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Distinguishing characters of *Niphargus gebhardti* Schellenberg, 1934 and *Niphargus molnari* Mehely, 1927 (Crustacea: Amphipoda): a clarification

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Abstract. Two endemic *Niphargus* species, *N. gebhardti* Schellenberg, 1934 and *N. molnari* Méhely, 1927 are known from two caves of the Mecsek Mts. (SW Hungary). The species are morphologically close to each other and differ only in few characters. Although, the original descriptions contain only scattered information and few drawings, more characters can be found in the additional literature. The purpose of this paper is to summarize the available distinguishing morphological characters and to provide sufficient drawings to ease the identification of *N. gebhardti* and *N. molnari*.

Keyword. Niphargidae, Mecsek Mts., caves, taxonomy

INTRODUCTION

The eyeless amphipod genus, *Niphargus* is one of the most neglected aquatic troglobiont taxon in Hungary so far. While globally, the number of the *Niphargus* species and subspecies has reached 300, taxonomic state of the few described Hungarian species remained uncertain. The checklist of Hungarian Malacostraca published by Muskó (2007) lists 15 *Niphargus* species and furthermore, gathers all records available in the literature, yet without commenting on their validity. In the last six decades elapsed since the descriptions, many new caves had been discovered without biospeleological examinations in the country. Therefore the data about the distributions and the species does not match the possibilities provided by the geological knowledge. Most of the descriptions provide insufficient morphological information and few drawings, and often even the type locality cannot be exactly identified. In most cases the holotypes are no more available in the type collections either because they were sent abroad and never returned or perished in the fire which ravaged the Hungarian Natural History Museum during the revolution in 1956. In such cases collecting new samples from the type locality can help to gather information about the species.

The morphology of niphargids is highly variable, therefore collecting and analyzing samples from the whole potential distribution area of the species can serve as a proof of the reliability of the characters.

Among the five known endemic *Niphargus* species of Hungary, two, *Niphargus gebhardti* Schellenberg, 1934 and *Niphargus molnari* Méhely, 1927 were described from the caves of the Mecsek Mts. *N. gebhardti* was first found in the pools formed by dripping water of the Abaligeti Cave. It was originally described as *Niphargus foreli gebhardti* by Schellenberg in 1934. The description contains two drawings about the telson and the propodus of the second gnathopod and little information about the pereopods, antennae, maxilliped and first maxilla (Schel-

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lenberg 1934). Later on, Schellenberg (1935) mentioned some additional data about the telson and the body size. The comparative study of Méhely (1941) contains a figure on the retinacles of the third pleopod and mentions the number of the teeth of the right lacinia mobilis.

N. molnari was described from the stream and pools of the Mánfai-kőlyuk Cave, and then it was also found in the stream of the Abaligeti Cave (Gebhardt 1963). The description is rather poor with only two drawings about the pereion segments and the epimeral plates. The species was originally described as *N. molnari* (Méhely 1927), and later on it was mentioned as a subspecies, *N. leopoliensis molnari* by Schellenberg (1933). In the paper of Schellenberg (1935) the species appeared again with its original name and taxonomic rank. A figure about the right lacinia mobilis can also be found in one of Méhely's papers (Méhely 1941). A single data about the number of the setae of the first maxilla's palpus was also given (Schellenberg 1935).

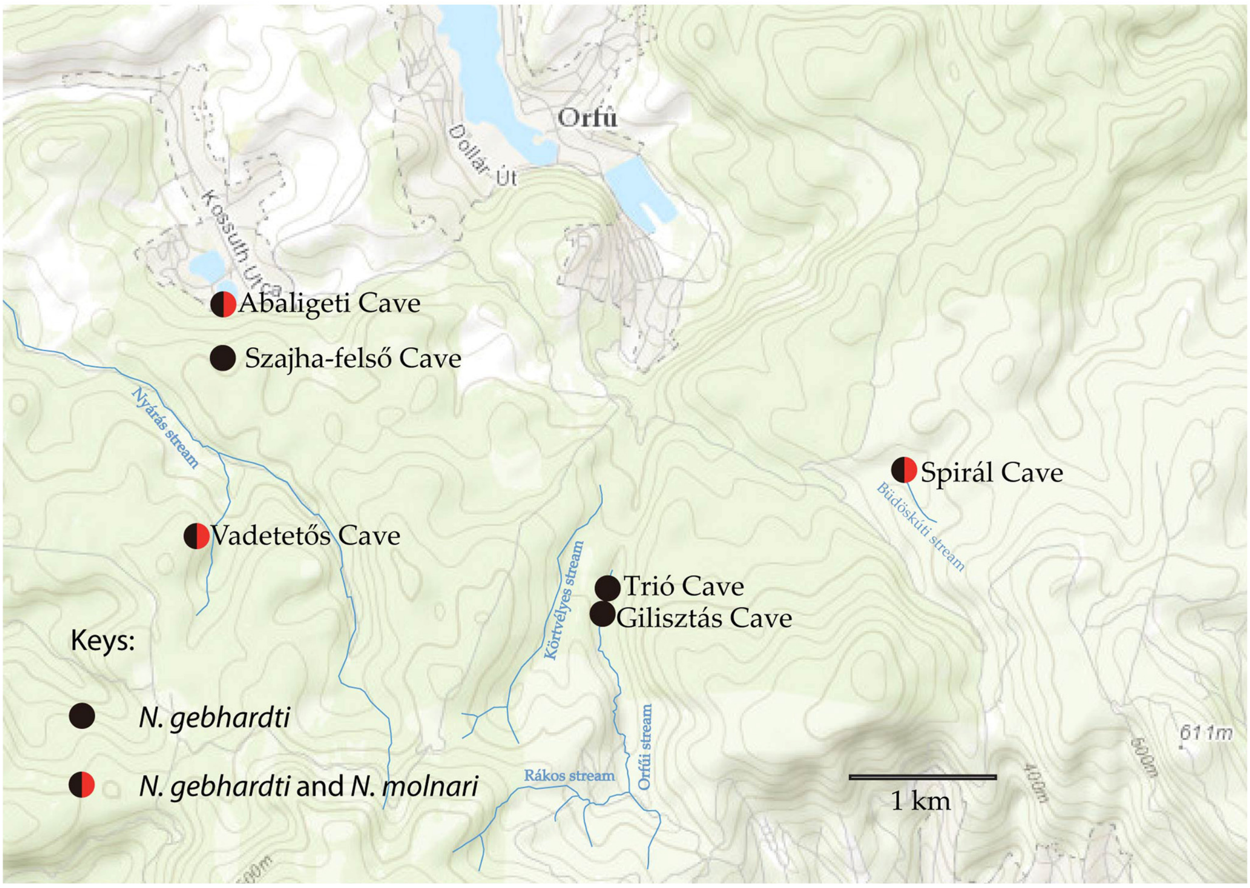


Figure 1. Locations of *N. gebhardti* and *N. molnari* in the six examined caves in Western-Mecsek

MATERIALS AND METHODS

Samples were collected between May 2010 and October 2011 in six caves from the Western–Mecsek (Figure 1.). Most of the caves examined were sinkholes with various length and vertical extensions (Table 1.). 40 individuals were collected by singling, fixed and stored in 96% ethanol. The material was identified by Cene Fišer and the authors. Preparation techniques were used after Fišer *et al.*, (2009).

Specimens were cooked in 10% KOH solution, rinsed with HCl and washed in distilled water. Cleared exoskeletons were stained with chlorazol black in glycerol, and then dissected under a Leica MZ75 stereomicroscope. Two slides were made of each specimens, one contained the left side appendages and the mouth parts, while the other contained the whole body with the right side appendages. The slides were examined using a Leica DM 1000 light microscope. Drawings were made using a drawing tube.

