et al,* 2012), Acari: Oribatida (Mahunka & Mahunka-Papp 2010), Uropodina (Kontschán 2010, 2013), Zerconidae (Ujvári 2011), Opiliones (Murányi 2013a), Collembola (Dányi 2010, 2013), Insecta: Odonata (Lopau 2010), Plecoptera (Kovács & Murányi 2008, Kovács *et al,* 2012, Murányi 2007, 2011), Embidiina (Murányi 2013b), Dermaptera (Murányi 2013b), Isoptera (Murányi 2013b), Psocoptera (Sziráki 2013), Trichoptera (Oláh 2010), Diptera (Papp 2010) and Crustacea: Isopoda (Schmalfuss 2008, 2010).

MATERIALS AND METHODS

Herein are enumerated our soil zoological collecting sites and those of our collaborators taken in Greece between 2006 and 2013. These include the data of 8 Balkan trips, wholy or partly to Greece. Sites of the Albanian tours were already published in similar format in Murányi *et al.* (2011). The localities are given in chronological order, as the followings: region, regional unit, mountains, settlement, locality and habitat, date, (locality code used during the collectings), geocoordinate, elevation, methods of collecting, (literature wherethe materials were already published). The localities are depicted on the map of Greece (Figs. 1–4). A list of new taxa described upon the

urn:lsid:zoobank.org:pub:062E043B-507D-4BEA-AC4E-706941A6C5F1
HU ISSN 2063-1588 (online), HU ISSN 0237-5419 (print)

materials collected during the present tours follow the list of localities, with locality numbers referring to their type localities.

LIST OF LOCALITIES

12–15.05.2006 (leg. László Dányi, Jenő Kontschán, Dávid Murányi)

1: Epirus region, Ioannina peripheral unit, Kalpaki, Vellas Monasteri, karst spring and its outlet in secondary macchia forest, 12.05.2006 (2006/96), N39°51.950' E20°37.435', 420 m; singled, beaten, waternet, soil sample (Kontschán 2010, Lopau 2010, Oláh 2010, Schmalfuss 2010, Szederjesi & Csuzdi 2012).

2: Epirus region, Ioannina peripheral unit, Klimatia, rocky grassland E of the village, 12.05.2006 (2006/97), N39°41.717' E20°42.217', 640 m; singled, soil sample (Szederjesi & Csuzdi 2012).

3: Epirus region, Ioannina peripheral unit, Agios Georgios, gallery forest and Tiria River E of the village, 12.05.2006 (2006/98), N39°39.400' E20°33.378', 110 m; singled, beaten, waternet, sweeping net, soil sample (Lopau 2010).

4: Epirus region, Thesprotia peripheral unit, Petrovitsa, gorge below the village, 12.05.2006 (2006/99), N39°33.475' E20°28.130', 315 m; singled, beaten, waternet, soil sample (Mahunka & Mahunka-Papp 2010, Oláh 2010, Szederjesi & Csuzdi 2012, Ujvári 2011).

5: Epirus region, Ioannina peripheral unit, Kato Zalogo, oak forest above the village, 12.05.2006 (2006/100), N39°37.248' E20°31.355', 360 m; singled, soil sample (Lazányi *et al.* 2012, Murányi 2013b, Ujvári 2011).

6: Epirus region, Ioannina peripheral unit, Soulopoulo, Smolitsas River before its confluence with Thyamis River, NE of the village, 12.05.2006 (2006/101), N39°43.053' E20°36.645', 170 m; singled, beaten, waternet (Murányi 2013b, Oláh 2010).

7: Epirus region, Ioannina peripheral unit, Votosoni, stream and its plane tree gallery W of the village, 13.05.2006 (2006/102), N39°45.965' E21°05.838', 660 m; singled, beaten, waternet, soil sample (Fehér *et al,* 2010, Lazányi *et al.* 2012, Murányi 2013b).

8: Epirus region, Ioannina peripheral unit, Metsovo, Spring 'Metzovou 1987', its outlet brook and forest edge W of the city, 13.05.2006 (2006/103), N39°45.277' E21°08.940', 1025 m; singled, beaten, waternet, sweeping net, soil sample (Lopau 2010, Oláh 2010, Ujvári 2011).

9: Epirus region, Ioannina peripheral unit, Metsovo, occupied spring on the central square, 13.05.2006 (2006/104A), N39°46.192' E21°10.993', 1150 m; singled.

10: Epirus region, Ioannina peripheral unit, Metsovo, Metsovo Stream below the city, 13.05.2006 (2006/104B), N39°46.162' E21°11.435', 990 m; singled, beaten, waternet.

11: Epirus region, Ioannina peripheral unit, Metsovo, beech forest above the city, 13.05.2006 (2006/105), N39°46.647' E21°10.207', 1345 m; singled, soil sample (Schmalfuss 2008, Szederjesi & Csuzdi 2012).

12: Epirus region, Ioannina peripheral unit, Metsovo, open brook, beech forest and subalpine grassland at the Katara Pass, 13.05.2006 (2006/106), N39°46.878' E21°09.610', 1400 m; singled, beaten, waternet, sweeping net, sweeping net sample (subalpine grassland and brookshore vegetation).

13: Thessaly region, Trikala peripheral unit, Panagia, clear of a pine forest W of the village, 13.05.2006 (2006/107), N39°48.245' E21°17.762', 1180 m; plancton sample, soil sample (small pond in a clear of a pine forest).

14: Thessaly region, Trikala peripheral unit, Koridallos, oak forest W of the village, 13.05.2006 (2006/108), N39°48.545' E21°19.658', 775 m; singled.

15: Thessaly region, Trikala peripheral unit, Mikani, Mikani River and its plane tree gallery S of the village, 13.05.2006 (2006/109), N39°47.457' E21°31.772', 310 m; singled, beaten, waternet.

16: West Macedonia region, Grevena peripheral unit, Anixi, stream in an oak forest S of the village, 13.05.2006 (2006/110), N39°53.775' E21°33.883', 555 m; singled, beaten, waternet (Lopau 2010).

17: West Macedonia region, Grevena peripheral unit, Eleftherochori, Venetikos River N of the village, 13.05.2006 (2006/111), N40°03.110' E21°28.837', 475 m; singled, beaten, soil sample (Kovács *et al.* 2012: Fig. 23).

18: West Macedonia region, Grevena peripheral unit, Zakas, Venetikos River and its gallery forest NE of the village, 14.05.2006 (2006/112), N40°02.322' E21°17.320', 700 m; singled, beaten, waternet (Kovács *et al.* 2012: Fig. 24, Lazányi *et al.* 2012, Lopau 2010).

19: West Macedonia region, Grevena peripheral unit, Polineri, roadside bush E of the village, 14.05.2006 (2006/113), N40°03.233' E21° 14.530', 875 m; singled.

20: West Macedonia region, Grevena peripheral unit, Aetia, Filippaioi River and its gorge SE of the village, 14.05.2006 (2006/114), N40° 04.465' E21°12.100', 975 m; singled, beaten, waternet, soil sample (Kovács *et al.* 2012: Fig. 22, Szederjesi & Csuzdi 2012).

21: West Macedonia region, Grevena peripheral unit, Smolikas Mts, Samarina, Samarina Stream at the village, 14.05.2006 (2006/115), N40°06.462' E21°01.270', 1410 m; singled, beaten, waternet (Schmalfuss 2008).

22: West Macedonia region, Grevena peripheral unit, Smolikas Mts, Samarina, open stream and alpine grassland N of the village, 14.05.2006 (2006/116), N40°06.988' E21°00.373', 1480 m; singled, beaten, waternet, soil sample.

23: West Macedonia region, Kozani peripheral unit, Neapoli, Aliakmonas River and its shore dunes NE of the city, 14.05.2006 (2006/117), N40°19.953' E21°24.702', 560m; singled, beaten, waternet, soil sample (Kovács & Murányi 2008, Lopau 2010).

24: West Macedonia region, Kozani peripheral unit, Kaloneri, coffee bar E of the village, 14.05.2006 (2006/117A), N40°17.601' E21° 30.071', 660 m; singled.

25: West Macedonia region, Kastoria peripheral unit, Verga, brook in oak forest NE of the village, 14.05.2006 (2006/118), N40°33.452' E21°27.040', 980 m; singled, beaten, waternet, soil sample.

26: West Macedonia region, Kastoria peripheral unit, Vissinea, stream and its alder gallery S of the village, 15.05.2006 (2006/119), N40° 36.532' E21°18.225', 850 m; singled, beaten, waternet, plancton sample (puddles in alder wood), soil sample (Kontschán 2010).

27: West Macedonia region, Florina peripheral unit, Kotas, small, open river and oak forest S of the village, 15.05.2006 (2006/120), N40°39.030' E21°10.655', 835 m; singled, beaten, waternet, sweeping net, soil sample (Mahunka & Mahunka-Papp 2010).

28: West Macedonia region, Florina peripheral unit, Agios Achillios, Prespa Lake and its shore vegetation at the settlement, 15.05.2006 (2006/ 121), N40°48.942' E21°05.075', 855 m; singled, waternet, sweeping net, sweeping net sample (lakeshore dry grassland) (Lopau 2010, Oláh 2010).

29: West Macedonia region, Florina peripheral unit, Karies, spring in an oak forest E of the village, 15.05.2006 (2006/122), N40°45.302' E21° 10.122', 990 m; singled, soil sample.

30: West Macedonia region, Florina peripheral unit, Trigono, stream in a meadow N of the village, 15.05.2006 (2006/123), N40°44.975' E21° 11.913', 995 m; singled, beaten, waternet.

31: West Macedonia region, Florina peripheral unit, Verno Mts, Pisoderi, stream in a beech forest W of the village, 15.05.2006 (2006/124), N40° 47.275' E21°13.445', 1315 m; singled, beaten, waternet, soil sample (Murányi 2007, Papp 2010: Fig. 61, Szederjesi & Csuzdi 2012).

32: West Macedonia region, Florina peripheral unit, Florina, brook in an oak forest N (above) of the city, 15.05.2006 (2006/125), N40°48.042' E21°23.272', 920 m; singled, beaten, waternet, soil sample (Szederjesi & Csuzdi 2012).

30.03–05.04.2007 (leg. Zoltán Erőss, Zoltán Fehér, László Dányi, Jenő Kontschán, Dávid Murányi)

33: Central Macedonia region, Serres peripheral unit, Kerkini Mts, Ano Poroia, stream and springs in a plane tree forest N (above) of the village, 30.03.2007 (2007/3), N41°17.637' E23° 02.187', 510 m; singled, beaten, waternet (Murányi 2013b, Oláh 2010, Szederjesi & Csuzdi 2012).

34: Central Macedonia region, Serres peripheral unit, Neo Petrisi, Strimonas River, grassland and limestone rocks at Loutra Sidirokastrou, 30.03.2007 (2007/4), N41°17.000’ E23°19.994’, 75 m; singled, waternet, soil sample (Murányi 2013b, Ujvári 2011).

35: Central Macedonia region, Serres peripheral unit, Orvilos Mts, Agkistro, thermal spring outlet and ruderal bush at Loutra Angistrou, 30. 03.2007 (2007/5), N41°22.083’ E23°25.651’, 285 m; singled, beaten, waternet.

36: Central Macedonia region, Serres peripheral unit, Orvilos Mts, Agkistro, rocky forest NE of the village, 30.03.2007 (2007/6), N41°23.936’ E23°30.321’, 660 m; singled, beaten, soil sample (Kontschán 2010, Szederjesi & Csuzdi 2012, Ujvári 2011).

37: Central Macedonia region, Serres peripheral unit, Orvilos Mts, Agkistro, forest brook NE of the village, 30.03.2007 (2007/7), N41°23.578’ E23°28.659’, 370 m; singled, beaten, waternet (Lazányi *et al.* 2012, Szederjesi & Csuzdi 2012).

38: Central Macedonia region, Serres peripheral unit, Vrondous Mts, pine forest at the Lailias mountain hut, 30.03.2007 (2007/8), N41°15.310’ E23°35.286’, 1500 m; singled, soil sample (Kontschán 2010, Szederjesi & Csuzdi 2012).

39: Central Macedonia region, Serres peripheral unit, Vrondous Mts, Ano Orini, temporary brook in an open bush W of the village, 30.03. 2007 (2007/9), N41°12.343’ E23°34.477’, 885 m; singled, beaten, waternet.

40: Central Macedonia region, Serres peripheral unit, Vrondous Mts, Angistrou, rocky forest along the Serres–Kato Vrondou road, 30.03.2007 (2007/10), N41°12.319’ E23°38.627’, 925 m; singled (Szederjesi & Csuzdi 2012).

41: Central Macedonia region, Serres peripheral unit, Vrondous Mts, Ano Vrondou, stream and its alder gallery S of the village, 30.03.2007 (2007 /11), N41°14.229’ E23°40.175’, 895 m; singled, beaten, waternet (Lazányi *et al.* 2012).

42: Central Macedonia region, Serres peripheral unit, Vrondous Mts, Ano Vrondou, brook in a beech forest S of the village, 30.03.2007 (2007/ 12), N41°14.722’ E23°40.513’, 915 m; singled, beaten, waternet, soil sample (Szederjesi & Csuzdi 2012, Ujvári 2011).

43: East Macedonia and Thrace region, Drama peripheral unit, Orvilos Mts, Katafyto, stream in alder gallery, and limestone rocks W of the village, 31.03.2007 (2007/13), N41°20.725’ E23° 40.463’, 825 m; singled, beaten, waternet, soil sample (Kontschán 2013, Szederjesi & Csuzdi 2012, Ujvári 2011).

44: East Macedonia and Thrace region, Drama peripheral unit, Orvilos Mts, Katafyto, Katafyto Lake, inflow brook and secondary forest SW of the village, 31.03.2007 (2007/14), N41°20.257’ E23°39.664’, 900 m; singled, beaten, waternet, plancton sample (shallow, boggy shore water of Katafyto Lake), soil sample (Szederjesi & Csuzdi 2012, Ujvári 2011).

45: East Macedonia and Thrace region, Drama peripheral unit, Ochiro, marble quarry S of the village, 31.03.2007 (2007/15), N41°17.080’ E23° 51.314’, 590 m; singled, plancton sample (shallow, temporary puddle in the strip pit).

46: East Macedonia and Thrace region, Drama peripheral unit, Aggitis, Maara Cave, its emergent river and rocky macchia N of the village, 31.03. 2007 (2007/16), N41°13.266’ E23°53.590’, 135 m; singled, beaten, waternet (Lazányi *et al.* 2012).

47: East Macedonia and Thrace region, Drama peripheral unit, Falakro Mts, rocky alpine grassland below the ski centre, 31.03.2007 (2007 /17), N41°17.373’ E24°01.631’, 1350 m; singled, soil sample (Ujvári 2011).

48: East Macedonia and Thrace region, Drama peripheral unit, Falakro Mts, beech forest below the ski centre, 31.03.2007 (2007/18), N41° 17.582’ E24°00.422’, 1185 m; singled, beaten, soil sample (Kontschán 2010, 2013, Szederjesi & Csuzdi 2012, Ujvári 2011).

49: East Macedonia and Thrace region, Drama peripheral unit, Mikroklisoura, stream in a secondary forest W of the village, 31.03.2007 (2007/ 19), N41°22.717’ E24°02.139’, 480 m; singled, beaten, waternet (Lopau 2010).

50: East Macedonia and Thrace region, Drama peripheral unit, Potami, secondary vegetation on the shore of Nestos Lake SW of the village, 31. 03.2007 (2007/20), N41°23.253’ E24°04.825’, 405 m; singled.

51: East Macedonia and Thrace region, Drama peripheral unit, Dit-Rodopi Mts, Mikromilia, forest stream S of the village, 31.03.2007 (2007/ 21), N41°23.326’ E24°10.078’, 430 m; singled, beaten, waternet, soil sample (Kontschán 2010, Ujvári 2011).

52: East Macedonia and Thrace region, Drama peripheral unit, Dit-Rodopi Mts, Sidironero, balcony of Hotel Druades, 31.03.2007 (2007/22), N41°22.115' E24°13.976', 655 m; singled, light trap.

53: East Macedonia and Thrace region, Drama peripheral unit, Dit-Rodopi Mts, Kalikarpos, small gorge with secondary forest N of the village, 01.04.2007 (2007/23), N41°25.682' E24° 13.093', 735 m; singled.

54: East Macedonia and Thrace region, Drama peripheral unit, Dit-Rodopi Mts, Kalikarpos, torrent in beech forest N of the village, 01.04.2007 (2007/24), N41°27.033' E24°14.817', 750 m; singled, beaten, waternet (Szederjesi & Csuzdi 2012).

55: East Macedonia and Thrace region, Drama peripheral unit, Dit-Rodopi Mts, Kalikarpos, stream in beech forest N of the village, 01.04. 2007 (2007/25), N41°27.959' E24°14.389', 870 m; singled, beaten, waternet, soil sample (Szederjesi & Csuzdi 2012, Ujvári 2011).

56: East Macedonia and Thrace region, Drama peripheral unit, Dit-Rodopi Mts, Elatia, Karandere Forest, brook in pine wood NW of the settlement, 01.04.2007 (2007/26), N41°30.378' E24°16.784', 1395m; singled, beaten, waternet (Sziráki 2013).

57: East Macedonia and Thrace region, Drama peripheral unit, Dit-Rodopi Mts, Skalot, brook in a beach forest NE of the village, 01.04.2007 (2007/27), N41°27.004' E24°18.342', 1530 m; singled, waternet.

58: East Macedonia and Thrace region, Drama peripheral unit, Dit-Rodopi Mts, Skalot, small brook in a secondary forest N (above) of the village, 01.04.2007 (2007/28), N41°25.009' E24° 17.155', 1030 m; singled, beaten, waternet (Szederjesi & Csuzdi 2012).

59: East Macedonia and Thrace region, Drama peripheral unit, Dit-Rodopi Mts, Sidironero, Miloi Stream in secondary forest SE of the village, 01.04.2007 (2007/29), N41°21.223' E24°16.286', 525m; singled, beaten, waternet (Lazányi *et al.* 2012, Murányi 2013b, Szederjesi & Csuzdi 2012).

60: East Macedonia and Thrace region, Drama peripheral unit, Dit-Rodopi Mts, Dichali, Georuadi Stream and its gorge E of the settlement, 01. 04.2007 (2007/30), N41°21.923' E24°19.483', 515 m; singled, beaten, waternet (Szederjesi & Csuzdi 2012).

61: East Macedonia and Thrace region, Drama peripheral unit, Tholos, rocks above the Arkoudorema River N of the village, 01.04.2007 (2007/ 31), N41°18.584' E24°30.396', 180 m; singled (Lazányi *et al.* 2012, Szederjesi & Csuzdi 2012).

62: East Macedonia and Thrace region, Kavala peripheral unit, Lekanis Mts, Kechrokambos, rocky pasture N of the village, 02.04.2007 (2007/ 32), N41°09.972' E24°38.587', 370 m; singled (Lazányi *et al.* 2012, Szederjesi & Csuzdi 2012).

63: East Macedonia and Thrace region, Kavala peripheral unit, Lekanis Mts, Kechrokambos, quarry W (above) of the village, 02.04.2007 (2007 /33), N41°09.524' E24°36.549', 670 m; singled, beaten (Lazányi *et al.* 2012).

64: East Macedonia and Thrace region, Kavala peripheral unit, Lekanis Mts, Makrichori, quarry SE of the village, 02.04.2007 (2007/34), N41° 02.109' E24°37.941', 230 m; singled (Lazányi *et al.* 2012, Murányi 2013b).

65: East Macedonia and Thrace region, Kavala peripheral unit, Lekanis Mts, Zarkadia, limestone rocks N (above) of the village, 02.04.2007 (2007/ 35), N41°01.625' E24°38.168', 340 m; singled.

66: East Macedonia and Thrace region, Kavala peripheral unit, Lekanis Mts, Zarkadia, macchia at the village, 02.04.2007 (2007/36), N41°01.400' E24°38.507', 200 m; singled, beaten (Lazányi *et al.* 2012, Murányi 2013b).

67: East Macedonia and Thrace region, Kavala peripheral unit, Nestos Delta, Nea Karia, irrigation channel SE of the village, 02.04.2007 (2007/ 37), N40°53.455' E24°44.406', 5 m; singled, waternet (Lazányi *et al.* 2012, Murányi 2013b, Oláh 2010).

68: East Macedonia and Thrace region, Kavala peripheral unit, Nestos Delta, shallow floodplain pond in a poplar forest, 02.04.2007 (2007/38), N40°52.313' E24°47.453', 10m; waternet, plancton sample (shallow floodplain pond) (Szederjesi & Csuzdi 2012).

69: East Macedonia and Thrace region, Kavala peripheral unit, Nestos Delta, Aegean Sea coastal puddles and open sand vegetation, 02.04.2007

(2007/39), N40°50.907’ E24°47.960’, 5 m; singled, waternet, sweeping net, plancton sample (temporary brackish puddles on sandy grassland), sweeping net sample (coastal sand vegetation) (Murányi 2013b).

70: East Macedonia and Thrace region, Kavala peripheral unit, Chrisoupoli, Nestos River and its softwood gallery E of the city, 02.04.2007 (2007/40), N40°59.458’ E24°44.579’, 30 m; singled, beaten, waternet (Lazányi *et al.* 2012, Murányi 2013b, Oláh 2010).

71: East Macedonia and Thrace region, Xanthi peripheral unit, Galani, quarry above the Nestos River, W of the village, 02.04.2007 (2007/41), N41°05.595’ E24°46.278’, 60 m; singled, beaten (Lazányi *et al.* 2012, Murányi 2013b).

72: East Macedonia and Thrace region, Xanthi peripheral unit, Toxotes, pension on the edge of the village, 02.04.2007 (2007/42), N41°05.140’ E24°47.222’, 85 m; singled, light trap.

73: East Macedonia and Thrace region, Xanthi peripheral unit, Eora, small river and limestone rocks NW of the village, 03.04.2007 (2007/43), N41°12.495’ E24°51.752’, 200 m; singled, beaten, waternet (Lazányi *et al.* 2012, Murányi 2013b, Lopau 2010).

74: East Macedonia and Thrace region, Xanthi peripheral unit, Koula Mts, Kiknos, spring in macchia S of the village, 03.04.2007 (2007/44), N41°15.324’ E24°52.359’, 560 m; singled, waternet.

75: East Macedonia and Thrace region, Xanthi peripheral unit, Koula Mts, Oreo, Aspro Stream and its gallery forest E of the village, 03.04.2007 (2007/45), N41°16.369’ E24°51.275’, 550m; singled, beaten, waternet, soil sample (Lopau 2010, Oláh 2010, Szederjesi & Csuzdi 2012, Ujvári 2011).

76: East Macedonia and Thrace region, Xanthi peripheral unit, Koula Mts, Oreo, limestone rocks and beech forest N (above) of the village, 03.04.2007 (2007/46), N41°17.511’ E24°49.743’, 975 m; singled.

77: East Macedonia and Thrace region, Xanthi peripheral unit, Koula Mts, Oreo, limestone gorge with beech forest NE of the village, 03.04.2007 (2007/47), N41°17.485’ E24°50.767’, 820 m; singled, soil sample (Szederjesi & Csuzdi 2012, Ujvári 2011).

78: East Macedonia and Thrace region, Xanthi peripheral unit, Koula Mts, Oreo, cave and spring brooks in a gorge NE of the village, 03.04.2007 (2007/47A), N41°17.620’ E24°50.656’, 875 m; singled, beaten, waternet.

79: East Macedonia and Thrace region, Xanthi peripheral unit, Kamertsi Mts, Miki, limestone gorge with a torrent W of the village, 03.04.2007 (2007/48), N41°14.728’ E24°54.273’, 310 m; singled, beaten, waternet (Lazányi *et al.* 2012, Lopau 2010).

80: East Macedonia and Thrace region, Xanthi peripheral unit, Kamertsi Mts, Miki, limestone gorge with a stream W (below) of the village, 03.04.2007 (2007/49), N41°14.804’ E24°54.822’, 340m; singled, beaten, waternet, sweeping net (Szederjesi & Csuzdi 2012).

81: East Macedonia and Thrace region, Xanthi peripheral unit, Lagos, Vistonida Lake and lakeshore halophite grassland with puddles N of the village, 04.04.2007 (2007/50), N41°00.888’ E25°06.839’, 5 m; singled, waternet, plancton sample (puddles on halophite grassland) (Lazányi *et al.* 2012, Murányi 2013b).

82: East Macedonia and Thrace region, Rhodope peripheral unit, Papikio Mts, Sostis, brook in a secondary forest N of the village, 04.04.2007 (2007/51), N41°09.859’ E25°16.939’, 440 m; singled, beaten, waternet, soil sample (Lazányi *et al.* 2012, Ujvári 2011).

83: East Macedonia and Thrace region, Rhodope peripheral unit, Papikio Mts, Kerasia, temporary brook and limestone rocks at the village, 04.04.2007 (2007/52), N41°10.905’ E25°16.871’, 580 m; singled, beaten, waternet.

84: East Macedonia and Thrace region, Rhodope peripheral unit, Papikio Mts, Vronti, stream and its gorge S of the village, 04.04.2007 (2007/53), N41°11.421’ E25°17.693’, 425 m; singled, beaten, waternet (Murányi 2013b, Oláh 2010).

85: East Macedonia and Thrace region, Rhodope peripheral unit, Papikio Mts, Vronti, karst cave spring S of the village, 04.04.2007 (2007/54), N41°11.412’ E25°17.752’, 445 m; singled, beaten, waternet (Oláh 2010).

86: East Macedonia and Thrace region, Rhodope peripheral unit, Sapka Mts, Nea Sanda, river and rocky forest E of the village, 04.04.2007 (2007/55), N41°06.845' E25°50.328', 275 m; singled, beaten, waternet (Lopau 2010).

87: East Macedonia and Thrace region, Rhodope peripheral unit, Sapka Mts, Nea Sanda, forest brook and oak forest NE of the village, 04.04.2007 (2007/56), N41°07.672' E25°53.223', 650 m; singled, beaten, waternet, soil sample (Erőss *et al.* 2011, Kontschán 2010, 2013, Murányi 2013b, Oláh 2010, Szederjesi & Csuzdi 2012).

88: East Macedonia and Thrace region, Evros peripheral unit, Lesitse Mts, Avas (Avantas), stream and limestone rocks N (above) of the village, 05.04.2007 (2007/57), N40°56.268' E25° 54.792', 95 m; singled, beaten, waternet (Szederjesi & Csuzdi 2012).

89: East Macedonia and Thrace region, Evros peripheral unit, Mesimvria, sandy seashore at the Mesimvria Archeological Zone, W of the village, 05.04.2007 (2007/58), N40°51.692' E25°38.721', 5 m; singled (Murányi 2013b, Szederjesi & Csuzdi 2012).

90: East Macedonia and Thrace region, Rhodope peripheral unit, Maronia Hills, Petritis (Petrota), rocky grassland W (above) of the village, 05.04.2007 (2007/59), N40°54.080' E25°36.348', 220 m; singled (Murányi 2013b).

91: East Macedonia and Thrace region, Rhodope peripheral unit, Maronia Hills, Maronia, rocky macchia at the Maronia Cave, NW of the village, 05.04.2007 (2007/60), N40°55.732' E25° 30.138', 165 m; singled, beaten (Murányi 2013b).

14–15.03.2008 (leg. Szilvia Czigány, Dávid Murányi)

92: Epirus region, Ioannina peripheral unit, Limni, oak forest SW of the village, 14.03.2008 (2008/28), N39°54.115' E20°31.378', 475 m; singled, beaten, soil sample (sifted oak litter).

93: Epirus region, Ioannina peripheral unit, Klidonia, Voidomatis River and its plane tree gallery SW of the village, 14.03.2008 (2008/29), N39°58.376' E20°39.555', 405 m; singled, beaten, waternet, soil sample (soil and moss), (Mahunka & Mahunka-Papp 2010, Oláh 2010).

94: West Macedonia region, Kozani peripheral unit, Agia Sotira, temporary brook in open oak forest SW of the village, 14.03.2008 (2008/30), N40°11.679' E21°10.353', 780 m; singled, waternet, soil sample (sifted oak litter and soil) (Kontschán 2013, Szederjesi & Csuzdi 2012).

95: West Macedonia region, Kozani peripheral unit, Neapoli, Aliakmonas River NE of the city, 14.03.2008 (2008/31), N40°19.953' E21°24.702', 560 m; singled, beaten, waternet.

96: West Macedonia region, Florina peripheral unit, Lechovo, open oak forest S of the village, 15.03.2008 (2008/32), N40°34.049' E21°30.051', 1005 m; singled, soil sample (oak litter).

97: Central Macedonia region, Kilkis peripheral unit, Polykastro, Axios River W of the city, 15.03.2008 (2008/33), N40°59.246' E22°33.523', 30 m; singled, waternet.

02–09.04.2009 (leg. László Dányi, Jenő Kontschán, Dávid Murányi)

98: Peloponnese region, Arcadia peripheral unit, Garea, open wood and permanent puddle E of the village, 02.04.2009 (2009/1), N37°26.576' E22°27.467', 680 m; singled, beaten, plancton sample (permanent puddle in open wood), soil sample (Lazányi *et al.* 2012, Szederjesi & Csuzdi 2012).

99: Peloponnese region, Arcadia peripheral unit, Parnon Mts, Mesorrahi, stream and its gorge with chestnut-oak forest SW of the village, 02.04.2009 (2009/2), N37°22.222' E22°32.121', 900 m; singled, beaten, waternet, soil sample (Kontschán 2010, 2013).

100: Peloponnese region, Arcadia peripheral unit, Parnon Mts, Kastri, spring and spring brook SW of the village, 02.04.2009 (2009/3), N37° 21.381' E22°31.748', 960 m; singled, beaten, waternet.

101: Peloponnese region, Arcadia peripheral unit, Parnon Mts, Elatos, chestnut forest W of the village, 02.04.2009 (2009/4), N37°20.909' E22° 32.169', 1005 m; singled (Murányi 2013b, Szederjesi & Csuzdi 2012).

102: Peloponnese region, Arcadia peripheral unit, Parnon Mts, Agios Petros, stream and open forest W of the village, 02.04.2009 (2009/5), N37°19.659' E22°31.860', 950 m; singled, beaten, waternet (Szederjesi & Csuzdi 2012).

103: Peloponnese region, Arcadia peripheral unit, Parnon Mts, Platanos, open brook and rocky grassland N of the village, 02.04.2009 (2009/6), N37°20.202' E22°39.239', 580 m; singled, beaten, waternet, litter hoover sample (rocky grassland).

104: Peloponnese region, Arcadia peripheral unit, Parnon Mts, Platanos, pine forest NW of the village, 02.04.2009 (2009/7), N37°20.128' E22°38.699', 545 m; singled.

105: Peloponnese region, Arcadia peripheral unit, Parnon Mts, Sitena, brook and its shore bush in the village, 02.04.2009 (2009/8), N37°17.477' E22°38.872', 630 m; singled, beaten, waternet.

106: Peloponnese region, Laconia peripheral unit, Geraki, walls of a motel, 03.04.2009 (2009/9), N36°59.659' E22°42.171', 335 m; singled.

107: Peloponnese region, Laconia peripheral unit, Peristeri, macchia N of the village, 03.04.2009 (2009/10), N36°53.226' E22°40.251', 435 m; singled (Murányi 2013b, Szederjesi & Csuzdi 2012).

108: Peloponnese region, Laconia peripheral unit, Skala, Evrotas River and the shore vegetation at the city, 03.04.2009 (2009/11), N36°51.279' E22°40.521', 10 m; singled, beaten, waternet (Szederjesi & Csuzdi 2012).

109: Peloponnese region, Laconia peripheral unit, Trinisa, sandy seashore and mouth section of a stream at the village, 03.04.2009 (2009/12), N36°48.251' E22°37.086', 0 m; singled, waternet, soil sample (Kontschán 2010).

110: Peloponnese region, Laconia peripheral unit, Valtaki, brackish puddle and wet pasture by the sea, at the village, 03.04.2009 (2009/13), N36°47.561' E22°35.446', 5 m; singled, sweeping net, plancton sample (brackish puddle).

111: Peloponnese region, Laconia peripheral unit, Gytheio, seaside karst spring and macchia N of the city, 03.04.2009 (2009/14), N36°46.440' E22°33.856', 0 m; singled, waternet.

112: Peloponnese region, Laconia peripheral unit, Chania, woody pasture S of the village, 03.04.2009 (2009/15), N36°51.722' E22°31.720', 190 m; singled.

113: Peloponnese region, Laconia peripheral unit, Chania, olive grove S of the village, 03.04.2009 (2009/16), N36°52.690' E22°31.465', 205 m; singled, sweeping net, litter hoover sample (undergrowth of olive stands).

114: Peloponnese region, Laconia peripheral unit, Potamia, stream and its plane tree gallery SE of the village, 03.04.2009 (2009/17), N36°55.332' E22°29.877', 220 m; singled, beaten, waternet (Murányi 2013b).

115: Peloponnese region, Laconia peripheral unit, Taygetos Mts, Krioneri (Poliana), pine-spruce forest at the settlement, 03.04.2009 (2009/18), N36°58.056' E22°23.446', 860 m; singled, soil sample.

116: Peloponnese region, Laconia peripheral unit, Taygetos Mts, Krioneri (Poliana), Varbaras Stream and its mixed gallery W (above) of the settlement, 03.04.2009 (2009/19), N36°57.952' E22°22.884', 985 m; singled, beaten, waternet, soil sample (Kontschán 2010, Szederjesi & Csuzdi 2012).

117: Peloponnese region, Laconia peripheral unit, Taygetos Mts, Krioneri (Poliana), brook and conifer-plane tree forest NW (above) of the settlement, 03.04.2009 (2009/20), N36°58.588' E22°22.898', 1130 m; singled, beaten.

118: Peloponnese region, Laconia peripheral unit, Taygetos Mts, Krioneri (Poliana), stream in an open coniferous wood NW (above) of the settlement, 03.04.2009 (2009/21), N36°58.739' E22°22.478', 1270 m; singled, beaten, waternet.

119: Peloponnese region, Laconia peripheral unit, Taygetos Mts, Krioneri (Poliana), spring in alpine grassland NW (above) of the settlement, 03.04.2009 (2009/22), N36°58.973' E22°22.567', 1295 m; singled.

120: Peloponnese region, Laconia peripheral unit, Taygetos Mts, Toriza, brook and chestnut forest in the village, 03.04.2009 (2009/23), N36°57.845' E22°24.273', 780 m; singled, beaten, waternet.

121: Peloponnese region, Laconia peripheral unit, Taygetos Mts, Mystras, stream and its plane tree gallery in the city, 04.04.2009 (2009/24), N37°04.192' E22°22.305', 310 m; singled, beaten, waternet, soil sample (Szederjesi & Csuzdi 2012).

122: Peloponnese region, Laconia peripheral unit, Taygetos Mts, Tripi, karst spring in the village, 04.04.2009 (2009/25), N37°05.622' E22° 20.879', 500 m; singled, beaten, waternet, soil sample (Oláh 2010).

123: Peloponnese region, Laconia peripheral unit, Taygetos Mts, Tripi, limestone walls W of the village, 04.04.2009 (2009/26), N37°05.695' E22°19.971', 545 m; singled.

124: Peloponnese region, Messenia peripheral unit, Taygetos Mts, Langada (Knamion) Stream, its sidestream and plane tree gallery along the Sparti-Kalamata road, 04.04.2009 (2009/27), N37°04.751' E22°17.468', 595 m; singled, beaten, waternet.

125: Peloponnese region, Messenia peripheral unit, Taygetos Mts, Kefalovriso, brook in burnt spruce forest NW (below) of the settlement, 04.04.2009 (2009/28), N37°02.733' E22°15.485', 1440 m; singled, beaten, waternet, soil sample (Szederjesi & Csuzdi 2012).

126: Peloponnese region, Messenia peripheral unit, Taygetos Mts, Dendro, rocky grassland with conifers near the settlement, 04.04.2009 (2009/ 29), N37°00.590' E22°14.396', 1160 m; singled, beaten.

127: Peloponnese region, Messenia peripheral unit, Messini, side-channel of the Pamisos River SE of the city, 04.04.2009 (2009/30), N37° 01.548' E22°01.660', 5 m; singled, waternet.

128: Peloponnese region, Messenia peripheral unit, Messini, sandy seashore at the mouth of Pamisos River, S of the city, 04.04.2009 (2009/ 31), N37°01.285' E22°01.244', 0 m; singled, waternet, soil sample.

129: Peloponnese region, Messenia peripheral unit, Messini, pasture SE of the city, 04.04.2009 (2009/32), N37°01.974' E22°01.984', 10 m; singled, sweeping net (Szederjesi & Csuzdi 2012).

130: Peloponnese region, Messenia peripheral unit, Velika, small river and its shore ruderalia at the village, 04.04.2009 (2009/33), N37°00.310' E21°55.811', 10 m; singled, beaten, waternet (Murányi 2013b, Oláh 2010).

131: Peloponnese region, Messenia peripheral unit, Chrani, sandy seashore in the village, 04.04. 2009 (2009/34), N36°54.292' E21°55.479', 0 m; singled.

132: Peloponnese region, Messenia peripheral unit, Charavgi, Polilimnio, pasture and forest edge S of the village, 05.04.2009 (2009/35), N36° 58.818' E21°51.013', 320 m; singled, beaten.

133: Peloponnese region, Messenia peripheral unit, Charavgi, Polilimnio, stream and its gorge S of the village, 05.04.2009 (2009/36), N36°58.916' E21°51.036', 290 m; singled, beaten, waternet, light trap, soil sample (Kontschán 2010, Oláh 2010).

134: Peloponnese region, Messenia peripheral unit, Agii Apostoli, stream and plane tree gallery E of the village, 05.04.2009 (2009/37), N37° 04.158' E21°47.275', 415 m; singled, beaten, waternet (Murányi 2011, Oláh 2010, Szederjesi & Csuzdi 2012).

135: Peloponnese region, Messenia peripheral unit, Egaleo Mts, Platanovrisi, stream, temporary puddle and ruderal olive grove NW of the village, 05.04.2009 (2009/38), N37°07.214' E21°47.925', 400 m; singled, beaten, waternet, plancton sample (roadside temporary puddle), (Murányi 2013b, Oláh 2010).

136: Peloponnese region, Messenia peripheral unit, Kondovounia Mts, Tripila, stream and open macchia N of the village, 05.04.2009 (2009/39), N37°11.311' E21°47.148', 390 m; singled, beaten, waternet (Murányi 2013b).

137: Peloponnese region, Messenia peripheral unit, Kondovounia Mts, Aetos, karst spring and limestone rocks in the village, 05.04.2009 (2009/40), N37°14.587' E21°49.647', 370 m; singled, waternet (Oláh 2010).

138: Peloponnese region, Arcadia peripheral unit, Faneti, rocky pasture NW of the village, 05.04.2009 (2009/41), N37°18.946' E22°03.774', 530 m; singled.

139: Peloponnese region, Arcadia peripheral unit, Tripotamo, oak forest S of the village, 05. 04.2009 (2009/42), N37°20.996' E22°06.392', 400 m; singled, beaten, soil sample (Murányi 2013b).

140: Peloponnese region, Arcadia peripheral unit, Tetrazi Mts, Agia Theodora, stream, karst springs and rocky maple forest at the monastery, 05.04.2009 (2009/43), N37°21.269' E21°58.782', 490 m; singled, beaten, waternet, soil sample (Kontschán 2010, Lazányi *et al.* 2012, Murányi 2011, 2013b, Ujvári 2011).

141: Peloponnese region, Arcadia peripheral unit, Tetrazi Mts, Agia Theodora, oak forest above the monastery, 05.04.2009 (2009/44), N37°20.960’ E21°59.342’, 610 m; singled (Mahunka & Mahunka-Papp 2010).

142: Peloponnese region, Arcadia peripheral unit, Tetrazi Mts, Isaris, oak forest SW of the village, 05.04.2009 (2009/45), N37°21.290’ E21° 59.848’, 795 m; singled, soil sample (Mahunka & Mahunka-Papp 2010).