Table 1. Names and basic data of the caves where the two *Niphargus* species were collected

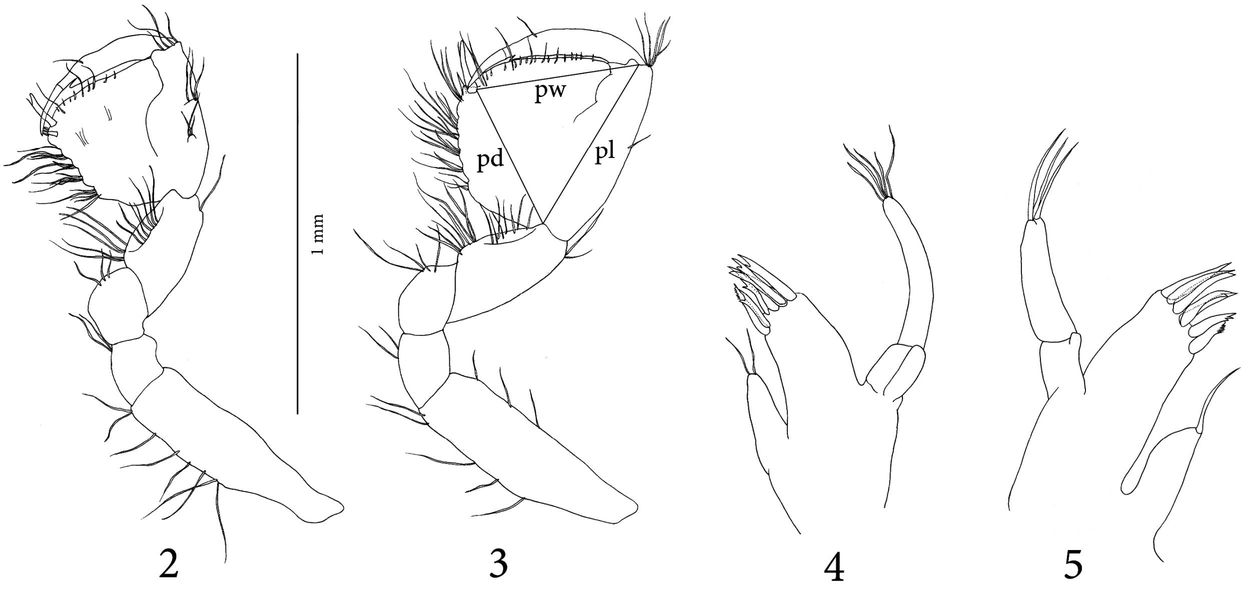
Name of cave	**Type of cave**	**Cadastre number**	**Entrance's altitude above sea level (m)**	**Y (Decimal degree)**	**X (Decimal degree)**	**Length of cave (m)**	**Vertical extension of cave (m)**
Abaligeti Cave	spring cave	4120–1	218,77	578056,43	88434,52	1712	48,7
Vadetetős Cave	sinkhole	4120–27	320,701	577872,84	86795,058	177	35
Trió Cave	sinkhole	4120–71	301,035	580722,26	86347,182	250	58
Gilisztás Cave	sinkhole	4120–70	307,704	580693,26	86268,727	134	51,1
Spirál Cave	sinkhole	4120–130	350,28	582719,93	87242,072	1000	86,4
Szajha-felső Cave	sinkhole	4120–16	283,508	578056,14	88041,665	98	40

Table 2. The seven distinguishing characters of *N. gebhardti* and *N. molnari*

Character	***N. gebhardti***	***N. molnari***
Body size	6–8 mm	9–10 mm
Number of setae on the palpus of maxilla I	5	3
Number of retinacles of pleopods	> 2 (3)	2
Shape of the propodus of gnathopod II, Ratio of propodus length (pl), propodus diagonal (pd) and propodus width (pw)	rectangular 26/24/26	elongated 30/24/29
Number of teeth of the lacinia mobilis on the right mandible	4–5	12–13
Shape of the telson Ratio of telson length (tl) and telson width (tw)	a bit longer then wide 11/10	significantly longer then wide 11/7
Shape of the epimeral plate 3	distoposterior angle is rounded	distoposterior angle is sharply inclined

RESULTS

N. gebhardti was collected in six caves (Abaligeti Cave, Vadetetős Cave, Szajha-felső Cave, Trió Cave, Spirál Cave, and Gilisztás Cave). *N. molnari* was not found in the type locality, however the species occurred in the Abaligeti Cave and in two other caves (Vadetetős Cave and Spirál Cave). In three out of the six caves both species occurred, but as it was suggested by Gebhardt (1963) coexistence in the same micro habitat within the same cave was never found. Examining all the literature related to the two species, seven distinguishing characters were gathered (Table 2, Figure 2–17). In case of the second gnathopod and the telson, measurement ratios were added according to the modern standard (Fišer *et al.* 2009). The seven characters proved stable in all the 23 specimens of *N. gebhardti* and all the 17 specimens of *N. molnari*, regardless the locality where the individuals were collected from. It seems that using combination of characters is a reliable method for distinguishing the two species.



Figures 2-5. 2 = gnathopod II, *N. gebhardti* (Abaligeti Cave), 3 = gnathopod II, *N. molnari* (Abaligeti Cave), pw = propodus width, pl = propodus length, pd = propodus diagonal, 4 = maxilla I, *N. gebhardti* (Szajha-felső Cave), 5 = maxilla I, *N. molnari* (Vadetetős Cave)

DISCUSSION

The new distributional data suggests that exploration of more caves for the two species would be required for determining the whole distribution area of *N. gebhardti* and *N. molnari* in the Mecsek Mts. The absence of *N. molnari* in the type locality can be due to the artificial changes of the hydrological system of the cave. The intrusive introduction of waterworks has led to the disappearance of endemic fauna elements and the appearance of distracted, urban habitat–dwelling species (Angyal 2012).

Because of the stability of the character combination, samples from other subterranean habitats of the Mecsek Mts. could also be dependably identified. However, redescription of both species is necessary to fulfil the modern *Niphargus* taxonomical requirements.

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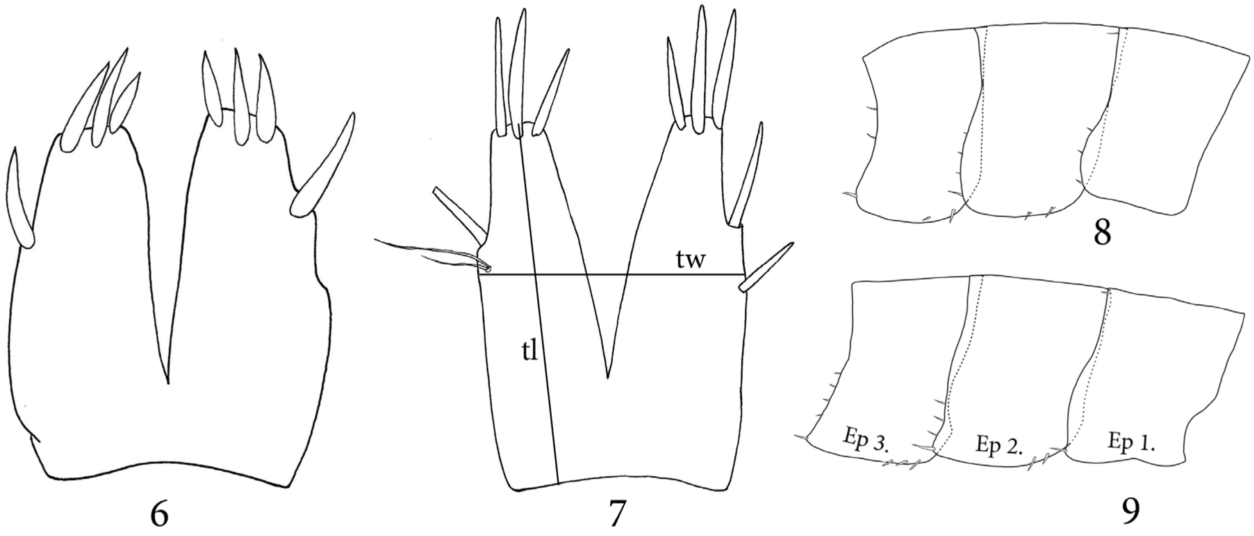
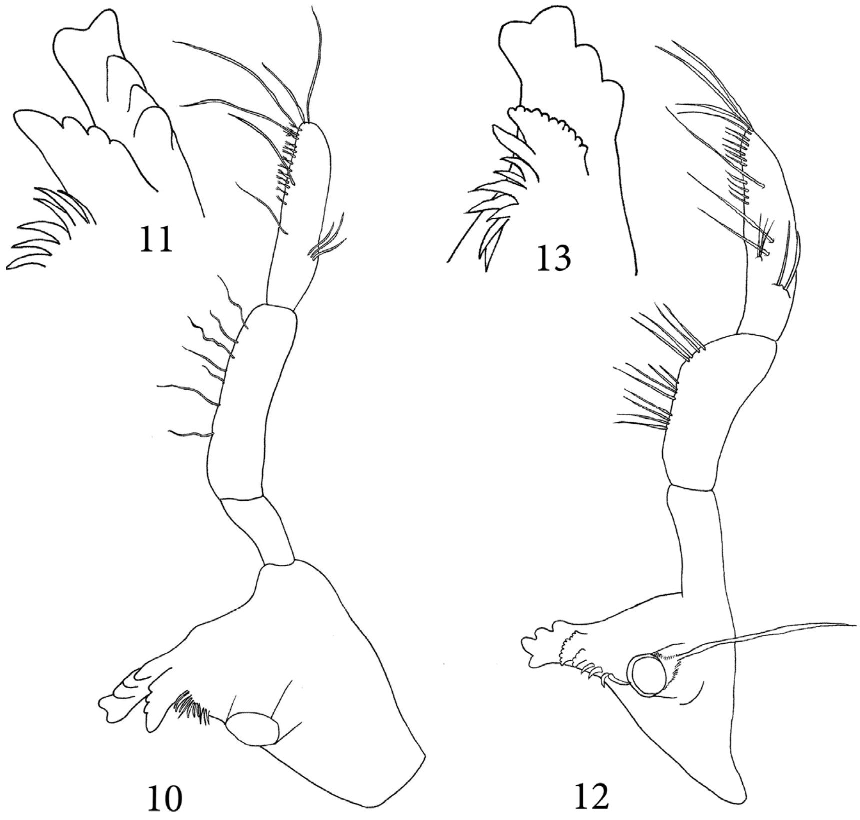
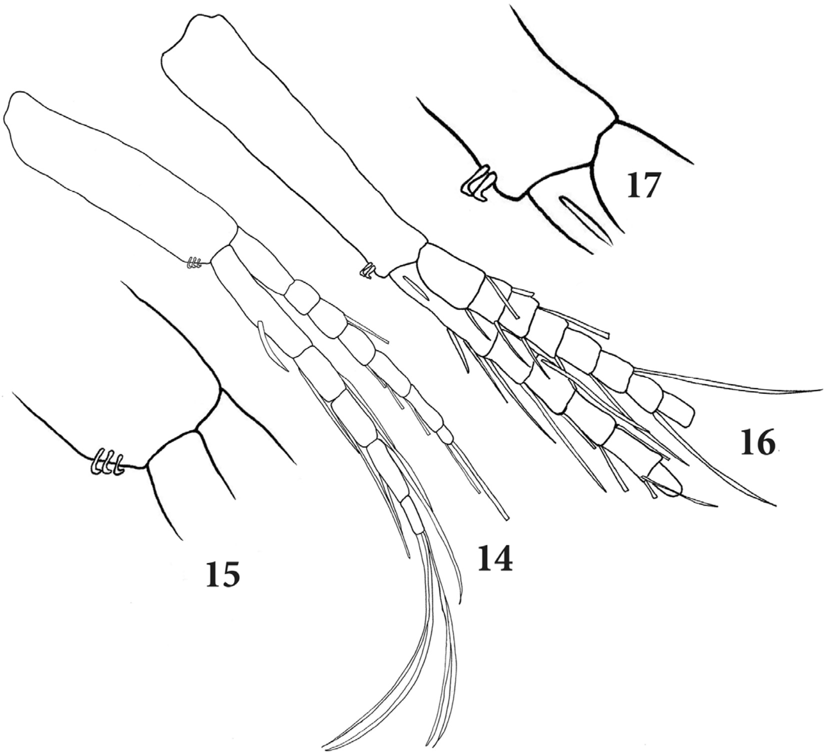


Figures 6-9. 6 = telson, *N. gebhardti* (Abaligeti Cave), 7 = telson, *N. molnari* (Abaligeti Cave), tl = telson length, tw = telson width, 8 = epimeral plate 1–3 *N. gebhardti* (Abaligeti Cave), 9 = epimeral plate 1–3 *N. molnari* (Abaligeti Cave)



Figures 10-13. 10 = right mandible, *N. gebhardti* (Abaligeti Cave), 11 = lacinia mobilis and incisor of the right mandible *N. gebhardti* (Abaligeti Cave), 12 = right mandible, *N. molnari* (Abaligeti Cave), 13 = lacinia mobilis and incisor of the right mandible, *N. molnari* (Abaligeti Cave)



Figures 14-17. 14 = pleopod II, *N. gebhardti* (Szajha-felső Cave), 15 = retinacles of pleopod II, *N. gebhardti* (Szajha-felső Cave),16 = pleopod II, *N. molnari* (Vadetetős Cave), 17 = retinacles of pleopod II, *N. molnari* (Vadetetős Cave)

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Additional description of *Scheloribates* (*Bischeloribates*) *mahunkai* Subías, 2010 (Acari: Oribatida: Scheloribatidae) on the basis of Vietnamese specimens

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Abstract. The oribatid mite, *Scheloribates* (*Bischeloribates*) *mahunkai* Subías, 2010 is redescribed in details on the basis of specimens from Vietnam. The size of body structures, morphology of the gnathosoma and legs are presented for the first time. Morphological differences of Vietnamese and Malaysian specimens are discussed.

Keywords. Oribatida, redescription, *Scheloribates* (*Bischeloribates*) *mahunkai*, Vietnam

INTRODUCTION

Scheloribates (*Bischeloribates*) *mahunkai* Subías, 2010 (Acari, Oribatida, Scheloribatidae) was described as *Bischeloribates heterodactylus* Mahunka, 1988. However, Subías (2004, online version 2006) has suggested to consider the genus *Bischeloribates* as subgenus of *Scheloribates* Berlese, 1908 because *Bischeloribates* differs from *Scheloribates* only by a single main character (leg tarsi with two claws versus with three claws). I support the subgeneric status for *Bischeloribates*, following the concept of Subías, because the number of leg claws is not apomorphic character at genus-level in Oripodoidea. Also, as the name *heterodactylus* is preoccupied by *Scheloribates* (*Topobates*) *heterodactylus* Pletzen, 1963 (see system of *Scheloribates* in Weigmann 2006), therefore Subías (2010) has proposed a replacement name – *mahunkai*.

At present, *Scheloribates* (*Bischeloribates*) *mahunkai* is recorded only in Malaysia and India (Subías 2004, online version 2012). In the course of taxonomic identification of Vietnamese oribatid mites, my friend (A. E. Anichkin) and I have found several specimens of this species; hence, it is first record in Vietnam.

Scheloribates (*Bischeloribates*) *mahunkai* is the type species of the subgenus *Bischeloribates*, therefore providing detailed morphological data on this species is needed, especially because, the original description (see Mahunka 1988) is incomplete and brief (lacking information on the measures of morphological structures, leg setation and solenidia, morphology of gnathosoma). The main goal of this paper is to present an additional description of *Scheloribates* (*Bischeloribates*) *mahunkai*, on the basis of the specimens found in Vietnam.

MATERIAL AND METHODS

Material examined. Ten specimens (three males and seven females) of *Scheloribates* (*Bischeloribates*) *mahunkai* found in Southern Vietnam, Dong Nai Province, Dong Nai Culture and Nature Reserve, pine (*Pinus kesiya* Royle ex Gordon, 11°16' N, 107° 40' E) and acacias (*Acacia auriculiformis* A.Cunn. ex Benth, 11°18' N, 107°3' E) plantations, in soil, leaves and litter, collected by A.E. Anichkin and S.G. Ermilov in July 2012.

Specimens were mounted in lactic acid on temporary cavity slides for measurement and il-

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lustration. All body measurements are presented in micrometers. Body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the ventral plate, to avoid discrepancies caused by different degrees of notogastral distortion. Notogastral width refers to the maximum width in dorsal aspect. Lengths of body setae were measured in lateral aspect. Formulae for leg setation (famulus included) are given in parentheses according to the sequence trochanter–femur–genu–tibia–tarsus. Formulae for leg solenidia are given in square brackets according to the sequence genu–tibia–tarsus.

The general morphological terminology used in the description follows that summarized by Coetzer (1967–1968) and Norton & Behan-Pelletier (2009).

TAXONOMY

Scheloribates (*Bischeloribates*) *mahunkai* Subías, 2010

(Figures 1–17)

Scheloribates (Bischeloribates) mahunkai Subias, 2010: 38, nom. nov. pro *Scheloribates heterodactylus* Mahunka, 1988 non *Scheloribates (Topobates) heterodactylus* (Pletzen, 1963)

Diagnosis. Body size 365–431 × 232–249. Rostrum rounded. Translamellar line present, interrupted medially. Prolamellar lines complete or incomplete. Rostral, lamellar and interlamellar setae long, setiform, barbed. Sensilli long, clavate, with barbed head. Four pairs of short notogastral setae (h_1, p_1–p_3) present; the other setae represented only by alveoli. Sacculi *Sa* with elongate openings, *S1*, *S2* and *S3* with rounded openings. Anogenital setae short and smooth.

Measurements. Ten specimens: body length 365–431 (mean 403); notogaster width without pteromorphs 232–249 (mean 242).

Integument (Figs. 1–5). Body light brown. Body surface smooth. Lateral surfaces of prodorsum microgranulate (diameter of granules less than 1). Epimeres IV with muscle sigillae. Circumgastric band of sigillae weakly visible.