143: Peloponnese region, Arcadia peripheral unit, Tetrazi Mts, Isaris, stream and burnt mixed forest E of the village, 05.04.2009 (2009/46), N37°22.102’ E22°01.602’, 595 m; singled, beaten, waternet.

144: Peloponnese region, Arcadia peripheral unit, Elliniko, Lousios River, its plane tree gallery and rocky bush at Gortis ruins, 06.04.2009 (2009 /47), N37°32.378’ E22°02.788’, 320 m; singled, beaten, waternet, soil sample (Lazányi *et al.* 2012, Mahunka & Mahunka-Papp 2010, Murányi 2011, 2013b).

145: Peloponnese region, Arcadia peripheral unit, Elliniko, forest brook and plane tree forest SE of Gortis ruins, 06.04.2009 (2009/48), N37° 32.020’ E22°03.191’, 380 m; singled, beaten, waternet, soil sample (Mahunka & Mahunka-Papp 2010, Ujvári 2011).

146: Peloponnese region, Arcadia peripheral unit, Dimitsana, Lousios River, chestnut-plane tree gallery and limestone rocks N of the city, 06.04.2009 (2009/49), N37°37.331’ E22°03.037’, 920 m; singled, beaten, waternet.

147: Peloponnese region, Arcadia peripheral unit, Magouliana, spruce forest SW of the village, 06.04.2009 (2009/50), N37°39.404’ E22°06.976’, 1130 m; singled, soil sample (Dányi 2010, Mahunka & Mahunka-Papp 2010).

148: Peloponnese region, Arcadia peripheral unit, Magouliana, stream, sidebrook and woody pasture SE of the village, 06.04.2009 (2009/51), N37°39.425’ E22°08.730’, 1035 m; singled, beaten, waternet (Murányi 2011, Szederjesi & Csuzdi 2012, Sziráki 2013).

149: Peloponnese region, Arcadia peripheral unit, Menalo Mts, spruce forest below Mt. Mesovouni, 06.04.2009 (2009/52), N37°40.672’ E22° 13.297’, 1395 m; singled, beaten, soil sample.

150: Peloponnese region, Arcadia peripheral unit, Menalo Mts, limestone rocks below Mt. Mavri Korifi, 06.04.2009 (2009/53), N37°39.565’ E22°15.582’, 1615 m; singled (Dányi 2013: Fig. 1).

151: Peloponnese region, Arcadia peripheral unit, Vitina, Milaontas Stream, its gallery and woody pasture SW of the city, 06.04.2009 (2009/ 54), N37°39.031’ E22°10.156’, 960 m; singled, beaten, waternet, soil sample (Kontschán 2010, Murányi 2011: Fig. 14, Murányi 2013b, Szederjesi & Csuzdi 2012).

152: Peloponnese region, Arcadia peripheral unit, Panagitsa, karst springlake, its outlet brook, small river and its plane tree gallery at the village, 06.04.2009 (2009/55), N37°46.392’ E22°13.341’, 515 m; singled, beaten, waternet, soil sample (Murányi 2013b).

153: West Greece region, Achaea peripheral unit, Klitoria, small river S of the city, 06.04.2009 (2009/56), N37°53.376’ E22°07.525’, 505 m; singled, beaten, waternet.

154: West Greece region, Achaea peripheral unit, Aroania Mts, Planitero, Aroanios (Ladon) Stream and its plane tree gallery SW of the village, 07.04.2009 (2009/57), N37°55.985’ E22° 09.503’, 600 m; singled, beaten, waternet, soil sample (Kontschán 2010, Oláh 2010).

155: West Greece region, Achaea peripheral unit, Aroania Mts, Zarelia, open spring brook, rocky alpine grassland and limestone rocks below Mt. Nisi, 07.04.2009 (2009/58), N37°56.543’ E22°14.067’, 1600 m; singled, beaten, waternet (Lazányi *et al.* 2012, Oláh 2010).

156: West Greece region, Achaea peripheral unit, Aroania Mts, Zarelia, spruce forest and grassland SE of the village, 07.04.2009 (2009/59), N37°55.386’ E22°14.191’, 1310 m; singled, beaten (Lazányi *et al.* 2012).

157: West Greece region, Achaea peripheral unit, Aroania Mts, Zarelia, limestone rocks W of the village, 07.04.2009 (2009/60), N37°56.028’ E22°12.707’, 925 m; singled.

158: West Greece region, Achaea peripheral unit, Aroania Mts, Planitero, Planitero (Ladon) Springs, plane tree gallery and limestone rocks in the village, 07.04.2009 (2009/61), N37°56.022’ E22°09.971’, 640 m; singled, beaten, waternet, soil sample (Murányi 2013b, Oláh 2010, Szederjesi & Csuzdi 2012, Ujvári 2011).

159: West Greece region, Achaea peripheral unit, Aroania Mts, Kastria, open stream and pasture N of the village, 07.04.2009 (2009/62), N37° 58.267' E22°08.503', 980 m; singled, beaten, waternet.

160: West Greece region, Achaea peripheral unit, Kalavrita, Vouraikos River, ruderal vegetation and floodplain puddles W of the city, 07. 04.2009 (2009/63), N38°02.154' E22°05.899', 685 m; singled, beaten, waternet, plancton sample (floodplain puddles) (Dányi 2010, Murányi 2013b).

161: West Greece region, Achaea peripheral unit, Korfes, brook and its gorge with plane tree-conifer forest, SE of the village, 07.04.2009 (2009/64), N38°05.099' E22°02.036', 885 m; singled, beaten, waternet, soil sample (Lazányi *et al.* 2012, Szederjesi & Csuzdi 2012).

162: West Greece region, Achaea peripheral unit, Fteri, streamshore ruderal vegetation in the village, 07.04.2009 (2009/65), N38°09.016' E22° 04.384', 1080 m; singled.

163: West Greece region, Achaea peripheral unit, Neo Salmeniko, left tributary of Finikas River, and the shore vegetation at the village, 08.04. 2009 (2009/66), N38°16.292' E21°57.020', 185 m; singled, beaten, waternet (Murányi 2013b).

164: West Greece region, Achaea peripheral unit, Panahaiko Mts, Sella, karst spring outlet and ruderal vegetation in the village, 08.04.2009 (2009/67), N38°17.040' E21°52.748', 430 m; singled, beaten, waternet.

165: Central Greece region, Phocis peripheral unit, Agios Spyridonas, sandy seashore and grassy rocks at the village, 08.04.2009 (2009/68), N38° 21.903' E22°07.687', 0 m; singled.

166: Central Greece region, Phocis peripheral unit, Paralia Tolofonos, rocky seashore W of the village, 08.04.2009 (2009/69), N38°20.299' E22° 11.640', 0 m; singled.

167: Central Greece region, Phocis peripheral unit, Agioi Pantes, macchia with tree spurges SE of the village, 08.04.2009 (2009/70), N38°20.842' E22°18.846', 50 m; singled, beaten (Murányi 2013b).

168: Central Greece region, Phocis peripheral unit, Giona Mts, Prosilio, open stream and mountain pasture S of the village, 08.04.2009 (2009/71), N38°33.827' E22°20.939', 680 m; singled, beaten, waternet (Murányi 2013b, Oláh 2010).

169: Central Greece region, Phocis peripheral unit, Giona Mts, Prosilio, spruce forest NW of the village, 08.04.2009 (2009/72), N38°36.007' E22° 19.597', 1040 m; singled, beaten, soil sample.

170: Central Greece region, Phocis peripheral unit, Vargiani, springs and torrent the village, 08.04.2009 (2009/73), N38°38.499' E22°25.515', 970 m; singled, beaten, waternet (Oláh 2010).

171: Central Greece region, Phocis peripheral unit, Parnassos Mts, Eptolofos, spruce forest SE of the village, 08.04.2009 (2009/74), N38°35.245' E22°30.267', 1115 m; singled, soil sample (Lazányi *et al.* 2012, Ujvári 2011).

172: Central Greece region, Phocis peripheral unit, Parnassos Mts, Eptolofos, brook and shore plane trees in the village, 08.04.2009 (2009/75), N38°35.565' E22°29.236', 860 m; singled, beaten, waternet, soil sample (Kontschán 2010).

173: Thessaly region, Larissa peripheral unit, Ossa Mts, Stomio, stream and mixed decidous-conifer forest SE of the village, 09.04.2009 (2009/ 76), N39°51.524' E22°44.613', 85 m; singled, beaten, waternet, soil sample (Ujvári 2011).

174: Thessaly region, Larissa peripheral unit, Ossa Mts, Koutsoupia, stream mouth to the sea, in the village, 09.04.2009 (2009/77), N39°49.121' E22°48.598', 0 m; singled, beaten, waternet.

175: Thessaly region, Larissa peripheral unit, Ossa Mts, small brook in beech forest, 09.04.2009 (2009/78), N39°47.865' E22°45.298', 1115 m; singled, beaten, waternet, soil sample (Kontschán 2010, Mahunka & Mahunka-Papp 2010).

176: Thessaly region, Larissa peripheral unit, Ossa Mts, torrent in beech forest, 09.04.2009 (2009/79), N39°48.087' E22°45.666', 975 m; singled, beaten, waternet (Lazányi *et al.* 2012, Sziráki 2013).

177: Thessaly region, Larissa peripheral unit, Ossa Mts, stream in beech forest, 09.04.2009 (2009/80), N39°48.324' E22°45.886', 835 m; singled, beaten, waternet.

178: Thessaly region, Larissa peripheral unit, Ossa Mts, Karitsa, oak forest S of the village, 09.04.2009 (2009/81), N39°49.481' E22°46.255', 590 m; singled.

179: Thessaly region, Larissa peripheral unit, Ossa Mts, Karitsa, stream in oak forest S of the village, 09.04.2009 (2009/82), N39°49.615’ E22° 46.174’, 520 m; singled, beaten, waternet, soil sample (Dányi 2010, Mahunka & Mahunka-Papp 2010, Ujvári 2011).

180: Thessaly region, Larissa peripheral unit, Stomio, brackish puddles in the delta of Pinios River, at the village, 09.04.2009 (2009/83), N39°52.184’ E22°44.041’, 5 m; plancton sample (brackish puddles).

04–09.05.2011 (leg. Jenő Kontschán, Dávid Murányi, Tímea Szederjesi, Zsolt Újvári)

181: Epirus region, Ioannina peripheral unit, Lakmos Mts, Tampouria, bushy brook and secondary forest N of the village, 04.05.2011 (2011/1), N39°45.053’ E21°05.109’, 670 m; singled, beaten, waternet.

182: Epirus region, Ioannina peripheral unit, Lakmos Mts, Tampouria, rocky meadow, macchia and open woodland N of the village, 04.05.2011 (2011/2), N39°43.695’ E21°05.034’, 1010 m; singled, beaten (Szederjesi & Csuzdi 2012).

183: Epirus region, Ioannina peripheral unit, Lakmos Mts, subalpine grassland 5 km NW of Mt. Peristeri, 04.05.2011 (2011/3), N39°43.271’ E21°06.052’, 1375 m; singled, soil sample.

184: Epirus region, Ioannina peripheral unit, Lakmos Mts, Rachoula, forest torrent and secondary forest S of the village, 04.05.2011 (2011/ 4), N39°44.173’ E21°05.742’, 1060 m; singled, beaten, waternet.

185: Epirus region, Ioannina peripheral unit, Mitsikeli Mts, Ligiades, forest fragment and rocky grassland N of the village, 04.05.2011 (2011/5), N39°42.113’ E20°53.679’, 1215 m; singled (Szederjesi & Csuzdi 2012).

186: Epirus region, Ioannina peripheral unit, Kanneta, roadside rocks at the conjunction towards Vaseika, N of the village, 04.05.2011 (2011/6), N39°30.140’ E20°52.927’, 590 m; singled.

187: Epirus region, Ioannina peripheral unit, Melia, secondary forest at the Goura gorge, E of the village, 04.05.2011 (2011/7), N39°27.126’ E20°52.450’, 320 m; singled, beaten.

188: Epirus region, Ioannina peripheral unit, Vouliasta, plane tree gallery, spring lake and upper section of Louros River in the village, 04.05.2011 (2011/8), N39°25.939’ E20°50.605’, 235 m; singled, beaten, waternet (Murányi 2013a, Szederjesi & Csuzdi 2012).

189: Epirus region, Preveza peripheral unit, Stefani, dry ditch and ruderal macchia W of the village, 05.05.2011 (2011/9), N39°10.675’ E20° 46.473’, 10 m; singled, sweeping net, sweeping net sample (ruderal macchia).

190: Epirus region, Preveza peripheral unit, Louros, rocky macchia and open oak wood N of the village, 05.05.2011 (2011/10), N39°10.630’ E20°44.063’, 90 m; singled, sweeping net (Murányi 2013b).

191: Epirus region, Preveza peripheral unit, Thesprotiko Mts, Vrisoula, stream, its plane tree gallery and roadside puddle S of the village, 05. 05.2011 (2011/11), N39°14.904’ E20°41.735’, 220 m; singled, beaten, waternet, plancton sample (roadside puddle), soil sample (Kontschán 2013, Murányi 2013a, 2013b, Szederjesi & Csuzdi 2012).

192: Epirus region, Preveza peripheral unit, Ano Kotsanopoulo, garden of a cafe bar W of the village, 05.05.2011 (2011/12), N39°13.026’ E20° 42.823’, 130 m; singled.

193: Epirus region, Preveza peripheral unit, Nikopoli, sandy seashore of the Amvrakikos Gulf, E of the village, 05.05.2011 (2011/13), N39° 01.909’ E20°45.563’, 0 m; singled, waternet.

194: Epirus region, Preveza peripheral unit, Nikopoli, shrubby grassland and walls of the ancient ruins S of the village, 05.05.2011 (2011/ 14), N39°00.629’ E20°43.952’, 15 m; singled (Murányi 2013a).

195: Epirus region, Preveza peripheral unit, Mitikas, bush and rocky seashore of the Ionian Sea at the village, 05.05.2011 (2011/15), N39° 00.106’ E20°42.084’, 0 m; singled, beaten, sweeping net, soil sample (Kontschán 2013).

196: West Greece region, Aetolia-Acarnania peripheral unit, Aktio, bushy ditch at Saltini Lake, S of the settlement, 05.05.2011 (2011/16), N38° 54.779’ E20°47.251’, 5 m; singled, waternet.

197: West Greece region, Aetolia-Acarnania peripheral unit, Agios Nikolaos, tall macchia and roadside vegetation N of the village, 05.05.2011 (2011/17), N38°53.579’ E20°48.183’, 80m; singled, sweeping net.

198: West Greece region, Aetolia-Acarnania peripheral unit, Agia Varvara, shallow brackish lake N of the village, 05.05.2011 (2011/18), N38° 51.027’ E20°44.608’, 0 m; singled, waternet, sweeping net, plancton sample (shallow brackish lake).

199: Ionian Islands region, Lefkada peripheral unit, Lefkada Island, Rahi, stream, limestone rocks, plane tree gallery and bush W of the village, 06.05.2011 (2011/19), N38°43.363’ E20° 41.404’, 50 m; singled, beaten, waternet, sweeping net sample (plane tree gallery and bush), soil sample (Murányi 2013a, 2013b).

200: Ionian Islands region, Lefkada peripheral unit, Lefkada Island, Neohori, tall macchia S of the village, 06.05.2011 (2011/20), N38°42.212’ E20°40.985’, 225 m; singled, beaten.

201: West Greece region, Aetolia-Acarnania peripheral unit, Agios Nikolaos, Cleopatra channel and its shore gallery at the village, 06.05.2011 (2011/21), N38°51.891’ E20°48.303’, 5 m; singled, waternet, sweeping net.

202: West Greece region, Aetolia-Acarnania peripheral unit, Akarnanika Mts, Trifos, small artifical pond and its shore vegetation S of the village, 06.05.2011 (2011/22), N38°48.396’ E21° 05.650’, 330 m; singled, beaten, waternet, sweeping net, plancton sample (small artificial pond) (Murányi 2013b).

203: West Greece region, Aetolia-Acarnania peripheral unit, Stanos, open woodland S of the village, 06.05.2011 (2011/23), N38°46.469’ E21° 11.018’, 30 m; singled, beaten, sweeping net.

204: West Greece region, Aetolia-Acarnania peripheral unit, Kamaroula, small river and its littoral scrub N of the village, 07.05.2011 (2011/ 24), N38°38.302’ E21°27.092’, 130 m; singled, beaten, waternet, sweeping net (Szederjesi & Csuzdi 2012).

205: West Greece region, Aetolia-Acarnania peripheral unit, Panetoliko Mts, Agios Vlasios, open brook, pine forest and forest puddle S of the village, 07.05.2011 (2011/25), N38°48.360’ E21° 30.676’, 825 m; singled, beaten, waternet, plancton sample (forest puddle), soil sample (Kontschán 2013, Szederjesi & Csuzdi 2012).

206: West Greece region, Aetolia-Acarnania peripheral unit, Chouni, forest spring and plane tree forest N of the village, 07.05.2011 (2011/26), N38°51.053’ E21°32.720’, 565 m; singled, beaten, waternet (Murányi 2013b, Szederjesi & Csuzdi 2012).

207: Central Greece region, Evrytania peripheral unit, Agios Georgios, forest brook and plane tree forest E of the village, 07.05.2011 (2011/27), N38°51.053’ E21°32.720’, 565 m; singled, beaten, waternet (Szederjesi & Csuzdi 2012).

208: Central Greece region, Evrytania peripheral unit, Anatoliki Fragista, small river, stream and plane tree forest N of the village, 07.05.2011 (2011/28), N38°57.577’ E21°36.750’, 550 m; singled, beaten, waternet, soil sample (Kontschán 2013, Szederjesi & Csuzdi 2012).

209: Central Greece region, Evrytania peripheral unit, Anatoliki Fragista, karst spring and open rocky woodland E of the village, 07.05.2011 (2011/29), N38°57.612’ E21°37.836’, 730 m; singled, beaten, waternet (Szederjesi & Csuzdi 2012).

210: Central Greece region, Evrytania peripheral unit, Timfristos Mts, Ano Kalesmeno, forest brook and spruce forest E of the village, 07.05.2011 (2011/30), N38°54.931’ E21°43.825’, 980 m; singled, beaten, waternet, soil sample (Kontschán 2013, Murányi 2013a, Szederjesi & Csuzdi 2012).

211: Central Greece region, Evrytania peripheral unit, Timfristos Mts, alpine grassland around the ski course, 2 km W of Mt. Timfristos, 07.05.2011 (2011/31), N38°56.516’ E21°48.412’, 1865 m; singled, soil sample (Szederjesi & Csuzdi 2012).

212: Central Greece region, Evrytania peripheral unit, Timfristos Mts, rocky alpine grassland 2 km SW of Mt. Timfristos, 07.05.2011 (2011/32), N38°56.000’ E21°48.590’, 1760 m; singled.

213: Central Greece region, Evrytania peripheral unit, Timfristos Mts, Karpenisi, parking of Hotel Lekadin, 08.05.2011 (2011/33), N38° 54.803’ E21°47.024’, 1010 m; singled (Murányi 2013a).

214: Central Greece region, Phthiotis peripheral unit, Timfristos Mts, Timfristos, forest brook and spruce forest at the Timfristos Pass, W of the village, 08.05.2011 (2011/34), N38°53.816’ E21°

53.423’, 1125 m; singled, beaten, waternet, soil sample (Szederjesi & Csuzdi 2012).

215: Central Greece region, Phthiotis peripheral unit, Agios Georgios, Sperchios River and its gallery forest W of the village, 08.05.2011 (2011/35), N38°57.009’ E21°56.712’, 365 m; singled, beaten, waternet (Kovács *et al.* 2012: Fig. 21, Murányi 2013a, Szederjesi & Csuzdi 2012).

216: Central Greece region, Phthiotis peripheral unit, Paleokastro, oak forest S of the village, 08.05.2011 (2011/36), N38°58.653’ E21°54.221’, 685 m; singled, soil sample (Kontschán 2013, Murányi 2013a, Szederjesi & Csuzdi 2012).

217: Central Greece region, Evrytania peripheral unit, Fourna, open brook, spruce forest and wet meadow S of the village, 08.05.2011 (2011/37), N39°01.803’ E21°52.933’, 1220 m; singled, beaten, waternet.

218: Central Greece region, Evrytania peripheral unit, Klisto, forest brook, spruce forest, wet meadow and roadside puddle N of the village, 08.05.2011 (2011/38), N39°07.326’ E21°49.064’, 1145 m; singled, beaten, waternet, plancton sample (roadside puddle), soil sample (Kontschán 2013, Szederjesi & Csuzdi 2012).

219: Thessaly region, Karditsa peripheral unit, Sarantaporo, small river and its gallery forest S of the village, 08.05.2011 (2011/39), N39°09.231’ E21°49.845’, 700 m; singled, beaten, waternet.

220: Thessaly region, Karditsa peripheral unit, Kastania, open, rocky macchia E of the village, 08.05.2011 (2011/40), N39°14.258’ E21°50.324’, 625 m; singled (Szederjesi & Csuzdi 2012).

221: Thessaly region, Karditsa peripheral unit, Mouzaki, garden of Hotel Panorama, 09.05.2011 (2011/41), N39°26.270’ E21°40.363’, 165 m; singled (Murányi 2013a).

222: Thessaly region, Trikala peripheral unit, Kerketio Mts, Pertouli, open stream and wet meadow E of the village, 09.05.2011 (2011/42), N39°32.588’ E21°30.662’, 1175 m; singled, beaten, waternet, soil sample (Kontschán 2013).

223: Thessaly region, Trikala peripheral unit, Neraida Mts, Desi, karst spring, its outlet and bushy grassland E of the village, 09.05.2011 (2011/43), N39°33.637’ E21°22.315’, 1040 m; singled, beaten, waternet (Szederjesi & Csuzdi 2012).

224: Thessaly region, Trikala peripheral unit, Athamon Mts, Athamania, small river and mixed rocky forest S of the village, 09.05.2011 (2011/44), N39°30.944’ E21°14.997’, 935 m; singled, beaten, waternet, sweeping net (Szederjesi & Csuzdi 2012).

225: Thessaly region, Trikala peripheral unit, Athamon Mts, Athamania, forest torrent in deciduous rocky forest N of the village, 09.05.2011 (2011/45), N39°32.034’ E21°15.131’, 1020 m; singled, beaten, waternet.

226: Thessaly region, Trikala peripheral unit, Katafito, limestone rocks and deciduous forest W of the village, 09.05.2011 (2011/46), N39°37.996’ E21°13.449’, 950 m; singled.

227: Thessaly region, Trikala peripheral unit, Lakmos Mts, Chaliki, open torrent and brook, and rocky subalpine grassland N of the village, 09.05. 2011 (2011/47), N39°41.908’ E21°11.037’, 1225 m; singled, beaten, waternet, soil sample (Szederjesi & Csuzdi 2012).

228: Epirus region, Ioannina peripheral unit, Lakmos Mts, open brook and rocky beech forest at the pass of the Chaliki–Anilio road, 09.05.2011 (2011/48), N39°43.008’ E21°11.602’, 1610 m; singled, waternet (Szederjesi & Csuzdi 2012).

229: Epirus region, Ioannina peripheral unit, Lakmos Mts, beech forest and grassland N of the pass of the Chaliki–Anilio road, 09.05.2011 (2011 /49), N39°43.472’ E21°11.731’, 1475 m; singled, soil sample (Szederjesi & Csuzdi 2012).

25–28.05.2012 (leg. Jenő Kontschán, Dávid Murányi, Tímea Szederjesi)

230: Central Macedonia region, Kilkis peripheral unit, Efzoni, garden of a hotel N of the village, 25.05.2012 (2012/1), N41°06.740’ E22° 33.296’, 80 m; singled.

231: East Macedonia and Thrace region, Rhodope peripheral unit, Sapka Mts, Nea Sanda, river and rocky forest E of the village, 26.05.2012 (2012/2), N41°06.928’ E25°49.686’, 225 m; singled, beaten, waternet.

232: East Macedonia and Thrace region, Rhodope peripheral unit, Sapka Mts, Nea Sanda, forest brook and oak forest E of the village, 26.05.2012 (2012/3), N41°07.672’ E25°53.223’, 650m; singled, beaten, waternet (Murányi 2013a).

233: East Macedonia and Thrace region, Rhodope peripheral unit, Sapka Mts, Nea Sanda, open brook and pasture NE of the village, 26.05. 2012 (2012/4), N41°07.965' E25°54.052', 790 m; singled, beaten, waternet.

234: East Macedonia and Thrace region, Rhodope peripheral unit, Tsifliki, slow stream SW of the village, 26.05.2012 (2012/5), N41°03.085' E25°37.569', 35m; singled, waternet, sweeping net.

235: East Macedonia and Thrace region, Rhodope peripheral unit, Tsifliki, Lissios River and its shore bush W of the village, 26.05.2012 (2012/6), N41°03.163' E25°37.114', 30 m; singled, waternet.

236: East Macedonia and Thrace region, Rhodope peripheral unit, Sapka Mts, Kizario, stream and pasture SW of the village, 27.05.2012 (2012 /7), N41°03.492' E25°45.672', 140 m; singled, beaten, waternet (Murányi 2013b).

237: East Macedonia and Thrace region, Rhodope peripheral unit, Evrinos, small pit hole lakes and puddles E of the village, 27.05.2012 (2012/8), N41°03.908' E25°44.250', 90 m; singled, waternet, sweeping net, plancton sample (permanent puddles and small pit hole lakes).

238: East Macedonia and Thrace region, Evros peripheral unit, Mesti, dry grassland at ancient Via Egnatia, SE of the village, 27.05.2012 (2012 /9), N40°56.735' E25°39.431', 200 m; singled, sweeping net.

239: East Macedonia and Thrace region, Evros peripheral unit, Dikella, rocky seashore SE of the village, 27.05.2012 (2012/10), N40°50.910' E25° 42.440', 0 m; singled, soil sample.

240: East Macedonia and Thrace region, Evros peripheral unit, Lesitse Mts, Nipsa, large, permanent puddle NE of the village, 27.05.2012 (2012 /11), N40°56.279' E26°03.379', 85 m; singled, waternet, sweeping net, plancton sample (large, permanent puddle).

241: East Macedonia and Thrace region, Evros peripheral unit, Lesitse Mts, Loutros, stream and its gallery N of the village, 27.05.2012 (2012/12), N40°55.485' E26°03.673', 55 m; singled, beaten, waternet.

242: East Macedonia and Thrace region, Evros peripheral unit, Loutra Traianoupolis, river and thermal spring at the ruins, 28.05.2012 (2012/13), N40°51.889' E26°01.881', 15 m; singled, beaten, waternet.

243: East Macedonia and Thrace region, Evros peripheral unit, Anatoliki Rodopi Mts, Mikro Dereio, temporary puddle by an oak forest, W of the village, 28.05.2012 (2012/14), N41°18.927' E26°03.639', 280 m; singled, plancton sample (temporary puddle), soil sample.

244: East Macedonia and Thrace region, Evros peripheral unit, Anatoliki Rodopi Mts, Roussa, open brook and dry forest N of the village, 28.05. 2012 (2012/15), N41°18.636' E26°01.055', 360 m; singled, beaten, waternet, soil sample (Kontschán 2013).

245: East Macedonia and Thrace region, Evros peripheral unit, Anatoliki Rodopi Mts, Polia, Erithropotamos River S of the village, 28.05.2012 (2012/16), N41°26.280' E26°13.435', 50 m; singled, beaten, waternet.

06–14.11.2012 (leg. Jenő Kontschán, Dávid Murányi)

246: South Aegean region, Rhodes peripheral unit, Rhodes Island, Rhodes, street trees in the city, 06.11.2012 (2012/1), N36°27.101' E28° 13.120', 5 m; singled.

247: South Aegean region, Rhodes regional unit, Rhodes Island, Mt. Prophitis Ilias, rocky cedar forest at the monastery, 07.11.2012 (2012 /2), N36°16.624' E27°56.543, 605 m; singled, beaten, soil sample (moss from soil) (Murányi 2013b).

248: South Aegean region, Rhodes regional unit, Rhodes Island, Salakos, forest spring on Mt. Prophitis Ilias above the city, 07.11.2012 (2012 /3), N36°16.073' E27°54.686', 485 m; singled, beaten, waternet.

249: South Aegean region, Rhodes regional unit, Rhodes Island, Mt. Atavyros, rocky grassland in the peak region, 07.11.2012 (2012/4), N36°12.233' E27°51.913', 1095 m; singled (Murányi 2013b).

250: South Aegean region, Rhodes regional unit, Rhodes Island, Mt. Atavyros, rocky evergreen oak stand, 07.11.2012 (2012/5), N36° 12.247' E27°51.344', 1055 m; singled, beaten (Murányi 2013b).

251: South Aegean region, Rhodes regional unit, Rhodes Island, Mt. Atavyros, trees on rocky pasture, 07.11.2012 (2012/6), N36°12.085' E27° 50.352', 835 m; singled.

252: South Aegean region, Rhodes regional unit, Rhodes Island, Mt. Atavyros, Ploumadhes area, pine forest, 07.11.2012 (2012/7), N36° 12.017' E27°49.286', 610 m; singled, beaten (Murányi 2013b).

253: South Aegean region, Rhodes regional unit, Rhodes Island, Mt. Atavyros, Ploumadhes area, mixed forest edge, 07.11.2012 (2012/8), N36°12.370' E27°48.810', 475 m; singled.

254: South Aegean region, Rhodes regional unit, Rhodes Island, Monolithos, street trees at Hotel Thomas, 07.11.2012 (2012/9), N36°07.789' E27°44.352', 290 m; singled.

255: South Aegean region, Rhodes regional unit, Rhodes Island, Apolakkia Bay, Sousounia area, sandy seashore with grassy dunes, 08.11. 2012 (2012/10), N35°59.632' E27°44.897', 0 m; singled, soil sample (decaying leaves).

256: South Aegean region, Rhodes regional unit, Rhodes Island, Kattavia, semidesert on Oros hill, S of the village, 08.11.2012 (2012/11), N35° 53.861' E27°46.506', 40 m; singled, beaten (Sziráki 2013).

257: South Aegean region, Rhodes regional unit, Rhodes Island, Hochlakas, streambed with scattered pools W of the village, 08.11.2012 (2012/12), N35°56.722' E27°49.668', 15 m; singled, beaten, waternet.

258: South Aegean region, Rhodes regional unit, Rhodes Island, Mesanaghros, trees at a coffee bar in the village, 08.11.2012 (2012/13), N36°00.685' E27°49.207', 300 m; singled.

259: South Aegean region, Rhodes regional unit, Rhodes Island, Arnitha, macchia on Mt. Troulos, S of the village, 08.11.2012 (2012/14), N36°03.090' E27°49.169', 170 m; singled, beaten, soil sample (decaying wood).

260: South Aegean region, Rhodes regional unit, Rhodes Island, Arnitha, olive groove at the village, 08.11.2012 (2012/15), N36°03.438' E27° 49.266', 145 m; singled, beaten.

261: South Aegean region, Rhodes regional unit, Rhodes Island, Arnitha, Eucalyptus and plane trees at an occupied spring in the village, 08.11.2012 (2012/16), N36°03.724' E27°48.816', 105 m; singled, soil sample (plane tree leaf litter).

262: South Aegean region, Rhodes regional unit, Rhodes Island, Vati, roadside spring E of the village, 08.11.2012 (2012/17), N36°03.225' E27° 54.486', 75 m; singled, beaten, waternet, soil sample (leaf litter) (Sziráki 2013).

263: South Aegean region, Rhodes regional unit, Rhodes Island, Asklipiio, rocky pine forest on Selli hill, N of the village, 09.11.2012 (2012 /18), N36°06.595' E27°54.998', 200 m; singled (Murányi 2013b).

264: South Aegean region, Rhodes regional unit, Rhodes Island, Thari, intermittent stream and its bushy shore S of the settlement, 09.11.2012 (2012/19), N36°07.001' E27°54.936', 185 m; singled, beaten, waternet.

265: South Aegean region, Rhodes regional unit, Rhodes Island, Laerma, horticulture at the village, 09.11.2012 (2012/20), N36°09.474' E27° 56.180', 255 m; singled, beaten.

266: South Aegean region, Rhodes regional unit, Rhodes Island, Laerma, stream and its willow-plane tree gallery SE of Aghios Ioannis monastery, 09.11.2012 (2012/21), N36°11.593' E27°54.362', 215 m; singled, beaten, waternet, soil sample (plane tree leaf litter).

267: South Aegean region, Rhodes regional unit, Rhodes Island, Agios Isidhoros, Souloutranas Spring, limestone rocks and bush E of the city, 09.11.2012 (2012/22), N36°10.442' E27° 51.812', 490 m; singled, beaten, waternet, soil sample (soil).

268: South Aegean region, Rhodes regional unit, Rhodes Island, Embonas, streamside ruderalia E of the city, 09.11.2012 (2012/23), N36° 14.107' E27°52.036', 365 m; singled, beaten (Murányi 2013b).

269: South Aegean region, Rhodes regional unit, Rhodes Island, Apollona, Triana area, stream in a gorge with plane trees, 09.11.2012 (2012/24), N36°15.261' E27°55.157', 315 m; singled, beaten, waternet, soil samples (moss from stone, plane tree leaf litter, ant nest) (Murányi 2013b).

270: South Aegean region, Rhodes regional unit, Rhodes Island, Platania, 'Koinotis Platania' Spring W of the village, 09.11.2012 (2012/25), N36°15.321' E28°00.129', 285 m; singled (Murányi 2013b).

271: South Aegean region, Rhodes regional unit, Rhodes Island, Salakos, 'Butterfly River', forested gorge with a stream NE of the city, 10.11.2012 (2012/26), N36°17.391' E27°57.007', 135 m; singled, beaten, waternet, soil sample (plane tree leaf litter) (Murányi 2013b, Sziráki 2013).

272: South Aegean region, Rhodes regional unit, Rhodes Island, Laerma, Klima area, open stream above Ghadhoura Lake, 10.11.2012 (2012/27), N36°10.444' E27°57.423', 110 m; singled, waternet.

273: South Aegean region, Rhodes regional unit, Rhodes Island, Epta Piges, karst springs and their outlet in plane tree forest, 10.11.2012 (2012 /28), N36°15.195' E28°06.859', 80 m; singled, beaten, waternet (Sziráki 2013).

274: South Aegean region, Karpathos regional unit, Karpathos Island, Aperi, spring, bushy stream and plane trees in the village, 11.11.2012 (2012/29), N35°32.995' E27°10.187', 265 m; singled, beaten, waternet, soil sample (plane tree leaf litter) (Sziráki 2013).

275: South Aegean region, Karpathos regional unit, Karpathos Island, spring along the Aperi-Spoa road, at the conjunction to Apella Bay, 11.11.2012 (2012/30), N35°36.175' E27°08.865', 315 m; singled, waternet.

276: South Aegean region, Karpathos regional unit, Karpathos Island, Spoa, Plakakia area, open spring along the road, N of the village 11.11.2012 (2012/31), N35°39.380' E27°09.474', 215 m; singled, beaten, soil sample (moss from soil).

277: South Aegean region, Karpathos regional unit, Karpathos Island, Diafani, open brook and macchia W of the village, 11.11.2012 (2012/32), N35°45.118' E27°11.637', 95 m; singled, beaten, waternet.

278: South Aegean region, Karpathos regional unit, Karpathos Island, Diafani, street trees in the village, 11.11.2012 (2012/33), N35°45.293' E27°12.555', 5 m; singled.

279: South Aegean region, Karpathos regional unit, Karpathos Island, Avlona, limestone rocks S of the village, 11.11.2012 (2012/34), N35°45.657' E27°10.758', 345 m; singled.

280: South Aegean region, Karpathos regional unit, Karpathos Island, Spoa, Profitis Ilias area, open spring along the road, N of the village, 11.11.2012 (2012/35), N35°39.851' E27°09.097', 285 m; singled, waternet.

281: South Aegean region, Karpathos regional unit, Karpathos Island, Kipos, rocky semidesert N of the village12.11.2012 (2012/36), N35°27.228' E27°09.476', 65 m; singled, soil sample (soil from beneath stones) (Murányi 2013b).

282: South Aegean region, Karpathos regional unit, Karpathos Island, Arkasa, Vlycha (Fleya) Stream and its shore bush S of the village, 12.11. 2012 (2012/37), N35°27.494' E27°06.228', 5 m; singled, beaten, waternet.

283: South Aegean region, Karpathos regional unit, Karpathos Island, Mt. Lastos, limestone rocks in the peak region, 12.11.2012 (2012/38), N35°34.300' E27°09.541', 905 m; singled, soil sample (soil from beneath rocks) (Murányi 2013b).

284: South Aegean region, Karpathos regional unit, Karpathos Island, Voloda, brook in a gorge by the village, 12.11.2012 (2012/39), N35° 33.240' E27°09.878', 405 m; singled, beaten, waternet, soil sample (brookside plane tree leafs) (Murányi 2013b).

285: South Aegean region, Karpathos regional unit, Karpathos Island, Lefkos, pine forest S of the village, 12.11.2012 (2012/40), N35°35.730' E27°05.577', 135 m; singled, beaten, soil sample (soil from beneath stones).

286: South Aegean region, Karpathos regional unit, Karpathos Island, Mesochori, spring and its outlet at Vryssiani church, 12.11.2012 (2012/41), N35°37.954' E27°06.600', 125 m; singled, beaten, waternet, soil sample (pomegranate leaf litter).

287: South Aegean region, Rhodes regional unit, Rhodes Island, Petaloudes ('Butterfly Valley'), forested stream gorge, 13.11.2012 (2012 /42), N36°20.269' E28°03.716', 190 m; singled, beaten, waternet.

288: South Aegean region, Rhodes regional unit, Rhodes Island, Afandou, olive groove N of the village, 13.11.2012 (2012/43), N36°18.167' E28°08.964', 105 m; singled.

289: South Aegean region, Rhodes regional unit, Rhodes Island, Haraki, Haraki Beach, sandy seashore N of the village, 14.11.2012 (2012/44), N36°10.524' E28°05.854', 0 m; singled (Sziráki 2013).

290: South Aegean region, Rhodes regional unit, Rhodes Island, Haraki, Tou. Thanasi Spring W of the village, 14.11.2013 (2012/45), N36° 10.563' E28°05.362', 5 m; singled, waternet.

291: South Aegean region, Rhodes regional unit, Rhodes Island, Aghios Nektarios, pine forest E of the monastery, 14.11.2012 (2012/46), N36° 15.943' E28°04.822', 145 m; singled, soil sample (pine leaf litter) (Murányi 2013b).

292: South Aegean region, Rhodes regional unit, Rhodes Island, Aghios Nektarios, Loutanis River and its plane tree gallery at the monastery, 14.11.2012 (2012/47), N36°15.932' E28°04.625', 140 m; singled, beaten, waternet.

293: South Aegean region, Rhodes regional unit, Rhodes Island, Eleousa, artificial spring lake at the village 14.11.2012 (2012/48), N36°16.370' E28°01.439', 290 m; singled, waternet.

294: South Aegean region, Rhodes regional unit, Rhodes Island, Aghios Nikolaos Foundoukli, trees at the monastery, 14.11.2012 (2012/49), N36°16.459' E27°59.836', 320 m; singled.

295: South Aegean region, Rhodes regional unit, Rhodes Island, Mt. Prophitis Ilias, limestone rocks E of the monastery, N36°16.401' E27° 57.463', 550 m; singled.

296: South Aegean region, Rhodes regional unit, Rhodes Island, Kremasti, stream and degraded grassland at the city, along the main road, 14.11.2012 (2012/51), N36°24.530' E28°06.633', 5 m; singled, beaten, waternet (Murányi 2013b).

30.03–07.04.2013 (leg. Jenő Kontschán, Dávid Murányi, Tímea Szederjesi)

297: Thessaly region, Magnesia regional unit, Pelio Mts, Hania, beech forest torrent at the settlement, 30.03.2013 (2013/1), N39°23.613' E23° 02.757', 1150 m; singled, beaten, waternet, soil samples (soil from beneath plane trees, beech leaf litter).

298: Crete region, Chania regional unit, Kakopetros, stream and its plane tree gallery near the village, 31.03.2013 (2013/2), N35°24.803' E23° 45.391', 430 m; singled, beaten, waternet, soil sample (plane tree leaf litter) (Murányi 2013b).

299: Crete region, Chania regional unit, Vamvakades, rocky grassland S of the village, 31.03. 2013 (2013/3), N35°18.068' E23°45.057', 855 m; singled.

300: Crete region, Chania regional unit, Sougia, seashore tamarisk stands at the village, 31.03. 2013 (2013/4), N35°14.917' E23°48.706', 0 m; singled, beaten.

301: Crete region, Chania regional unit, Skafi, stream and its plane tree gallery S of the village, 31.03.2013 (2013/5), N35°18.806' E23°47.612', 370 m; singled, beaten, waternet, soil sample (mixed soil and plane tree leaf litter).

302: Crete region, Chania regional unit, Lefka Ori Mts, Omalos, rocky grassland W of the village, 31.03.2013 (2013/6), N35°21.225' E23° 51.355', 1020 m; singled, soil sample (soil) (Murányi 2013b).

303: Crete region, Chania regional unit, Lefka Ori Mts, Omalos, rocky grassland W of the village, 31.03.2013 (2013/7), N35°19.483' E23° 53.507', 1060 m; singled.

304: Crete region, Chania regional unit, Lefka Ori Mts, Samaria, spring in oak stand at the rest area, 31.03.2013 (2013/8), N35°18.481' E23° 55.051', 1250 m; singled, beaten, soil sample (soil).

305: Crete region, Chania regional unit, Fournes, roadside by a dry gorge S of the village, 31.03.2013 (2013/9), N35°25.400' E23°56.495', 125 m; singled.

306: Crete region, Chania regional unit, Georgioupoli, swamp E of the village; 01.04.2013 (2013/10), N35°21.112' E24°17.442', 5 m; singled, waternet, soil samples (dry leaf litter of Eucalyptus, leaf litter from wet channelside), plancton sample (swamp edge open water).

307: Crete region, Rethymno regional unit, Goulediana, olive grove with oak stands at the village, 01.04.2013 (2013/11), N35°17.206' E24° 29.949', 440 m; singled, beaten (Murányi 2013b).

308: Crete region, Rethymno regional unit, Mirthios, D. Dason Rethymnis spring E of the village, 01.04.2013 (2013/12), N35°17.619' E24° 33.360', 155 m; singled, beaten, waternet, soil sample (wet plane tree leaf litter).

309: Crete region, Rethymno regional unit, Moni Veni, springs at the monastery, 01.04.2013 (2013/13), N35°16.228' E24°36.377', 595 m; singled, beaten, soil sample (soil).

310: Crete region, Rethymno regional unit, Voleones, spring in the village, 01.04.2013 (2013/14), N35°16.286' E24°35.373', 325 m; singled, waternet.

311: Crete region, Rethymno regional unit, Apostoli, stream and its plane tree gallery N of the village, 01.04.2013 (2013/15), N35°16.211' E24°36.821', 320 m; singled, beaten, waternet.

312: Crete region, Rethymno regional unit, Nithavris, spring in the village, 01.04.2013 (2013/16), N35°10.292' E24°43.989', 480 m; singled, waternet.

313: Crete region, Heraklion regional unit, Kali Limenes, semidesert above the village, 02.04.2013 (2013/17), N34°56.038' E24°47.826', 70 m; singled.

314: Crete region, Heraklion regional unit, Kali Limenes, rocky seashore at the village, 02.04.2013 (2013/18), N34°55.805' E24°48.008', 0 m; singled.

315: Crete region, Heraklion regional unit, Pigaidakia, rocky macchia S of the village, 02.04.2013 (2013/19), N34°57.917' E24°50.006', 345 m; singled.

316: Crete region, Heraklion regional unit, Agii Deka, small river and its gallery at Agios Tilos basilica, 02.04.2013 (2013/20), N35°03.704' E24°56.792', 160 m; singled, beaten, waternet, soil sample (soil).

317: Crete region, Heraklion regional unit, Astyraki, pools of a temporary stream SE of the village, 02.04.2013 (2013/21), N35°17.844' E24°57.718', 395 m; singled, beaten, waternet.

318: Crete region, Rethymno regional unit, Ida Mts, spring and its outlet at an archeogical site and taverna, 02.04.2013 (2013/22), N35°12.388' E24°50.044', 1380 m; singled, beaten, waternet, soil sample (nest of ants).

319: Crete region, Rethymno regional unit, Ida Mts, limestone rocks at a pasture towards the observatory, 02.04.2013 (2013/23), N35°12.560' E24°52.536', 1480 m; singled (Murányi 2013b).

320: Crete region, Rethymno regional unit, Axos, spring S of the village, 02.04.2013 (2013/24), N35°17.934' E24°50.485', 590 m; singled, beaten, soil sample (mixed soil and leaf litter).

321: Crete region, Rethymno regional unit, Sisarcha, stream and its plane tree gallery N of the village, 03.04.2013 (2013/25), N35°18.073' E24°54.800', 575 m; singled, beaten, waternet, soil sample (plane tree leaf litter).

322: Crete region, Heraklion regional unit, Krasi, spring system in the village, 03.04.2013 (2013/26), N35°14.010' E25°28.154', 610 m; singled, waternet.

323: Crete region, Lasithi regional unit, Dikti Mts, Pinakiano, slow stream in a meadow, W of the village, 03.04.2013 (2013/27), N35°11.615' E25°25.976', 815 m; singled, beaten, waternet, soil sample (nest of ants).

324: Crete region, Lasithi regional unit, Dikti Mts, Mesa Potami, torrent W of the village, 03.04.2013 (2013/28), N35°12.727' E25°30.952', 915 m; singled, beaten, waternet, soil sample (moss).

325: Crete region, Lasithi regional unit, Dikti Mts, Roussakiana, hazel bush in the village, 03.04.2013 (2013/29), N35°12.738' E25°31.884', 845 m; singled.

326: Crete region, Lasithi regional unit, Dikti Mts, Katharo, stream in the settlement, 03.04.2013 (2013/30), N35°08.068' E25°33.674', 1125 m; singled, beaten, waternet, soil sample (moss).

327: Crete region, Lasithi regional unit, Dikti Mts, Katharo, rocky evergreen oak forest E of the settlement, 03.04.2013 (2013/31), N35°09.242' E25°35.185', 1070 m; singled, soil sample (mixed soil and leaf litter) (Murányi 2013b).

328: Crete region, Lasithi regional unit, Sfaka, dry limestone gorge beneath the village, 04.04.2013 (2013/32), N35°09.197' E25°55.248', 240 m; singled, beaten (Murányi 2013b).

329: Crete region, Lasithi regional unit, Sitia, roadside Ricinus bush E of the city, 04.04.2013 (2013/33), N35°12.163' E26°06.654', 5 m; singled.

330: Crete region, Lasithi regional unit, Analoukas, sandy seashore at the village, 04.04.2013 (2013/34), N35°12.687' E26°11.131', 0 m; singled, soil sample (decaying seagrass).

331: Crete region, Lasithi regional unit, Kouremenos Beach, large brackish puddle close to the settlement, 04.04.2013 (2013/35), N35°12.379' E26°16.149', 0 m; singled, plancton sample (large brackish puddle).

332: Crete region, Lasithi regional unit, Agathia, wet meadow NE of the village, 04.04.

2013 (2013/36), N35°11.936' E26°16.462', 5 m; singled, beaten, sweeping net, soil sample (soil).

333: Crete region, Lasithi regional unit, Zakros, stream and its plane tree gallery N of the village, 04.04.2013 (2013/37), N35°06.918' E26° 13.153', 190 m; singled, beaten, waternet, soil sample (mixed soil and leaf litter) (Murányi 2013b).

334: Crete region, Lasithi regional unit, Zakros, Zakros Spring above the village, 04.04.2013 (2013/38), N35°06.837' E26°12.827', 265 m; singled, beaten, waternet, soil samples (wet plane tree leaf litter, dry plane tree leaf litter).

335: Crete region, Lasithi regional unit, Kato Zakros, sandy seashore at the village, 04.04.2013 (2013/39), N35°05.761' E26°15.793', 0 m; singled.

336: Crete region, Lasithi regional unit, Karidi, rocky grassland W of the village, 04.04.2013 (2013/40), N35°07.912' E26°12.849', 290 m; singled.

337: Crete region, Lasithi regional unit, Thriptis Mts, Agios Ioannis, stream and its gallery E of the village, 05.04.2013 (2013/41), N35°03.615' E25°51.938', 460 m; singled, beaten, waternet, soil samples (very wet plane tree leaf litter, wet plane tree leaf litter) (Sziráki 2013).

338: Crete region, Lasithi regional unit, Thriptis Mts, Orino, stream in the village, 05.04.2013 (2013/42), N35°04.883' E25°54.848', 625 m; singled, beaten, waternet.

339: Crete region, Lasithi regional unit, Thriptis Mts, Orino, open brook above the village, 05.04.2013 (2013/43), N35°05.466' E25°53.984', 805 m; singled, beaten, waternet.

340: Crete region, Lasithi regional unit, Agios Georgios, large reservoir below the village, 05. 04.2013 (2013/44), N35°03.042' E25°41.750', 60 m; singled, waternet, sweeping net (Murányi 2013b).

341: Crete region, Heraklion regional unit, Loutraki, olive orchard above the village, 05.04. 2013 (2013/45), N35°01.315' E25°32.163', 415 m; singled, sweeping net.

342: Crete region, Heraklion regional unit, Loutraki, stream and its gorge below the village, 05.04.2013 (2013/46), N35°03.413' E25°24.887', 670 m; singled, beaten, waternet, soil sample (plane tree leaf litter) (Murányi 2013b).

343: South Aegean region, Naxos regional unit, Naxos Island, Ghalini, open stream at the village, 06.04.2013 (2013/47), N37°06.888' E25° 25.715', 35 m; singled, beaten, waternet (Murányi 2013b).

344: South Aegean region, Naxos regional unit, Naxos Island, Abram, stream and its plane tree gallery N of the village, 06.04.2013 (2013/ 48), N37°10.177' E25°29.291', 50 m; singled, beaten, waternet, soil sample (plane tree leaf litter).

345: South Aegean region, Naxos regional unit, Naxos Island, Koronidha, stream and its plane tree gallery N of the village, 06.04.2013 (2013/49), N37°09.850' E25°32.730', 125 m; singled, beaten, waternet.

346: South Aegean region, Naxos regional unit, Naxos Island, Koronidha, stream in a gorge below the village, 06.04.2013 (2013/50), N37° 08.580' E25°31.857', 455 m; singled, beaten, waternet, soil sample (wet soil).

347: South Aegean region, Naxos regional unit, Naxos Island, Koronidha, stream above the village, 06.04.2013 (2013/51), N37°08.071' E25° 31.507', 670 m; singled, beaten, waternet, soil sample (soil).

348: South Aegean region, Naxos regional unit, Naxos Island, Koronis, occupied brook N of the village, 06.04.2013 (2013/52), N37°06.857' E25°32.077', 620 m; singled, beaten, waternet.

349: South Aegean region, Naxos regional unit, Naxos Island, Aghia Paraskevi, shallow brackish lake by the sea, 07.04.2013 (2013/53), N36°59.765' E25°23.521', 5 m; singled, waternet, soil sample (lakeshore debrits), plancton sample (shallow brackish lake).

350: South Aegean region, Naxos regional unit, Naxos Island, Dhamalas, rocky phrygana W of the village, 07.04.2013 (2013/54), N37°02.921' E25°27.351', 260 m; singled.

351: South Aegean region, Naxos regional unit, Naxos Island, Mt. Zas, Filoti, vicinity of Zas Cave, 07.04.2013 (2013/55), N37°01.9' E25° 29.8', 680 m; singled, beaten, waternet.

352: South Aegean region, Naxos regional unit, Naxos Island, Apiranthos, olive orchard E of the village, 07.04.2013 (2013/56), N37°04.408' E25°31.842', 525m; singled.

353: South Aegean region, Naxos regional unit, Naxos Island, dry gorge of Pnichtis Stream below the emery mines, 07.04.2013 (2013/57), N37°05.899' E25°33.313', 200 m; singled.

354: South Aegean region, Naxos regional unit, Naxis Island, Mesi, spring in the village, 07.04.2013 (2013/58), N37°08.846' E25°33.153', 375 m; singled, beaten, soil sample (mixed leaf litter).

355: South Aegean region, Naxos regional unit, Naxos Island, Skeponi, bushy brook W of the village, 07.04.2013 (2013/59), N37°08.277' E25°28.910', 165 m; singled, beaten, waternet.

356: South Aegean region, Naxos regional unit, Naxos Island, Pachia Ammos, large puddle by the sea, 07.04.2013 (2013/60), N37°08.416' E25°27.016', 5 m; singled, plancton sample (large seaside puddle).

Taxa described upon the materials collected during the present tours

Oligochaeta.

Dendrobaena retrosella Szederjesi & Csuzdi, 2012 – holotype: loc. 227.

Eisenia oreophila Szederjesi & Csuzdi, 2012 – holotype: loc. 228, paratypes: loc. 211.

Mollusca.

Balcanodiscus (Balcanodiscus) danyii Erőss, Fehér & Páll-Gergely, 2011 – holotype: loc. 87.

Diplopoda.

Megaphyllum danyii Lazányi & Korsós, 2012 – holotype: loc. 144.

Megaphyllum (Megaphyllum) cygniforme Lazányi & Korsós, 2012 – holotype: loc. 82, paratype: loc. 62.

Megaphyllum (Cyphobrachyiulus) digitatum Lazányi & Korsós, 2012 – holotype: loc. 156.

Collembola.

Hypogastrura peloponnesica Dányi, 2013 – holotype: loc. 150.

Plecoptera.

Brachyptera kontschani Murányi, 2011 – holotype: loc. 151, paratypes: loc. 140, 144, 148.

Perlodes floridus floridus Kovács & Vinçon, 2012 – paratypes: loc. 17, 18, 20.

Trichoptera.

Drusus muranyorum Oláh, 2010 – holotype: loc. 87.

Diptera.

Hesperinus graecus Papp, 2010 – holotype: loc. 31.

Acari

Phthiracarus duplex Mahunka & Mahunka-Papp, 2010 – holotype: loc. 93.

Lauroppia (Lauroppia) brevisimile Mahunka & Mahunka-Papp, 2010 – holotype: loc. 141.

Oribellopsis grecus Mahunka & Mahunka-Papp, 2010 – holotype: loc. 93.

Oribatella valeriae Mahunka & Mahunka-Papp, 2010 – holotype: loc. 141.

Zygoribatula longa Mahunka & Mahunka-Papp, 2010 – holotype: loc. 147, paratypes: loc. 175.

Trachytes parnonensis Kontschán, 2010 – holotype: loc. 99.

Uroobovella graeca Kontschán, 2010 – holotype: loc. 48, paratypes: loc. 36, 51.

Cilliba vellas Kontschán, 2010 – holotype: loc. 1.

Prozercon achaeanus Ujvári, 2011 – holotype: loc. 4, paratype: loc. 8.

Prozercon dramaensis Ujvári, 2011 – holotype: loc. 43, paratypes: loc. 48, 55.

Prozercon graecus Ujvári, 2011 – holotype: loc. 179, paratypes: loc. 34, 36, 42, 43, 48, 51, 55, 75, 82, 173.

Prozercon morazae Ujvári, 2011 – holotype: loc. 158, paratypes: loc. 140.

Prozercon norae Ujvári, 2011 – holotype: loc. 5, paratype: loc. 171.

Acknowledgements – Field work was supported by the Hungarian Scientific Research Fund (OTKA 72744, OTKA-NNF 78185) and the National R&D Programme (3B023-0-4).

REFERENCES

DÁNYI, L. (2010): Review of the genus *Bilobella* Caroli, 1912 in the Balkan Peninsula with description of a new species (Collembola: Neanuridae). *Zootaxa,* 2605: 27–44.

DÁNYI, L. (2013): An undescribed collembolan species swarming on the Peloponnese (Greece). *Opuscula Zoologica Budapest,* 44(Suppl.): 157–166.

Erőss, Z. P., Fehér, Z. & Páll-Gergely, B. (2011): A new species of *Balcanodiscus* Riedel & Urbáński 1964 (Gastropoda: Pulmonata: Zonitidae) from northeastern Greece. *Journal of Conchology,* 40(6): 577–581.

Fehér, Z., Deli, T. & Sólymos, P. (2010): Revision of *Granaria frumentum* (Draparnaud 1801) (Mollusca, Gastropoda, Chondrinidae) subspecies occurring in the eastern part of the species' range. *Journal of Conchoogy,* 40: 201–217.

Kontschán, J. (2010): Taxonomical and faunistical studies on the Uropodina mites of Greece (Acari: Mesostigmata). *Opuscula Zoologica Budapest,* 41(1): 29–38.

Kontschán, J. (2013): Uropodina mites of the Balkan Peninsula (Acari: Mesostigmata). *Opuscula Zoologica Budapest,* 44(Suppl.): 97–131

Kovács, T. & Murányi, D. (2008): New data on genus *Besdolus* from the Balkan Peninsula (Plecoptera: Perlodidae). *Illiesia,* 4(9): 91–93.

Kovács, T., Vinçon, G., Murányi, D. & Sivec, I. (2012): A new *Perlodes* species and its subspecies from the Balkan Peninsula (Plecoptera: Perlodidae). *Illiesia,* 8(20): 182–192.

Kuthy, D. (1907): Insectorum messis in Insula Creta a Lud. Biró congregata. I. Orthoptera. *Annales historico-naturales Musei nationalis hungarici,* 5(2): 551–555.

Lazányi, E., Vagalinski, B. & Korsós, Z. (2012): The millipede genus *Megaphyllum* Verhoeff, 1894 in the Balkan Peninsula, with description of new species (Myriapoda: Diplopoda: Julida: Julidae). *Zootaxa,* 3228: 1–47.

Lopau, W. (2010): Bischer unveröffentlichte Libellen beobachtungen aus Griechenland IV (Odonata). *Libellula,* Suppl. 10: 155–260.

Mahunka, S. & Mahunka-Papp, L. (2010): New and little known Oribatid mites from the Carpathian Basin and the Balkan Peninsula (Acari: Oribatida). *Acta Zoologica Academiae Scientiarum Hungaricae,* 56(3): 211–234.

Malicky, H. (2005): Die Köcherfliegen Griechenlands. *Denisia,* 17: 1–240.

Murányi, D. (2007): New and little-known stoneflies (Plecoptera) from Albania and the neighbouring countries. *Zootaxa,* 1533: 1–40.

Murányi, D. (2011): The genus *Brachyptera* Newport (Plecoptera: Taeniopterygidae) in the Peloponnes, Greece. *Zootaxa,* 2977: 61–68.

Murányi, D. (2013a): Poorly-known phalangiid harvestmen (Opiliones: Phalangioidea) from the Balkans. *Opuscula Zoologica Budapest,* 44 (Suppl.): 139–156

Murányi, D. (2013b): Data to three insect orders (Embiidina, Dermaptera, Isoptera) from the Balkans. *Opuscula Zoologica Budapest,* 44 (Suppl.): 167–186.

Oláh, J. (2010): New species and new records of Palaearctic Trichoptera in the material of the Hungarian Natural History Museum. *Annales Historico-Naturales Musei Nationalis Hungarici,* 102: 65–117.

Papp, L. (2010): A study on *Hesperinus* Walker with description of a new species (Diptera: Hesperinidae). *Acta Zoologica Academiae Scientiarum Hungaricae,* 56(4): 347–370.

Schmalfuss, H. (2008): The terrestrial isopods (Isopoda: Oniscidea) of Greece. 25th contribution: The genus *Armadillidium* (Armadillidiidae) in the provinces Macedonia and Thrace. *Stuttgarter Beiträge zur Naturkunde A, Neue Serie,* 1: 153–201.

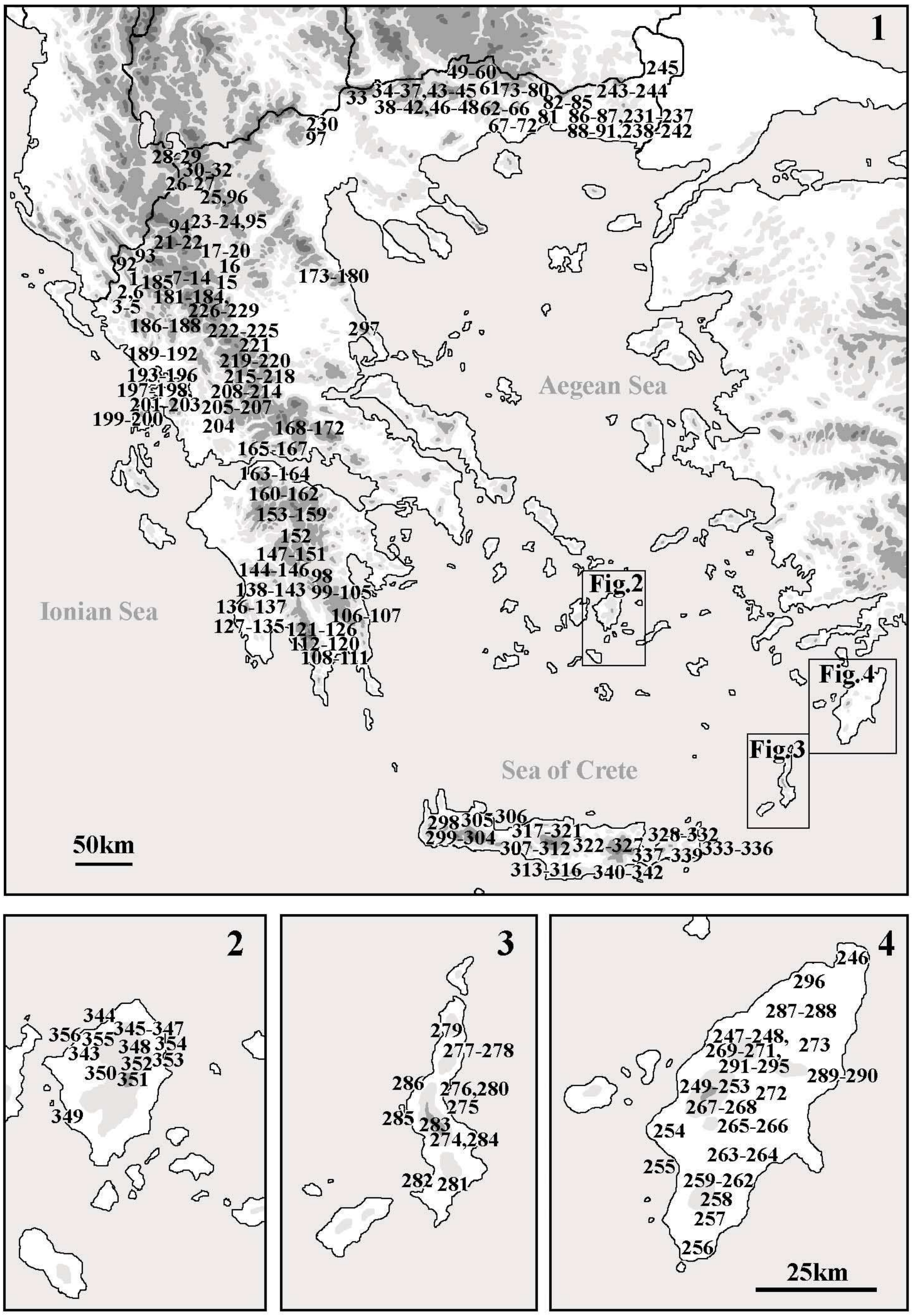
Schmalfuss, H. (2010): The terrestrial isopods (Isopoda: Oniscidea) of Greece. 26th contribution: The genus *Armadillidium* (Armadillidiidae) in the province of Epirus. *Stuttgarter Beiträge zur Naturkunde A, Neue Serie,* 3: 1–31.

Szederjesi, T. & Csuzdi, Cs. (2012): New and little known earthworm species from Greece (Oligochaeta: Lumbricidae, Acanthodrilidae). *Zootaxa,* 3304: 25–42.

Sziráki, Gy. (2013): Data to the Psocoptera fauna of Balkan Peninsula and two Aegean islands. *Folia historico-naturalia Musei Matraensis,* 37: in press.

Ujvári, Zs. (2011): Six new species of *Prozercon* Sellnick, 1943 (Acari, Mesostigmata, Zerconidae) from Greece, with remarks on the genus. *Zootaxa,* 2785: 1–31.

Supporting online material: Appendix 1 (http://opuscula.elte.hu/PDF/Tomus44_2/Muranyi_App1.pdf)



Figures 1–4. Collecting sites in Greece (altitudes above 500, 1000 and 2000 meters are shaded in different grey). 1 = Localities on the mainland, Lefkada, Peloponnes and Crete; 2 = Localities on Naxos; 3 = Localities on Karpathos; 4 = Localities on Rhodes.

Opusc. Zool. Budapest, 2013, 44(2): 161–166

First records of *Larca lata* (Hansen, 1884) and *Neobisium biharicum* Beier, 1939 in Hungary

J. NOVÁK

János Novák, Department of Systematic Zoology and Ecology, Eötvös Loránd University,
H-1117 Budapest, Pázmány P. sétány 1/C. E-mail: novakjanos01@gmail.com

Abstract. The first records of *Larca lata* (Hansen, 1884) and *Neobisium biharicum* Beier, 1939 are reported from Hungary. With *L. lata* and *N. biharicum* the number of the recorded pseudoscorpion species for Hungary has raised to 47. The family of Larcidae Harvey, 1992 proved to be new for Hungary. The morphometrical and morphological characters of the specimens found are discussed.

Keywords. Pseudoscorpions, Central Europe, faunistics, taxonomy.

INTRODUCTION

Although studies regarding the pseudoscorpions have more than a hundred years' tradition in Hungary (Tömösváry 1882, 1884; Daday 1889), the species list of the Hungarian pseudoscorpion fauna is far from complete, and even in the past few years several species new to the fauna of the country were reported (Kárpáthegyi 2007, Novák 2012).

Elaborating the pseudoscorpion material of the Hungarian Natural History Museum two species, *Larca lata* (Hansen, 1884) and *Neobisium biharicum* Beier, 1939 proved to be new for the fauna of Hungary.

The presence of *L. lata* has recently been reported from Slovakia (Christophoryová 2011a). This species occurs also in the neighbouring countries e.g. Austria (Beier 1956) and Romania (Dumitresco & Orghidan 1964). Regarding to our present knowledge *Larca lata* is possessing seemingly a Northern and Central European distribution with reported occurrences in Denmark (Hansen 1884), Sweden (Lohmander 1939), Poland (Beier 1956, Rafalski 1953, 1967), the Czech Republic (Ducháč 1993), Germany (Drogla & Lippold 1994) and the United Kingdom (Judson & Legg 1996). However, the species seems to be absent from the Mediterranean region (Zaragoza 2005). The genus *Larca* is xerophylous, and from its six European species *Larca lata* is the only epigean one. It is regarded to one of the most rare European pseudoscorpion species (Judson & Legg 1996).

Neobisium biharicum was originally described from the Bihar Mts., Transylvania, Romania (Beier 1939), and later was reported from the Northeastern Carpathians (Gyertyánliget, Máramaros, Ukraine) (Szent-Ivány 1941), from the Lepşa Valley in the Eastern Carpathians, Romania (Dumitrescu 1976) and from the Movile Cave in southern Dobrogea, Romania (Ćurčić *et al.* 1993).

The Hungarian specimens of *L. lata* and *N. biharicum* provide a good opportunity to broaden our knowledge regarding to their distribution area, and furthermore, their morphological and morphometrical variations.

MATERIAL AND METHODS

The studied material belongs to the collection of the Hungarian Natural History Museum (HNHM), and it was not investigated until now. Unfortunately, as it is a very old sample, it was not accompanied by proper data on the habitat of collecting locality, the full name of the collector, nor the date of the collection.

urn:lsid:zoobank.org:pub:CA8AF139-F235-48E7-B951-FDB7EBB611B3
HU ISSN2063-1588 (online), HU ISSN 0237-5419 (print)

The material was examined by using a stereomicroscope and light microscope. The specimens were cleared in lactic acid, drawings were made with the aid of a Zeiss Axioskop 2 microscope.

The specimens were identified using the publications of Beier (1939), Christophoryová (2011a; 2011b), Ćurčić *et al*. (1993), Dumitresco & Orghidan (1964), Gardini (1983), Judson & Legg (1996) and Tooren (2001) and deposited in the Hungarian Natural History Museum, in 70% ethanol.

RESULTS

Larca lata **(Hansen, 1884)**

(Figures 1A–D)

Material examined. One male and one female specimen, data accompanied to the material: Pápa 1896.IV. Lg. Wachsmann J.

Measurements (in mm). *Male*. Body length 1.61. Carapace length 0.52. Palpal femur length 0.78, width 0.17, length/width ratio 4.58. Palpal patella length 0.59, width 0.18, length/width ratio 3.27. Chela length 1.0, width 0.23. Chelal hand length 0.56, chelal finger length 0.44.

Female. Body length 1.89. Carapace length 0.6. Palpal femur length 0.83, width 0.17, length/width ratio 4.88. Palpal patella length 0.62, width 0.18, length/width ratio 3.44. Chela length 1.0, width 0.23. Chelal hand length 0.56, chelal finger length 0.44.

Short description. *Carapace* (Fig. 1A). Triangular and granulated, with two transverse furrows, two pairs of well developed eyes with lenses. Epistome absent. At the male the carapace bears 38 setae, 8 situated at the anterior, 4 at the posterior margin of carapace. At the female the carapace bears 34 setae, 8 situated at the anterior, 4 at the posterior margin of carapace. The three situated between the eye-pairs apically enlarged. In case of both specimens 4 pairs of slitlike lyrifissures present.

Chelicerae (Fig. 1B). 5 setae are present on the cheliceral hand, and one on the movable finger. The terminal end of the galea broken by both specimens. Flagellum with 4 blades, serrula exterior with 16 blades.

Pedipalps (Fig. 1C). Surface of pedipalps granulated, clavate vestitural setae present on its surface. Movable chelal finger with 2 trichobotria and 31 marginal teeth at the female, 28 at the male; fixed chelal finger with 8 trichobotria and 33 marginal teeth at the female (Fig. 1D), 30 at the male.

Abdomen. Tergites granulated, tergites II–VIII. divided, tergite IX partly divided. Tergal chaetotaxy of the male from tergite I. to tergite IX: 6:7:10:10:11:13:12:10:12. Tergal chaetotaxy of the female from tergite I to tergite IX: 6:9:10:12:12:12:14:12:12. Tergite X with 6 setae at the male, 8 at the female, and two long tacticle setae broken at both specimens. Number of tergal lyrifissures at the male from tergite I to tergite X: 4:6:6:8:8:9:8:9:8:6 Number of tergal lyrifissures at the female from tergite I to tergite X: 4:8:8:10:10:10:10:10:10:6. Sternal chaetotaxy of the male from sternite IV to sternite X: 8:9:8:8:8:8:8. Sternal chaetotaxy of the female from sternite IV to sternite X: 10:8:10: 10: 10: 10: 10. Number of sternal lyrifissures at the male from sternite IV to sternite X: 7:8:10:8:8:8:6. Number of sternal lyrifissures at the female from sternite IV to sternite X: 6:8:8:8-10:8:8:6.

Arolia. The tarsal arolia longer than the claws of tarsi.

Neobisium biharicum **Beier, 1939**

(Figures 2A–D)

Material examined. One female, data accompanied to the material: 1931. Macskabarlang (the Macskabarlag Cave is located in the Pilis Mts., Hungary).

Measurements (in mm). Body length 3.39. Carapace length 1.12. Carapace breadth 1.17. Chelicera length 0.75. Chelicera breadth 0.4. Length of movable cheliceral finger 0.5. Palpal femur length 1.8, width 0.38, length/width ratio 4.74. Patella length 1.26, width 0.42, length/width ratio 3. Chela length 3.1, width 0.75. Hand length with pedicel 1.35. Hand length without pedicel 1.2. Finger length 1.75.

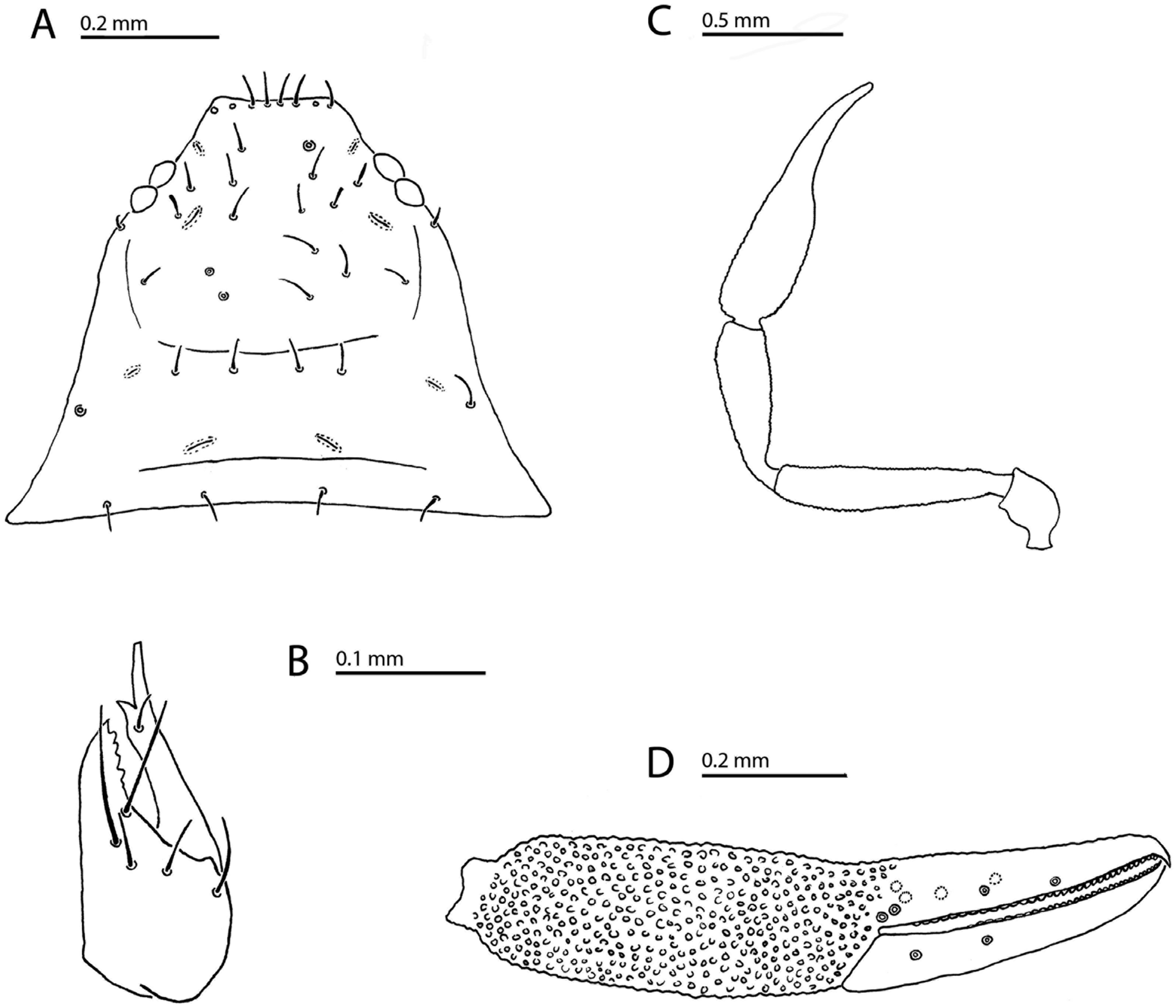


Figure 1. Larca lata. A = Carapace of ♀, B = Chelicera of ♀, C = Pedipalp of ♀, D = Chela of ♀.

Short description. Carapace (Fig. 2A). With triangular, pointed epistome. Two pair of well-developed eyes with lenses. The carapace bears 24 setae and one or two microsetae at the praeopercular recesses. The carapace approximately as long as wide.

Chelicerae (Fig. 2B). Cheliceral palm with 8 setae, and one at the movable finger. Movable cheliceral finger with an enlarged medial tooth.

Pedipalps (Fig. 2C). Trochanter with tubercle. Femur with pedicel and without granulation or tubercles. The chelal finger approximately one third longer than the hand without pedicel. Fixed chelal finger with 90, movable 78 close-set and mostly equal long teeth (Fig. 2D).

Abdomen. Tergal chaetotaxy from tergite I to tergite X: 7:8:8:8:6:6:8:8:8:6. Sternal chaetotaxy from sternite IV to sternite X: 8:8:10:10:10:10:8.

DISCUSSION

After its Slovakian occurrence (Christophoryová 2011a), this is the second data of *Larca lata* from the Carpathian Basin. Although this is a quite rare pseudoscorpion species, according to our present knowledge its occurrence in Transylvania is also expected.

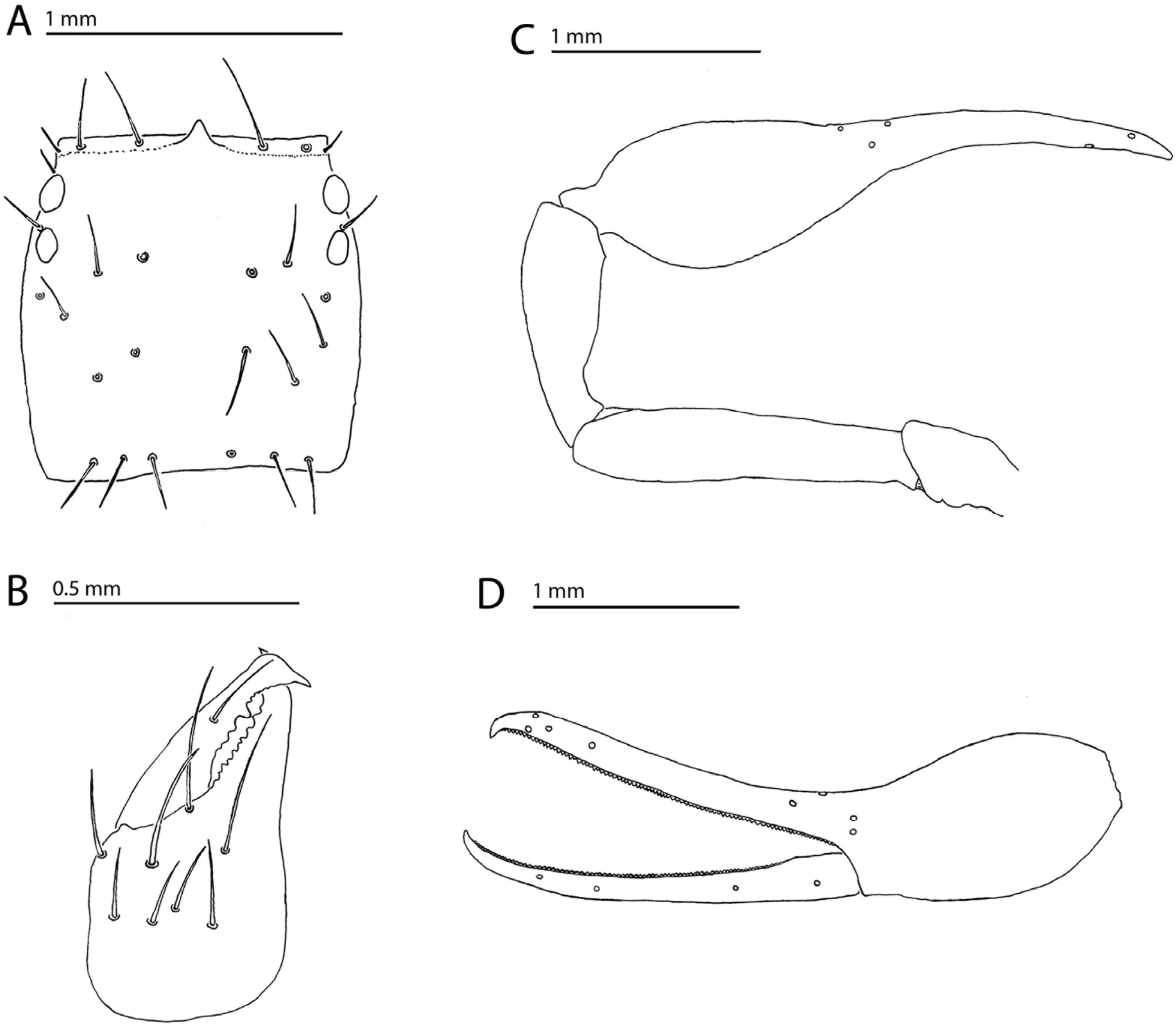


Figure 2. *Neobisium biharicum*. A = Carapace, B = Chelicera, C = Pedipalp, D = Chela.