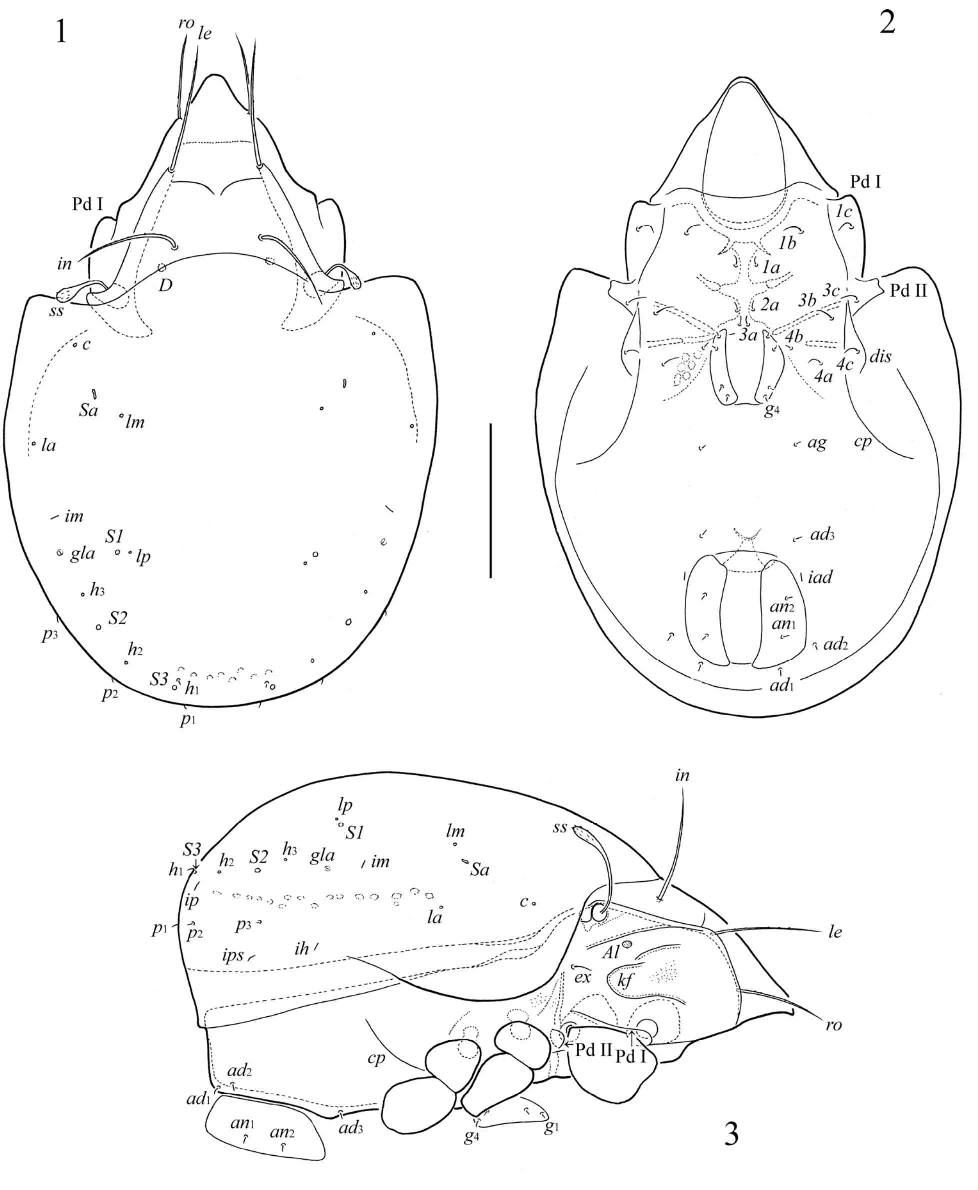
Prodorsum (Figs. 1, 3, 4, 6, 7). Rostrum rounded, weakly protruding in dorsal view. Lamellae equal approximately to half of prodorsum. Translamellar line present, interrupted medially. Prolamellar lines complete (in nine specimens) or incomplete, only its basal part developed (in one specimen). Sublamellar lines long and thin. Sublamellar porose areas (*Al*) small and rounded (4–6). Keel-shaped chitinized ridges (*kf*) distinct. Rostral (*ro*, 53–61), lamellar (*le*, 73–86) and interlamellar (*in*, 73–86) setae setiform, barbed. Sensilli (*ss*, 57–65) with long (32–41) stalk and shorter (20–24), barbed and distally rounded head. Exobothridial setae (*ex*, 12–24) setiform, thin and indistinctly barbed.

Notogaster (Figs. 1, 3, 4, 5). Anterior margin convex medially. Dorsophragmata (*D*) small and rounded. Four pairs of short, thin and smooth notogastral setae (h_1, p_1–p_3) present; other six pairs (rarely seven, including also h_1) represented only by alveoli. Sacculi *Sa* with elongate openings, *S1*, *S2* and *S3* small, with rounded openings. Lyrifissures *ia* inconspicuous; *im*, *ip*, *ih* and *ips* developed in typical arrangement for *Scheloribates*. Opisthonotal gland openings (*gla*) located posteriorly to *im* and laterally to *S1*.

Gnathosoma (Figs. 8–10). Subcapitulum longer than wide (86–94 × 49–57). Subcapitular setae setiform and slightly barbed; *h* and *a* (both 16–20) longer than *m* (8–12). Two pairs of adoral setae (or_1, or_2, 6–8) thickened, barbed and hook-like distally. Palps (53–57) with setation 0–2–1–3–9(+ω). Solenidion thickened, blunt-ended, attached with eupathidium *acm*. Chelicerae (94–98) with two setiform and barbed setae; *cha* (24–28) longer than *chb* (16–20). Trägårdh's organ (Tg) distinct.

Epimeral and lateral podosomal regions (Figs. 1–4, 11). Epimeral setal formula 3–1–3–3. Setae setiform and slightly barbed; *1a*, *2a*, *3a*, *4b* (6–12) shorter than others (16–20). Pedotecta I (Pd I) convex, pedotecta II (Pd II) rectangular and weakly concave distally. Discidia (*dis*) rounded distally. Circumpedal carinae (*cp*) distinct.

Anogenital region (Figs. 2, 3, 12, 13). Four pairs of genital (g_1–g_4, 4–8), one pair of aggenital

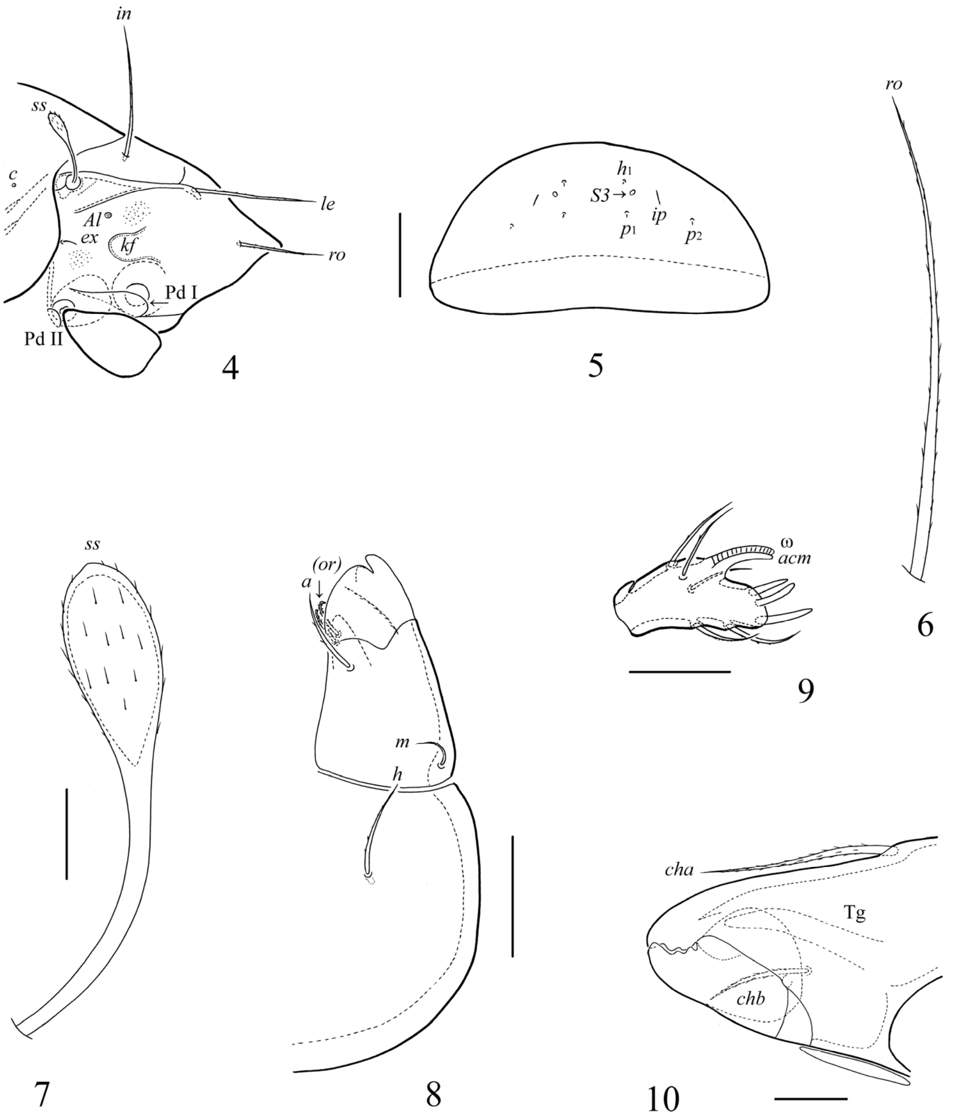


Figures 1–3. *Scheloribates (Bischeloribates) mahunkai* Subías, 2010. 1 = Dorsal view of body, 2 = ventral view of body (gnathosoma and legs not shown), 3 = lateral view of body (gnathosoma, epimeral setae, leg I and distal parts of legs II–IV not shown). Scale bar 100 μm.