Unfortunately, we have no detailed data on the habitat of these specimens, but as far as we know, *L. lata* prefers the hollows of old trees (Lohmander 1939; Rafalski 1953), birds' (Christophoryová 2011a; Ressl 1963) and mammals' nests (Ressl 1963). They were also found in caves in bat guano (Dumnitresco & Orghidan 1964).

Phoresy on parasitic insects is also recorded in case of *Larca lata* (Ressl 1965).

Comparing with the descriptions of Christophoryová (2011a), Judson & Legg (1996) and Tooren (2001), our specimens are in accordance with the main taxonomic and morphometric characters reported. Nevertheless, the body size and the number of slitlike lyrifissures on the carapace show a greater variability than reported in the earlier literature.

After Romania (Beier 1939, Dumitrescu 1976, Ćurčić *et al.* 1993) and Ukraine (Szent-Ivány 1941), Hungary is the third country where the presence of *Neobisium biharicum* was reported. In the Pilis Mts., just like in Dobrogea, it was collected from a cave. Though *N. biharicum* is basically an epigean species, it occasionally also occurs in caves (Ćurčić *et al.* 1993). The Hungarian data of the species supports the opinion of Ćurčić *et al.* (1993), that this species earlier might have a larger distribution area, and now it represents a relict form. Regarding to our present knowledge, it seems that with the exception of the Bihar Mts., the Eastern and Northeastern Carpathians *N. biharicum* is restricted to cavernicolous habitats.

The main taxonomic characters observed correspond well with the descriptions of Beier (1939) and Ćurčić *et al.* (1993) however, the less number of teeth on the chelal fingers and the smaller body size assume a greater variability of these characters in *N. biharicum*. It is important to mention that during the comparative morphological investigations of several pseudoscorpion materials of the Museum of Natural History of Vienna, I have observed a *N. biharicum* specimen with a similar number of teeth on its chelal fingers, belonging to the material collected and identified by Dr. Max Beier.

With the two species mentioned above, the list of pseudoscorpions recorded for Hungary is raised to 47 (from 45; Novák 2012). Together with Larcidae recently there are nine pseudoscorpion families reported from Hungary (Harvey 2011).

Acknowledgements – I am grateful to my supervisor, Dr. Klára Dózsa-Farkas and to Dr. Eszter Lazányi for their useful advices. My special thank belongs to the Hungarian Natural History Museum for allowing the access their pseudoscorpion material, as well as to the Museum of Natural History of Vienna for making accessible their pseudoscorpion collection. My visit to the Museum of Natural History of Vienna was supported by the SYNTHESYS Project http://www.synthesys.info/ which is financed by European Community Research Infrastructure Action under the FP7 "Capacities" Program.

REFERENCES

BEIER, M. (1939): Pseudoscorpionidea de Roumanie. *Bulletin du Musée Royal d'Histoire Naturelle de Belgique*, 15(39): 1–21.

BEIER, M. (1956): Bemerkenswerte Pseudoscorpioniden-Funde aus Niederösterreich. *Entomologisches Nachrichtenblatt Wien*, 8: 24–25.

CHRISTOPHORYOVÁ, J., FENĎA, P. & KRIŠTOFÍK, J. (2011a): *Chthonius hungaricus* and *Larca lata* new to the fauna of Slovakia (Pseudoscorpiones: Chthoniidae, Larcidae). *Arachnologische Mitteilungen*, 41: 1–6.

CHRISTOPHORYOVÁ, J., ŠŤÁHLAVSKÝ, F. & FEDOR, P. (2011b): An updated identification key to the pseudoscorpions (Arachnida: Pseudoscorpiones) of the Czech Republic and Slovakia. *Zootaxa*, 2876: 35–48.

ĆURČIĆ, B. P. M., POINAR JR, G. O. & SARBU, S. M. (1993): New and little-known species of Chthoniidae and Neobisiidae (Pseudoscorpiones, Arachnida) from the Movile Cave in southern Dobrogea, Romania. *Bijdragen tot de Dierkunde,* 63: 221–241.

DADAY, E. (1889): Ujabb adatok a magyar-fauna álskorpióinak ismeretéhez. *Természetrajzi Füzetek*, 12: 25–28.

DUCHÁČ, V. (1993): Zwei neue Afterskorpione-Arten aus der Tschechischen Republik. *Arachnologische Mitteilungen*, 3: 36–38.

DROGLA, R. & LIPPOLD, K. (2004): Zur Kenntnis der Pseudoskorpion-Fauna von Ostdeutschland (Arachnida, Pseudoscorpiones). *Arachnologische Mitteilungen,* 27–28: 1–54.

DUMITRESCO, M. & ORGHIDAN T. (1964): Contribution à la connaissance des Pseudoscorpions de la Dobroudja. 1re note. *Annales de Spéléology,* 19: 599–630.

DUMITRESCU, D. (1976): Opilionida, Pseudoscorpionida et Acari. In: Contributions a la connaissance de la faune du département Vrancea. *Travaux du Muséum d'Histoire Naturelle Grigore Antipa,* 17: 273–276.

HANSEN, H. J. (1884): Arthrogastra Danica: en monographisk fremstilling af de i Danmark levende Meiere og Mosskorpioner med bidrag til sidstnaevnte underordens systematik. *Naturhistorisk Tidsskrift*, 3(14): 491–554.

HARVEY, M.S. (2011): Pseudoscorpions of the World, version 2.0. Western Australian Museum, Perth. http://www.museum.wa.gov.au/catalogues/pseudoscorpions

GARDINI, G. (1983): *Larca italica* n. sp. cavernicole dell'Appennino Abruzzese (Pseudoscorpionida, Garypoidea) (Pseudoscorpioni d'Italia XV). *Bolletino della Società Entomologica Italiana*, 115: 63–69.

JUDSON M. L. I. & LEGG, G. (1996): Discovery of the pseudoscorpion *Larca lata* (Garypoidea, Larcidae) in Britain. *Bulletin of the British Arachnological Society*, 10: 205–210.

KÁRPÁTHEGYI, P. (2007): Pseudoscorpions of Hungary. *Folia Historico Naturalia Musei Matraensis*, 31: 81–90.

LOHMANDER, H. (1939): Zur Kenntnis der Pseudoskorpionfauna Schwedens. *Entomologisk Tidskrift*, 60: 279–323.

NOVÁK, J. (2012): New records of pseudoscorpions for the fauna of Bükk Mts., Northeast Hungary (Arachnida: Pseudoascorpiones). *Opuscula Zooolgca Budapest,* 43(1): 57–65.

RAFALSKI, J. (1953): Fauna of arachnids in the National Park of the Wolin island in the light of the previous studies. *Ochrona Przyrody*, 21: 217–248.

RAFALSKI, J. (1967): Zaleszczotki. Pseudoscorpionidea. *Katalog Fauny Polski*, 32(1): 1–34.

RESSL, F. (1963): Können Vögel als passive Verbreiter von Pseudoscorpioniden betrachtet werden? *Vogelwelt*, 84: 114–119.

RESSL, F. (1965): Über Verbreitung, Variabilität und Lebensweise einiger österreichischer Afterskorpione. *Deutsche Entomologische Zeitschrift*, 12: 289–295.

SZENT-IVÁNY, J. (1941): Neue Angaben zur Verbreitung der Pseudoscorpione im Karpatenbecken. *Fragmenta Faunistica Hungarica,* 4 (1–4): 85–90.

TOOREN D. VAN DEN (2001): First record of the pseudoscorpion *Larca lata* in the Netherlands (Pseudoscorpiones: Garypoidea: Larcidae). *Nederlandse Faunistische Mededelingen*, 15: 33–39.

TÖMÖSVÁRY, Ö. (1882): A Magyar fauna álskorpiói. *Magyar Tudományos Akadémia Matematikai és Természettudományi Közlemények,* 18: 135–256.

TÖMÖSVÁRY, Ö. (1884): Adatok az álskorpiók ismeretéhez (Data ad cognitionem Pseudoscorpionum). *Természetrajzi Füzetek,* 8: 16–27.

ZARAGOZA, J. A. (2005). Two new cave-dwelling *Larca* species from the south-east of Spain (Arachnida, Pseudoscorpiones, Larcidae). *Revue suisse de Zoologie*, 112: 195–213.

Opusc. Zool. Budapest, 2013, 44(2): 167–200

The *Potamophylax nigricornis* group (Trichoptera, Limnephilidae): resolution of phylogenetic species by fine structure analysis

J. OLÁH[1], T. ANDERSEN[2], P. CHVOJKA[3], G. COPPA[4], W. GRAF[5],
H. IBRAHIMI[6], O. LODOVICI[7], A. PREVIŠIĆ[8] & M. VALLE[9]

[1]*János Oláh, Residence postal address: Tarján u. 28, H-4032 Debrecen, Hungary*
E-mail: profolah@gmail.com

[2]*Trond Andersen, Department of Natural History, University Museum of Bergen, University of Bergen, P.O. Box 7800, N-5020 Bergen, Norway. E-mail: trond.andersen@um.uib.no*

[3]*Pável Chvojka, Department of Entomology National Museum, Kunratice 1, CZ-148 00 Praha 4, Czech Republic. E-mail: pavel_chvojka@nm.cz*

[4]*Gennaro Coppa, 1, rue du Courlis, F-08350 Villers-sur-Bar, France. E-mail: gennaro.coppa@wanadoo.fr*

[5]*Wolfram Graf, Institute of Hydrobiology and Aquatic Ecology Management, University of Natural Resources and Applied Life Sciences, Vienna, Austria. E-mail: wolfram.graf@boku.ac.at*

[6]*Halil Ibrahimi, University of Prishtina, FSHMN, Department of Biology, Mother Teresa p.n., 10000 Pristina, Kosovo. E-mail: halilibrahimi@yahoo.com*

[7]*Omar Lodovici, Museo Scienze Naturali "E. Caffi", Piazza Cittadella 10, I-24129 Bergamo, Italy. E-mail: olodovici@comune.bg.it*

[8]*Ana Previšić, Department of Biology, Faculty of Science, University of Zagreb, Croatia.*
E-mail: ana.previsic@zg.biol.pmf.hr

[9]*Marco Valle, Museo Scienze Naturali "E. Caffi", Piazza Cittadella 10, I-24129 Bergamo, Italy. E-mail: mvalle@comune.bg.it*

Abstract. Applying the phylogenetic species concept and the sexual selection theory we have reviewed some natal aspects of incipient species and their accelerated evolution. How can we recognise early stages of divergence? Which selection pressures are at work during speciation? Which pathways accelerate the speed of speciation? Which kinds of trait variabilities makes difficult to find initial split criteria? Elaborating the principles of Fine Structure Analysis (FSA) and the morphological Initial Split Criteria (ISP) it was discovered that the European spring dwelling caddisfly *Potamophylax nigricornis* doesn't belong to a single species. It represents an entire species group with seventeen peripatric species evolving on the southern peripheries of the distributional area. Four new species subgroups have been erected: *Potamophylax nigricornis* new species subgroup, *P. elegantulus* new species subgroup, *P. horgos* new species subgroup, *P. simas* new species subgroup. Eleven new species have been described: *Potamophylax apados* sp. nov., *P. fules* sp. nov., *P. fureses* sp. nov., *P. hasas* sp. novov., *P. horgos* sp. nov., *P. kethas* sp. nov., *P. lemezes* sp. nov., *P. peremes* sp. nov., *P. simas* sp. nov., *P. tuskes* sp. nov., *P. ureges* sp. nov. One *Potamophylax* sp. nov. has been differentiated and three new species status have been documented: *Potamophylax elegantulus* (Klapálek) stat. n., *P. mista* (Navás) stat. nov., *P. testaceus* (Zetterstedt) stat. nov.

Keywords. *Potamophylax nigricornis* group, Trichoptera, phylogenetic species, sexual selection, new species

INTRODUCTION

Potamophylax nigricornis (Pictet, 1834), this beautiful caddisfly species with faded light stripes on the dark forewing, is a widely distributed European spring dweller. It has been reported on the triangle from Lapland to Pyrenees and to Turkey. The forewing colour pattern as well as the digitate paraproct and gonopod are remarkably stable. These elongated periphallic organs have dominated the scope of the routine identification practice so much, that the high diversity of the phallic organs remained undetected (Figs. 1–3). Emerging theory of sexual selection has started to

urn:lsid:zoobank.org:pub:AABC1CA1-A977-49D0-8085-7F49843A86F5
HU ISSN 2063-1588 (online), HU ISSN 0237-5419 (print)

focus on structural details of the phallic organ and on the internal structures of the female genital chamber. Colour divergences on the distributional peripheries induced early description of new species or variants: *Phryganea testacea* Zetterstedt, 1840 (= *P. testaceu*s (Zetterstedt, 1840) stat. n.) from Lappland; *Stenophylax nigricornis* var. *elegantulus* Klapálek, 1899 (=*P. elegantulus* (Klapálek, 1899) stat. n.) from Bosnia; *Stenophylax nigricornis* var. *mista* Navas 1918, and *Stenophylax aculeatus* Navas 1919, both from Spain (Pyrenees) (*P. mista* (Navás, 1918) stat. n.) The second valid species *Potamophylax schmidi* Marinkovic was recognised also by its remarkable dark striped forewing from Bosnia-Herzegovina.

The doubts about identification and misidentifications of recently collected dark striped specimens from various mountains in the Balkan Peninsula and paler specimens from France (Oláh 2010) have initiated our present study to find other traits than just pigmentation in order to separate and to distinguish among taxa. Application of the phylogenetic species concept and the sexual selection theory inspired us to initiate the examination of the fine structures of the phallic organ as well as of the vaginal sclerite complex directly involved in mating. This theoretical background accompanied with our principle of Fine Structure Analysis (FSA) revealed that *Potamophylax nigricornis* doesn't belong to a single species. It represents an entire species group composed of seventeen peripatric species evolving on the southern peripheries of the distributional area. This intense population differentiation possibly developed during the Pleistocene and probably in sexual and ecological speciation processes.

Molecular genetics has created spectacular resolution in research of speciation processes. Our FSA on male and female structures directly involved in sexual selection processes of mating offers even higher resolution level per value for money (Oláh *et al*. 2012, Oláh & Ito, 2013). It was shocking to realise that seventeen phylogenetic species hid under a single species. However more diversity of this species group is still to be discovered because the present synopsis was based upon limited material that was put together from set aside materials. A target oriented systematic collection project will produce more new taxa. It seems that juvenile incipient taxa of the phylogenetic species concept are strongly camouflaged by the former species ranking concept in spite of the spreading practice of routine DNA sequencing.

Here we have reviewed some pointed areas of theoretical relations concerning the birth of the incipient species and their accelerated evolution. We are working in alpha taxonomy and not familiar in details about the rapid progress of molecular genetics. Therefore this review was just prepared for our own understanding in the following questions. How can we recognise early stages of divergence? Which selection pressures are at work during speciation? Which pathways accelerate the speed of speciation? Which kinds of trait variabilities make it difficult to find initial split criteria?

THEORETICAL PART

According to the phylogenetic species concept the species are "branches in the lines of descent" (Darwin 1859). Species are entire population lineages and not only a stage in the lineage divergence. Species has been transferred from the hierarchy of taxonomic rank to the hierarchy of biological organisation (deQueiroz 2011). Species is not a taxonomic rank, but it is a level of biological organisation. Placing discrete boundaries on the continuous process of diversification is a misleading practice. Species are organised and permanently changing realities during their entire life span, from initial separation to extinction. Molecular genetics proves that reproductive barriers are semipermeable to gene flow and species can differentiate despite ongoing interbreeding (Hausdorf 2011). The basic challenge however remained both for taxonomist and for geneticist how to find initial split criterion. That very point in the continuum of morphological or molecular divergence where or when a new species is born. In taxonomy we have to search stable structural entities for initial split criterion. This allows covering the two roles of taxa in the phylogenetic species concept.

(1) As entity of the evolution theory, manifesting the organising continuum of living world.

(2) As lineage, describing biodiversity and reflecting the pattern of the organised life (Oláh *et al.* 2012).

How to recognise early stages of divergence?

To detect initial separation, the very beginning of the morphological divergence, the birth of a new divergent structure is a great, but promising challenge to alpha taxomomist. Two ways to study the genetic and structural changes in the time course of speciation have been differentiated and symbolized by spyglass and magnifying glass (Via 2009).

(1) Retrospective analysis of reproductive isolation through spyglass starts late when speciation already completed, and looks back in time. This approach focusses on postzygotic genetic incompatibilities of hybrid sterility or inviability and allopatric speciation remains the null model.

(2) Prospective analysis in early stage of speciation starts early through magnifying glass when species born. It looks perspective or prospective in time how a variable population evolves into a divergent pair of populations. This population level analysis focusses on how ecological, sexual and social selection pressures and genetics interact and cause the evolution of sexual or ecological barriers to gene flow and how this result in partial reproductive isolation.

Top-down and bottom-up ways to study the genetic and structural changes in the selection processes of speciation have been outlined (Andersson & Simmons 2006) Top-down inferring causes from phenotypic pattern and bottom-up from DNA sequences via protein to phenotypic expression. Top-down is a deductive reasoning approach with theory-driven method and bottom-up is an inductive approach with data-driven method. The resource intensive multidisciplinary models of top-down (morphology-molecules) and bottom-up (molecules-morphology) speciation research are resource limited. The pure taxonomic bottom-up model from fine structure to gross morphology is resource effective. It may help us to find initial split criterion in order to understand the early stages of speciation as well as the real diverging point of a newly born species.

Pressures in accelerated speciation

Natural, ecological, sexual, and social selections are different forms of the same process with interrelations. A possible alternative idea is to consider the ecological, sexual and social environment as stimulating and acting pressures in natural selection. Understanding how reproductive barriers evolve during accelerated speciation remains an important question in evolution. Divergence in mating preferences may be a common first step in this process.

Ecological speciation is defined as the evolution of reproductive isolation through ecologically based divergent natural selection. *Reproductive character displacement* by *reinforcement* may play a diversifying role when previously allopatric populations join. Divergence in sympatry can be driven by sexual conflict or by association of mating types with ecological differences. In a broad definition of sexual selection, traits that influence competition for mates are sexually selected, whereas those that directly influence fecundity or offspring survival are naturally selected.

Combined sexual and ecological selection as mainspring of diversification. Mate choice by phenotype matching cannot be hindered by recombination because the same genes control both the mate signals and the mate preferences (Conte & Schluter 2013). Speciation is made even faster if phenotype matching is based on a trait under divergent natural selection. In this case, assortative mating should rapidly evolve as a byproduct of divergent selection on the trait. Sexual selection is strong and rapid especially in conjunction with ecological divergence (Bonduriansky 2011). Rapidly changing environment can drive and speed reproductive isolation in the process of ecological speciation. During adaptive radiation the speciation rates are accelerated by the availability and diversity of the newly exposed resources. Later niche filling and resource limitation decelerate speciation rates. Ecological differences can drive the evolution of partial reproductive barriers in dozens to hundreds of generations (Hendry *et al.* 2007). Some exceptionally rapid pleistocene speciation probably followed similar temporal cycles (Phillimore & Price 2009)

The postcopulatory *cryptic female choice* is achieved during the long temporal and spatial journeys of the sperms within the female genital system. This sexual selection mechanism with various female-controlled processes is more distributed, particularly in polyandry, than the classic Darwinian precopulatory female choice (Eberhard 2009, 2010). Promiscuous females that mate to both related and unrelated males are able to bias paternity against their relatives to avoid inbreeding. They control and manipulate sperm storage in the process of cryptic female choice (Bretman *et al.* 2009).

Gamete recognition. Fertilization is realised by the interaction of proteins on the surfaces of sperm and egg. These proteins may evolve rapidly and supported by definitive block to polyspermy.

Accelerated ways of speciation

There are no universal molecular clocks for invertebrates even if we apply the „relaxed clock" method recalibrated for variable substitution rates. The accumulation process of fixed mutation is very complex (Thomas *et al.* 2006). The genetic distance measured by DNA sequence analysis is related to lineage divergence time but with unconstant rates. The speciation speed estimated by molecular clock is in the range of million years. However animal and plant communities in many parts of the world have shorter history. For instance the environmental alteration at the end of the Pleistocene, only 10,000 years ago, triggered rapid evolution of juvenile incipient phylogenetic species. Genetic models of adaptation created by Modern Synthesis are focusing on allelic variation, Mendelian inheritance and random gene mutation with slow speciation processes. These former models are incomplete and unable to explain mechanisms of the accelerated divergence processes under various selection pressures. Today there is growing diversity of mechanisms allowing inheritance of acquired traits. It seems that heredity is not mediated by a single, universal mechanism. A pluralistic model of heredity is now emerging (Bonduriansky 2012). Newly discovered mechanisms can accelerate or even modify the rate and direction of adaptation in various speciation pathways.

Genetic inheritance. Speciation can be rapid under both ecological and mutation-order models, because alleles are driven to fixation by natural selection in both cases. However mutation-order speciation is more difficult when gene flow spreads favourable mutations to other populations, preventing divergence (Schluter 2009). Migration and also the genetic drift affect the entire genome, but the effects of natural selection are limited to the genomic regions harboring loci that affect the selected phenotypic trait. Ecological selection maintains divergence in those parts of the genome that affect favorable traits, while gene flow continues on other genomic region. Therefore in early stages of ecological speciation with gene flow (in synpatry) the genetic divergence is restricted to the divergently selected genomic region of the favorable quantitative trait loci. In incipient species this *genetic mosaic of speciation* involves only few stable characters of the diverging loci leaving the genom largely homogenised with polymorphisms by ongoing gene flow. These noise or *random variations* are neutral changes with respect to selection. Nearby the diverging loci the selective sweep reduces polymorphism through genetic drift or evolutionary hichhiking. In rapidly adapting populations, the loci with aberantly high outlier values are under divergent selection and its split could be estimated by retrospective coalescent simulation.

Nongenetic inheritance. Inheritance mediated by the transmission to offspring of elements of the parental phenotype or environment: epigenetic state (epiallele), cytoplasmic and somatic factors, nutrients, extraorganismal environment, behavior, and culture (Bonduriansky & Day 2009). According to hard/soft dichotomy the hard heredity is the Central Dogma of the exclusive one-way passage of information from DNA sequence to RNA to protein, refuting the possibility of soft or Lamarkian heredity that an individual's experiences during its lifetime could have predictable effects on the phenotype of its offsring. Nongenetic inheritance can track too rapid environmental changes for genetically based adaptation. It can overcome some of the limitations of genetic inheritance, partially decoupling phenotypic change from genotypic change by using acquired traits, by permitting transmission of favorable trait combination when genetic recombination is diluting its pool, by generating heritable phenotypic variation to replace the depleted additive genetic variation (Bonduriansky 2012).

Genetic encoding. In nongenetic inheritance a hypothesized process whereby an aquired trait is encoded in the germ-line DNA sequence, thereby giving rise to a new, transmissible gene allele (Bonduriansky 2012).

Biased mutation. Speciation processes could be speed up by non-random mutation, when particular environmental factors tend to induce particular changes in the DNA sequence (Bonduriansky 2012). Some non-random *epimutation* are also influenced by environment. Similar to *nucleotide mutations*, *epimutations* have the potential to be beneficial, neutral or deleterious.

Developmental phenotype plasticity. Within-generation and transgenerational phenotypic plasticity bring individuals closer to phenotypic optimum allowing populations to persist through periods of rapid environmental change when slow genotypic changes cannot keep pace during evolution sensu stricto (Bonduriansky *et al.* 2012). Natural selection acts upon favorable mutation, but this random process is unlikely to produce all the variants therefore the importance of environmental induction in evolution should not be ignored.

Phenotypic and genetic accommodation. Baldwin effect (Baldwin 1896) is based on two concepts of rapid changes.

(1) *Organic selection* is the ability of plasticity to increase survival.

(2) *Orthoplasy* is the directional influence of organic selection on evolution.

Plastic individuals are able to adapt to environmental changes rapidly within one generation. This plasticity dictates the course and direction of evolution and over time standing genetic variation can be selected in the direction of induced plastic response. Baldvin spoke of accommodation in reference to this non-heritable phenotypic change. Today (Crispo 2007) we distinguish phenotypic accommodation (Baldwin's accommodation) and genetic accommodation when heritable variation occurs in the same direction as the plastic response, similarly to Baldwin's coincident variation or orthoplasy.

Genetic assimilation (Waddington, 1942) suggests that environmentally induced phenotypes may become genetically fixed (Pigliucci & Murren 2003), the induced phenotypic variation becomes constitutively produced (Pigliucci *et al.* 2006) and no longer requires the original environmental stimulus for expression. In the original idea of *phenocopy* (Goldschmidt 1940) the environmentally induced phenotype looks like the result of a genetic random mutation.

Epigenetics. Rapid heritable changes, phenotypic variations in gene expression are frequently unexplained by differences in DNA sequence. Epigenetic fitness differences, as selection pressures provide additional system of heritable variation for natural selection. Epigenetic variations, unlike genetic variations are alterable directly by ecological or sexual interactions, providing acelerated way for evolutionary change (Bossdorf e*t al.* 2008). Epigenetic changes are based on molecular processes like DNA methylation or chromatin acetylation and methylation. Epigenetic processes modify genotype expression through epigenotype to phenotype. Transgenerational epigenetic inheritance supports Lamarkian inheritance of acquired phenotypic traits when environment in one generation can cause epigenetic changes that are inherited for multiple generations. Aquired trait could be encoded in the germ-line DNA sequence initiating new, transmissible gene allele.

Phenotypic trait variability

In alpha taxonomy we have to find stable trait for initial split criterion to separate juvenile incipient taxa when applying the phylogenetic species concept. In nature the intraspecific trait variation occupies a central role as rough material for evolutionary sorting processes of natural selection and random drift. The description of a single individual is frequently not sufficient to describe an entire species. No two individuals of the same species are identical. Even identical twins, possessing the same set of genes, have different fine structures due to the random effects of any biological processes. Instead, the description of many individuals taken together defines a range of variation that encompasses the species.

Different individuals possess different sets of genes forming the intraspecific variation (Darwin's individual variability). The observable individual variability is refered to as *phenotypic variation* or as *phenotypic polymorphism*. In alpha taxonomy we search stable specific characters of phenotype with trials to understand the range of phenotypic variation. Phenotypic variation results from genetic and environmental factors. The genetically controlled phenotypic variation is recognised as *genetic polymorphism* or simple *polymorphism*. There are three primary sources of genetic variation:

(1) *Mutations* are changes of the nucleotide sequence of the genome. A single mutation can have a large effect, but evolutionary change is based on the accumulation of many mutations.

(2) *Gene flow* is any movement of genes from one population to another.

(3) Sex can introduce new gene combinations into a population by genetic reshuffling (recombination) and by genetic random drift. *Standing genetic variation* represents alleles alredy present in population.

Phenotypic variability is the tendency or potential of an organism to vary (Wagnes & Altenberg 1996), while phenotypic variation can be observed and documented. Variability represents a range of potential outcomes and expressed phenotypic variation in a population what is available to natural selection. Developmental processes and their interactions limit the variability including molecular, genetic, cellular, individual, population and environmental factors. Development itself is evolvable with interactions producing ever-changing landscape of variability. Processes of canalization, developmental stability and morphological integration are interrelated components of variability (Willmore *et al.* 2007):

(1) *Canalization* ensures similar phenotypic expression buffering development against both environmental and genetic perturbations. Canalization is measured by pattern and amount of among-individual variation indicates differences in ability to canalize development against genetic and environmental stresses.

(2) Developmental stability ensures consistent phenotypic expression within individuals and measured by within individual variation or fluctuating asymmetry. Any deviation from symmetry reflects some developmental instability, high levels of fluctuating asymmetry indicate low level of developmental stability. Both developmental stabilty and canalization limit the expression of phenotypic variation, but differ according to how they are measured.

(3) Morphological integration refers to the phenotypic interdependence of two or more structures enhancing the overal stability of the organism. Pleiotropy and linkage disequilibrium create genetic integration and coordinated evolution of traits is considered as evolutionary integration. Modularity is related to the concept of morphological integration and the module is a set of characters integrated internally. Morphological integration is estimated by measuring the level of covariation or correlation among structures.

Even subtle structural variations seem to be correlated with fitness parameters in local specialization for resource use. Morphological differenttiation should be reduced when individuals shift from a geographically heterogeneous habitat. *Adaptive variation* suggests that morphologies of population members can result in differences in their niches. The *niche variation hypothesis* (Van Valen 1965) suggests that populations with wider niches (generalist) are more variable than populations with narrower niches (specialist). Phenotypic variation in a generalist population could be achieved by an increase in genetic variation and by phenotypic plasticity if plasticity itself is evolvable. Constraints on genetic variation, such as the absence of assortative mating, may limit the amount of variation that can evolve in a sexual population. Response to selection in the early stages of divergence is based on *standing genetic variation*, producing more rapid speciation than the variation generated from new mutation.

MATERIAL AND METHODS

Cooperation to put together available materials

The discovered *Potamophylax nigricornis* species group could be a deterrent depressing model how we miss to resolve the fine diversity of our living world even in the "intensively studied Europe". In spite of the ongoing declared "green" policy the science of biodiversity, the basic science of ecosystem services, that is the alpha taxonomy is resource limited, not supported. To overcome this mismanaged environmental policy the first author has developed an idea of cooperation how to realise comprehensive studies on the so called obscured taxa. Many European caddisfly species with wide distribution and with high apparent phenotypic variability are possible object of such cooperation. Many of these noise or random variations are neutral changes with respect to selection and frequently accompanied by stable traits, the product of the particular selection during the ealy stages of speciation. These childhood stable traits of the icipient phylogenetic species could serve as reliable initial split criteria to distinguish a newly evolved species. The neutral random variations in the populations of the so called widely distributed and highly varying "species" are the direct signs of intense speciation processes. This can be demonstrated if we are able to confirm the particular selection process by finding stable morphological traits, the target of selection and the first morphological product of speciation.We have already documented such condition, under the pressure of sexual slection at *Chaetopteryx rugulosa* species group. In this group the periphallic organs exhibit high variation, but some structures on the intromittent phallic organ are very stable (Oláh *et al.* 2012). It is promising that FSA offers us to find such a stable characters. These early products of selection are not yet confounded by additional differences. These additional diversifying structural changes, mostly among the periphallic organs develop later in the adult stages of the species. In FSA we need to examine many specimens from many populations. Today under the present course of resource disposing policy we have to rely upon caddisfly specimens already collected in various research projects and deposited in various collections. If money limits our efforts in alpha taxonomy we have to put together what we have. To bring together these scattered specimens we need a specialist interested in that particular species complex. He will initiate and organise this collective effort. We understand that collected, sorted and determined material incorporates already significant scientific work and has high primary value for such surveys. Therefore we practice that colleagues who contribute to the survey with their specimens and agree with the final findings become coauthor of the paper and/or of the species automatically.

Fine Structure Analysis (FSA)

Early steps of divergence can be studied by magnifying glass and by bottom-up procedures. Both approaches make it possible to find initial split criteria before they become confounded by additional differences. This population level bottom-up research by "magnifying glass" can be realized either by sophisticated and expensive molecular genetics or by simple and cheap FSA. Boths are particularly suitable to analyse speciation processes under sexual and ecological selection pressures. We have already documented that bottom-up magnifying glass of FSA may cope effectively with the challenge to find the initial split criterion in alpha taxonomy (Oláh *et al.* 2012, Oláh & Ito 2013). This pinpoint precision helps us to recognise the phylogenetic species along a continuum of divergence. The FSA is directed to determine the stability and variability of phallic organ and/or vaginal sclerite complex. Finding stable fine structures nearby the stuctural diverging point requires high structural resolution and patient effort to determine the ranges of phenotypic variations. Studies on stability and variability are possible if we have many specimens from many populations as well as if we apply careful clearing (chemical) and cleaning (mechanical) processes. It may well happen reasonable that a new phylogenetic juvenile species is described from a single male or female or from a few specimens. In this case future studies will confirm the stabilities of the putative specific traits.

FSA is also applicable to estimate divergence distance between incipient species. Like in molecular clock the structural distance is related to lineage divergence time. In order to quantify a structural clock this pure phenomenological relation could be calibrated by known absolute age of evolutionary divergence events, geological event or by fossils.

Limits of Initial Split Criterion (ISC)

The theory of morphological initial split criterion is formulated to detect the initial separation or the early divergence of the ancestral lineage. It has some analogy to the retrospective model of *coalescent theory* in genetics tracing the ancestry of two taxa back to the most recent common ancestor. In principle, applying FSA, we are able to find any stable morphological divergent trait evolved either in males or in females. In practice the primary premise when applying FSA for ISC is that a single individual never sufficient to describe a species. We need to examine many specimens of males and females in many populations in order to determine the range of phenotypic variation. The description and drawings of divergent trait of several specimens represent the specific morphological range of the phenotypic variation. Nevertheless the description based on a single individual could be an important taxonomic action to initiate, inspire, or provoke further morphological or molecular studies. Having only single male specimen we have described *Potamophylax peremes* sp. nov. from Italy and the subspecies of *Potamophylax nigricornis testaceus* (Zetterstedt, 1840) was raised to specific rank as *Potamophylax testaceus* (Zetterstedt) stat. nov.

Clearing, cleaning and drawing procedures

This study is based on animals preserved in 70–80% alcohol. In order to observe morphological details in the genitalia, the entire or only the terminal segments of abdomen were removed and placed in a small glass beaker of 25 cm^3 with 10% KOH solution and boiled during 5–15 minutes for digestion above a spirit burner. The duration of the treatment is adjusted individually to the effectiveness of clearing process which depends on the species or even on the nutritive state of tissues or on the physiological condition of the specimens. The process of digestion can be easily followed by transparency. The dissolution rate of the soft tissues, the clearing transparency is visible to naked eye. The clearing process and time are so much taxon, size, age, sex, and nutrition state specific that automatic hot plate or bath clearing is not practical. The digested abdomen was subsequently transferred to distilled water and the macerated tissue was removed mechanically in patient cleaning process by fine tipped forceps and needles. The internal vaginal sclerite complex was exposed to clear view by cutting windows into the dorsum and left pleuron with fine scissor. The cleared and cleaned abdomen was transferred to 80% ethyl alcohol, and to glycerine for examination under microscope. Different sized pins modified to supporting ring bottom was introduced into the abdomen and used to hold and stabilise the genitalia in lateral, dorsal, and ventral position for drawing. However, the plane of view is never perfect and we made no special procedures of grid, matrix, or reflection to produce absolute mirror symmetry of the drawings. Instead, the genital structures are drawn exactly as seen in the microscope. However setae are represented only by their alveoli and moreover their density is only symbolic. If essential the setal length or setal shape are presented by drawing a single or a few setae only. The genital structure was traced by pencil on white paper using a drawing tube mounted on a WILD M3Z microscope at between 260x and 416x magnification. Final illustrations were prepared by enlarging the original pencil drawings and redrawn on transparent paper by Black India Ink.

Terminology

We used our functional appendicular terminology and not the conventional anatomical directional terminology to describe the genital structures in species description (Oláh & Johanson 2008). Species descriptions were standardized to ensure consistently formatted and comparable description in general accord with Evenhuis's template principle (2007). We have standardized also the terminology to describe space extensions of variously formed structural elements. The following terms were used to qualify the dimensions and extensions of genital structural elements:

(1) *short* or *long* for length dimension on the longitudinal direction of coronal plane along the anteroposterior axis;

(2) *low* or *high* (traditionally *shallow* or *deep* especially for excisions) for height dimension on the vertical direction of the sagittal plane along the dorsoventral axis and

(3) *narrow* or *wide* (*broad*) on the lateral direction of the transversal plane along the mediolateral or left-right axis. The three dimensional Cartesian coordinate system provides theoretical possibility to quantify by measurements the three physical dimensions of length, width, and height of each structural element. However this quantification is used very seldom in species description. Here we quantify only the length of forewing.

Variability of the phallic organ

Phallic organ is composed of phallobase, aedeagus and paramere. Phallobase (phallic apodeme+phallotheca+endotheca) starts with a very short ringlike phallic apodeme fused to and continuing with the sclerotized tubelike phallotheca that housing the retracted membranous endotheca. The rectractable and erectile endotheca holds the aedeagus and parameres. The phallobase suspended on its dorsoapical rim by a pair of sclerotized straps. These straps are located dorsolaterally connecting the phallobase to the area where the basal triangle of the paraproct and the finger-like sclerotized strip of segment IX meet. The three meeting structures seem not fused sclerotically. The sclerotized aedeagus forms bifid apex and ventral subapical variously developed heels. Membranous retractable endophallus with the gonopore is nested in the dorsal deppression of the aedeagus. Its main function is to direct and fit the gonopore to the oppening of the spermathecal process. Gonopore configuration is variously sclerotized, ejaculatory duct discernible. Pair of parameres is rooted in the endophallus and composed of well developed shaft and spine-like setae of various and specific numbers and patterns. These strong spine-like structures articulate to the shaft with alveoli.

The sclerotized stem of the aedeagus has specific ventral profile with diagnostic value that could be parallel-sided or variously bellied laterad. The ventral subapical heels on the aedeagus head have evolved specifically into various forms that have high diagnostic value, in spite of certain variability in the range of specificity. The very tip of the bifid aedeagus supplied with very small setae of sensory function inside the female genital chamber. This tip is rather variable within population. It is possible that tips are erectile and the apparent variability what we detect is the result of erection stage. Other alternative is the unusually high phenotypic variability.

The dorsal and lateral profile of the paramere shaft including its sclerotized basement is rather stable. Even more stable is the pattern of the spine-like setae, having very high diagnostic value. These setae have stimulatory function during copulation giving signals of various functions to meet the female preference range in the processes of cryptic female choice of sexual selection. Frequently it is not easy to visualise the genuine pattern due to their disturbed or injured condition. During copulation the spine-like setae are exposed to various effects resulting in deformation, or even in breaking down at alveoli or at various lengths. Usually the original virgin setal pattern is very disturbed after copulation, discouraging the observers.

Structure and function of vaginal sclerite complex

The diversity potential of the sclerotized structure functioning in the female genital chamber is underutilized in distinguishing among the closely related caddisfly species. Female internal apparatus cleared in caustic potash was first recognised and applied by Morton (1902), later by Nielsen (1943), to separate *Apatania* females. In limnephilids the vulvar opening formed and surrounded by the lower lip (*vulvar scale* of McLachlan (1974–1880), *gonopods of segments* VIII and IX by Nielsen (1980)) and by the upper lip (*supragenital plate*, part of segment X) is the vestibule to vagina. The vaginal chamber is formed by fusion of the distal parts of the common oviduct and the duct of the accessory or collateral glands. These glands usually are very large filling most part of the female abdomen and their ducts are rather wide at their opening section. This may divide the vaginal chamber into a ventral and dorsal branch. The *vaginal sclerite complex* (*internal sclerite* of Morton (1902), *spermathecal sclerite* of Nielsen (1980)) developed along the junction of oviduct and the duct of the accessory glands and receiving also the spermathecal duct plus the duct of bursa copulatrix. It is a rather diverse and complex organ, but this potential was not yet explored to differentiate among caddisfly species. Species specificity of female genitalia, higher than at male, was demonstrated only recently in families of dipteran Sepsidae (Puniamoorthy *et al.* 2010) and mecopteran Panorpidae (Ma *et al.* 2012). Its complex nature as well as difficulties in understanding and drawing, limited its use in taxonomy. We understood the vaginal sclerite complex evolved with flexing, bracing, holding, and stretching functions for the structural organisation of the four ducts entering and forming the vaginal chamber. Its dorsal position to oviduct and anterad position to the duct of accessory gland as well as the variously developed sclerotized substructures to receive duct of bursa copulatrix and the duct of spermatheca explain this basic function. Morton's original terminology is still rather functional. Based upon his original findings, we have differentiated six substructures in the vaginal sclerite complex for our taxonomic purposes.