Table 1. Leg setation and solenidia of *Scheloribates (Bischeloribates) mahunkai* Subías, 2010

Leg	Trochanter	Femur	Genu	Tibia	Tarsus
I	*v′*	*d, (l), bv″, v″*	*(l), v′*, σ	*(l), (v)*, φ_1, φ_2	*(ft), (tc), (it), (p), (u), (a), s, (pv), v′, e*, ω_1, ω_2
II	*v′*	*d*, l'_1, l'_2, *bv″, v″*	*(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	*l′, (v)*, φ	*(ft), (tc), (it), (p), (u), (a), s, (pv)*
IV	*v′*	*d, ev′*	*d, l′*	*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.



Figures 4–10. *Scheloribates* (*Bischeloribates*) *mahunkai* Subías, 2010. 4 = Lateral view of prodorsum (specimen with incomplete prolamellar line) and anterior part of notogaster (gnathosoma, epimeral setae, leg I and distal part of leg II not shown), 5 = posterior view of notogaster, 6 = rostral seta, 7 = sensillus, 8 = subcapitulum, ventral view of left half, 9 = palptarsus, 10 = chelicera, anterior part. Scale bars (4, 5) 50 µm, (6, 7, 9, 10) 10 µm, (8) 20 µm.

(*ag*, 4–8), two pairs of anal (an_1, an_2, 6–10) and three pairs of adanal (ad_1–ad_3, 6–10) setae setiform, thin and smooth. Lyrifissures *iad* short, located anteriorly to the level insertions of an_2.

Legs (Figs. 14–17). Both claws smooth. Formulae of leg setation and solenidia: I (1–5–3–4–17) [1–2–2], II (1–5–3–4–15) [1–1–2], III (2–3–1–3–15) [1–1–0], IV (1–2–2–3–12) [0–1–0]; homology of setae and solenidia indicated in Table 1. Famulus (*e*) short, straight, blunt-ended. Solenidia ω_2 on tarsi I, ω_1 and ω_2 on tarsi II, σ on genua III setiform, thickened and blunt-ended; other solenidia thinner (φ_1 on tibiae I longest).

Remarks. The present Vietnamese specimens of *Scheloribates* (*Bischeloribates*) *mahunkai* are morphologically and in general appearance similar to the Malaysian specimens (see the original description of Mahunka (1988), but there are slight differences as well; i.e. body size (365–431 × 232–249 in Vietnamese specimens versus 282–302 × 188–213 in Malaysian specimens), development of prolamellar lines (well developed, complete, exception – incomplete in Vietnamese specimens versus only its basal part developed in Malaysian specimens). I believe these differences represent intraspecific (perhaps geographical) variability, and it should be indicated in any future diagnosis of *Scheloribates* (*Bischeloribates*) *mahunkai*.

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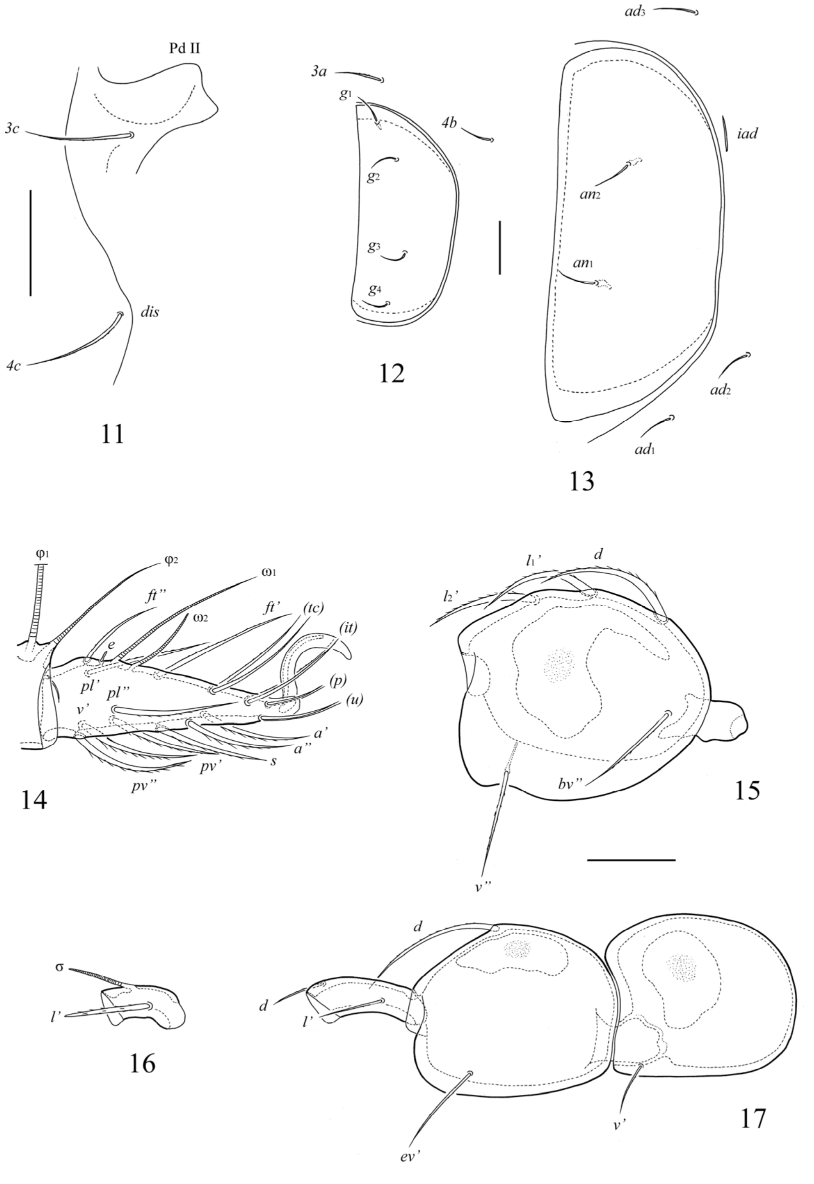

Figures 11–17. *Scheloribates* (*Bischeloribates*) *mahunkai* Subías, 2010. 11 = Pedotectum II, discidium and epimeral setae *3c*, *4c* in dissected specimen, 12 = left genital plate and epimeral setae *3a*, *4b*, 13 = left anal plate, adanal lyrifissures and adanal setae, 14 = tarsus and anterior part of tibia of leg I (right, antiaxial view), 15 = femur of leg II (left, antiaxial view), 16 = genu of leg III (right, antiaxial view), 17 = trochanter, femur and genu of leg IV (right, antiaxial view).
Scale bars (11, 14–17) 20 μm, (12, 13) 10 μm.

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Two new species of *Neoribates (Neoribates)* Berlese, 1914 from China (Acari, Oribatida, Parakalummidae)

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Abstract. Two new oribatid mite species, *Neoribates (N.) cheni* and *Neoribates (N.) particula* spp. nov. are described from soil and litter of bamboo and under moss from China. *Neoribates (N.) cheni* sp. nov. is morphologically most similar to *Neoribates (N.) spindleformis* Ermilov, 2012 but differs from it in the number of leg claws and the position of epimeral setae. *Neoribates (N.) particula* sp. nov. is morphologically most similar to *Neoribates (N.) gracilis* Travé, 1972 but differs from it in the shape and size of rostral and lamellar setae, and the position of adanal setae *ad3*.

Keywords. Oribatid mites, Parakalummidae, *Neoribates*, new species, China.

INTRODUCTION

The oribatid mite family Parakalummidae Grandjean, 1936 is the second biggest in the superfamily Galumnoidea consisting of 2 genera 3 subgenera 45 species and 1 subspecies (Subías 2004, online version 2012). The genus *Neoribates* was proposed by Berlese (1914) with the type species *Oribata roubali* Berlese, 1910. Currently, this genus comprises 2 subgenera 42 species and one subspecies and has a cosmopolitan distribution (Subías 2004, 2012). Previously only 5 species of this family; *Neoribates (N.) rotundus* Aoki, 1982, *Neoribates (N.) roubali* (Berlese, 1910), *Neoribates* (*Parakalumma) lydia* (Jacot, 1923), *Neoribates (N.) parvisetigerum* Aoki, 1965 and *Sandenia laiae* (Tseng, 1984), were known to be found in China (Chen 2010), of which three belong to the subgenus *Neoribates* (*Neoribates*).

Working on a material from Guizhou, Ningxia and Shanxi Province of China, two new species of the subgenus *Neoribates* (*Neoribates*): *Neoribates (N.) cheni* and *Neoribates (N.) particula* spp. nov. were discovered. Their morphological descriptions and illustrations are herewith presented.

MATERIAL AND METHODS

Specimens were examined in lactic acid, mounted on temporary cavity slides for the duration of the study, and then stored in vials in 75% alcohol. All measurements are presented in micrometers. Body length was measured in lateral view, from the tip of the rostrum to the posterior edge of the ventral plate, to avoid discrepancies caused by different degrees of notogastral distension. Notogastral width refers to the maximum width in dorsal aspect. General terminology used in this paper follows that of Norton & Behan-Pelletier (2009).

Formulae of leg setation are given in order of trochanter-femur-genu-tibia-tarsus (famulus included). Formulae of leg solenidia are given (in parentheses) in order of genu-tibia-tarsus.

TAXONOMY

Neoribates (N.) cheni sp. nov.

(Figures 1–7)

Diagnosis. Body size 475–570 × 385–430. Body surface smooth. Rostral, lamellar and inter-

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lamellar setae long. Sensilli spindle-form. Four pairs of genital setae. All legs tarsi heterotridactylous.

Material examined. *Holotype* (female). Southwestern China, Guizhou Province, Chishui Bamboo National Forest Park, 27°52' N, 107°18' E, bamboo forest, litter of bamboo, 14. Aug. 2012, collected by Prof. Maofa Yang (GUGC).

Paratypes 5 (female), with same data as of the holotype; one (female), Southwest China, Guizhou Province, Kuankuoshui Natural Reserve, 28° 22' N, 107°15' E, soil of under broad-leaved forest, 15. Aug. 2010, collected by Wenqin Liang (GUGC); 6 (female), Northwest China, Shanxi Province, Ziboshan National Forest Park, 33°40' N, 106°47' E, under the moss, 22. July 2010, collected by Wenqin Liang and Qiuxiao Tang (GUGC).

Measurements. Body length 550, notogaster length 440 (holotype), 475–570 (five paratypes), width 420 (holotype), 385–430 (five paratypes).

Integument (Fig. 1). Body color brown to dark brown. Body surface smooth. Anterolateral parts of notogaster with radiate impressions and light spots. Epimeral region with some light spots.

Prodorsum (Figs. 1, 6). Rostrum protruding, rounded in dorsal view. Rostral (*ro*, 72–80) and lamellar (*le*, 95–106) setae setiform, distinctly barbed. Interlamellar (*in*, 120–133) and exobothridial (*ex*, 6–10) setae setiform, slightly or indistinctly barbed. Sensilli (*ss*, 131–148) spindle-form, smooth or indistinctly barbed, with long stalk (72–85), fusiform head (21–28) and thin apex (23–31). Porose areas *Ad* absent. Lamellae (*Lam*) thin.

Notogaster (Figs. 1, 5). Dorsosejugal furrow convex, conspicuous. Notogaster slightly ball shaped, long nearly equal to wide. Notogastral setae represented by 10 pairs of alveoli. Four pairs of sacculi (*Sa*, *S1–S3*) and all lyrifissures located as typical for the genus. Median pore absent.

Gnathosoma (Fig. 4). Morphology typical for *Neoribates* (*e.g.* Travé 1972, Grishina & Vladimirova 2009, Nakamura 2009).

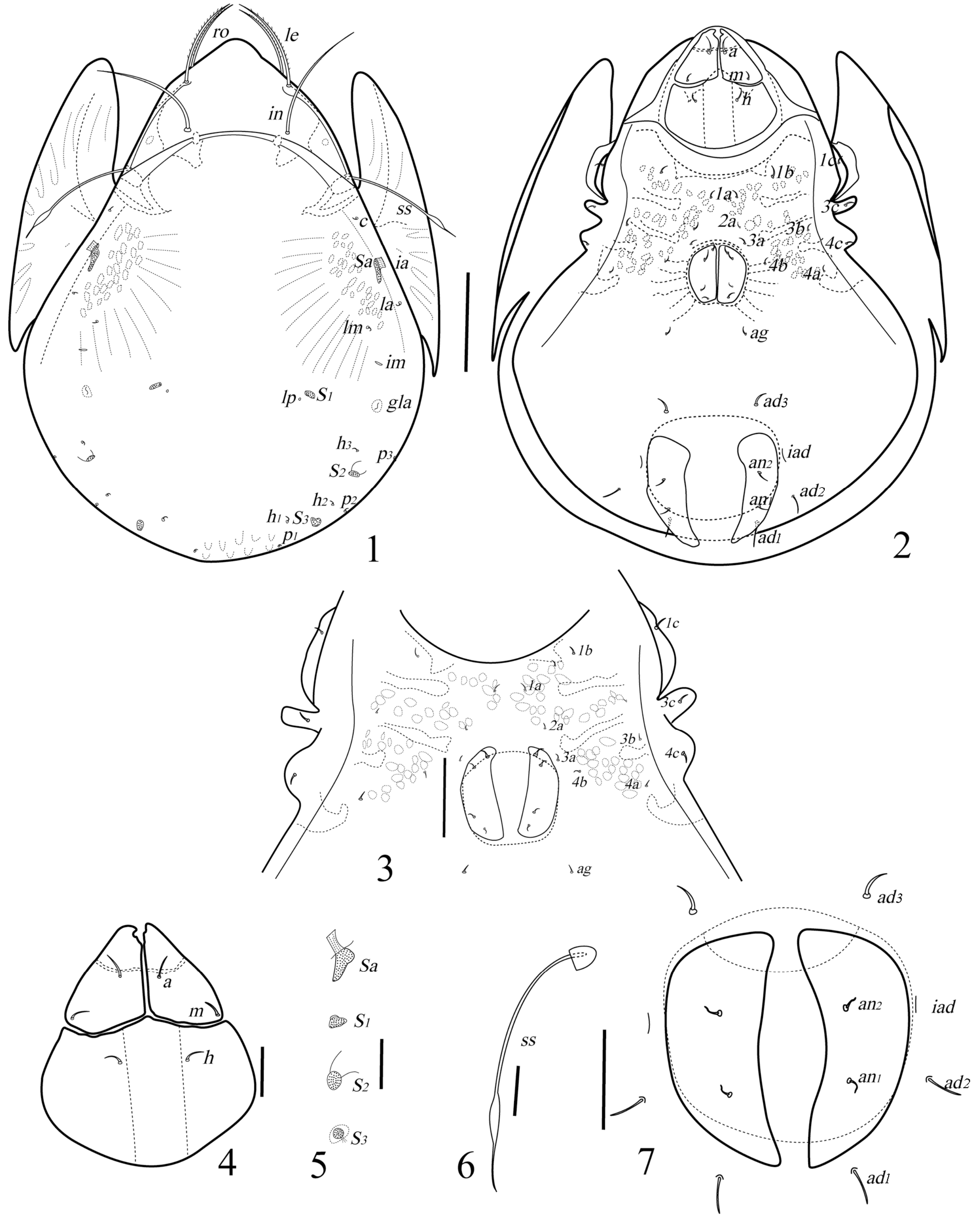
Epimeral region (Figs. 2, 3). Epimeral setal formula: 3–1–3–3. All setae short, smooth, setiform. The distance of setae 3a–3a longer than 2a–2a, slightly wider than the genital pore.

Anogenital region (Figs. 2, 3, 7). Four pairs of genital (*g1–g4*, 3–8), one pair of aggenital (*ag*, 3–5), three pairs of adanal (*ad1–ad3*, 10–12) and two pairs of anal (*an1*, *an2*, 8–10) setae thin and smooth. Lyrifissures *iad* located in inverse apoanal position. Adanal setae *ad3* positioned anterior to anal opening. Postanal porose area absent.

Legs. Morphology of leg segments, setae and solenidia typical for *Neoribates* (e.g. Travé 1972, Grishina & Vladimirova 2009, Nakamura 2009). All legs tridactylous, with strong median and slender lateral claws. Formulae of leg setation and solenidia: I (1–5–3–4–19) [1–2–2], II (1–5–3–4–15) [1–1–2], III (2–3–1–3–15) [1–1–0], IV (1–2–2–4–12) [0–0–0]; homology of setae and solenidia indicated in Table 1.

Remarks. *Neoribates (N.) cheni* sp. nov. is most similar to *Neoribates (N.) spindleformis* Ermilov, 2012 described from Southern Vietnam, but clearly differs from it by the following characters: rostral and lamellar setae with distinct barbs (*versus* indistinct in *N. (N.) spindleformis*); all legs tridactylous (*versus* leg tarsi I with one claw, leg tarsi II–IV with two claws); the distance of epimeral setae 3a–3a longer than 2a–2a, slightly wider than the genital pore (*versus* distinctly shorter than genital pore in *N. (N.) spindleformis*); 1a far from 2a (*versus* close in *N. (N.) spindleformis*).