(1) Morton's *paired lateral blades* are the *vaginal slerite plate* itself on the dorsum of the vagina. The vaginal sclerite plate may form variously sclerotized lateral folds, flanks and subdivided structures in different groups. We have separated two additional substructures of the plate with particular functions.

(2) The substructure of mostly sclerotic articulation to the internal continuation of the lateral processes of the vulvar scales, the paired gonopods of segment IX, is usually a double layered *folding plica* ensuring a firm flexible attachment or suspension of the membranous genital chamber and its tubing complex to the exoskeleton of the vulvar scale.

(3) The vaginal sclerite plate has a pair of sclerotized wing-shaped substructure laterad serving stretch function to the vagina and apodemic function anterad to receive vaginal muscles.

(4) Morton's *central triangular piece* is the usually hood-shaped *junction sclerite* holding and stretching the junction where the ducts of ovarium and accessory gland meet.

(5) Morton's *central foot-shaped piece* is the *spermathecal process* (*processus spermathecae* of Nielsen (1980)) receiving the ductus spermathecae and forming frequently a longitudinal keel on the ventrum of the vaginal sclerite. The opening of the spermathecal duct forms variously sclerotized window on the spermathecal process.

(6) This small sclerite was not specified by Morton. The ductus bursae open between the spermathecal process and the common oviduct at the anterior margin of the vaginal sclerite. The mesoanterior margin of the vaginal sclerite plate is bulking and bending upwards elevating the position of the duct opening. These substructures and functions constitute the vaginal sclerite complex, but their development and sclerotization are highly varying in the different groups.

Windows to examine and to draw the vaginal sclerite complex

The carefully cut dorsal and lateral windows on segment VIII give a clear view for the examination and drawing of internal vaginal sclerite complex in general. In the *Potamophylax nigricornis* species group the vaginal sclerite complex incorporates several morphological informations discernible both in dorsal and lateral view. In the present species descriptions we utilise only the dorsal profile of this complex structure to differentiate between species. This dorsal profile is rather simple, but also rather stable and specific. The lateral view produces more morphological informations, but this view is extremely sensitive to the observation plane. It is almost impossible to reproduce the repeated redrawings. Various folding, curving and bending organisations in three dimensions create very composite and complex structure composed of by the six substructures: lateral margins of the vaginal plate, the articulation sclerite, the wing-shaped vaginal stretching plate, junction sclerite, spermathecal process, bursal sclerite. This very composite structure contains more unexplored specific informations to find initial split criteria with a more detailed finer structure analysis.

Depositories

Civic Natural Science Museum, Bergamo (CNSMB)
Coppa Private Collection (CPC)
Department of Biology, Faculty of Mathematics and Natural Sciences, University of Prishtina, Prishtina, Kosovo (DBFMNSUP)
Hungarian Natural History Museum, Budapest (HNHM)
University Museum of Bergen, University of Bergen, Norway (ZMBN)
National Museum of Natural History, Bulgarian Academy of Sciences (NMNHBAS)
National Museum, Prague, Czech Republic (NMPC)
Oláh Private Collection (OPC) under national protection of the Hungarian Natural History Museum, Budapest
Sipahiler Collection in the Department of Biology Education, Hacettepe University, Ankara, Turkey (SCHUA)

TAXONOMY

Potamophylax nigricornis group

This new species group is composed of closely related species characterized by rather stable periphallic organs, but very diverse phallic organ. The periphallic organ consists of long digitate paraprocts and gonopods as well as the more or less elongated cerci. The long paraprocts and the acute gonopods (McLachlan 1874–1880) serve best to separate this species group from allied taxa. The widely distributed nominate *Potamophylax nigricornis* species is possibly the ancestor of the entire species group. At least it has a wide distribution and the evolved species seem all peripatric. Moreover it has the most complex paramere and according to Williston's principle the structures tend toward reduction. Therefore an ancestor must be constituted by the integration of the largest possible number of characters (Schmid 1979). Although we have to remind that the terms primitive, generalized, specialized, simple, complex or secondarily complex are all strictly comparative (Ross 1956; Schmid 1958).

The ancestral paramere of *P. nigricornis* is characterized by sigmoid shaft with subquadratic basement in dorsal view, as well as by complex setal pattern with basal tuft of 5 mesad curving long spine-like setae accompanied by 2 regularly set subapical and 2 apical spine-like setae. This sophisticated structure is extraordinary stable in the examined 106 populations over the entire distributional area. The discovered new species evolved probably from this dark species having this very complex paramere. Diversification developed possibly during the Pleistocene mostly in peripatry and probably in the sexual selection processes. The speciation processes are detectable by depigmentation and by the simplification of the parameres and by the modifications of the aedeagal head. Based on these structural changes we have separated an ancestral and three descendant species subgroups simply for taxonomic practices: *Potamophylax nigricornis* new species subgroup, *P. elegantulus* new species subgroup, *P. horgos* new species subgroup, *P. simas* new species subgroup. However it seems, but not examined here, that their speciation was associated with more than one glacial-interglacial cycle at least according to the distribution pattern and detectable also by the branching structure of lineages among the described species. Branching is discernible along the depigmentation pattern, paramere simplification, and aedeagal modification.

Potamophylax nigricornis new species subgroup

Forewing patterned by narrow, longitudinal pale stripes present in the cells on the dark forewing background. Paramere characterized by sigmoid shaft with quadratic basement as well as by complex setal pattern with basal tuft of 5 mesad curving long spine-like setae accompanied by 2 regularly set subapical and 2 apical spine-like setae. The ventral subapical heel on the aedeagus present as variously developed pointed corner plate. Two species belong to this ancestral subgroup: the nominate species *P. nigricornis* and the incipient, just diverging species *P. testaceus* Zetterstedt status novus.

***Potamophylax nigricornis* (Pictet, 1834)**

(Figures 1–6)

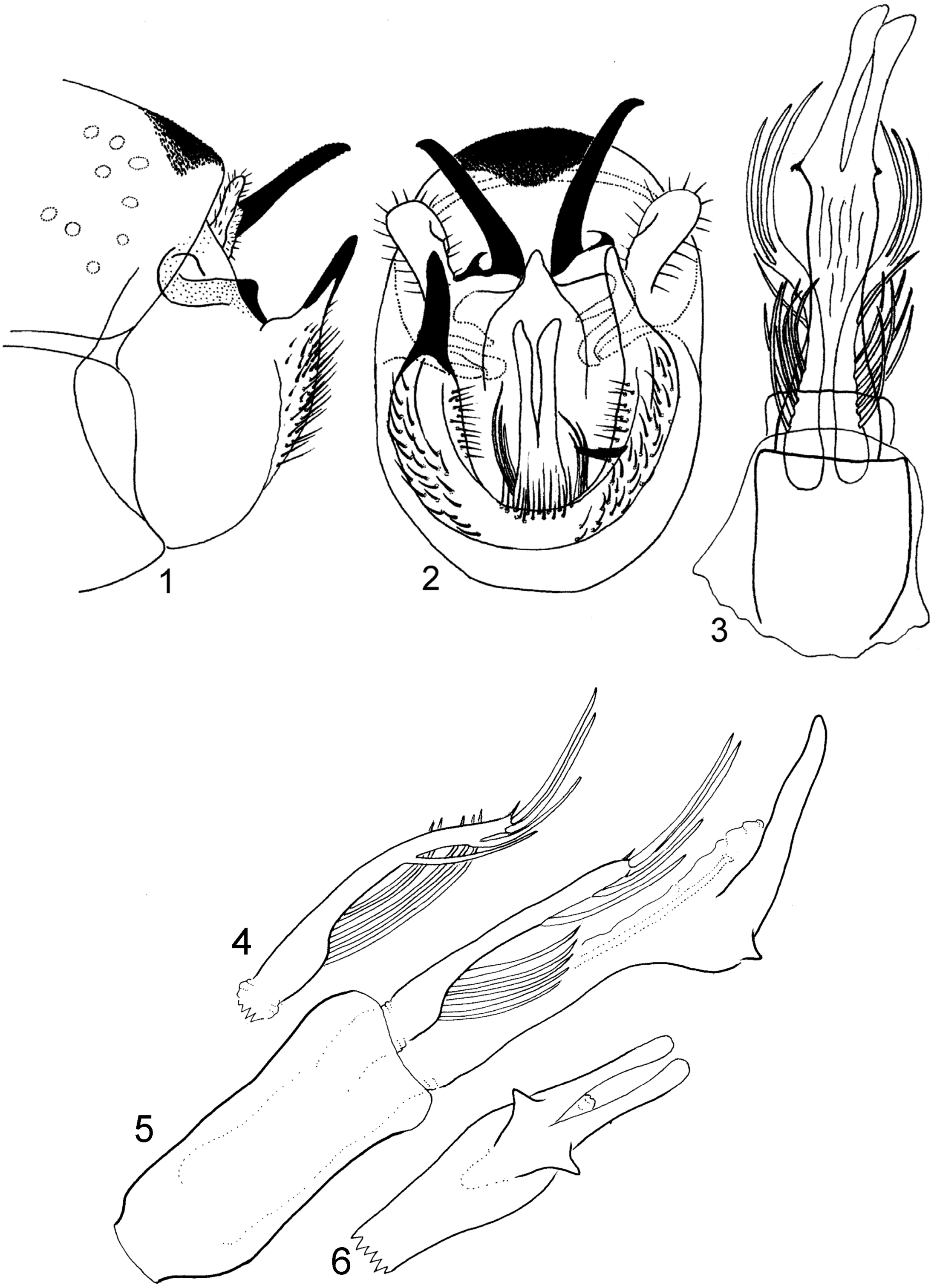
Phryganea nigricornis Pictet, 1834:136–137, (Switzerland).
Stenophylax nigricornis (Pictet, 1834) Transferred by McLachlan, 1875:127–128.
Potamophylax nigricornis (Pictet, 1834), Transferred and listed in genus *Potamophylax* by Schmid 1955:176.
Stenophylax areatus Kolenati 1856:166, (Austria). Synonymised by Fischer 1969:152.

Diagnosis. This widely distributed, probably ancestral species has dark gray forewing with narrow longitudinal pale stripes present in the cells on the dark forewing background. Paramere characterized by sigmoid shaft with quadratic basement as well as by complex setal pattern produced by basal tuft of 5 mesad curving long spine-like setae accompanied by 2 regularly set subapical and 2 apical spine-like setae. The ventral subapical heel on the aedeagus present as pointed corner plate with variously developed tooth-like profile.

Material examined. Austria: Styria, Soboth 25. VI. 2005, leg. W. Graf (1 male, OPC). Carinthia, Launsdorf-Elsgraben, 535 m, 29. V. 1994 light trap, leg. Ch Wieser, (2 males, OPC). Carinthia, St. Oswald, Nockberge, 1989 leg. W. Graf (2 males, OPC). *Croatia***:** Izvor Crne Rijeke, P2, 4.V.2008, leg. A. Previsic (1 male, 1 female; OPC). Izvor Crne Rijeke, P3, 5.V.2008, leg. A. Previsic (1 male, OPC). Izvor Crne Rijeke, P5, 5.V.2008, leg. A. Previsic (4 males, 4 females; OPC). *Czech Republic*: Bohemia, centr. Praha, Drahanska rokle brook, 20. V. 1990, leg. P. Chvojka, (1 male, 1 female; NMPC). Bohemia or., Orlicke hory Mts., Serlich Mt., 11. VII. 1995, light leg. P. Chvojka, (1 male, NMPC). Moravia sept., Jeseniky pot., pritok Desné JV Cervenohorské sedlo, 11. VII. 1999, leg. P. Chvojka, (1 male, NMPC). Bohemia or., MPR Králicky Snéznik, Morava, 1100 m, VI.–VII. 2003, leg. Jezek & P. Chvojka, (1 male, 3 females, NMPC). Bohemia sept., Jizerské hory, NPR Raseliniste Jizery [MT], 26. VI– 9. VII. 2003, leg. Vonicka & Preisler (6 males, 1 female; NMPC). Bílé Karpaty Mts., Bílé potoky Nature Reserve SE of Valašské Klobouky,spring area, 430 m, N49° 06'56", E18° 01'38", 13.–16.VIII.2007, J. Ježek, yellow pan traps (1♂, NMPC). Bílé Karpaty Mts., Spring area N of Ploštiny hill, 630 m, N49°08'40", E18°03'46", 06.06.–13.VII.2006, P. Chvojka, J. Ježek & J. Macek, Malaise trap (1♂1♀, NMPC). Bílé Karpaty Mts., spring area N of Petrůvka, 430 m, N49°06'35", E17°48'39", 23.VI.–16.VII.2008, P. Chvojka, J. Ježek & J. Macek, Malaise trap (1♂, NMPC). Bílé Karpaty Mts., Kladenka stream S of Petrůvka, 390 m, N49°05'50", E17°48'53", 04.–25.VII.2008, P. Chvojka, J. Ježek & J. Macek, Malaise trap (1♂, NMPC). Bílé Karpaty Mts., Hutě Nature Reserve NE of Žítková, spring area, 460 m, N48°59'24", E17°54'21", 29.V.–19.VI. 2007, P. Chvojka, J. Ježek & J. Macek, Malaise trap (1♂, NMPC). Bílé Karpaty Mts., Svinárský potok stream S of Strání, 590 m, N48°52'00", E17°40'37", 29.VI.–27.VII.2005, P. Chvojka, J. Ježek & J. Macek, Malaise trap (1♂, NMPC). Bílé Karpaty Mts., right tributary of Velička stream NE of Hryzlácké Mlýny, 450 m, N48°53' 10", E17°36'08", 22.VI.–15.VII.2009, P. Chvojka, J. Ježek & J. Macek, Malaise trap (1♂, NMPC). Bílé Karpaty Mts., Čertoryje National Nature Reserve SE of Tvarožná Lhota, Járkovec brook, 320 m, N48°51'22", E17°24'27", 10–31.VII.2006, P. Chvojka, J. Ježek & J. Macek, Malaise trap (1♂, NMPC). *Hungary*: Lengyeltóti, 27.VI.1962, light trap, (8 males, OPC). Sopron, Fáberrét, 23.V. 1962, light trap, (3 males, OPC). Sopron, 6.VI.

1984, light trap, (1 female, OPC). Sopron, 8.VI. 1984, light trap, (1 male, OPC). Sopron, 19.V. 1984, light trap, (1 female, OPC). Kőszeg Mts. Velem, Borha spring, 23.VI. 1987, leg. S. Nógrádi & Á. Uherkovich, (6 males, 6 females; OPC). Mecsek Mts. Kisújbánya, Pásztor spring, 18.VII. 1984, leg. Á. Uherkovich, (2 males, 2 females; OPC). Mecsek Mts. Középdeindol-hegyhát, 15. VI.1988, leg. Á. Uherkovich, (2 males, OPC). Mecsek Mts. Vékény, Vár valley, Iharos spring, 20.VI.1994, leg. S. Nógrádi & Á. Uherkovich, (4 males, OPC). Mátra Mts. Gyöngyös-Mátrafüred, Waterworks, 2.VII.1987, leg. F. Buscgmann, (2 males, OPC). Bükk Mts. Garadna stream, 8.VII. 1983, light, leg. J. Oláh, (3 males, OPC). Jósvafő, VIII.1980 light, leg. Z. Varga (10 males, 9 females; OPC). Jósvafő, V.1981 light, leg. Z. Varga (4 males, 2 females; OPC). Jósvafő, VI.1981 light leg. Z. Varga (14 males, 6 females; OPC). Jósvafő, 1–2.VI.1981 light, leg. Z. Varga (1 male, OPC). Jósvafő, VIII.1981 light, leg. Z. Varga (3 males, OPC). Jósvafő, 3–9.X.1981 light, leg. Z. Varga (2 males, OPC). Jósvafő, V.1982 light, leg. Z. Varga (1 male, OPC). Jósvafő, 5–10.VI.1982, light leg. Z. Varga (2 males, 1 female; OPC). Jósvafő, 10–11.VI.1982 light, leg. Z. Varga (1 male, OPC). Jósvafő, 14–15.VI.1982 light, leg. Z. Varga (1 male, OPC). Jósvafő, 15–20.VII.1982 light, leg. Z. Varga (2 males, 1 female; OPC). Jósvafő, 22.VII.1982 light, leg. Z. Varga (1 male, OPC). Jósvafő, 1–2. VIII.1982 light, leg. Z. Varga (1 male, OPC). Jósvafő, 14–15.VIII.1982 light, leg. Z. Varga (1 male, OPC). Jósvafő, 19–20. VIII.1982 light, leg. Z. Varga (2 males, 1 female; OPC). Jósvafő, 7.X.1982 light, leg. Z. Varga (1 male, OPC). Jósvafő, Ménesvölgy, Ménes stream, spring stream, 3.VII.1983 singled, leg. J. Oláh (1 male, OPC). Jósvafő, Ménesvölgy, Patkós spring, 4.VII.1983 singled, leg. J. Oláh (1 male, OPC). Jósvafő, Ménesvölgy, 5.VII.1983 light, leg. Z. Varga (4 males, 1 female; OPC). Jósvafő, 5–10. VI.1983 light, leg. Z. Varga (9 males, 17 females, OPC). Jósvafő, 18.VI.1983 light, leg. Z. Varga (18 males, 17 females; OPC). Jósvafő, 28–29. VI. 1983 light, leg. Z. Varga (14 males, 10 females; OPC). Jósvafő, 30.VI.1983 light, leg. Z. Varga (1 male, 3 females; OPC). Jósvafő, 2.VII.1983 light, leg. Z. Varga (2 males, 3 females; OPC). Jósvafő, 4–5.VII.1983 light, leg. Z. Varga (1 male, 2 females; OPC). Jósvafő, 6.VII.1983 light, leg. Z. Varga (1 female, OPC). Jósvafő, 1.VII.1983 light, leg. Z. Varga (1 female; OPC). Jósvafő, 7–9.VII. 1983 light, leg. Z. Varga (3 males, 2 females; OPC). Jósvafő, 2–5.VII. 1983 light, leg. Z. Varga (14 males, 3 females; OPC). Jósvafő, 25–31.V. 1983 light, leg. Z. Varga (5 males, OPC). Jósvafő, 9.V.1983 light, leg. Z. Varga (13 males, OPC). Jósvafő, V.1983 light, leg. Z. Varga (6 males, 4 females; OPC). Jósvafő, Tohonya völgy, 10–12. VII.1983 leg. Z. Varga (3 males, OPC). Jósvafő, Tohonya völgy, 5.V.1984 leg. Z. Varga (2 males, OPC). Jósvafő, 1–7.VI.1984 light leg. Z. Varga (6 males, OPC). Jósvafő, 1–7.VI.1984 light leg. Z. Varga (6 males, OPC). Jósvafő, VIII.1985 light, (14 males, 3 female; OPC). Jósvafő, 13.V.1985 light, (1 male, 2 females; OPC). Jósvafő, 13.VI. 1985 light, leg. Z. Varga (6 males, 9 females; OPC). Jósvafő, Tohonya völgy, 20.V.1986 leg. Z. Varga (3 males, 4 females; OPC). Jósvafő, Tohonya völgy, 26.V.1986 leg. J. Oláh (6 males, 4 females; OPC). Jósvafő, Tohonya völgy, 14–16. VI.1986 leg. J. Oláh (2 males, 4 females; OPC). Szögliget, 20–30.V.1986 light trap (19 males, 4 OPC). Szelcepuszta, 15.VIII.1982 light, (1 male, OPC). Szelcepuszta, V.1983 light, (2 males, OPC). Zemplén Mts. Telkibánya, 1.IX.1982 light, (1 male, OPC). Zemplén Mts. Telkibánya, 24. VIII.1984 light, (1 male, OPC). Zemplén Mts. Telkibánya, 25.VIII.1984 light, (1 male, OPC). Zemplén Mts. Telkibánya, 1–2.IX.1984 light, (1 male, OPC). Zemplén Mts. Lászlótanya, 2.X. 1982 light, (1 male, OPC). Zemplén Mts. Lászlótanya, 5.X.1982 light, (1 male, OPC). Zemplén Mts. Lászlótanya, V.1983 light, (5 males, 1 female; OPC). Zemplén Mts. Lászlótanya, VII. 1983 light, (18 males, OPC). Zemplén Mts. Lászlótanya, 10–31.VIII.1983 light, (1 male, OPC). Zemplén Mts. Lászlótanya, 14.VI.1985 light, leg. J. Oláh (31 males, 43 females; OPC). Zemplén Mts. Mátyás Király Kútja, 13.VI.1985 leg. J. Oláh (1 female, OPC). Zemplén Mts. Lászlótanya, 24. VII.1983 light, leg. J. Oláh (6 males, OPC). Zemplén Mts. Füzér, Lászlótanya, 15.VI.1995 leg. V. G. Papp (1 male, 1 female; OPC). Zemplén Mts. Makkoshotyka, 27.IX.1982 light, (2 males, OPC). Zemplén Mts. Makkoshotyka, 15. IX.1983 light, (4 males, 1 female; OPC). Zemplén Mts. Makkoshotyka, 16.IV.1984 light, (2 males, 1 female; OPC). *Italy*: Lombardia, Bergamo, Gazzaniga, Valle Platz, 850 m, 27.V.1990 leg. C. Gusmini (1 male, CNSMB). Lombardia, Bergamo, Tarvisio, Rio del Lago, N46.4882 E13.6724, 870 m, 21.VII.1996 leg. C. P. Pantini & M. Valle (1 male, CNSMB). Friuli-Venezia Giulia-Udine, Lusevera, torrente Vedronza, N46.2609 E 13.2567, 330 m, 21.VII.1996 light leg. C. P. Pantini & M. Valle (4 males, CNSMB). Friuli-Venezia Giulia-Udine, Grimacco, Liessa, affluente fiume Cosizza, N46.1561 E13.5863, 250 m, 19.VII.1996 leg. C. P. Pantini & M. Valle (1 male, CNSMB). Lombardia, Bergamo, Valgoglio, Valsanguigno, sorgente con igropetrico, N 45.9694 E9.8897, 1250 m, 7.VIII.2009 leg. S. Cerea (1 female, CNSMB). Lombardia, Bergamo, Valgoglio, Valsanguigno, sorgente con igropetrico, N45.9694 E9.8897, 1250 m, 29.VIII. 2009 leg. S. Cerea (1 female, CNSMB). Lombardia, Bergamo, Vertova, Val Vertova, rifugio G.A.V., N45.8179 E9.8039, 480 m, 19.VIII.1996 leg. R. Parella (1 male, 4 females; CNSMB). Lombardia, Bergamo, Mezzoldo, Alpe Ancogno, N46.0381 E9.6359, 1800 m, 30.VII.1994 leg. E. Bertuetti (1 male, CNSMB). Lombardia, Bergamo, Mezzoldo, Alpe Ancogno, N46.0381 E 9.6359, 1800 m, 11.VIII.1994 leg. E. Bertuetti (1 male, CNSMB). Piemonte, Torino, Ala di Stura, Martassina Val d'Ala, torrente Mölar, N45.3159 E7.2772, 1250 m, 17.VIII.2004 leg. F. Vaccarino (1 male, CNSMB). Trentino-Alto Adige-Bolzano, Marebbe-Enneberg, S, Vigilio Marebbe, Val de Rit, N46.6740 E11.9444, 1600 m, 27.VII.1994 leg. B. Becci & R. Pisoni (1 male, CNSMB). *Norway*: Sør Trøndelag, Oppdal, Kongsvoll, N62.30338 E9.60535, 920m, 15–22.VII.1992, Malaise trap, leg. J. Skartveit (2 males, ZMBN). Buskerud, Nedre Eiker, Miletjern, N59.74833 E10.04063, 20–30.VII.1988, light trap, leg. L. O. Lars (1 male, ZMBN). Oppland, Lunner, Stryken, N60.16540 E10.71836, 6–17.VIII.1990, light trap, leg. T. Andersen (1 male, ZMBN). Oppland, Dovre, Brennhaug, N61.92211 E9.33338, 5.VII. 1988 net, leg. K. A. Johansson (7 males, 1 female; ZMBN). Telemark, Porsgrunn, Gravastranda, N59.08569 E9.64670, 10 m, 13.VI–12.VII.1988, light trap, leg. G. E. E. Soli (7 males, 3 females; ZMBN). *Poland*: Gorce Mts. Kamienica stream, 26.VI.1985 ligh, leg. J. Oláh (3 males, 2 females; OPC). *Romania*: Transylvania, Valea Cupas, Lacu Rosu, 950 m, 26.VI.1981, light leg. Peregovits & Ronkay (2 males, HNHM). Transylvania, Valea Cupas, Lacu Rosu, 950 m, 3.VII.1981, light leg. Peregovits & Ronkay (3 males, HNHM). Transylvania, Valea Cupas, Lacu Rosu, 950 m, 9.VII. 1981 light, leg. Peregovits & Ronkay (2 males, HNHM). Transylvania, Valea Cupas, Lacu Rosu, 950 m, 14.VII.1981 light, leg. Peregovits & Ronkay (1 male, HNHM). Transylvania, Valea Cupas, Lacu Rosu, 950 m, 17.VII.1981, light leg. Peregovits & Ronkay (1 male, HNHM). Transylvania, Valea Cupas, Lacu Rosu, 950 m, 19.VII.1981, light leg. Peregovits & Ronkay (2 males, HNHM). Maramures county, Maramuresului Basin, Sighetu Marmatiei, Mocsár area, orchard, N47°55'07.1" E23°56'43.5", 369 m, 30.VI.2005 leg. J. Kontschán, D. Murányi & K. Orci (1 male, NHMB). Maramureş county, Muntii Ignis, Deseşti-Staţiunea Izvoare, forest spring at settlement, 920 m, N47°45'11" E23°42'58", 8.VIII.2012 light, leg. J. Oláh & L. Szél (7 males, 5 females; OPC). Maramures county, Maramures Mts. Frumuseaua stream, 764 m, N47°52'43'' E24°18'22'', 7.VIII. 2012 light, leg. J. Oláh & L. Szél (1 male, 1 female; OPC). *Slovakia*: Mala Studena dol. 19. VII.1966 leg. J. Oláh (3 males, 2 females; OPC). Dobsina, Gubas Grindel, 13.VII.1986 leg Á. Uherkovich (1 male, 1 female; OPC). Dobsina, Gubas Grindel, 16.VII.1980 leg Á. Uherkovich (2 males, OPC). Zbojsky stream, nad N. Sedlica, 500 m, 18.VII.1990 leg. P. Chvojka, (1 male, NMPC). High Tatr, stream E Biely Váh, 1280 m, 21.VII. 1990 leg. P. Chvojka, (1 male, NMPC). *Slovenia*: Kreza, Kreske Ravne, 31.VII.1992, leg. L. Ábrahám (4 males, 3 females; OPC). *Ukraine*: deposited in NMPC under K263 with label: *Worochta, Stoeckel*. Vorokhta is a settlement on northern slopes of the Ukrainian Carpathians (locality, where also Dziedzielewicz collected). The collecting date is missing (probably the end of 19th century). This species is from the Klapalek's collection, but it is not a part of series of *Potamophylax nigricornis* v. *elegantulus*.

Variability. Both the head structure of the aedeagus as well as the shaft and setal pattern of the parameres are remarkably stable in all of the examined 106 populations representing specimens from Austria, Croatia, Czech Republic, Hungary, Italy, Norway, Poland, Romania, Slovakia, Slovenia, Ukraine. Only the ventral subapical heel, that is the variously formed, pointed pair of corner plate reduced in size in 4 specimens from two populations: Czech Republic (Bohemia, Jizerské hory), Hungary (Szelcepuszta). However even in these specimens the very characteristic narrowly S-shaped shaft and the setal pattern are very stable.



Figures 1-6. *Potamophylax nigricornis* (Pictet, 1834) male. 1 = genitalia in left lateral view, 2 = genitalia in caudal view, 3 = phallic organ in ventral view, 4 = paramere in dorsal view, 5 = phallic organ in left lateral view, 6 = aedeagus in ventral view. (Figures 1–3 were drawn by the first author 50 years ago in 1963 with some features of habitus drawings; figures 4–6 are drawn recently in diagrammatic styles).

***Potamophylax testaceus* (Zetterstedt, 1840) stat. nov.**

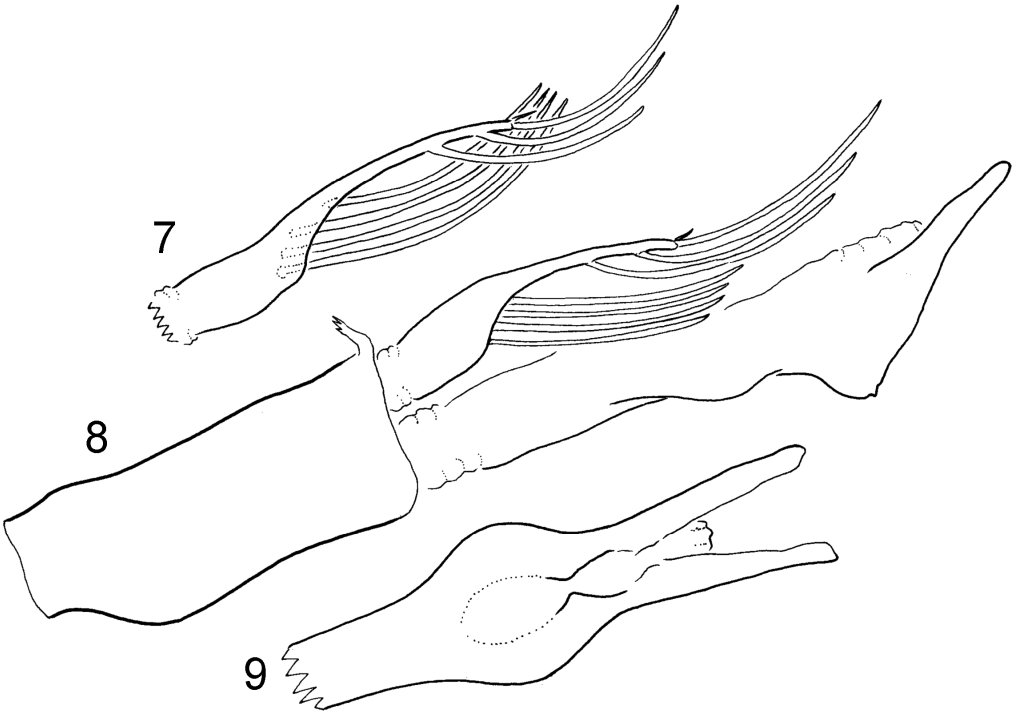
(Figures 7–9)

Phryganea testacea Zetterstedt, 1840:1065-1066. Type specimens are not available!
Stenophylax nigricornis var. *testaceus* (Zetterstedt, 1840), Brauer, 1876:286.
Potamophylax nigricornis (Pictet, 1834), Transferred and listed in genus *Potamophylax* by Schmid 1955:176.

Diagnosis. This light coloured taxon has pale lines on the forewings almost obsolete. Compared to *P. nigricornis* the forewing colour is testaceus, brick red, not gray mouse; the pointed corner plate on the ventral subapical heel on the aedeagus reduced in size; lateral bellies on the aedeagus very much developed, not moderate; subquadratic basement of the shaft enlarged; single spine-like apical seta present, not two. All these distinguishing characters were established by the examination of the available single male specimen. The ranges of phenotypic variations has to be examined and the stability of these diverging characters confirmed by future studies on more male and female specimens. However the forewing color of *P. nigricornis* is stable on its entire distributional area and the depigmentation process is also stable in the perypatric speciation determining even the subgroup formations evolved by characteristic forewing colour and pattern.

Material examined. Norway: Finnmark, Alta, Gargia Fjellstue, N69.80525 E23.48937, 120 m, 30–31.VIII.2010 light, Finnmarlsprosjektet (1 male, ZMBN). Finnmark, Sør Varanger, Pasvik, Russevann, N69.44497 E29.89904, 60 m, 20–30. VII.2010, Malaise trap, Finnmarlsprosjektet (1 female, ZMBN).

Description. Description by Zetterstedt (1840:1065–1066): "tota testacea, pedibus pallidioribus, alis flavescentubus, subpubescentibus (major) ♂♀ (long corp. 4–4.5, al. exp. 11–12 lin.). "Hab. in Lapponia Suecica raro, sed ad littora maris glacialis Nordlandiae Finmarkiaeque Norvegicae, ex gr. ad Tromsoe et Alten, mense Jul. freq. (Lappon. – Scania, Sept. in copula). Mas et Fem. Inter majores. Tota testacea aut rufa, pedi-



Figures 7-9. *Potamophylax testaceus* (Zetterstedt, 1840) stat. nov. male. 7 = paramere in dorsal view, 8 = phallic organ in left lateral view, 9 = aedeagus in ventral view.

bus flavis et abdomine interdum obscuro. Alae apice subrotundatae totae subpubescentes, nervis dorsallibus elevatis pilosis. Obs. Phr. Interpunctata et concentrica huic affines, se dalis nonnihil obscurioribus in subdivisione sequente sub numeris 29 et 30 in veniendae." Addition by McLachlan, (1874–1880). "Paler than *P. nigricornis*, testaceous, wings with yellowish tinge, pale lines nearly obsolete."

Potamophylax elegantulus new species subgroup

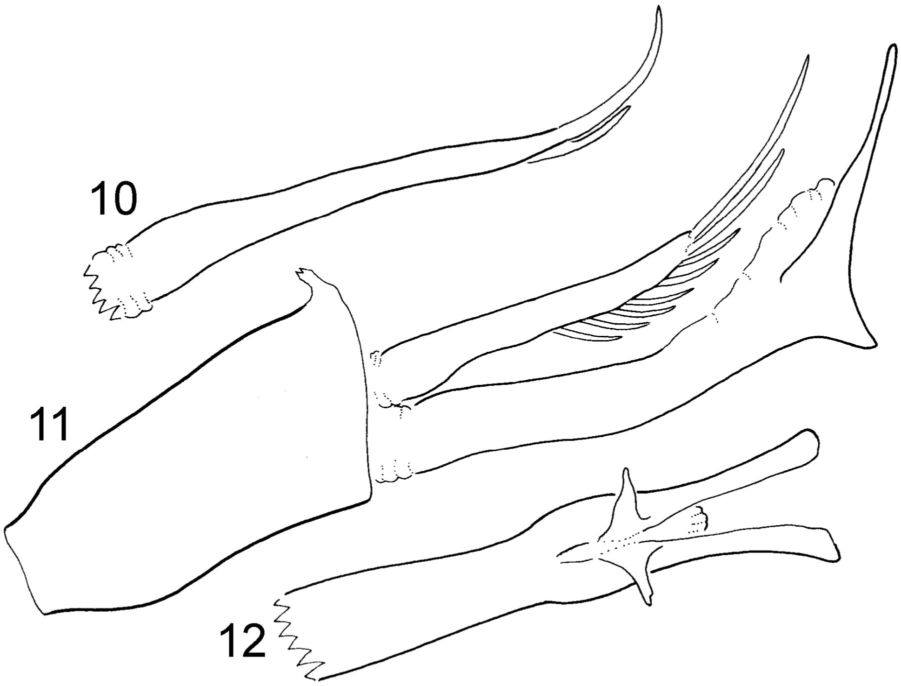
The narrow longitudinal pale light stripes present in the cells on the dark forewing of *Potamophylax nigricornis* have widened to light bands and the dark background disappeared and reduced to narrow stripes along the longitudinal veins. As a result the forewing was depigmented from light-striped dark background to dark-striped light background at all of the newly evolved species on the Balkan peninsula to Turkey. The complex pattern of the parameres is modified into simpler pectinate pattern, characterized by long or gradually apicad shortening and less arching spine-like setae. The ventral subapical heel on the aedeagus is reduced, extremely enlarged, or double layered. Doubled heels enclose some concavity.

Potamophylax apados Oláh & Chvojka sp. nov.

(Figures 10–12)

Diagnosis. This light coloured species having dark striped forewing belongs to the *Potamophylax elegantulus* species subgroup, but differs from all the known species by the extremely elongated subapical ventral heels on the bifid head of the aedeagus as well as by the very short, abbreviated setae on the ventral side of parameres.

Material examined. Holotype. *Turkey*: Bolu Province, Abant Gölü Lake, brooklets, N40°36' 00", E31°17'00", 13.VI.1998, leg. P. Chvojka (1 male, NMPC). Paratypes same as holotype (2 males NMPC, 2 males OPC, 2 male SCHU). Same as holotype, but 7.VII.1993 leg. O. Hovorka (1 male, NMPC)



Figures 10-12. *Potamophylax apados* sp. nov. male. 10 = paramere in dorsal view, 11 = phallic organ in left lateral view, 12 = aedeagus in ventral view.

Etymology. apados from “apadós” ebbing of in Hungarian refers to the very short abbreviated setae on the parameres.

Description. Male (in alcohol). Body and wing colour faded stramineous, possibly forewing stripe-patterned when alive. Periphallic organs are typical for the species group. Aedeagus almost parallel-sided in ventral view; bulging slightly below the ventral heels. Ventral heels extremely elongated spine-like. Apices parallel-sided, not tapering and not spatulate. Paramere shaft with mesad turning apical third accompanied by a single subapical seta closely adhering to the shaft. Nine short upward curving setae present on the ventrum of the shaft, almost invisible in dorsal view.

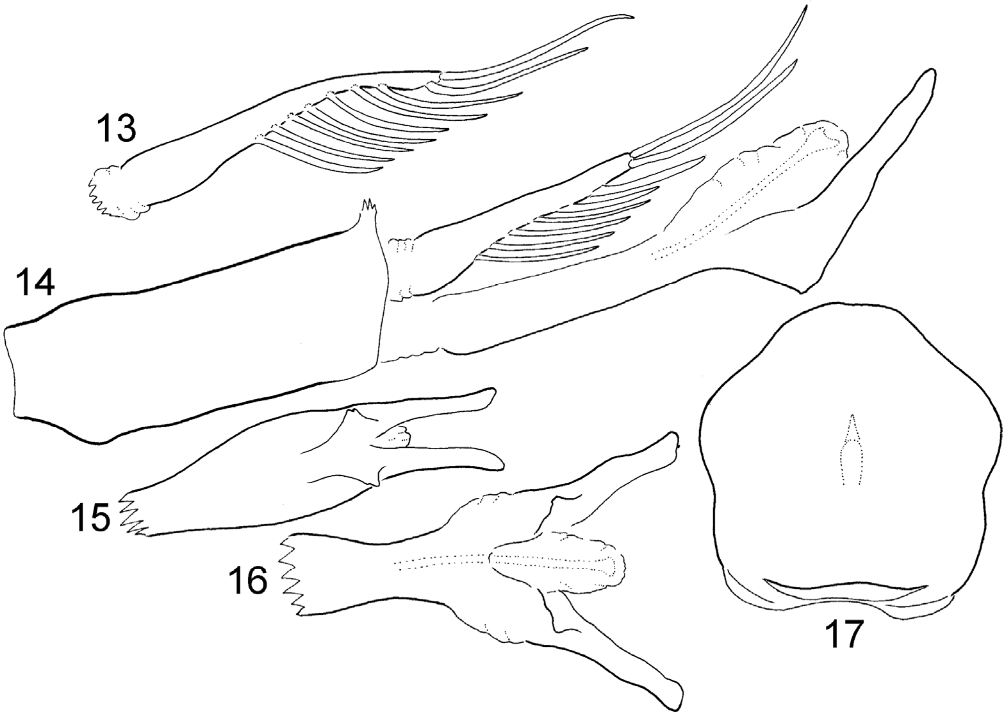
***Potamophylax elegantulus* (Klapálek, 1899) stat. nov.**

(Figures 13–17)

Stenophylax nigricornis var. *elegantulus* Klapálek 1899:325.

Stenophylax nigricornis var. *elegantulus* Klapálek 1900:673.