This new species is also similar to *Neoribates (N.) gracilis* Travé, 1972 from Southern Europe, but clearly differs from the latter by being the epimeral setal distance 3a–3a slightly wider than the genital pore (*versus* distinctly shorter in *N. (N.) gracilis*); genital plates with four pairs of genital setae (*versus* five pairs in *N. (N.) gracilis*). *Neoribates cheni* sp. nov. is easily distinguishable from other species reported from China: *Neoribates (N.) rotundus* Aoki, 1982 and *Neoribates (N.) roubali* (Berlese, 1910) by the fusiform sensilli, possessing thin and long apex (*versus* setiform in *Neoribates (N.) rotundus,* its head shortly fusiform and provided with barbs in *N. roubali*).



Figures 1–7. *Neoribates (N.) cheni* sp. nov. 1 = dorsal view, 2 = ventral view, 3 = anterior of ventral plate, 4 = hypostome, 5 = saccules, 6 = sensillus, 7 = anal plate with adanal setae *ad1*, *ad2*, *ad3* and lyrifissure *iad*.
Scale bars (1, 2) 100 µm, (3, 7) 50 µm, (4, 5, 6) 25 µm.

Etymology. The new species is named in honour of the Chinese oribatid mite experts, Dr. Jun Chen, Institute of Zoology, Chinese Academy of Sciences.

Type deposition. All examined specimens are deposited in the collection of the Institute of Entomology, Guizhou University, Guizhou, China (GUGC).

Neoribates (N.) particula sp. nov.

(Figures 8–15)

Diagnosis. Body size 475–500 × 330–360 (male), 520–570 × 380–400 (female). Body surface smooth. Rostral, lamellar setae shorter than half of the interlamellar setae, setiform, smooth or indistinctly barbed. Interlamellar setae setiform, smooth, not extended to the margins of rostrum. Sensilli spindle-form. Five pairs of genital setae. All legs tarsi heterotridactylous.

Material examined. *Holotype* (male). North-western China, Ningxia Hui Autonomous region, Jingyuan County, 35°21' N, 106°20' E, pine needles, 8. July 2009, collected by Tianci Yi (GUGC).

Paratypes 4 (male), 3 (female), with same data as of the holotype.

Measurements. Body length 480, notogaster length 385 (holotype, male), 475–500 (four paratypes, male), 520–570 (three paratypes, female); width 335 (holotype), 330–360 (four paratypes, male), 380–400 (three paratypes, female).

Integument (Fig. 8). Body color light brown. Notogaster with lots of particles. Anterolateral parts of notogaster with radiate impressions, around of notogaster with some light spots. Epimeral region smooth.

Prodorsum (Figs. 8, 11, 12). Rostrum protruding, rounded in dorsal view. Rostral (*ro*, 34–40), lamellar (*le*, 31–44), interlamellar (*in*, 67–90) and exobothridial (*ex*, 6–8) setae setiform, slightly or indistinctly barbed. Sensilli (*ss*, 122–140) spindle-form, smooth or indistinctly barbed, with well developed stalk (71–92), oblong head (28–31) and thin apex (16–19). Porose areas *Ad* absent. Lamellae (*Lam*) thin, end of lamellar lines extended within a short distance.

Notogaster (Figs. 8, 10, 13). Dorsosejugal furrow convex, conspicuous. Notogaster oval, distinctly longer than wide. Notogastral setae represented by 10 pairs of alveoli. Four pairs of sacculi (*Sa*, *S1–S3*) and all lyrifissures located as typical for the genus, *S1–S3* indistinct. Median pore absent.

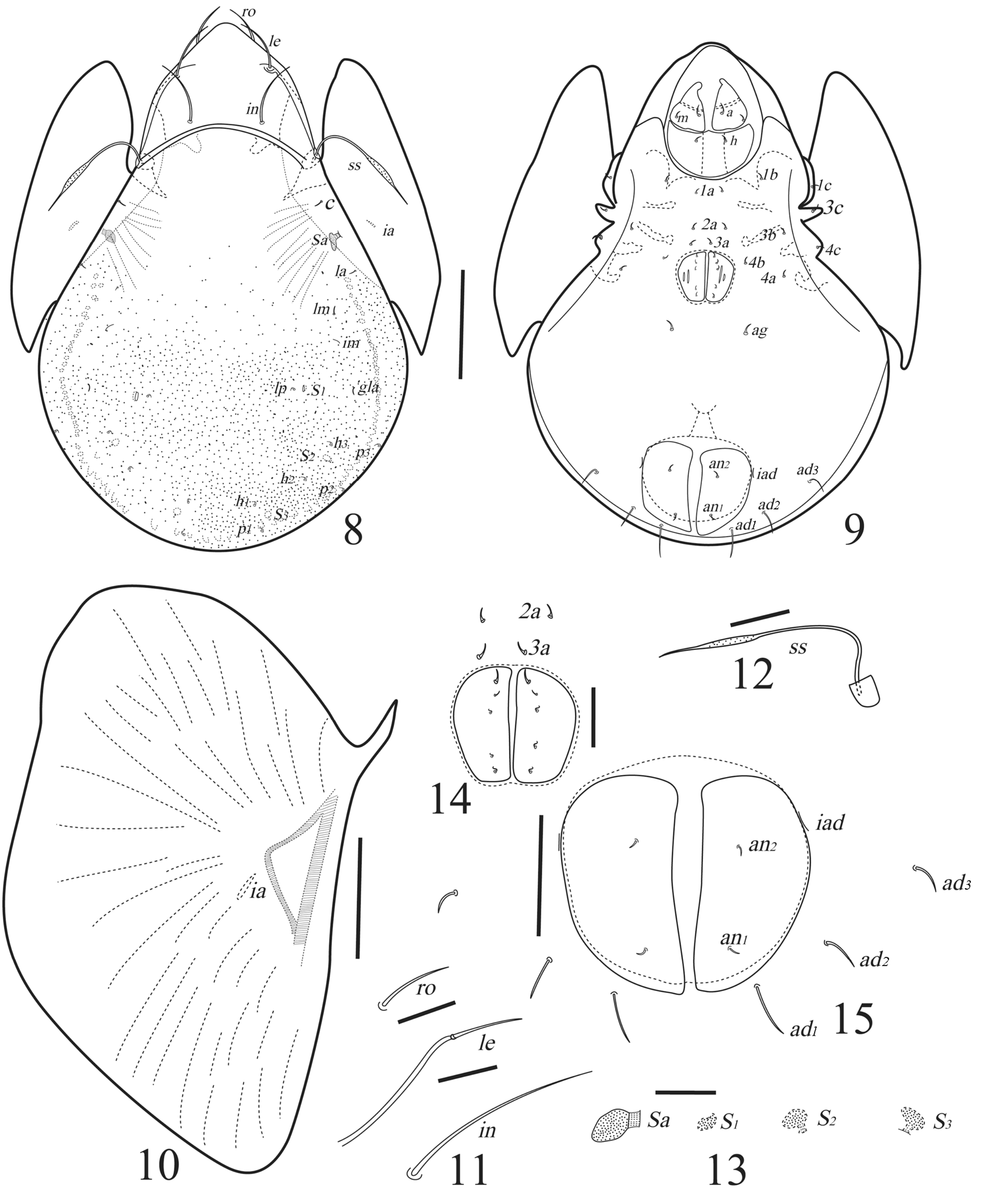
Gnathosoma. Morphology typical for *Neoribates* (e.g. Travé 1972, Grishina & Vladimirova 2009, Nakamura 2009).

Epimeral region (Fig. 9). Epimeral setal formula: 3–1–3–3. All setae short, smooth, setiform. The distance of setae 3a–3a shorter than 2a–2a, and shorter than half width of the genital pore.

Anogenital region (Figs. 9, 14, 15). Five pairs of genital (*g1–g5*, 3–6), one pair of aggenital (*ag*, 6–8), three pairs of adanal (*ad1–ad3*, 14–25) and two pairs of anal (*an1*, *an2*, 5–7) setae thin and smooth. Lyrifissures *iad* located in inverse apoanal position. Adanal setae *ad3* located on the lateral border of anal pore, positioned from *iad* at a large distance. Postanal porose area absent.

Legs. Morphology of leg segments, setae and solenidia typical for *Neoribates* (e.g. Travé 1972, Grishina & Vladimirova 2009, Nakamura 2009). All legs tridactylous with strong median and slender lateral claws. Formulae of leg setation and solenidia: I (1–5–3–4–20) [1–2–2], II (1–5–3–4–15) [1–1–2], III (2–3–1–3–15) [1–1–0], IV (1–2–2–4–12) [0–0–0]; homology of setae and solenidia indicated in Table1.