Diagnosis. This species having dark striped forewing was described as a variant. The original description of *Potamophylax nigricornis* var. *elegantulus* is based upon the characteristic forewing pattern. Klapálek has not cleared the abdomen and thus he was unable to detect the significant modifications in the structure of the phallic organ. The ability of the aedeagal head to extend so much laterad during erection has been never observed at any specimens of *P.nigricornis*. Compared to *P. nigricornis* the paramres has lost the basal quadratic basement of the shaft; sigmoid pattern reduced; the basal tuft of 5 strogly mesad curving setae shortened, straightened, doubled and spread upto the end of the shaft; apical seta fused to the end of the shaft, alveolus almost indiscernible. Female vaginal sclerite complex rounded, not elongated longitudinally, and has short sclerotized opening on the spermathecal process, not long; transversal bursal slerite long, not short.



Figures 13-17. *Potamophylax elegantulus* (Klapálek 1899) stat. n. male. 13 = paramere in dorsal view, 14 = phallic organ in left lateral view, 15 = aedeagus in ventral view, 16 = expanded aedeagus in ventral view, 17 = dorsal profile of the vaginal sclerite complex.

Material examined. The original description in 1899 was based on 6 males and 2 females specimens without any type labels. Here we have designated lectotype and selected allotype. *Lectotype. Bosnia-Herzegovina*: Vrelo Bosna, 16 May (1 male, K369, NMPC). *Allotype.* same as lectotype (1 female: K373, NMPC). Paralectotypes. same as lectotype (1 male: K371, 1 male: K264, 1 male: K265, 1 male: K370, 1 male: K372; NMPC). Trebević leg. Winnegth (1 female, K374, NMPC).

New record. Bosnia-Herzegovina: Toplice, N43°35.658 E18°29.697, 995 m 3.VI.2009, leg. W. Graf, (1 female, OPC)

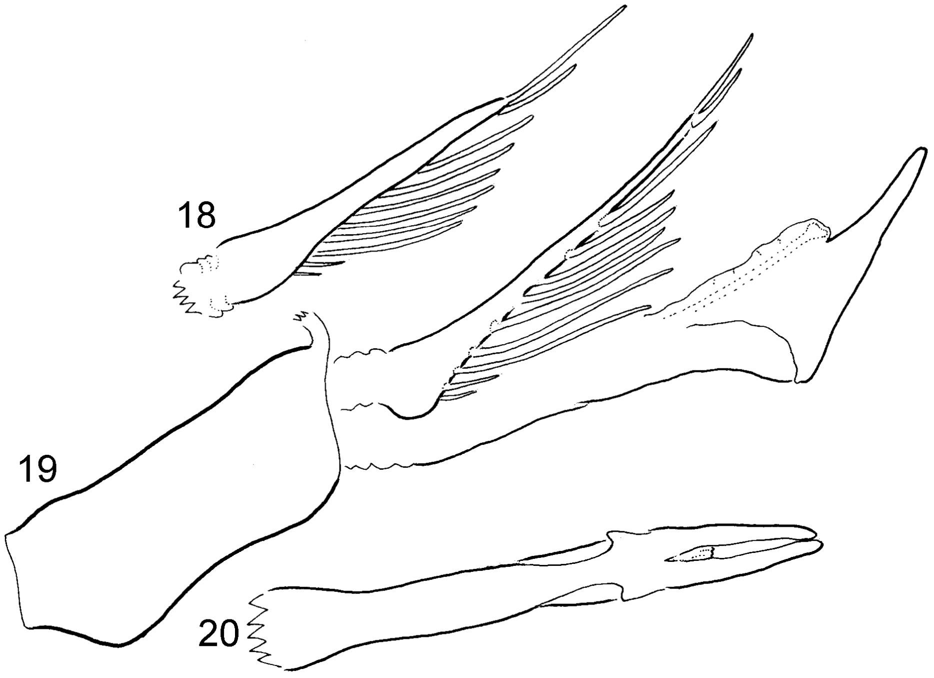
Description. Male (pinned). Forewing pattern clearly dark striped on all the old pinned syntypes. Periphallic organs are typical for the species group. Aedeagus bulging below the ventral heels and the bifid head is highly produced laterad at half of the males. This laterad extended possibly erected state is never observed in any of the *Potamophylax nigricornis* populations. Subapical ventral sclerotized heels blunt triangular with varying pointed profile. End of lateral arms triangular, not tapering, and not spatulate. Paramere shaft slightly sigmoid; terminal seta fused, without alveolus; subapical seta almost as long as the terminal. 9-10 shortened, almost straight setae spread from base to subapicad.

Female. We have cleared the abdomen of the two females in the syntype series and of the newly collected female. The dorsal profile of the vaginal sclerite complex of the three females is as short as wide; the sclerotized opening of the spermathecal duct on the spermathecal process is short and located on the middle of the sclerite; the transversal sclerite of the duct of bursa copulatrix is long.

Potamophylax fules **Oláh & Ibrahimi sp. nov.**

(Figures 18–20)

Diagnosis. This species having dark striped forewing belongs to the *Potamophylax elegantulus* species subgroup. Close to *P. ureges* sp. nov. but differs by having the ventral subapical double layered heel with lateral plates abbreviated; the lateral plate is longer at *P. fules*; as a result the mesal plate is long exposed free in lateral view; pectinate patterned setae distributed along to the subapical region, not limited to the basal half of the paramere shaft.



Figures 18-20. *Potamophylax fules* sp. nov. male. 18 = paramere in dorsal view, 19 = phallic organ in left lateral view, 20 = aedeagus in ventral view.

Material examined. Holotype. *Romania*: South Carpathians, Caras-Severin county, Tarcu Mts. Poina Marului, upper section of Sucu Stream, S of the village, N45°20.907' E22°31.073', 955 m, 08.VI.2011, leg. T. Kovács, D. Murányi & G. Puskás, (1 male, HNHM). Paratypes. *Kosovo*: Skënderaj Municipality, entrance into the Kuçicë village, Klinë river sidespring, N42°48.36' E20° 46.29', 690 m, 12.V.2011, leg. H. Ibrahimi, Ar. Gashi & B. Deliu (1 male, DBFMNSUP). Prishtinë Municipality, Gollak region, Keqekollë village, streamlet, N42.7237°, E21.3067°, 804 m, 15.06.2009, leg. H. Ibrahimi & F. Asllani Ibrahimi (1 male, DBFMNSUP). *Montenegro*: Biogradska Gora, N42 54 01.5 E19 35 44.7, 1093 m, 29.V.2009, leg W. Graf (1 male, OPC).

Description. Male (in alcohol). Body dark coloured, forewing dark striped. Forewing 19 mm. Periphallic organs are typical for the species group. Aedeagus almost parallel-sided in ventral view; ventral subapical heels double layered enclosing a concavity. Apices of bifid aedeagal head broad paralle-sided, not tapering. Paramere shaft straight with broad basement. regularly tapering apicad; setae almost equal long, pectinate patterned and distributed up to subapicad.

Etymology. fules from "füles" auriculate in Hungarian, refers to the ear-shaped small corner produced by the abbreviated lateral plate of the double-layered ventral subapical heel on the aedeagus.

Potamophylax hasas Oláh sp. nov.

(Figures 21–24)

Potamophylax nigricornis (Pictet, 1834). Kumanski 1971:103, Bulgaria (Rodope Mts.). Misidentification.

Diagnosis. Close to *P. kethas* sp. nov. but differs by having single belly on the aedeagus without a strong constriction midway, apical seta on paramere long, not short; basal setae four, not eight. Kumanski's original male and female specimens were examined designated as allotype and paratype and compared to the holotype.

Material examined. Holotype. *Bulgaria*: Smoljan Province, Perelik Mts. Pamporovo, open brooks and alpine grassland at the settlement, 1560 m, N41°37.540' E24°42.411', 31.V.2012, leg. J. Kontschán, D. Murányi & T. Szedrejesi (1 male, OPC). Allotype. Bulgaria, Rodope Mts. above Triglad 25.VII.1968, leg. A. Slivov (1 female, NMNHBAS) Paratype. same as allotype (1 male, NMNHBAS).

Description. Male (in alcohol). Body dark coloured, forewing with dark striped-pattern. Periphallic organs typical for the species group. Aedeagus with bulging lateral bellies in ventral view; ventral subapical heels without pointed corner; apices of bifid aedeagal head parallesided, not tapering. Paramere shaft straight with broadening basement and regularly taperring apicad; setae pectinate patterned; apical seta is the direct continuation of the shaft without alveolus; five basal setae curving mesad two setae located subapicad.

Etymology. hasas from "hasas" bellied in Hungarian, refers to the subapical lateral bulging on the aedeagus.

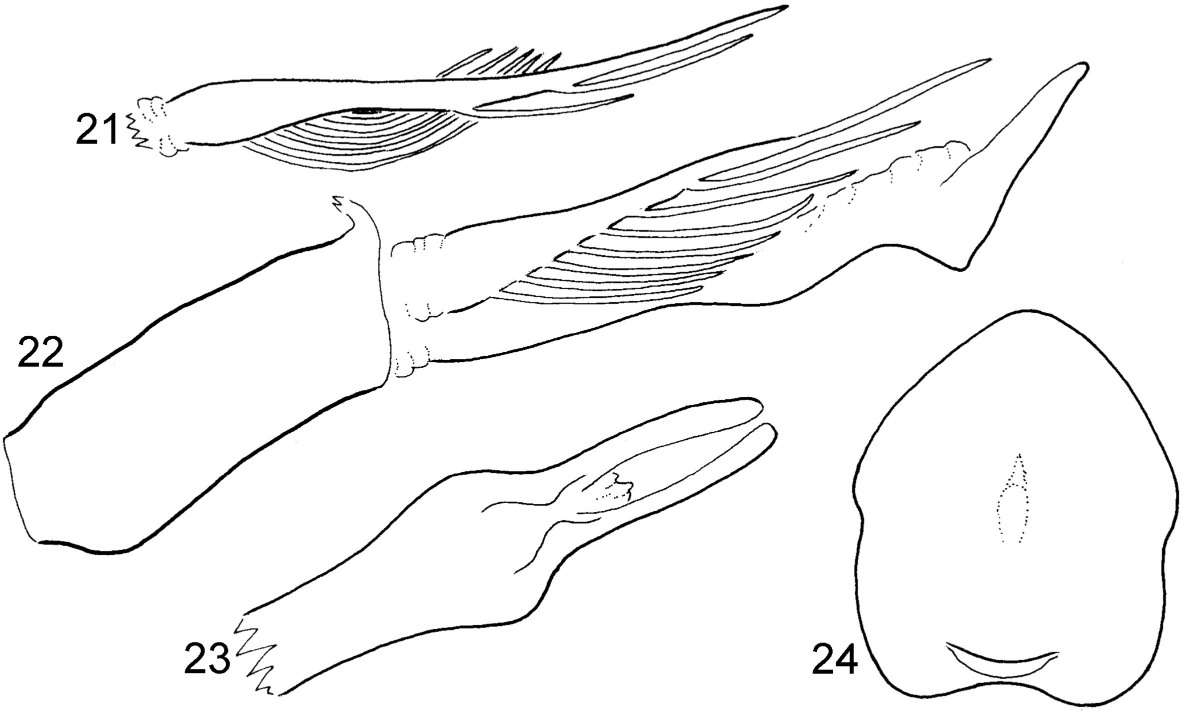
Potamophylax kethas Oláh sp. nov.

(Figures 25–27)

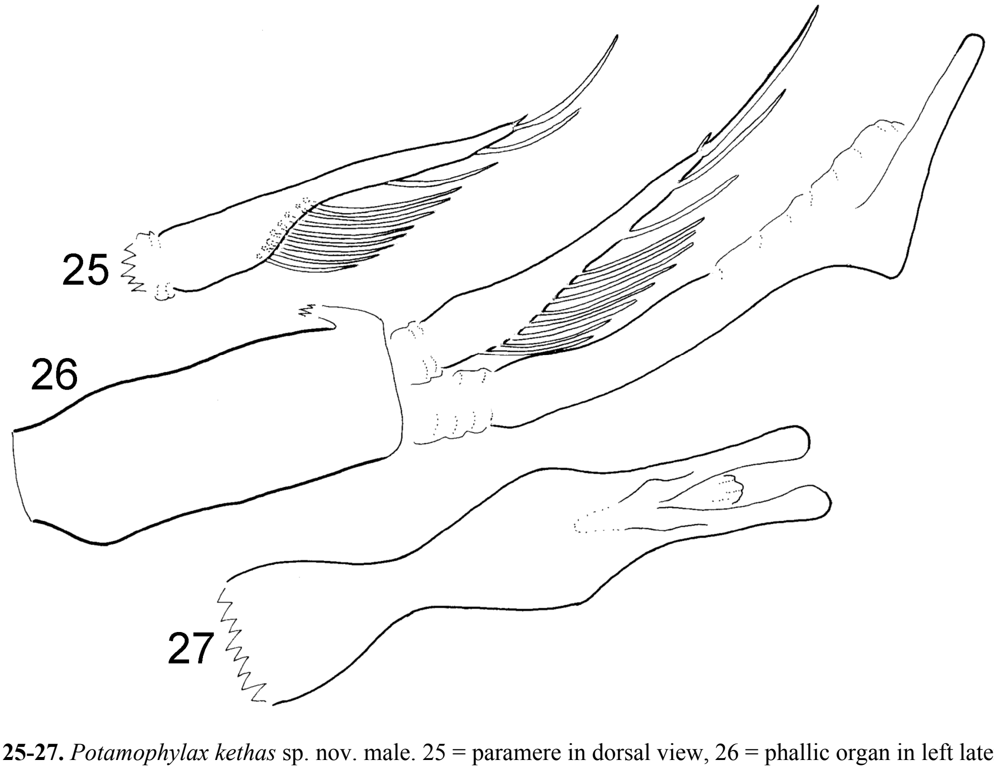
Diagnosis. Close to *P. hasas* sp. nov. but differs by having double bellies on the aedeagus with a strong constriction midway, apical seta on paramere short, not long; basal setae eight, not four.

Material examined. Holotype. *Bosnia-Harcegovina*: Vucjaluka, N43.93221 E18.52135, 12.VII. 2008, leg. M. Bálint & S. Lelo (1 male, OPC).

Description. Male (in alcohol). Body dark coloured, forewing dark striped. Periphallic organs are typical for the species group. Aedeagus with pronounced constriction midway producung double bellies. Apices of bifid aedeagal head parallelsided, slightly spatulate. Paramere shaft straight with very broad subquadratic basement and tapering apicad; single apical seta accompanied with a minute spine; basal tuft of eight setae followed by two subapical setae.



Figures 21-24. *Potamophylax hasas* sp. nov. male. 21 = paramere in dorsal view, 22 = phallic organ in left lateral view, 23 = aedeagus in ventral view, 24 = dorsal profile of the vaginal sclerite complex.



Figures 25-27. *Potamophylax kethas* sp. nov. male. 25 = paramere in dorsal view, 26 = phallic organ in left lateral view, 27 = aedeagus in ventral view.

Etymology. *kethas* from "két has" double bellies in Hungarian, refers to the strong constriction midway on the aedeagus resulting double bellies in ventral view.

Potamophylax lemezes **Oláh & Graf sp. nov.**

(Figures 28–30)

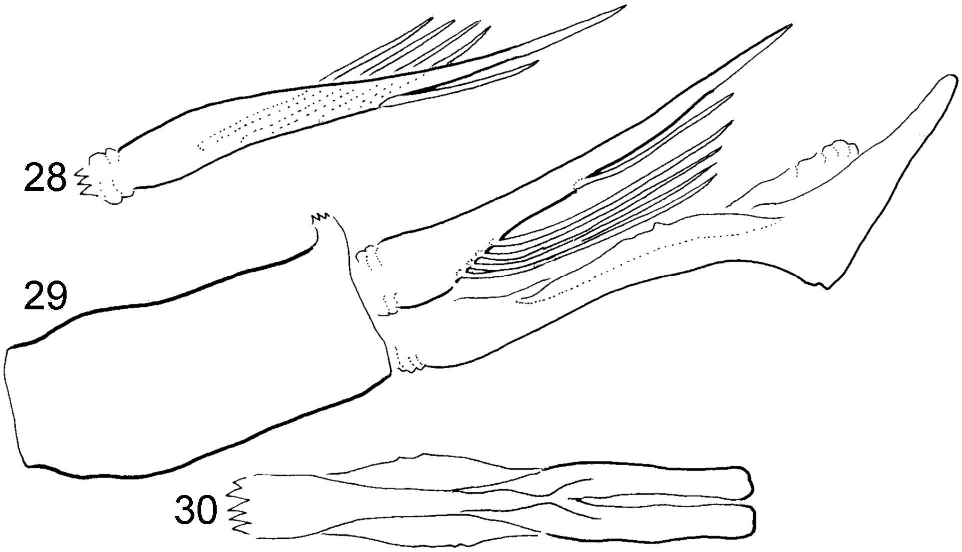
Diagnosis. This species having no double layered heels (*P. ureges, P. fules*), no bellies on aedeagus (*P. hasas, P. kethas*), no elongated pointed heels (*P. apados*) and no broad paramere shaft (*P. schmidi*) has resemblence in the subgroup to *P. elegantulus*, but differs by having the unique lateral plate developed on the aedeagus subapicad, and by the differently patterned setal structure on the paramere shaft.

Material examined. Holotype. *Macedonia*: Mavrovo, Galicnicka spring, N41.35364, E 20.39523, 1407 m, 2.VII.2010, leg. W. Graf (1 male, OPC). Allotype. Same as holotype (1 female, OPC). Paratypes. Same as holotype (1 males, 2 females; OPC). Vitosa, 27.V.2010, leg. I. Sivec (1 male, 1 female; OPC).

Description. Male (in alcohol). Body dark coloured, forewing dark striped. Periphallic organs are typical for the species group. Aedeagus with pronounced elongated lateral plate subapicad; apices of bifid aedeagal head paralle-sided, slightly spatulate. Paramere shaft straight and taperring apicad; basal tuft of four-six setae and single subapical spine-like seta present.

Female. The dorsal profile of the vaginal sclerite complex almost regular diamond-shaped. Spermathecal process located above the middle line.

Etymology. *lemezes* from "lemezes" laminate in Hungarian, refers to lateral laminar plates present subapicad on the aedeagus.



Figures 28-30. *Potamophylax lemezes* sp. nov. male. 28 = paramere in dorsal view, 29 = phallic organ in left lateral view, 30 = aedeagus in ventral view.

Potamophylax schmidi **Marinković, 1971**

(Figures 31–38)

Potamophylax schmidi Marinković 1971:80–83 (Southeast Bosnia)

Potamophylax schmidi Marinković 1971:144 „Southeast Bosnia, ♂♂ ♀♀ in many small brooks on the mountain Zelengora and Maglić."

Diagnosis. Type specimens of this species were lost. We have collected only females and effort to borrow males failed. Male drawings are reproduced from the original description and drawings. Compared to other species of this group the reconstructed lateral view of phallic organ and the dorsal view of the paramere with setal formation are rather particular. We have examined the availaable 10 females. Dorsal profile of the vaginal sclerite complex as well as the spermathecal process and the bursal sclerite are, as usual, very stable indicated by the narrow range of phenothipic variation.

Material examined. Bosnia-Herzegovina: Sutjeska NP, Izvor uz Cestu, N43°15.902 E18° 35.56716, 1109 m. 15.V.2008, leg. W. Graf & H. Ibrahimi (7 females, OPC). Same but 2.VI.2009, leg. W. Graf (2 females, OPC). Same but, spring by the road, 2.VI.2009, leg. A. Previsic (1 female, OPC).

Potamophylax ureges Oláh sp. nov.

(Figures 39–42)

Diagnosis. This beautiful species having dark striped forewing belongs to the *Potamophylax elegantulus* species subgroup. Close to *P. fules* sp. nov. but differs by having the ventral subapical double layered heel with mesal and lateral plates almost equal enclosing a concavity; the lateral plate is shorter at *P. fules*, pectinate patterned setae distributed only on the basal half of the paramere shaft, not along to subapical region.

Material examined. Holotype. *Montenegro*: Žabljak municipality, Sinjajevina Mts, Dobrilovina, forest stream at the monastery, N43° 01.652’, E19°24.086’, 765 m, 25.05.2013, leg. P. Juhász, T. Kovács, G. Magos, G. Puskás, (1 male, OPC). Allotype same as paratype: (1 female, OPC). Paratypes**.** Same as holotype (4 males, 3 females; OPC; 1 male, 2 females, NMPC). Same but 14.VI.2012 leg. Z. Fehér, T. Kovács, D. Murányi (6 females, OPC).

Description. Male (in alcohol). Body dark coloured, forewing dark striped. Periphallic organs are typical for the species group. Aedeagus almost parallel-sided in ventral view; ventral subapical heels double layered enclosing a concavity. Apices of bifid aedeagal head broad paralle-sided, not tapering. Paramere shaft straight with broad basement and regularly taperring apicad; setae almost equal long, pectinate patterned and restricted to the basal half.

Etymology. ureges from “üreges” supplied with hollow in Hungarian, refers to the concavity enclosed by the double-layered heels.

Potamophylax horgos new species subgroup

Depigmentation produced the forewing background paler and the narrow longitudinal light stripes present in the cells more obsolete. The subgroup has evolved along west and south peripheries of the Alps and in the direction of the Appenine peninsules. The complex pattern of the parameres modified into a simpler fan-like formation, characterized by strong, closely set mesad arching regular spine-like setae. The ventral subapical heel on the aedeagus modified into serrated, hooked, or spiny rim armed with various numbers of short peg-like prickles on the ventromesal surface.

Potamophylax fureses Oláh, Lodovici & Valle sp. nov.

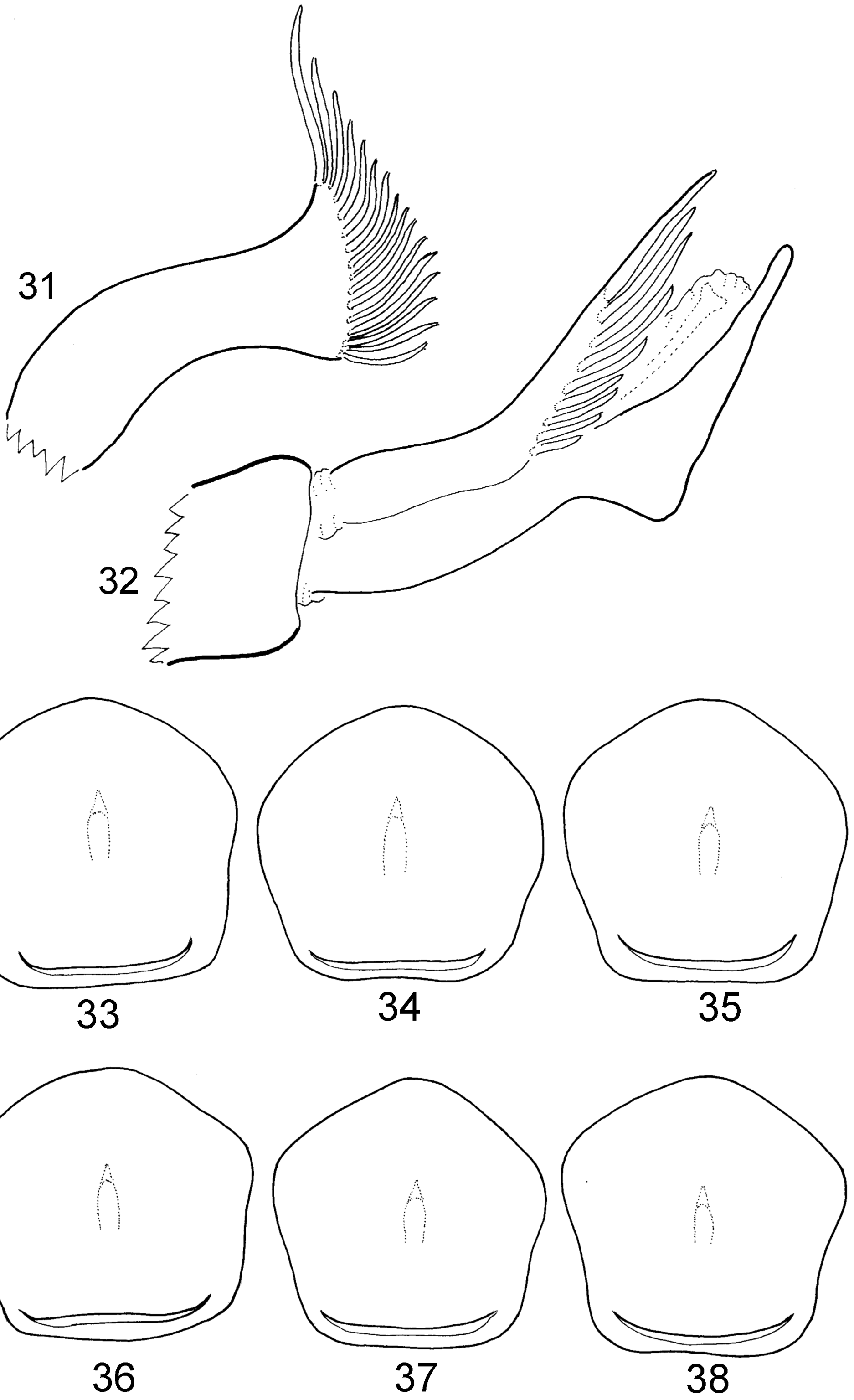
(Figures 43–45)

Diagnosis. This species is most close to *P. tuskes* sp. nov. but differs by having lateral rim on the ventral subapical heels narrow, but present with serrated margin; apices of the bifid aedeagal head spatulate; setal fan of the paramere is shorter. The stabilities of these diverging traits must be examined on several newly collected specimens, including examination of the vaginal sclerite complex.

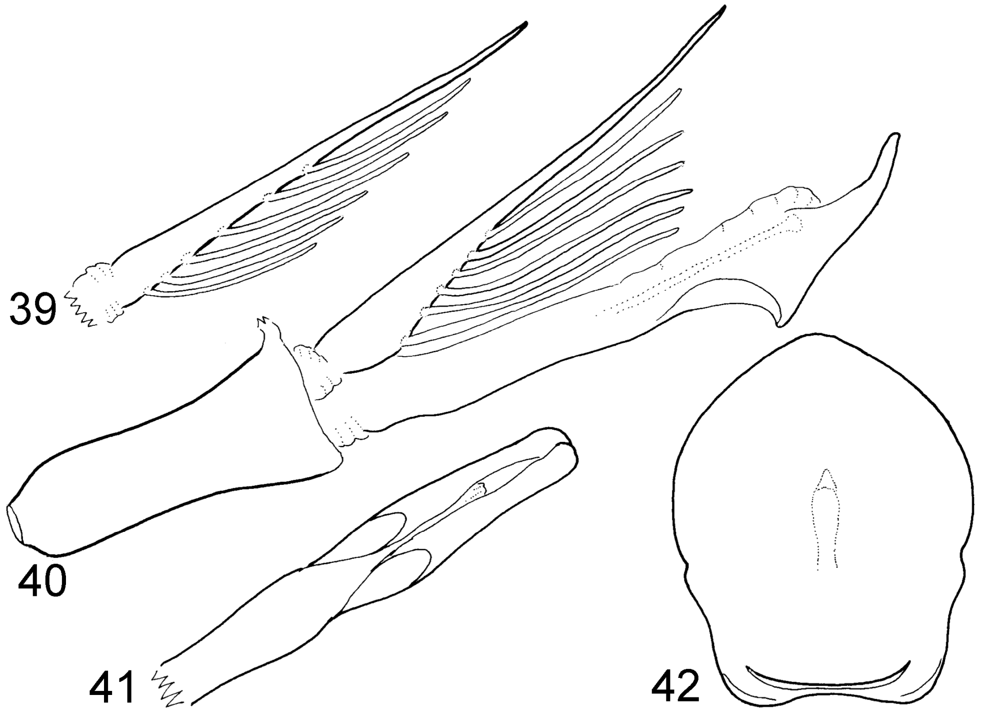
Material examined. Holotype. *Italy*: Toscana-Firenze, Marradi (FI), Monte Bruno, N44.0259 E11.6786, 700 m, 24.VIII.2003, leg. A. Usvellii (1 male, CNSMB). Paratype. Same as holotype (1 male, OPC).

Description. Male (in alcohol). Forewing paler, longitudinal stripes obsolete. Forewing length 19 mm. Periphallic organs are typical for the species group. Aedeagus constricted midway; apices of the bifid aedeagal head spatulate; ventral subapical heel produced into narrow serrated rounded rims. Paramere straight in dorsal, ventrad curving in lateral view; fanlike formation of short and strong spine-like setae is very short.

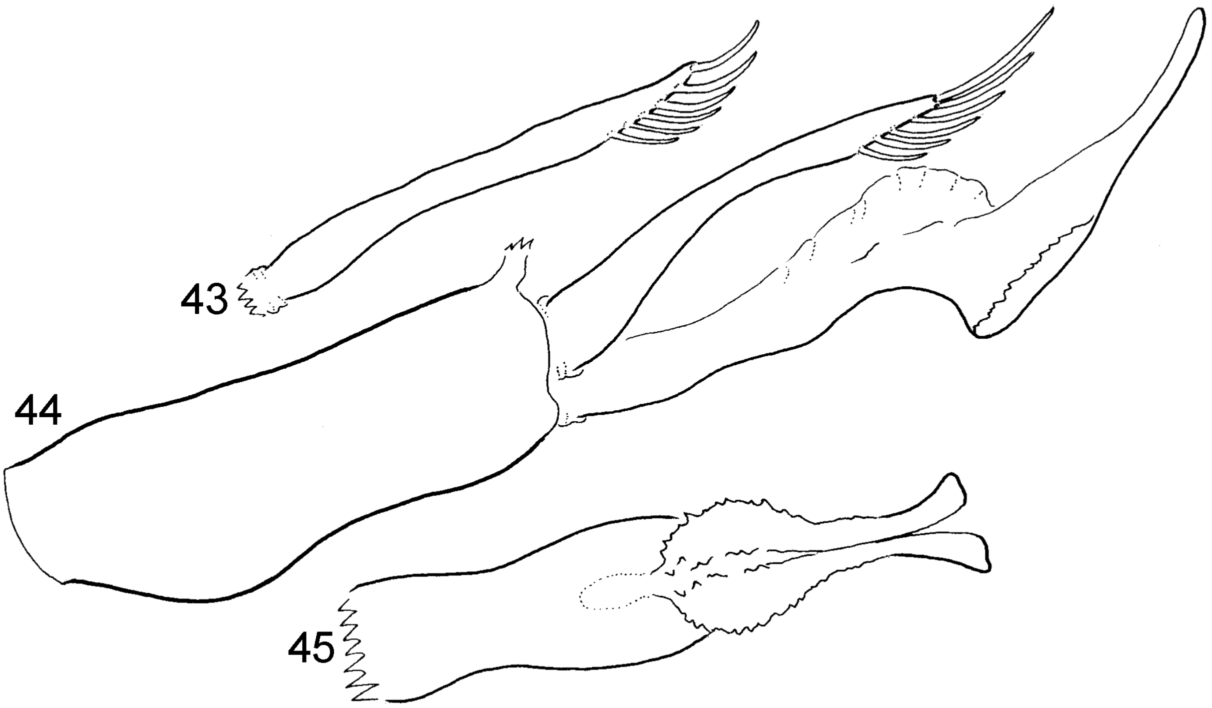
Etymology. fureses from “fűrészes” serrated in Hungarian, refers to the serrated margin of the rim of the ventral subapical slecrotized heels on the aedeagus.



Figures 31-38. *Potamophylax schmidi* Marinković, 1971 male. 31 = paramere in dorsal view, 32 = phallic organ in left lateral view, 33–38 = dorsal profile of the vaginal sclerite complex.



Figures 39-42. *Potamophylax ureges* sp. nov. male. 39 = paramere in dorsal view, 40 = phallic organ in left lateral view, 41 = aedeagus in ventral view, 42 = dorsal profile of the vaginal sclerite complex.



Figures 43-45. *Potamophylax fureses* sp. nov. male. 43 = paramere in dorsal view, 44 = phallic organ in left lateral view, 45 = aedeagus in ventral view.

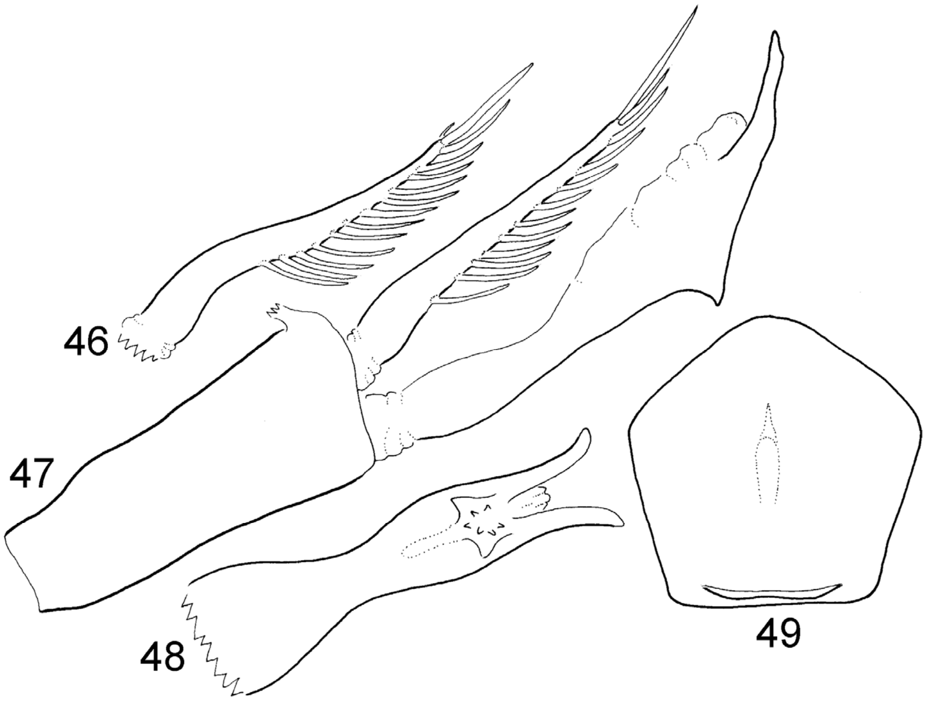
Potamophylax horgos Coppa & Oláh sp. nov.

(Figures 46–49)

Diagnosis. This species differs from the other species of the subgroup by having the longest fan on the paramere and hook formaton, no flange or rim formation developed on the ventral subapical heel.

Material examined. Holotype. *France*: Departement Lozere, Florac, Source du Pecher, 560 m, 11.VII.2006, leg. G. Coppa (1 male, CPC). Allotype. Departement Aveyron, Aurelle Verlac, Ruisseau de Saltou Piste, 28.V.2011, leg. G. Coppa (1 female, CPC). Paratypes: same as holotype (6 males CPC, 2 males, 3 females; OPC; 1 male, NMPC). Departement Ardennes, Elan, Bassins en amont de la Fontaine Saint-Roger, 9.VIII.2004, leg. G. Coppa (1 male, 3 females; CPC). Department Ardennes, Autrecourt, 22.VIII.2013, leg. G. Coppa (13 males, 15 females, CPC; 1 female, NMPC). France, Department Hautes-Alpes, Arvieux, 7.VII.2004, leg G. Coppa (1 male, OPC). France, Departement Haute-Savoie, Naves-Parmelan, 13. VIII. 2013, leg. A. Auzeil (11 males, CPC). Department Ardennes, Balaives, source du captage, 5.VI.2013, leg. G. Coppa (2 males, CPC) Department Ardennes, Elan, ruisseau près du captage, 6.VI.2013, leg. G. Coppa (5 males, CPC). Department Vosges, Le Valtin, source près du parking du col de la Schlucht, 2.VII.20, leg. G. Coppa (1 male, CPC). Department Isère, Séchilienne, ruisseau de Fontfroide, 8.VII.2013, leg. A. Auzeil (1 male, CPC). Departement Haute-Marne, Auberive, Marais du Vallon d'Amorey, Tuf, 26. VII.2001, leg. G. Coppa (3 females, OPC). Department Vosges, Le Valtin, Meurthe amont Ru Central, 2.VII.2008, leg. G. Coppa (1 male, 3 females, OPC).

Description. Male (in alcohol). Forewing paler, longitudinal stripes obsolete. Forewing length 20 mm. Periphallic organs are typical for the species group. Aedeagus constricted midway; apices of the bifid aedeagal head laterad directed, varying between tapering and spatulate; ventral subapical heel produced into hook formation with few short teeth ventrad between the hooks. Paramere slightly sigmoid with fanlike formation of



Figures 46-49. *Potamophylax horgos* sp. nov. male. 46 = paramere in dorsal view, 47 = phallic organ in left lateral view, 48 = aedeagus in ventral view, 49 = dorsal profile of the vaginal sclerite complex.

short and strong spine-like setae; the fan is long from the tip almost to the basement. Female with rather regular diamond-shaped dorsal profile of the vaginal sclerite complex.

Etymology. horgos from "horgos" hooked in Hungarian, refers to the hook-like shape of the ventral subapical slecrotized heels on the aedeagus.

Potamophylax peremes **Oláh, Lodovici & Valle sp. nov.**

(Figures 50–52)

Diagnosis. This species is most close to *P. fureses* sp. nov. but differs by having lateral rim on the ventral subapical heels very broad, less serrated and setal fan of the paramere is much longer; basement of paramere bulbous. The stabilities of these diverging traits must be examined on several newly collected specimens, includind examination of the vaginal sclerite complex.

Material examined. Holotype. *Italy*: Liguria, Mezzanego (GE), P.sso del Bocca, Parco Aveto T. L. Foresta Demaniale M.te Zatta, 1000 m, 31.VII.2009, leg. V. Raineri (1 male, CNSMB).

Description. Male (in alcohol). Forewing paler, longitudinal stripes obsolete. Forewing length 19 mm. Periphallic organs are typical for the species group. Aedeagus has broad ring subbasad; apices of the bifid aedeagal head narrowing apicad; ventral subapical heel produced into rounded rims. Paramere straight with bulbous basal region and developed fanlike formation of short and strong spine-like setae; the fan is long from the tip to midway.

Etymology. peremes from "peremes" supplied with rim in Hungarian, refers to the rounded rim shape of the ventral subapical slecrotized heels on the aedeagus.

Potamophylax tuskes **Oláh, Lodovici & Valle sp. nov.**

(Figures 53–55)

Diagnosis. This species is most close to *P. fureses* sp. nov. but differs by having lateral rim on the ventral subapical heels fully covered by short peg-like teeth; apices of the bifid aedeagal head narrowing, not spatulate; setal fan of the paramere is longer. The stabilities of these diverging traits must be examined on several newly collected specimens, includind examination of the vaginal sclerite complex.

Material examined. Holotype. *Italy*: Bormida (SV), Rivolo Sorg S. P. Colle Melogno, 11.X. 2001, leg. Museo Caffi BG, (1 male, CNSMB). Paratypes: Bardineto (SV) sorgenti del Bormida T.I., 820 m, 17. VII. 2001, leg. Museo Caffi BG, (1 male, OPC).

Description. Male (in alcohol). Forewing paler, longitudinal stripes obsolete. Forewing length 19 mm. Periphallic organs are typical for the species group. Aedeagus constricted midway; apices of the bifid aedeagal head narrowing; ventral subapical heel produced into densely dentate rim. Paramere straight both in dorsal and lateral view; fanlike formation of short and strong spine-like setae is moderately short.

Etymology. tuskes from "tüskés" dentate in Hungarian, refers to the short teeth covered rim of the ventral subapical slecrotized heels on the aedeagus.

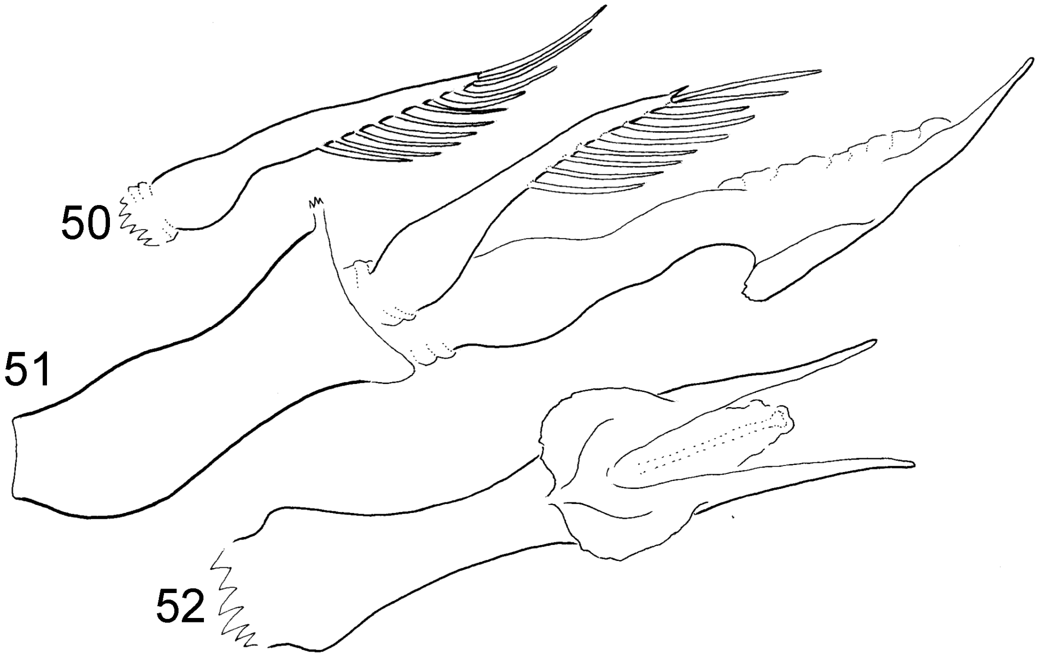
Potamophylax simas **new species subgroup**

Similarly to *P. elegantulus* species subgroup the complex pattern of the ancestral parameres is modified into simpler pectinate pattern, characterized by long and gradually apicad shortening row of less arching spine-like setae. However the forewing is pale, not dark-striped on light background. The subgroup distributed in Massif Central, Pyrenees and an isoleted taxon in the White Carpathians. Three species belong to this subgroup: *P. mista* Navas stat. nov., *P.* sp. nov. and *P. simas* sp. nov.

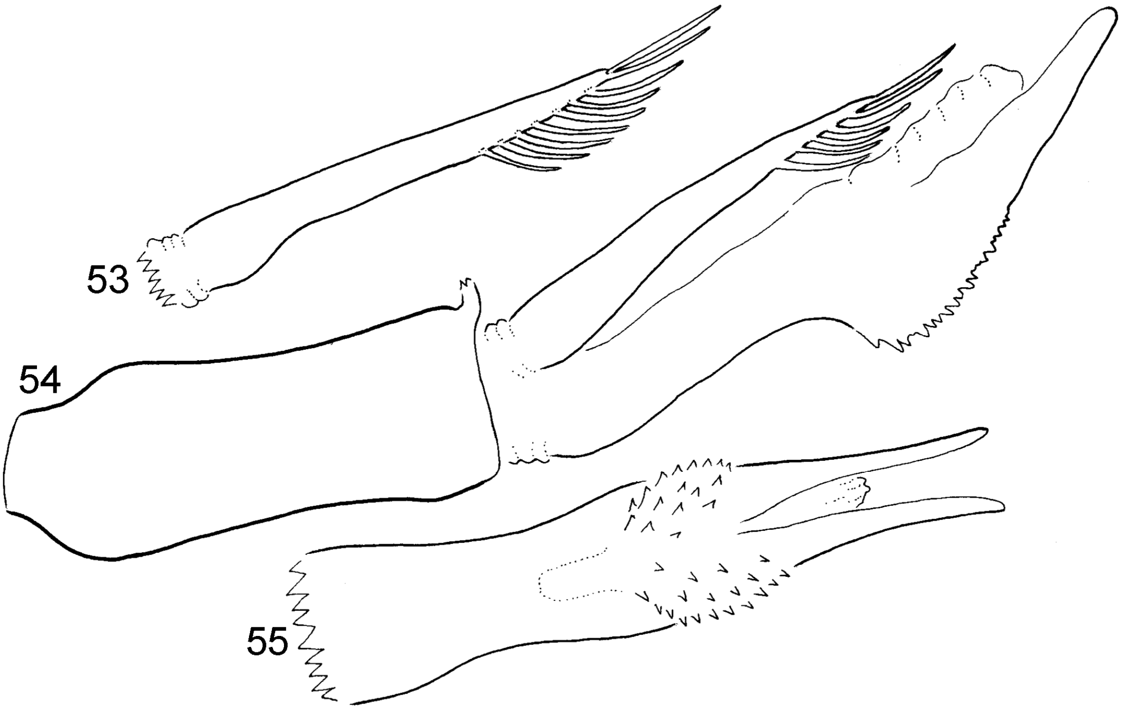
Potamophylax sp.

(Figures 56–58)

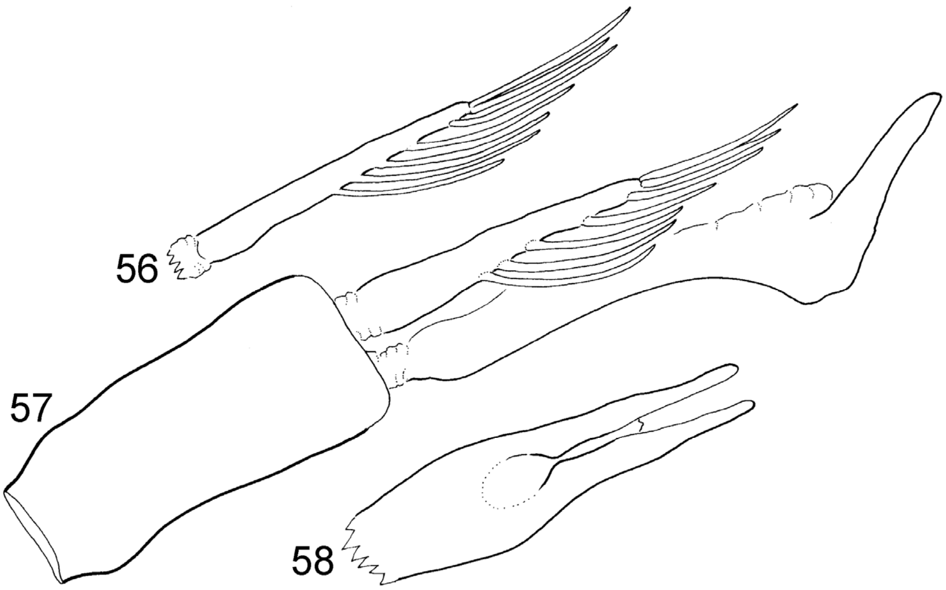
Potamophylax nigricornis (Pictet, 1834). Komzák & Chvojka 2012:744, Czech Republic (Bílé Karpaty Mts.). Misidentification.



Figures 50-52. *Potamophylax peremes* sp. nov. male. 50 = paramere in dorsal view, 51 = phallic organ in left lateral view, 52 = aedeagus in ventral view.



Figures 53-55. *Potamophylax tuskes* sp. nov. male. 53 = paramere in dorsal view, 54 = phallic organ in left lateral view, 55 = aedeagus in ventral view.



Figures 56-58. *Potamophylax* sp. nov. male. 56 = paramere in dorsal view, 57 = phallic organ in left lateral view, 58 = aedeagus in ventral view.

Diagnosis. Forewing colour is ancestral gray. Most similar to *P. nigricornis*, but differs by having gonopods more expanded; ventral subapical heels rounded without tooth-shaped pointed plate; ancestral complex seatal pattern simplified. More male and female specimens are required to examine and to confirm the divergence of this taxon. It could be an atavistic species (Oláh in prep.).

Material examined. Czech Republic: Moravia mer., Bílé Karpaty Mts., Bílé potoky Nat. Res. SE of Valašské Klobouky, spring area, 430 m, N49°06'56", E18°01'38", 13–16. VIII. 2007, leg. J. Ježek, yellow pan traps (1 male, NMPC).

Description. Male (in alcohol). Forewing colour gray, forewing length 17 mm. Periphallic organs are typical for the species group except gonopods slightly expanded in oblique transversal plane. Aedeagus almost parallel-sided in ventral view; bulging slightly below the ventral heels. Ventral heels forming rounded plate without tooth-shaped pointed corner. Apices parallel-sided, not tapering and not spatulate. Paramere shaft straight. Number of spine-like setae seven: two apical, one subapical and four regularly set from subapicad to the middle of the shaft.

***Potamophylax mista* (Navas, 1918) stat. nov.**

(Figures 59–62)

Stenophylax nigricornis var. *mista* Navas, 1918:44–45, (Spain: Lerida). Types are not available.

Stenophylax aculeatus Navas, 1919: 203–204, (Spain: Gerona). Synonymised with *P. nigricornis* by Fischer 1969:152. Types are not available.

Diagnosis. Close to *P. simas* sp. nov. but differs by having ventral subapical heel with small pointed tooth; setal pattern with basal tuft of setae curving mesad, the dorsal profile of the vaginal sclerite complex long, not short. All the specimens examined from the Pyrenees collected near to the locus typicus of both taxa described by Navas belong to this species.

Material examined. France: Departement Pyrenees-Atlantiques, Vieille Aure, Nest d'Oule, 1830 m, 10.VII.2009, leg. G. Coppa (2 males, 1 female, CPC; 2 males, 2 females, OPC). Departement Pyrenees-Atlantiques, Aragnouet, Neste de Couplan, 1380 m, 10.VII.2009, leg. G. Coppa (1 male, CPC). Departement Pyrenees-Atlantiques, Aragnouet, 1425 m, 8.VII.2009, leg. G. Coppa (2 males, 1 female; CPC). Departement Pyrenees-

Orientales, Thues en Valls, Suintement source Bord Chemin vers Milieu Ru, 19.VII.2005, leg. G. Coppa (2 females; CPC). Castillon de Larboust, département de Haute-Garonne, 11.VII. 2012, leg. G. Coppa (1 male, CPC). *Spain*: Lérida province, Pont del Nere, Río Nere, Vall d´Aran, N42º 40´35.41´´ E0º46´13.09´´, 1395 m, 17.IX. 1986, leg. M. González (1 male, CPC). Arros, val d'Aran source rio Varrados, 11.VII.1912, leg. G. Coppa (1 male, 1 female; CPC). Villanos, Garonne de Joen, 11.VII.1912, leg. G. Coppa (1 male, CPC).

Description. Description by Navas (1918:44–45): „Similar to var. *testacea* Zett. Et typo. Ala antertior griseo-susca, pubescentia sat densa; striis digitiformibus longitudinalibus testaceis vel pallidisw in plerisque cellulis apicalibus."

Remarks. Navas (1918) named his taxon as *mista* but he did not indicate the origin of the name and we treat *mista* as a noun in apposition.

Potamophylax simas Oláh & Coppa sp. nov.

(Figures 63–66)

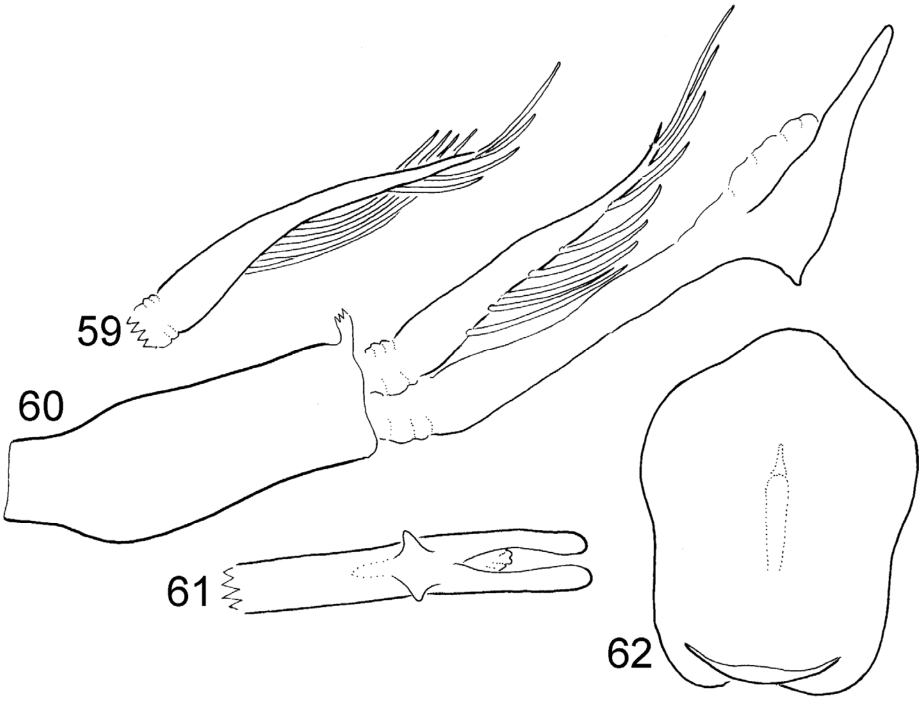
Diagnosis. Most close to *P. mista* (Navas), but differs by having ventral subapical heel without pointed tooth; setal pattern with basal setae less curving mesad; the dorsal profile of the vaginal sclerite complex short, not long.

Material examined. Holotype. *France*: Citou, Aude, N43.408 E2.591, 906 m, 14.VII.2007, leg. M. Bálint (1 male, HNHM). Allotype. *France*: Departement Puy-de-Dome, Chambon sur Lac, Zone de Suintements avant cadcade de la Biche, 1340 m, 25.V.2012, leg. G. Coppa (1 female, CPC). Paratypes. *France*: Same as holotype (1 male, OPC; 1 male, NMPC). France, Departement Puy-de-Dome, Chambon sur Lac, Cascade Moyenne a lest cascade de l'aigne, 1475 m, 24.VI.2012, leg. G. Coppa (1 male, CPC). France, Departement Puy-de-Dome, Chambon sur Lac, Zone de Suintements avant cadcade de la Biche, 1340 m, 25.V. 2012, leg. G. Coppa (2 males, CPC, 1 female, OPC). France, Departemente Lozere, Trelans, Source du Bes, 1440 m, 24.V.2011, leg. G.Coppa (2 males, CPC). France, Departement Cantal, Albepierre Bredons, Col de Prat de Bouc, 15.VII. 2006, leg. G. Coppa (1 male, CPC). France, Departement Puy-de-Dome, Chastreix, Cirque Fontaine Salee, 1353 m, 13.VII.2007, leg. G. Coppa (1 male, CPC). France, Departement Puy-de-Dome, Chastreix, Ru de la Jarrige, 8.V.2008, leg. G. Coppa (1 male, CPC). France, Departement Tarn, Lacaune, Ru de l'Albeouradou, 1110 m, 22.VII.2007, leg. G. Coppa (1 male, OPC). 25.07.2012. Pyrenees, Arbas, Estivede de Paloumere, N42°57'52.01'' E0°51'50.01'', 25.VII. 2012. leg. W. Graf (1 male, OPC). Massif Central, north of Caunes de Minervois, N43°24'58.4'' E2°35'10.24'', 807 m, 27.VII.2012, leg. W. Graf (1 male, 3 females, OPC). Department Haute-Vienne, Chateauneuf la Foret, Ru de Courtiane Pont D111, 5.VII.2010, leg. G. Coppa (1 female, CPC). Departement Puy-de-Dome, Chastreix, Ru de la Jarrige, 25.V.2009, leg. G. Coppa (1 female, CPC). Departement Puy-de-Dome, Mont Dore, Ru Prairie Tourbeuse au Nord-W du Puy Mareilh, 25.V.2009, leg. G. Coppa (2 males, 2 females, CPC). Departement Puy-de-Dome, Chambon sur Lac, Cascade de la Biche 22.VI.2012, leg. G. Coppa (1 female, CPC). Departement Puy-de-Dome, Chambon sur Lac, Reserve Naturelle de Chaudefour, Source de chemin de la rancune, 23. VI. 2012, leg. G. Coppa (1 female, CPC).

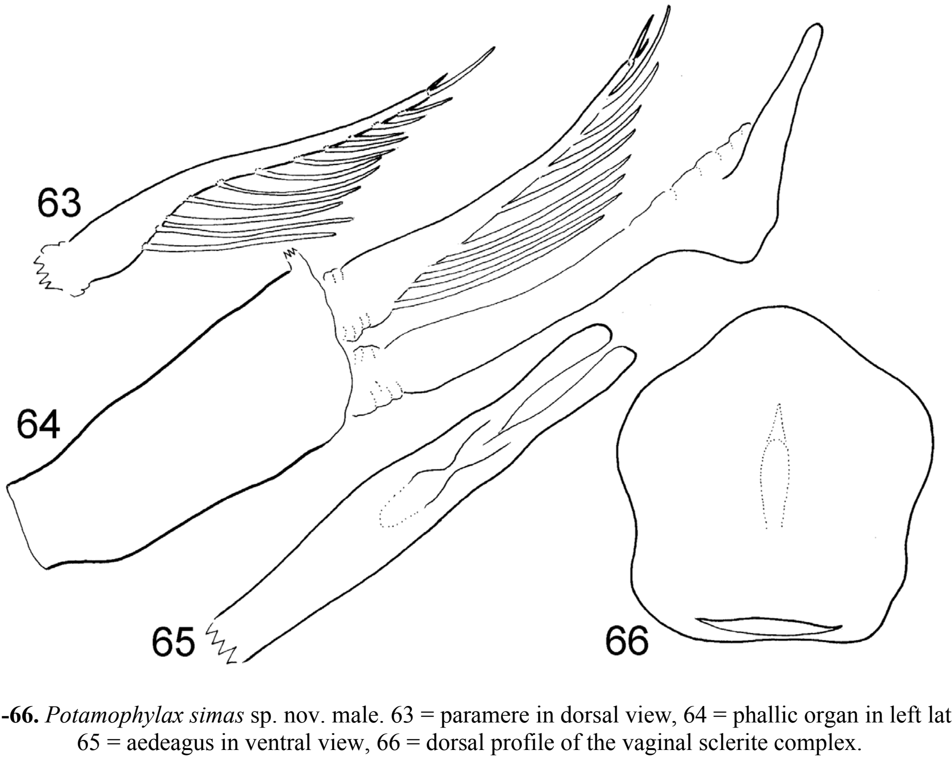
Description. Male (in alcohol). Forewing colour pale, forewing length 19 mm. Periphallic organs are typical for the species group. Aedeagus is parallel-sided in ventral view. Ventral heels forming rounded plate without tooth-shaped pointed corner. Apices of the aedeagal fifid head parallel-sided, not tapering, and not spatulate. Paramere shaft slightly sigmoid, its basement enlarged. Spine-like setal pattern pectinate, basal setae long, shortening subapicad, apical setae accompanied with a small seta.

Female. We cleared the abdomen of the ten females. The dorsal profile of the vaginal sclerite complex is stable, as short or shorter than wide; the sclerotized opening of the spermathecal duct on the spermathecal process is short and located on the middle of the sclerite; the transversal sclerite of the duct of bursa copulatrix is medium long.

Etymology. simas from "sima" plain or smooth in Hungarian refers to the simple parallel-sided aedeagus in ventral view and to the rounded ventral subapical heel without any pointed or tooth-like process.



Figures 59-62. *Potamophylax mista* (Navás, 1918) stat. nov. male. 59 = paramere in dorsal view, 60 = phallic organ in left lateral view, 61 = aedeagus in ventral view, 62 = dorsal profile of the vaginal sclerite complex.



Figures 63-66. *Potamophylax simas* sp. nov. male. 63 = paramere in dorsal view, 64 = phallic organ in left lateral view, 65 = aedeagus in ventral view, 66 = dorsal profile of the vaginal sclerite complex.

Acknowledgements – We sincerely appreciate the kind cooperation in supplying material, of Dr. Stoyan Beshkov, head of Invertebrates Department, National Museum of Natural History, Sofia and of Professor Marcos Gonzalez, Department of Zoology and Physical Anthropology, Faculty of Biology, University of Santiago de Compostela.

REFERENCES

ANDERSSON, M. & SIMMONS, L. W. (2006): Sexual selection and mate choice. *Trends in Ecology and Evolution,* 21(6): 296–302.

BALDWIN, J. M. (1896): A new factor in evolution. *The American Naturalist*, 30: 441–451, 536–553.

BONDURIANSKY, R. & DAY, T. (2009): Nongenetic inheritance and its evolutionary implications. *Annual Review of Ecology, Evolution and Systematics*, 40: 103–125.

BONDURIANSKY, R. (2011) Sexual selection and conflict as engines of ecological diversification. *The American Naturalist,* 178(6): 729–745.

BONDURIANSKY, R. (2012) Rethinking heredity, again. *Trends in Ecology and Evolution*, 27(6): 330–336.

BONDURIANSKY, R., CREAN, A. J. & DAY, T. (2012): The implications of nongenetic inheritance for evolution in changing environments. *Evolutionary Applications*, 5: 192–201.

BOSSDORF, O., RICHARDS, C. L. & PIGLIUCCI, M. (2008): Epigenetics for ecologists. *Ecology Letters*, 11: 106–115.

BRAUER, F. (1876): Die Neuropteren Europas und insbesondere Österreichs mit Rücksicht auf ihre georaphische Verbreitung. *Festschrift Zoologisch-botanischen Gesellschaft*, 1876: 263–300.

BRETMAN, A., NEWCOMBE, D. & TREGENZA, T. (2009): Promiscuous females avoid inbreeding by controlling sperm storage. *Molecular Ecology*, 18: 3340–3345.

CONTE, G. L. & SCHLUTER, D. (2013): Experimental confirmation that body size determines mate prefernce via phenotype matching in a stickleback species pair. *Evolution*, 67: 1477–1484.

CRISPO, E. (2007): The Baldvin effect and genetic assimilation: revisiting two mechanisms of evolutionary change mediated by phenotypic plasticity. *Evolution*, 61: 2469–2479.

DARWIN, CH. (1859): *On the origin of species by means of natural selection, or the preservation of favoured races in the struggle for life*. John Murray, London, 502 pp.

EBERHARD, W. G. (2009): Postcopulatory sexual selection: Darwin's omission and its consequences. *Proceedings of the National Academy of Sciences of the United State of America*, 106: 10025–10032.

EBERHARD, W. G. (2010): Cryptic female choice. *Encyclopedia of Animal Behavior*, 1: 430–434.

EVENHUIS, N. L. (2007): Helping solve the "other" taxonomic impediment: completing the eight steps to total enlightenment and taxonomic Nirvana. *Zootaxa,* 1407: 3–12.

FISCHER F. C. J. (1969): *Trichopterorum Catalogus*. Vol. X, Limnephilidae, Pars 3. Nederlandsche Entomologische Vereeniging, Amsterdam, 332 pp.

GOLDSCHMIDT, R. (1940): *The material basis of evolution*. Yale University Press, New Haven, 438 pp.

HAUSDORF, B. (2011): Progress toward a general species concept. *Evolution*, 65(4): 923–931.

HENDRY, A. P., NOSIL, P. & REISEBERG, L. H. (2000): The speed of ecological speciation. *Functional Ecology*, 21(3): 455–464.

KLAPÁLEK, F. (1899): Prilozi k poznovanu faune Trichoptera i Neuroptera Bosne i Hercegovine. *Glasnik Zemalskogo muzeja u Bosni i Hercegovini*, 11(2–3): 323–338.

KLAPÁLEK, F. (1900): Beiträge zur Kenntniss der Trichopeteren- und Neuropterefauna von Bosnien und der Hercegovina. *Wissenschaftliche Mitteilungen aus Bosnien und der Hercegovina*, 7: 671–682.

KOLENATI, A. F. (1856): Eine neue österreichische Phryganea. *Verhandlungen des Zoologisch-Botanischen Vereins Wien*, 6: 165–166.

KOMZÁK, P. & P. CHVOJKA (2012): Caddis flies (Trichoptera) of the Bílé Karpaty Protected Landscape Area and Biosphere Reserve (Czech Republic). *Acta Musei Moraviae, Scientiae biologicae (Brno)*, 96:697–761.

KUMANSKI, K. (1971): Beitrag zur Untersuchung der Köcherfliegen (Trichoptera) Bulgariens. III. *Bulletin de l'Institut de Zoologie et Musée Sofia*, 23: 99–109.

MA N., ZHONG, W., GAO, Q. & HUA, B. (2012): Female genital plate diversity and phylogenetic analysis of East Asian Panorpidae (Mecoptera). *Systematics and Biodiversity*, 10(2): 159–178.

MARINKOVIĆ-GOSPODNETIĆ, M. (1971): Descriptions of some species of Trichoptera from Yugoslavia. *Godišnjak Bioloskogo instituta Univerziteta u Sarajevu*, 23[1970]: 77–84.

MCLACHLAN, R. (1874–1880): *A monographic revision and synopsis of the Trichoptera of the European fauna*. Reprinted 1968. E. W. Classey Ltd. Hampton, Middlesex.

MORTON, K. J. (1902): Notes on the females of arctic and northern species of Apatania. *Entomologist's Monthly magazine*, 38: 150–-157.

NAVÁS, L. (1918): Excursiones entomologicas por el Norte de la provincia de Lérida. *Butlleti de la Institució Catalana d'Historia Natural*, 18: 44–48.

NAVÁS, L. (1919): Excursiones entomologicas por Cataluna durante el verano de 1918. *Memorias de la Real Academia de Ciencias y Artes de Barcelona*, 15(5): 181–210.

NIELSEN, A. (1943): *Apatania auricula* Forsslund from a Norwegian mountain lake. Description of the imago and notes on the biology. *Entomologiske Meddelelser, Kobenhavn*, 23: 18–30.

NIELSEN, A. (1980): A comparative study of the genital segments and the genital chamber in female Trichoptera. *Det Kongelige Danske Videnskabernes Selskab, Biologiske Skrifter*, 23(1): 1–200.

OLÁH, J. (2010): New species and new records of Palearctic Trichoptera in the material of the Hungarian Natural History Museum. *Annales Historico-Naturales Musei Nationalis Hungarici*, 102: 65–117.

OLÁH J. & JOHANSON K. A. (2008): Reasoning an appendicular and functional caddisfly genital terminology. *Braueria,* 35: 29–40.

OLÁH, J., KOVÁCS, T., SIVEC, I., SZIVÁK, I. & ÚRBANIC, G. (2012): Seven new species in the *Chaetopteryx rugulosa* species group: applying the phylogenetic species concept and the sexual selection theory (Trichoptera, Limnephilidae). *Folia Historico Naturalia Musei Matraensis*, 36: 51–79.

OLÁH, J. & ITO, T. (2013): Synopsis of the *Oxyethira flavicornis* species group with new Japanese *Oxyethira* species (Trichoptera, Hydroptilidae). *Opuscula Zoologica Budapest*, 44(1): 23–46.

PHILLIMORE, A. B. & PRICE, T. D. (2009): *Ecological influences on the temporal pattern of speciation*. In. BUTLIN, R. K., BRIDLE J. R. &SCHLUTER, D. (Eds.) Speciation and patterns of diversity. Cambridge University Press, p. 240–256.

PICTET, F. J. (1834): *Recherches pour server a l'histoire et l'anatomie des Phryganides*. A. Cherbuliez, Geneve, 235 pp.

PIGLIUCCI, M. & MURREN, C. J. (2003): Perspective: Genetic assimilation and a possible evolutionary paradox: can macroevolution sometimes be so fast as to pass us by? *Evolution*, 57(7): 1455–1464.

PIGLIUCCI, M., MURREN, C. J. & SCHLICHTING, C. D. (2006): Phenotypic plasticity and evolution by genetic assimilation. *The Journal of Experimental Biology*, 209: 2362–2367.

PUNIAMOORTHY, N., KOTRBA, M. & MEIER, R. (2010): Unlocking the "Black box": internal female genitalia in Sepsidae (Diptera) evolve fast and are species-specific. *BMC Evolutionary Biology*, 10: 275.

DE QUEIROZ, K. (2011): Branches in the lines of descent: Charles Darwin and the evolution of the species concept. *Biological Journal of the Linnean Society*, 103: 19–35.

ROSS, H. H. (1956): *Evolution and classification of the mountain caddisflies*. The University of Illinois Press, Urbana, 213 pp.

SCHLUTER, D. (2009): Evidence for ecological speciation and its alternative. *Science*, 323: 737–741.

SCHMID, F. (1955): Contribution a l'étude des Limnophilidae (Trichoptera). *Mitteilungen der Schweizerischen Entomologischen Gesellschaft*, 28: 1–245.

SCHMID, F. (1958): A propos de deaux récents ouvrages sur la phylogénie et la zoogeographie des Trichopteres. *Miscellania Zoologica Barcelona*, 1: 1–27.

SCHMID, F. (1979): On some new trends in Trichopterology. *Bulletin of the Entomological Society of Canada*, 11: 48–57.

THOMAS, J. A., WELCH, J. J. WOOLFIT, M. & BROMHAM, L. (2006): There is no universal molecular clock for invertebrates, but rate variation does not scale with body size. *Proceedings of the National Academy of Sciences of the United State of America*, 103(19): 7366–7371.

VAN VALEN, L. (1965): Morphological variation and width of ecological niche. *The American Naturalist*, 99: 377–390.

VIA, S. (2009): Natural selection in action during speciation. *Proceedings of the National Academy of Sciences of the United States of America*, 106(1): 9939–9946.

WADDINGTON, C. H. (1942): Canalization of development and the inheritance of acquired characters. *Nature*, 150: 563–565.

WAGNER, G. P. & ALTENBERG, L. (1996): Complex adaptations and the evolution of evolvability. *Evolution*, 50: 967–976.

WILLMORE, K. E., YOUNG, N. M. & RICHTSMEIER, J. T. (2007): Phenotypic variability: its components, measurement and underlying developmental processes. *Evolutionary Biology*, 34(3): 99–120.

ZETTERSTEDT, J. W. (1840): *Insecta Lapponica*. In. Fauna Insectorum Lapponiae. Vol. 1. Lipsiae, Sumtibus Leopoldi Voos, 314 pp.

Opusc. Zool. Budapest, 2013, 44(2): 201–209

New data to the earthworm fauna of Israel (Oligochaeta, Lumbricidae)

T. SZEDERJESI[1], T. PAVLÍČEK[2] & CS. CSUZDI[3]

[1]*Tímea Szederjesi, Department of Systematic Zoology and Ecology, Eötvös Loránd University, Budapest, Hungary.*
E-mail: t.szederjesi@gmail.com
[2]*Dr. Tomás Pavlíček, Institute of Evolution, University of Haifa, Israel.*
E-mail: pavlicek@research.haifa.ac.il
[3]*Dr. Csaba Csuzdi, Department of Zoology, Eszterházy Károly College, Eger, Hungary.*
E-mail: csuzdi.csaba@ektf.hu

Abstract. Elaborating several smaller earthworm samples collected in different parts of Israel resulted in recording 20 earthworm species including *Bimastos parvus* (Eisen, 1874) a North American peregrine which represents new record for the country. Three other species; *Dendrobaena nevoi* Csuzdi & Pavlíček, 1999, *Healyella jordanis* (Csuzdi & Pavlíček, 1999) and *Perelia shamsi* Csuzdi & Pavlíček, 2005 were first recorded after their original descriptions. The present list of lumbricid earthworms recorded for Israel is raised to 28.

Keywords. Earthworms, faunistics, new record, Middle East, Israel

INTRODUCTION

The earthworm fauna of Israel is quite well-known. From the turn of the last century till 1990th, more than ten papers dealt with the fauna of the region (Rosa 1893, Michaelsen 1901, 1910, 1926, Stephenson 1913, 1922, Bodenheimer 1935, 1937, Černosvitov 1938, 1940, 1942, Omodeo 1956, Zicsi 1985). From the mid- 1990's an intensive research on earthworms of Israel has been launched. As a result, Csuzdi *et al.* (1998) described a new species to science and then Csuzdi & Pavlíček (1999) recorded the presence of 10 *Dendrobaena* and two *Healyella* species from the country including four species new to science. Since then, the occurrence of *Murchieona minuscula* (Rosa, 1905) was reported as new record for the fauna (Csuzdi & Pavlíček 2002) and two new *Perelia* species were described from Israel (Csuzdi & Pavlíček 2005). With all these data, the list of the lumbricid earthworms in Israel consisted of 27 species.

In this paper we present the unpublished results of the earthworm collecting trips to Israel in the 2000s including formal recording of *Bimastos parvus* (Eisen, 1874) for the first time.

MATERIALS AND METHODS

Earthworms were collected by the diluted formaldehyde method (Raw 1959), complemented with digging and hand-sorting. A combination of these methods provides more efficient sampling of earthworms. The specimens collected were killed in 75% ethanol, fixed in 4% formalin, then transferred into 75% ethanol and deposited in the earthworm collection of the Hungarian Natural History Museum (HNHM). Part of the material was fixed and placed into 96% ethanol for further DNA studies.

RESULTS

Aporrectodea caliginosa (Savigny, 1826)

Enterion caliginosum Savigny, 1826: 80.
Allolobophora (Allolobophora) caliginosa: Rosa 1893: 7.
Allolobophora caliginosa: Bodenheimer 1935: 393.
Helodrilus caliginosus: Bodenheimer 1937: 259.

urn:lsid:zoobank.org:pub:75E9ACAD-AD20-4936-AF8D-BE6B0C31BC98
HU ISSN 2063-1588 (online), HU ISSN 0237-5419 (print)

Allolobophora caliginosa var. *trapezoides*: Černosvitov 1940: 446.
Allolobophora caliginosa f. *trapezoides*: Omodeo 1956: 335.
Aporrectodea caliginosa caliginosa: Pavlíček *et al.* 2003: 456.
Aporrectodea caliginosa trapezoides: Zicsi 1985: 330., Pavlíček *et al.* 2003: 456.
Aporrectodea caliginosa: Csuzdi & Pavlíček 2005: 88.

Material examined. HNHM/15117 1 ex., Dalton – Ein Zeitim, chalk, 33°00'41"N 35°28'52"E, 06.02.2006., leg. T. Pavlíček; HNHM/15121 2 ex., Wadi Al-Kelt, 28.01.2006., leg. T. Pavlíček; HNHM/15139 2 ex., Tel Gezer, 31°51'N 34°54'E, 04.01.2003., leg. T. Pavlíček; HNHM/15144 2 ex., Tel Keshet, temporary stream, 31°32'17"N 34°45'51"E, 31.01.2003., leg. T. Pavlíček; HNHM/15155 2 ex., 1 km N of Beer Sheva, 08.01.2003., leg. T. Pavlíček; HNHM/15159 2 ex., Ein Zeitim, 13.02.2005., leg. T. Pavlíček; HNHM/15192 3 ex., Al-Kelt, 30.03.2005., leg. T. Pavlíček; HNHM/16354 1 ex., Wadi Kelt, near of the spring, 31°50'30"N 35°21'39"E, leg. T. Pavlíček, P. Cardet; HNHM/16702 1 ex., Golan Heights, 714 m, 32°59'N 35°48'E, 26.03.2009., leg. T. Pavlíček.

Remarks. The Israeli population of *Ap. caliginosa* is dominated by the *trapezoides* form. Among the collected specimens only two (No. 15159) showed transitional characteristics and were more similar to the classical *caliginosa* form.

***Aporrectodea jassyensis* (Michaelsen, 1891)**

Allolobophora jassyensis Michaelsen, 1891: 15.
Allolobophora (Allolobophora) jassyensis: Rosa 1893: 8.
Helodrilus jassyensis orientalis: Bodenheimer 1935: 393., 1937: 259.
Allolobophora jassyensis f. *orientalis*: Omodeo 1956: 333.
Aporrectodea jassyensis: Pavlíček *et al.* 2003: 456., Csuzdi & Pavlíček 2005: 89.

Material examined. HNHM/14986 1 ex., Keren Ben Zimra – Alma, 25.01.2006., leg. T. Pavlíček; HNHM/15112 1 ex., Keren Ben Zimra – Alma, 01.02.2006., leg. T. Pavlíček; HNHM/15191 1 ex., Al-Kelt, 30.03.2005., leg. T. Pavlíček; HNHM/15216 1 ex., Nahal Tabor, 32°42'49"N 34°58'22"E, 28.04.2004., leg. T. Pavlíček; HNHM/15237 4 ex., Keren Ben Zimra, 08.02.2007., leg. T. Pavlíček; HNHM/15660 1 ex., Kerem Ben Zimra – Alma, chalk soil, 17.03.2007., leg. T. Pavlíček, HNHM/15661 2 ex., Kerem Ben Zimra – Alma, basalt soil, 17.03.2007., leg. T. Pavlíček; HNHM/15663 2 x., Tabgha, chalk, grassy area, 20.02.2007., leg. T. Pavlíček.

***Aporrectodea rosea* (Savigny, 1826)**

Enterion roseum Savigny, 1826: 182.
Allolobophora (Notogama) rosea: Rosa 1893: 2.
Eisenia rosea: Bodenheimer 1935: 393., 1937: 259.
Eisenia rosea? var.: Černosvitov 1940: 441.
Allolobophora rosea: Omodeo 1956: 334., Zicsi 1985: 331.
Aporrectodea rosea: Pavlíček *et al.* 2003: 456., Csuzdi & Pavlíček 2005: 89.

Material examined. HNHM/15118 1 ex., Dalton – Ein Zeitim, chalk, 33°00'41"N 35°28'52"E, 06.02.2006., leg. T. Pavlíček; HNHM/15138 1 ex., Tel Gezer, 31°51'N 34°54'E, 04.01.2003., leg. T. Pavlíček; HNHM/15145 2 ex., Tel Keshet, temporary stream, 31°32'17"N 34°45'51"E, 31.01.2003., leg. T. Pavlíček; HNHM/15149 1 ex., North Negev, W of Beer Sheva, 31°29'11"N 34°47'50"E, 31.01.2003., leg. T. Pavlíček; HNHM/15158 3 ex., Ein Zeitim, 13.02.2005., leg. T. Pavlíček; HNHM/15162 1 ex., HNHM/15165 1 ex., Golan Heights, Afiq, 28.02.2005., leg. T. Pavlíček; HNHM/15193 2 ex., Al-Kelt, 30.03.2005., leg. T. Pavlíček; HNHM/15204 7 ex., Golan Heights, Mas'ade, forest, 33°12'N 35°45'E, 26.04.2004., leg. T. Pavlíček.

***Bimastos parvus* (Eisen, 1874)**

Allolobophora parva Eisen, 1874: 46.
?*Bimastos parvus*: Pavlíček *et al.* 2003: 455.

Material examined. HNHM/14301 2 ex., Mount Carmel, Ein Kedem, 10.11.2001., leg. T. Pavlíček; HNHM/15170 1 ex., Kibutz Yagur, garden centre, 11.08.2005., leg. T. Pavlíček;

HNHM/15171 1 ex., Mount Carmel, Isfiya, garden centre, under flower pots, 23.07.2005., leg. T. Pavlíček; HNHM/16357 1 ex., Wadi Kelt, near of the spring, 31°50'30"N 35°21'39"E, leg. T. Pavlíček, P. Cardet.

Remarks. Pavlíček *et al.* (2003) already noted the possible presence of *Bimastos parvus* in Israel, but without exact locality and uncertain species identification. The new material is well preserved and reliably identified therefore this is the first, officially recorded occurrence of *B. parvus* from Israel. *B. parvus* is of North American origin and perhaps currently spreading via gardening centra.

***Dendrobaena byblica byblica* (Rosa, 1893)**

Allolobophora (Dendrobaena) byblica: Rosa, 1893: 4–5.
Helodrilus (Dendrobaena) lacustris: Stephenson 1913: 55.
Dendrobaena fedschenkoi: Michaelsen 1926: 352.
Helodrilus ganglbaueri byblicus: Bodenheimer 1937: 259.
Helodrilus lacustris: Bodenheimer 1937: 259.
Dendrobaena byblica var. *ganglbaueri*: Černosvitov 1940: 446., 1942: 225.
Dendrobaena byblica: Zicsi 1985: 328., Csuzdi & Pavlíček 1999: 474., 2002: 110., Pavlíček *et al.* 2003: 456.

Material examined. HNHM/14412 2 ex., Golan Heights, Nahal Neshef, 33°12'09"N 35°38'46"E, 16.02.2002., leg. T. Pavlíček; HNHM/14709 1 ex., Zarka, Main Jordan, 16.01. 2004., leg. T. Pavlíček; HNHM/14711 8 ex., Nahal Parash, W slope of Golan, 25.05.2002., leg. T. Pavlíček; HNHM/15190 4 ex., Al-Kelt, 30.03. 2005., leg. T. Pavlíček; HNHM/15198 7 ex., Golan Heights, upper part of Nahal Yehudia, 32° 50'03"N 35°48'03"E, 23.06.2002., leg. T. Pavlíček; HNHM/15669 1 ex., Wadi Kelt, 30.04. 2009, leg. T. Pavlíček; HNHM/16353 7 ex., Har Arbel, 12.05.2003., leg. T. Pavlíček; HNHM/ 16355 1 ex., Wadi Kelt, near of the spring, 31°50'30"N 35°21'39"E, leg. T. Pavlíček, P. Cardet; HNHM/ 16364 1 ex., Golan Heights, Nahal Samakh, near of water, 28.02.2005., leg. T. Pavlíček.

***Dendrobaena hauseri* Zicsi, 1973**

Dendrobaena hauseri Zicsi, 1973: 222., Csuzdi & Pavlíček 1999: 474., Pavlíček *et al.* 2003: 456.
Bimastos hauseri: Zicsi 1985: 329.

Material examined. HNHM/14717 2 ex., Rehaniya, limestone, 29.03.2002., leg. T. Pavlíček; HNHM/14719 1 ex., Mi'ilya, 29.03.2004., leg. T. Pavlíček; HNHM/14721 2 ex., Mi'ilya, 25.03.2004., leg. T. Pavlíček; HNHM/15107 2 ex., Ein Zeitim, basaltic rock, 33°00'N 35°28'E, 12.01.2005., leg. T. Pavlíček; HNHM/15110 2 ex., Ein Zeitim, 13.02.2005., leg. T. Pavlíček; HNHM/15219 1 ex., Nahal Tabor, 32°42'24"N 35°33'16"E, 28.02.2004., leg. T. Pavlíček.

***Dendrobaena kervillei* (Michaelsen, 1910)**

Helodrilus (Eisenia) venetus var. *kervillei* Michaelsen, 1910: 166–167.
Eisenia veneta var. *kervillei*: Michaelsen 1926: 352.
Allolobophora (Notogama) alpina: Rosa 1893: 3.
Dendrobaena veneta kervillei: Zicsi 1985: 329., Csuzdi & Pavlíček 1999: 479.
Dendrobaena kervillei: Csuzdi & Pavlíček 2002: 110., Pavlíček *et al.* 2003: 456.

Material examined. HNHM/16699 1 ex., Mount Hermon, 1630 m, 33°19'N 35°46'E, 19. 03.2009., leg. T. Pavlíček.

***Dendrobaena negevis* Csuzdi & Pavlíček, 1999**

Dendrobaena negevis Csuzdi & Pavlíček, 1999: 482., 2002: 112., Pavlíček *et al.* 2003: 456.

Material examined. HNHM/15120 5 ex., Wadi Al-Kelt, 28.01.2006., leg. T. Pavlíček; HNHM/ 15142 13 ex., Mount Gilboa, 32°25'07"N 35°26' 08"E, 11.02.2006., leg. T. Pavlíček; HNHM/ 15143 4 ex., Tel Keshet (S of Qiryat Gat), 08.01.2003., leg. T. Pavlíček; HNHM/15147 2 ex., North Negev, W of Beer Sheva, 31°29'11"N 34°47'50"E, 31.01.2003., leg. T. Pavlíček; HNHM/15150 2 ex., Tel Keshet, 31°32'N 34°45'E, 31.01.2003., leg. T. Pavlíček; HNHM/ 15153 1 ex., North Negev, 27 km N of Beer

Sheva, 31°28’34”N 34°47’55”E, 31.01.2003., leg. T. Pavlíček; HNHM/15195 10 ex., Tel Gezer, 31°51’N 34°54’E, 04.01.2003., leg. T. Pavlíček.

Dendrobaena nevoi Csuzdi & Pavlíček, 1999

Dendrobaena nevoi Csuzdi & Pavlíček, 1999: 480., Pavlíček *et al.* 2003: 456.

Material examined. HNHM/14722 2 ex., Allone Abba, 32°44’08”N 35°20’30”E, 27.03. 2004., leg. T. Pavlíček.

Dendrobaena orientalis Černosvitov, 1940

Dendrobaena orientalis Černosvitov, 1940: 444., Zicsi 1985: 327., Csuzdi & Pavlíček 1999: 475., 2002: 110., Pavlíček *et al.* 2003: 456.
Dendrobaena semitica: Omodeo 1956: 331.

Material examined. HNHM/14398 1 ex., Mount Meron, under oak, 33°00’33”N 35° 23’42”E, 06.02.2002., leg. T. Pavlíček; HNHM/ 14407 1 ex., Mount Carmel, Nahal Ezov, 09. 02.2002., leg. T. Pavlíček; HNHM/14410 1 ex., Mount Carmel, Nahal Ezov, Maqui slope, 09.02.2002., leg. T. Pavlíček; HNHM/14416 2 ex., Golan Heights, Rabana, 33°00’35”N 35° 23’42”E, 15.02.2002., leg. T. Pavlíček; HNHM/ 14419 8 ex., HNHM/14424 7 ex., Golan Heights, Rabana, sinkhole, 33°12’04”N 35°44’01”E, 15.02.2002., leg. T. Pavlíček; HNHM/14700 1 ex., Nahal Oren, 04.03.2002., leg. T. Pavlíček; HNHM/15108 1 ex., HNHM/15187 1 ex., Ein Zeitim, basalt, 33°00’34”N 35°28’50”E, 12.01. 2005., leg. T. Pavlíček; HNHM/15156 2 ex., Ein Zeitim, 16.02.2005., leg. T. Pavlíček; HNHM/ 15164 3 ex., Rehaniya, basalt, 10.02.2005., leg. T. Pavlíček; HNHM/15167 1 ex., Nahal Keziv, 29.04.2005., leg. T. Pavlíček; HNHM/15209 7 ex., Mi’ilya, 28.02.2005., leg. T. Pavlíček; HNHM/15220 3 ex., Nahal Tabor, 32°42’24”N 35°33’16”E, 28.02.2004., leg. T. Pavlíček; HNHM/15321 1 ex., Golan Heights, Afiq, 14.03. 2005., leg. T. Pavlíček; HNHM/15681 1 ex., Dalton, 11.01.2009., leg. T. Pavlíček; HNHM/ 16267 2 ex., Rehaniya, chalk, 12.01.2005., leg. T. Pavlíček; HNHM/16271 3 ex., Nahal Oren, 27. 03.2006., leg. T. Pavlíček; HNHM/16494 1 ex., Rehaniya, basalt soil, 12.01.2005., leg. T. Pavlíček; HNHM/16700 10 ex., Mount Hermon, 1630m, 33°19’N 35°46’E, 19.03.2009., leg. T. Pavlíček.

Dendrobaena samarigera (Rosa, 1893)

Allolobophora (Dendrobaena) samarigera Rosa, 1893: 5.
Helodrilus (Dendrobaena) samariger: Michaelsen 1901: 213., Stephenson 1922: 136.
Helodrilus samarigera: Bodenheimer, 1935: 391.
Helodrilus samariger: Bodenheimer, 1937: 259.
Dendrobaena samarigera: Omodeo 1956: 331., Csuzdi & Pavlíček 1999: 476., Pavlíček *et al.* 2003: 456.

Material examined. HNHM/14919 2 ex., Barta’ah, oak macqui, 32°28’46”N 35°08’00”E, 25.02.2006., leg. T. Pavlíček; HNHM/15212 2 ex., Lower Galilee, near of Kaukab Abu el Hija, 32°45’56”N 35°14’16”E, 18.04.2004., leg. T. Pavlíček; HNHM/15217 1 ex., Mount Tabor, 21.02.2004., leg. T. Pavlíček; HNHM/15635 2 ex., Mount Carmel, 18.02.2006., leg. T. Pavlíček; HNHM/16269 1 ex., Rehaniya, chalk, 12.01. 2005., leg. T. Pavlíček.

Dendrobaena semitica (Rosa, 1893)

Allolobophora (Dendrobaena) semitica Rosa, 1893: 3.
Dendrobaena semitica var. *kervillei*: Michaelsen 1910: 167., 1926: 353.
Helodrilus semiticus: Bodenheimer 1937: 259.
Dendrobaena semitica: Zicsi 1985: 324., Csuzdi & Pavlíček 1999: 477., 2002: 110., Pavlíček *et al.* 2003: 456.

Material examined. HNHM/14397 3 ex., E bank of Kineret, 32°50’10”N 35°38’52”E, 05.02.2002., leg. T. Pavlíček; HNHM/14400 1 ex., E bank of Kimeret, 32°50’N 35°39’E, 05.02.2002., leg. T. Pavlíček; HNHM/14404 12 ex., Mount Carmel, near of Ornit Cave, 32° 45’34”N 34°59’50”E, 02.02.2002., leg. T. Pavlíček; HNHM/14437 1 ex., Mount Carmel, Ein Kedem, 25.01.2002., leg. T. Pavlíček; HNHM/ 14442 4 ex., Nahal Keziv, under oak, 18.02.2002., leg. T. Pavlíček; HNHM/14712 5 ex., Nahal

Tabor, Jordan Valley, E side of road No. 90, 32°54’56”N 35°07’30”E, 21.02.2004., leg. T. Pavlíček; HNHM/14818 1 ex., Basmat Tab’un, 27.04.2004., leg. T. Pavlíček; HNHM/14874 1 ex., Lower Galilee, Hannaton, park forest, 32° 49’25”N 35°46’21”E, 2003., leg. T. Pavlíček; HNHM/15168 6 ex., Nahal Keziv, 29.04.2005., leg. T. Pavlíček; HNHM/15213 2 ex., Lower Galilee, near of Kaukab Abu el Hija, 32°45’56”N 35°14’16”E, 18.04.2004., leg. T. Pavlíček; HNHM/15218 4 ex., Mount Tabor, 21.02.2004., leg. T. Pavlíček; HNHM/15221 9 ex., Nahal Tabor, 32°42’24”N 35°33’16”E, 28.02.2004., leg. T. Pavlíček; HNHM/15636 1 ex., Mount Carmel, 18.02.2006., leg. T. Pavlíček; HNHM/15641 3 ex., Mount Carmel, near of a brook, 18.02.2006., leg. T. Pavlíček; HNHM/15679 1 ex., Mi’ilya, 28.02.2005., leg. T. Pavlíček; HNHM/15680 1 ex., Dalton, 11.01.2009., leg. T. Pavlíček; HNHM/16268 1 ex., Rehaniya, chalk, 12.01.2005., leg. T. Pavlíček.

Dendrobaena veneta veneta (Rosa, 1886)

Allolobophora veneta Rosa, 1886: 1.
Allolobophora (Notogama) veneta: Rosa 1893: 2.
Dendrobaena veneta: Zicsi 1985: 328., Csuzdi & Pavlíček 2002: 111.
Dendrobaena veneta veneta: Csuzdi & Pavlíček 1999: 478., Pavlíček *et al.* 2003: 456.

Material examined. HNHM/14393 2 ex., Nahal Kezif, near of E bank of Kineret, 32°51’47”N 35°37’04”E, 05.02.2002., leg. T. Pavlíček; HNHM/14394 2 ex., Nahal Keziv, 32°49’52”N 35°39’03”E, 06.02.2002., leg. T. Pavlíček; HNHM/14399 2 ex., Mount Meron, under oak, 33°00’33”N 35°23’42”E, 06.02.2002., leg. T. Pavlíček; HNHM/14403 1 ex., Mount Carmel, near of Ornit Cave, 32°45’34”N 34°59’50”E, 02.02.2002., leg. T. Pavlíček; HNHM/14408 1 ex., Mount Carmel, Nahal Ezov, 09.02.2002., leg. T. Pavlíček; HNHM/14411 2 ex., Mount Carmel, Nahal Ezov, Maqui slope, 09.02.2002., leg. T. Pavlíček; HNHM/14415 4 ex., Golan Heights, Rabana, 33°00’35”N 35°23’ 42”E, 15.02.2002., leg. T. Pavlíček; HNHM/14420 9 ex., HNHM/14425 2 ex Golan Heights, Rabana, sinkhole, 33°12’04”N 35°44’01”E, 15. 02.2002., leg. T. Pavlíček; HNHM/14421 2 ex., Golan Heights, Rabana, 33°12’38”N 35°43’50”E, 15.02.2002., leg. T. Pavlíček; HNHM/14423 3 ex., Golan Heights, Rabana, basalt, 33°00’35”N 35°23’42”E, 15.02.2002., leg. T. Pavlíček; HNHM/14429 2 ex., , HNHM/14431 2 ex., Keren Ben Zimra, rendzina, 33°01’37”N 35°28’04”E, 31.12.2001., leg. T. Pavlíček; HNHM/14435 2 ex., Upper Galilee, Rehaniya, 33°01’N 35°29’E, 20.01.2002., leg. T. Pavlíček; HNHM/14441 2 ex., Rehaniya, chalk, 21.02.2002., leg. T. Pavlíček; HNHM/14616 5 ex., Dalton, 13.03. 2002., leg. T. Pavlíček; HNHM/14701 1 ex., Nahal Oren, 04.03.2002., leg. T. Pavlíček; HNHM/14716 5 ex., Rehaniya, limestone, 29.03. 2002., leg. T. Pavlíček; HNHM/14817 2 ex., Basmat Tab’un, 27.04.2004., leg. T. Pavlíček; HNHM/14920 4 ex., Barta’ah, oak maquis, 32°28’ 46”N 35°08’00”E, 25.02.2006., leg. T. Pavlíček; HNHM/14984 1 ex., Keren Ben Zimra – Alma, 25.01.2006., leg. T. Pavlíček; HNHM/15109 1 ex., HNHM/15186 1 ex., Ein Zeitim, basalt, 33°00’34”N 35°28’50”E, 12.01.2005., leg. T. Pavlíček; HNHM/15113 2 ex., Keren Ben Zimra – Alma, 01.02.2006., leg. T. Pavlíček; HNHM/ 15119 3 ex., Dalton – Ein Zeitim, basalt, 33°00’41”N 35°28’52”E, 06.02.2006., leg. T. Pavlíček; HNHM/15140 2 ex., Tel Gezer, 31°51’N 34°54’E, 04.01.2003., leg. T. Pavlíček; HNHM/15157 2 ex., Ein Zeitim, 16.02.2005., leg. T. Pavlíček; HNHM/15161 3 ex., Rehaniya, 12.01.2005., leg. T. Pavlíček; HNHM/15163 2 ex., HNHM/15166 1 ex., Golan Heights, Afiq, 28.02.2005., leg. T. Pavlíček; HNHM/15169 3 ex., Mount Carmel, Mucharka, 04.02.2003., leg. T. Pavlíček; HNHM/15210 3 ex., Mi’ilya, 28.02. 2005., leg. T. Pavlíček; HNHM/15211 2 ex., Lower Galilee, near of Kaukab Abu el Hija, 32°45’56”N 35°14’16”E, 18.04.2004., leg. T. Pavlíček; HNHM/15214 4 ex., Lower Galilee, Basmat Tab’un, 18.04.2004., leg. T. Pavlíček; HNHM/15215 4 ex., Nahal Tabor, 32°42’49”N 34°58’22”E, 28.04.2004., leg. T. Pavlíček; HNHM/15222 10 ex., Nahal Tabor, 32°42’24”N 35°33’16”E, 28.02.2004., leg. T. Pavlíček; HNHM/15235 5 ex., Keren Ben Zimra, 08.02.2007., leg. T. Pavlíček; HNHM/15318 1 ex., HN

HM/15319 1 ex., HNHM/15320 1 ex., Golan Heights, Afiq, 14.03.2005., leg. T. Pavlíček; HNHM/15637 4 ex., HNHM/15640 4 ex., Mount Carmel, 18.02.2006., leg. T. Pavlíček; HNHM /15659 4 ex., Kerem Ben Zimra – Alma, chalk soil, 17.03.2007., leg. T. Pavlíček; HNHM/15662 1 ex., Tabgha, basalt, grassy area, 20.02.2007., leg. T. Pavlíček; HNHM/15665 5 ex., Golan Heights, Masade forest, under oaks, 25.04.2007., leg. T. Pavlíček; HNHM/15666 1 ex., HNHM /15667 3 ex., Golan Heights, basalt soil, 24.05.2007., leg. T. Pavlíček; HNHM/16266 8 ex., Rehaniya, chalk, 12.01.2005., leg. T. Pavlíček; HNHM/16270 5 ex., Rehaniya, chalk, 28.12.2005., leg. T. Pavlíček; HNHM/16272 1 ex., Nahal Oren, 27.03.2006., leg. T. Pavlíček; HNHM/16275 2 ex., HNHM/16278 1 ex., Rehaniya, basalt, 11.01.2005., leg. T. Pavlíček; HNHM/16365 1 ex., HNHM/16493 1 ex., Rehaniya, basalt soil, 12.01.2005., leg. T. Pavlíček; HNHM/16698 5 ex., HNHM/16703 2 ex., HN HM/16706 3 ex., HNHM/16707 3 ex., Golan Heights, 714 m, 32°59'N 35°48'E, 26.03.2009., leg. T. Pavlíček.

Eiseniella neapolitana Örley, 1885

Allurus neapolitanus Örley, 1885: 12.
Allurus ninnii: Rosa 1893: 11.
Allolobophora (Eiseniella) tetraedra var. *sewelli*: Stephenson 1924: 363.
Eiseniella tetraedra ninnii: Bodenheimer 1937: 393, Černosvitov 1938: 549.
Eiseniella tetraedra forma?: Černosvitov 1940: 440.
Eiseniella tetraedra neapolitana: Pavlíček *et al.* 2003: 456.
Eiseniella neapolitana: Csuzdi & Pavlíček 2005: 91.

Material examined. HNHM/14877 4 ex., Golan Heights, Nahal Neshet, 25.05.2002., leg. T. Pavlíček; HNHM/15199 2 ex., Golan Heights, upper part of Nahal Yehudia, 32°50'03"N 35° 48'03"E, 23.06.2002., leg. T. Pavlíček.

Eiseniella tetraedra (Savigny, 1826)

Enterion tetraedrum Savigny, 1826: 184.
Allurus tetraedrus: Rosa 1893: 10.
Eiseniella tetraedra: Bodenheimer 1935: 393, 1937: 259., Csuzdi & Pavlíček 2005: 91.
Eiseniella tetraedra tetraedra: Pavlíček *et al.* 2003: 457.

Material examined. HNHM/15160 2 ex., Ein Zeitim, 13.02.2005., leg. T. Pavlíček; HNHM/ 15194 2 ex., Al-Kelt, 30.03.2005., leg. T. Pavlíček; HNHM/16356 5 ex., Wadi Kelt, near of the spring, 31°50'30"N 35°21'39"E, leg. T. Pavlíček, P. Cardet.

Healyella jordanis (Csuzdi & Pavlíček 1999)

Bimastos jordanis Csuzdi & Pavlíček, 1999: 471., 2002: 109., Pavlíček *et al.* 2003: 456.
Healyella jordanis: Pavlíček *et al.* 2010: 1999.

Material examined. HNHM/14402 2 ex., HNHM/14427 1 ex., Rehaniya, 20.01.2002., leg. T. Pavlíček; HNHM/14428 2 ex., HNHM/14430 1 ex., HNHM/14432 2 ex., HNHM/14439 1 ex., Keren Ben Zimra, rendzina, 33°01'37"N 35° 28'04"E, 31.12.2001., leg. T. Pavlíček; HNHM/ 14433 1 ex., Upper Galilee, Rehaniya, 33°01'N 35°29'E, 20.01.2002., leg. T. Pavlíček; HN HM/14615 1 ex., HNHM/14619 1 ex., HNHM/ 14620 3 ex., Dalton, 13.03.2002., leg. T. Pavlíček; HNHM/14983 2 ex., HNHM/14985 3 ex., HNHM /15111 6 ex., HNHM/15114 1 ex., Keren Ben Zimra – Alma, 25.01.2006., leg. T. Pavlíček; HNHM/15116 2 ex., Keren Ben Zimra – Alma, 01.02.2006., leg. T. Pavlíček; HNHM/15234 5 ex., HNHM/15236 3 ex., Keren Ben Zimra, 08.02.2007., leg. T. Pavlíček; HNHM/16369 1 ex., Rehaniya, basalt, 21.01.2005., leg. T. Pavlíček.

Healyella syriaca (Rosa, 1893)

Allolobophora syriaca Rosa, 1893: 461.
Eophila atheca: Černosvitov 1940: 441.
Dendrobaena atheca typica: Omodeo 1956: 332.
Bimastos syriacus: Csuzdi & Pavlíček 1999: 471., 2002: 109., Pavlíček *et al.* 2003: 456.
Healyella syriaca: Omodeo & Rota 1989: 173.

Material examined. HNHM/14405 1 ex., Mount Carmel, 33°03'18"N 35°28'08"E, 02.02. 2002., leg. T. Pavlíček; HNHM/14406 1 ex., Mount Carmel, Nahal Ezov, 09.02.2002., leg. T. Pavlíček; HNHM/14409 2 ex., Mount Carmel, Nahal Ezov, Maqui slope, 09.02.2002., leg. T. Pavlíček; HNHM/14436 1 ex., Mount Carmel, Ein Kedem, 25.01.2002., leg. T. Pavlíček; HNHM/14699 1 ex., Nahal Oren, 04.03.2002., leg. T. Pavlíček; HNHM/14713 3 ex., Nahal Tabor, Jordan Valley, E side of road No. 90, 32°54'56"N 35°07'30"E, 21.02.2004., leg. T. Pavlíček; HNHM/14714 1 ex., Nahal Tabor, Jordan Valley, N side of road No. 90, 32°54'56"N 35°07'30"E, 21.02.2004., leg. T. Pavlíček; HNHM/14723 1 ex., Allone Abba, 32°44'08"N 35°20'30"E, 27. 03.2004., leg. T. Pavlíček; HNHM/14873 1 ex., Lower Galilee, Hannaton, park forest, 32°49' 25"N 35°46'21"E, 2003., leg. T. Pavlíček; HNHM/14916 4 ex., HNHM/14922 4 ex., HNHM /14923 1 ex., Barta'ah, oak maquis, 32°28'46"N 35°08'00"E, 25.02.2006., leg. T. Pavlíček; HNHM/15141 6 ex., W bank near Jordan Valley, small wadi, 32°19'40"N 35°30'50"E, 11.02. 2006., leg. T. Pavlíček; HNHM/15152 1 ex., North Negev, 27 km N of Beer Sheva, 31°28'34"N 34°47'55"E, 31.01.2003., leg. T. Pavlíček; HNHM/15196 3 ex., Tel Gezer, 31° 51'N 34°54'E, 04.01.2003., leg. T. Pavlíček; HNHM/15205; HNHM/15634 1 ex., HNHM/ 15638 2 ex., Mount Carmel, 18.02.2006., leg. T. Pavlíček; HNHM/15642 2 ex., Mount Carmel, near of a brook, 18.02.2006., leg. T. Pavlíček; HNHM/15664 1 ex., Kerem Ben Zimra – Alma, chalk soil, 17.03.2007., leg. T. Pavlíček; HNHM/ 16273 1 ex., Nahal Tabor in Jordan Valley, W side of the road No. 90, 21.02.2004., leg. T. Pavlíček; HNHM/16276 1 ex., Muhraqa, Mount Carmel, 22.11.2003., leg. T. Pavlíček; HNHM/ 16696 2 ex., HNHM/16697 1 ex., HNHM/16701 1 ex., HNHM/16705 1 ex., Golan Heights, 714 m, 32°59'N 35°48'E, 26.03.2009., leg. T. Pavlíček.

Helodrilus patriarchalis **(Rosa, 1893)**

Allolobophora patriarchalis Rosa, 1893: 9., Bodenheimer 1935: 393.

Helodrilus patriarchalis: Bodenheimer 1937: 259., Pavlíček *et al.* 2003: 457., Csuzdi & Pavlíček 2005: 92.

Material examined. HNHM/15189 4 ex., Al-Kelt, 30.03.2005., leg. T. Pavlíček; HNHM/15197 3 ex., Golan Heights, Wadi Meizar, upper part, 06.07.2002., leg. T. Pavlíček; HNHM/15668 5 ex., Wadi Kelt, 30.04.2009, leg. T. Pavlíček.

Murchieona minuscula **(Rosa, 1905)**

Allolobophora minuscula Rosa, 1905: 38.

Murchieona minuscula: Csuzdi & Pavlíček 2002: 108., Pavlíček *et al.* 2003: 457.

Material examined. HNHM/14921 1 ex., Barta'ah, oak maquis, 32°28'46"N 35°08'00"E, 25.02.2006., leg. T. Pavlíček.

Remarks. After the first record of this Adriatic-Mediterranean species in Nahal Keziv and Nahal Oren, Israel, this is the third occurrence which means that the species as hypothesized by Csuzdi & Pavlíček (2002) is more widely distributed in Israel, but easy to overlook due to its small size.

Perelia galileana **Csuzdi & Pavlíček, 2005**

Perelia galileana Csuzdi & Pavlíček, 2005: 81.

Material examined. HNHM/14698 1 ex., Nahal Oren, 04.03.2002., leg. T. Pavlíček; HNHM/14917 3 ex., HNHM/14918 6 ex., Barta'ah, oak maquis, 32°28'46"N 35°08'00"E, 25.02. 2006., leg. T. Pavlíček; HNHM/15223 2 ex., Nahal Oren, 15.04.2002., leg. T. Pavlíček; HNHM/15639 1 ex., Mount Carmel, 18.02.2006., leg. T. Pavlíček.

Perelia shamsi **Csuzdi & Pavlíček, 2005**

Perelia shamsi Csuzdi & Pavlíček, 2005: 84.

Material examined. HNHM/15146 2 ex., Tel Keshet, 08.01.2003., leg. T. Pavlíček; HNHM/ 15148 3 ex., North Negev, W of Beer Sheva, 31°29'11"N 34°47'50"E, 31.01.2003., leg. T. Pavlíček; HNHM/15154 4 ex., North Negev, 27 km N of Beer Sheva, 31°28'34"N 34°47'55"E, 31.01.2003., leg. T. Pavlíček.

Remarks. This is the first record of *P. shamsi* after the original description.

DISCUSSION

During sporadic surveys carried out in the 2000s in different parts of Israel altogether 20 earthworm species were collected including *Bimastos parvus*, a North American peregrine species which represents a new record for the fauna of Israel. Three other species; *Dendrobaena nevoi*, the Northern Negev species *Perelia shamsi*, and *Healyella jordanis* were firstly recorded after their original descriptions, the first two of some 20 km, the third one *ca.* 60 km distance from the type locality. This indicates that all the three Israeli endemic species might have a larger distribution area.

Together with the newly listed *B. parvus* the current number of the lumbricid species recorded for Israel is 28. Comparing this number with those recorded for the more than four times larger Hungary (59 species, Csuzdi & Zicsi 2003) indicates a quite well explored earthworm fauna, however finding more new records or species cannot be excluded especially the in the Northernmost region of the country.

REFERENCES

BODENHEIMER, F. S. (1935): *Animal Life in Palestine.* L. Mayer, Jerusalem, pp. 507.

BODENHEIMER, F. S. (1937): Prodromus faunae Palestinae. Essai sur les éléments zoogeographiques et historiques du sud-ouest du sous-règne Paléarctique. *Mémoires présentés a l'Institut d'Egypte,* 33: 1–286.

ČERNOSVITOV, L. (1938): The Oligochaeta. In: Washbourn, R. & Jones, R. F. (eds.) Report of the Percy Sladen Expedition to Lake Huleh; a contribution to the study of fresh waters of Palestine. *Annals and Magazine of Natural History,* (11)2: 535–550.

ČERNOSVITOV, L. (1940): On some Oligochaeta from Palestine. *Annals and Magazine of Natural History,* (11)6: 438–447.

ČERNOSVITOV, L. (1942): Oligochaeta from various parts of the world. *Proceedings of the Zoological Society of London,* 111: 197–236.

CSUZDI, CS. & ZICSI, A. (2003): *Earthworms of Hungary (Annelida: Oligochaeta; Lumbricidae).* In. Pedozoologica Hungarica 1. CSUZDI, CS. and MAHUNKA, S. (Eds.) Hungarian Natural History Museum, Budapest 273 pp.

CSUZDI, CS. & PAVLÍČEK, T. (1999): Earthworms from Israel. I. Genera *Dendrobaena* Eisen, 1874 and *Bimastos* Moore, 1893 (Oligochaeta: Lumbricidae). *Israel Journal of Zoology,* 45: 467–486.

CSUZDI, CS. & PAVLÍČEK, T. (2002): *Murchieona minuscula* (Rosa, 1906), a newly recorded earthworm from Israel, and distribution of the genera *Dendrobaena* and *Bimastos* in Israel (Oligochaeta, Lumbricidae). *Zoology in the Middle East,* 25: 105–114.

CSUZDI, CS. & PAVLÍČEK, T. (2005): Earthworms from Israel. II. Remarks on the genus Perelia Easton, 1983 with description of a new genus and two new species. *Acta Zoologica Academiae Scientiarum Hungaricae,* 51(2): 75–96.

CSUZDI, CS., PAVLÍČEK, T. & NEVO, E. (1998): A new earthworm species, *Dendrobaena rothschildae* sp. n. from Israel, and comments on the distribution of *Dendrobaena* species in the Levant (Oligochaeta: Lumbricidae). *Opuscula Zoologica Budapest,* 31: 25–32.

EISEN, G. (1874): Om Skandinaviens Lumbricider. *Öfversigt af Kongliga Vetenskaps-Akademiens Förhandligar,* 30(8): 43–56.

MICHAELSEN, W. (1891): Oligochaeten des Naturhistorischen Museums in Hamburg IV. *Jahrbuch der Hamburgischen Wissenschaftlichen Anstalten,* 8: 1–42.

MICHAELSEN, W. (1901): Oligochaeten der Zoologischen Museen zu St. Petersburg und Kiev. *Bulletin de l'Académie Impériale des Sciences de St. Pétersbourg,* 15: 136–215.

MICHAELSEN, W. (1910): Zur Kenntniss der Lumbriciden und ihrer Verbreitung. *Annuaire du Musée Zoologique de l'Académie Impériale des Sciences de St.-Pétersbourg,* 15: 1–74.

MICHAELSEN, W. (1926): *Note sur les Oligochètes rapportés par M. Henri Gadeau de Kerville de son voyage zoologique en Syrie. Voyage zoologique d'H. G. de Kerville en Syrie (Avril-Juin 1908).* Baillière et fils, Paris, p. 152–351.

OMODEO, P. (1956): Oligocheti dell'Indochina e del Mediterraneo Orientale. *Memorie del Museo Civico di Storia Naturale di Verona,* 5: 321–336.

OMODEO, P. & ROTA, E. (1989): Earthworms of Turkey. *Bolletino di Zoologia*, 56: 167–199.

ÖRLEY, L. (1885): A palaearktikus övben élő Terrikoláknak revíziója és elterjedése. *Értekezések a Természettudományok Köréből,* 15: 1–34.

PAVLÍČEK, T., CSUZDI, CS. & NEVO, E. (2003): Species richness and zoogeographic affinities of earthworms in the Levant. *Pedobiologia,* 47: 452–457.

PAVLÍČEK, T., CSUZDI, CS., MISIRLIOĞLU, M. & VILENKIN, B. (2010): Faunistic similarity and endemism of earthworms in east mediterrandean region. *Biodiversity and Conservation*, 19: 1989–2001.

RAW, F. (1959): Estimating earthworm populations by using formalin. *Nature,* 184: 1661–1662.

ROSA, D. (1886): Note sui lombrici del Veneto. *Atti del Reale Istituto Veneto di Scienze*, 4: 673–687.

ROSA, D. (1893): Viaggi del Dr. E. Festa in Palestina nel Libano e regioni vicine. *Bollettino del Museo regionale di Scienze Naturali Torino,* 8(160): 1–14.

ROSA, D. (1905): Terricolen. In. Ergebnisse einer Naturwissenschaftlichen Reise zum Erdschias Dag. *Annalen des K. u. K. Naturhistorischen Hofmuseums Wien*, 20: 104–106.

SAVIGNY, J.C. (1826): In. CUVIER, G. Analyse des Travaux de l'Académie royale des Sciences, pendant l'année 1821, partie physique. *Mémoires de l'Académie des Sciences de l'Institut de France Paris,* 5: 176–184.

STEPHENSON, J. (1913): Aquatic Oligochaeta from the Lake of Tiberias. *Journal of the Asiatic Society of Bengal,* 9: 53–56.

STEPHENSON, J. (1922): On some earthworms from India and Palestine belonging to the British Museum. *Annals and Magazine of Natural Histrory,* (9)9: 129–136.

ZICSI, A. (1973): Regenwürmer (Oligochaeta: Lumbricidae) aus der Türkei. *Acta Zoologica Academiae Scientiarum Hungaricae,* 19: 217–232.

ZICSI, A. (1985): Regenwürmer (Oligochaeta: Lumbricidae) aus Israel und den benachbarten Ländern. *Revue suisse de Zoologie,* 92: 323–331.

Opusc. Zool. Budapest, 2013, 44(2): 211–212

Restoration of London type of first earthworm – *Lumbricus terrestris* Linnaeus, 1758 (Annelida: Oligochaeta: Lumbricidae), and setting aside of a 'neo-neotype'

R. J. BLAKEMORE

Robert J. Blakemore, C/- Biodiversity Lab., Dept. Natural Sciences, Hanyang University, Seoul, S. Korea.
E-mail: rob.blakemore@gmail.com

Lumbricus terrestris was the first earthworm described by Carl Linnaeus in his *Systema Naturae* (1758). In a particularly well-reasoned and balanced scientific study, Sims (1973: 32) – the responsible curator at the then British Museum (Natural History) – made a cogent argument for stability of its nomenclature and designnated a neotype (BMNH Register No. 1973.1.1) since its original types are nonexistent. This nomenclatural act was supported by Gates (1973).

A new neotype was subsequently erected by James *et al.* (2010) on the assertion that Sims' neotype: "*is now missing (The Natural History Museum, in litt.)*" when they attempted a DNA study emulating that by Blakemore *et al.* (2010). However, a recent survey of the Museum shelves by the current author soon rediscovered the supposed missing specimen and confirmed its identity as that designated by Sims (1973). Under the rules of the International Code (ICZN, 1999: art. 75.8) the replacement neotype (Swedish Museum of Natural History, Stockholm catalogue number SMNH Type-8035) must now be set aside in favour of Sims' previous neotype.

As justification for presuming Sims' neotype lost, James *et al.* (2010) state:
"*The specimen of* L. terrestris *in the vial labelled as neotype (Natural History Museum, London; Register No. 1973.1.1) is shorter by 12 mm and has 6 fewer segments than the neotype described by Sims*" (*viz.* with length 165 mm and 153 segments).

However, reinspection of the single specimen in the labelled jar, as figured here (Figs. 1–2), noted that it was much coiled and, without stretching, measured 155 mm with ca. 151 segments. Such slight discrepancies may be accounted for by the post-preservation coiling affecting length and the presence of several hemi-schizometameres (segments in part abnormally sub-divided). Thus segmental counts would always give slightly different numbers depending on which line down the body the count was made. Regardless, both these metrics are well within tolerable median limits for significance (*ca.* ±0.03–0.01).

The exact commencement of dorsal pores could not be confirmed due to its previous dissection, however in every other morphological or anatomical respect the specimen agrees exactly with Sims' characterization leaving no doubt to its correct and proper identity as Sims' original neotype, as the label indeed states (Fig. 1). This is a tribute to the conscientious care of the Museum staff and keepers for the last 40 years.

A detailed account of the type specimen will be provided in due course, meanwhile a full description and global distribution of this important European species, now spread around the Globe, is provided in Blakemore (2012), including the first Australian/Tasmanian record of this so-called 'common earthworm' (Blakemore, 1997).

Acknowledgements – I am grateful to friends and colleagues for their support: to Emma Sherlock, curator of free-living worms of the "Aquatic Invertebrates Division" (sic) of the London Natural History Museum, and to Dr Csaba Csuzdi (Eszterházy K. College, Eger, Hungary) for their help in accessing the collection and confirming identification of the specimen in question. Here I quote (slightly out of context) from Shakespeare's *Anthony & Cleopatra* (Act V): "*Clown: Look you, the worm is not to be trusted, but in the keeping of wise people!*" (Fr. Ecoutez, le ver n'est pas digne de confiance, sauf dans la tenue des sages).

urn:lsid:zoobank.org:pub:EE679FC0-0844-4324-B0AD-A8E2A49F7554
HU ISSN 2063-1588 (online), HU ISSN 0237-5419 (print)

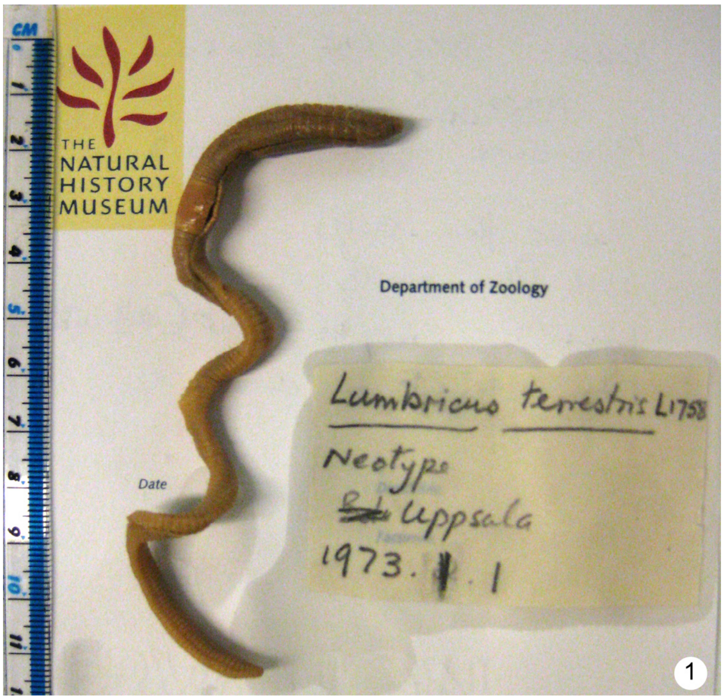


Figure 1. Natural History Museum, London *Lumbricus terrestris* neotype – *habeas corpus*!

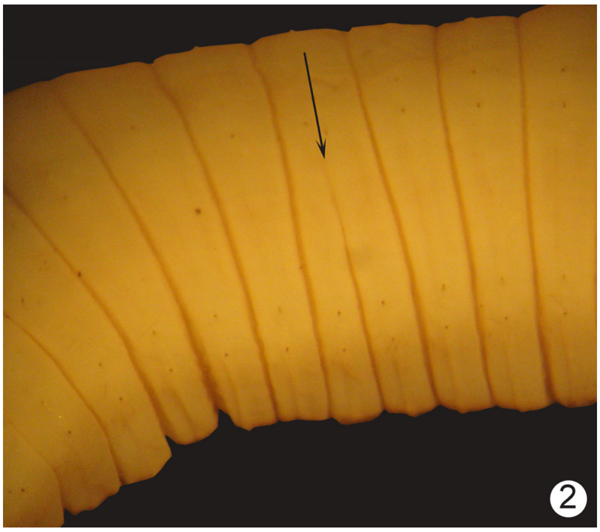


Figure 2. A schizo-metamere of the neotype 1973.1.1

REFERENCES

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

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

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

GATES, G. E. (1973): Memorandum on the species name *Lumbricus terrestris*. *The Bulletin of Zoological Nomenclature*, 30(1): 34.

ICZN (1999): International Code of Zoological Nomenclature. 4th Edition. Published by the International Trust for Zoological Nomenclature, c/o Natural History Museum, Cromwell Road, London, SW7 5BD, UK, 306 pp.

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

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

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