Remarks. *Neoribates (N.) particula* sp. nov. is most similar to the other new species *Neoribates (N.) cheni* sp. nov. but clearly differs from it by the following characters: rostral and lamellar setae smooth or indistinctly barbed, interlamellar setae not extended to the margins of rostrum (*versus* rostral and lamellar setae with distinct barbs, interlamellar setae long, extended more than the margins of rostrum in *N. (N.) cheni* sp. nov.); the distance of epimeral setae 3a–3a shorter than 2a–2a (*versus* longer in *N. (N.) cheni* sp. nov.); genital plates with five pairs of genital setae (*versus* four pairs in *N. (N.) cheni* sp. nov.); adanal se-



Figures 8–15. *Neoribates particula* sp. nov. 8 = dorsal view, 9 = ventral view, 10 = pteromorph, 11 = rostral, lamellar and interlamellar setae, 12 = sensillus, 13 = saccules, 14 = genital plates with epimeral setae 2a and 3a, 15 = anal plate with adanal setae *ad1*, *ad2*, *ad3* and lyrifissure *iad*. Scale bars (8, 9) 100 µm, (10,15) 50 µm, (11–14) 25 µm.

tae *ad3* located on the lateral border of anal pore, positioned from *iad* at a large distance (*versus* anterior to anal opening in *N. (N.) cheni* sp. nov.).

This new species is also similar to *Neoribates (N.) gracilis* Travé, 1972, but differs from it in the shape and size of rostral, lamellar and interlamellar setae and the position of adanal setae *ad3*.

Etymology. The specific epithet "*particula*" refers to the notogastral surface possessing lots of particles.

Type deposition. All examined specimens are deposited in the collection of the Institute of Entomology, Guizhou University, Guizhou, China

Acknowledgements – We gratefully acknowledge the specimen collector, Dr. Tianci Yi (Institute of Entomology, Guizhou University, Guizhou, China).

Table 1. Leg setation and solenidia of *Neoribates (N.) cheni* sp. nov. (same for *Neoribates (N.) particula* sp. nov.)

Legs	Trochanters	Femora	Genua	Tibiae	Tarsi
I	*v'*	*d, (l), bv'', v''*	*(l), v', σ*	*(l), (v),* φ_1, φ_2	*(ft), (tc), (it), (p), (u), (a), s, (pv), v', (pl), l'', e,* ω_1, ω_2
II	*v'*	*d,(l),bv'',v''*	*(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*	*l', (v), φ*	*(ft), (tc), (it), (p), (u), (a), s, (pv)*
IV	*v'*	*d, ev'*	*d, l'*	*d, l', (v)*	*ft'', (tc), (p), (u), (a), s, (pv)*

*Roman letters refer to normal setae (e–famulus), Greek letters refer to solenidia. A prime (′) marks anterolateral setae and a double prime (″) posterolateral setae of the given leg segment. Parentheses refer to a pair of setae.

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Synopsis of the *Oxyethira flavicornis* species group with new Japanese *Oxyethira* species (Trichoptera, Hydroptilidae)

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Abstract. A brief synopsis of the *Oxyethira flavicornis* species group is produced by the examination of type materials. Diagrammatic drawings with similar style were prepared for all the known and for the new species. Short description of genus *Oxyethira*, subgenus *Oxyethira*, species group of *Oxyethira flavicornis* are presented together with the description of five species clusters: *O. datra* new species cluster, *O. ecornuta* new species cluster, *O. flavicornis* new species cluster, *O. hiroshima* new species cluster, *O. tiunovae* new species cluster. Five new species are described from the *O. flavicornis* species group: *O chitosea* sp. n., *O. hena* sp. n., *O. hiroshima* sp. n., *O. kakida* sp. n., *O. mekunna* sp. n. One new species is described from the *Oxyethira grisea* species group: *Oxyethira ozea* sp. n. and two new species from the *Oxyethira ramosa* species group: *Oxyethira miea* sp. n., *Oxyethira okinawa* sp. n.

Keywords. Caddisflies, *Oxyethira*, new species, Japan.

INTRODUCTION

The micro-caddisfly genus *Oxyethira* is among the largest genera in the family Hydroptilidae and has a worldwide distribution. The *Oxyethira flavicornis* species group has been erected by Marshall (1979). She has established this group by broad genital morphological character range, based on the absence of a median ventral lobe on the fused gonopods and on the presence of broad, widely separated paraproct. This broadly defined diagnosis covered several species from three species groups redefined later: *O. falcata*, *O. flavicornis* and *O. ramosa*. Kelley (1984, 1985) modified this broad concept and restricted the group characters to flattened paramere that is split into two strands. As a result two species remained in *O. flavicornis* species group defined narrowly: *O. ecornuta* Morton, 1893 and *O. flavicornis* (Pictet, 1834). Later, four new species have been discovered having flattened and split paramere and added to the species group: *O. datra* Oláh, 1989 from Vietnam, *O. josifovi* Kumanski, 1990 from Korea, *O. sichuanensis* Yang & Kelley, 1997 from China and *O. tiunovae* Arefina & Armitage, 2003 from Russia (Far-East).

Malicky & Chantaramongol (2007) examined an *Oxyethira* specimen with flat and split paramere from Hokkaido and compared it with the published drawings of *O. datra* and *O. josifovi*. They have synonymised *O. josifovi* as a junior synonym of *O. datra* and thus identified the Hokkaido specimen as *O. datra*. Malicky sent his drawings of the Hokkaido specimen to the first author (J.O.). Examination without special care on paramere revealed no differences. Nozaki has collected specimens from Honshu and sent them to the first author to compare with *O. datra*. The second author (T.I.) borrowed Malicky's specimen and took several genitalia photos in 2008–2009. Actually the lack of understanding on the taxonomic position of this Hokkaido specimen initiated this research. We have completed a brief revision of the entire species group. Reexamining the drawings and genitalia photos as well as comparing it with more specimens and with all the related taxa, we have found it as a new species *O. kakida* sp. nov.

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Recently emerging new perspectives open more sophisticated approaches to discover diverse fine structures in searching stable traits to distinguish specific state of populations without molecular studies. Phylogenetic species concept and the sexual selection theory were applied effectively in the taxonomy of the obscured *Chaetopteryx rugulosa* species group (Oláh *et al.* 2012). The phallic organ and particularly one of its formerly neglected substructure, the subapical lateral lobes of the aedeagus as well as the anal tube of the females proved to be very diverse and stable traits to separate and distinguish among closely related species. In the present study on *Oxyethira flavicornis* species group we have found another phallic structure, the paramere as a promising diverse and stable character to distinguish among closely related species. In this study we have re-examined all the known and the newly described species and demonstrate that parameres are differing sufficiently among species. Key question remained however how to examine, visualise in three dimensions and how to draw these very complex and plane sensitive structures.

MATERIAL AND METHODS

This paper is based upon the *Oxyethira* material collected by Japanese scientists from various localities from Hokkaido to Ryukyu Islands and set aside during the last 37 years. In order to observe morphological details on the total body as well as to prevent the loss of the dissected small structures the entire animal was macerated in a small glass beaker of 25 cm^3 with nearly boiling 10% KOH solution for 5–15 minutes. The setal wart pattern of the head and thorax in all the anatomical planes are rarely described and figured in species descriptions, or are performed only on intact animals, without maceration of tissue. In many intact species the wart and groove patterns are poorly visible and frequently indiscernible, especially if the warts have the same colour as the cranial sclerites, or if the setae on the warts are not detached and the warts are densely covered by intact setae. Clearing the entire body thus gave us useful information on the setal wart pattern for the examined specimens. When sufficient material was available the head and thorax (except wings) were macerated together with the abdomen. 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 digested animals were subsequently transferred to distilled water and the macerated tissue was removed mechanically by fine tipped forceps and needles. The cleared animal was transferred to 80% ethyl alcohol, and to glycerine for examination under microscope. Different sized pins modified to supporting ring bottom were used to hold and stabilise the animal or the genitalia in lateral, dorsal and ventral position for drawing.

Improved visualization

Examination of fine genital structures is not easy in Hydroptilidae. On so small an object as hydroptilids it may be very difficult to visualise and understand genital substructures and functions with absolute certainty. The phallic organ and its very complex parameres are not consistent, in most of the published figures showing inconsistencies. Positive identification is most possible only with teasing out of the entire phallic organ, not only the phallic tip. In practice teasing the entire phallic organ either anterad or posterad may injure or distort those parts of the parameres which are directed in opposite of teasing. Especially when teasing the phallic organ anterad, the complex arm of the paramere is usually detached and hooked in its original position. Following the natural movement of the phallic organ as it functions by teasing out the aedeagus and paramere together posterad results free structure without significant injuries. It is advisable to examine several specimens with properly withdrawn phallic organ to understand in details the structure and function of an unknown paramere. The in situ paramere position is highly dependent on the pre or postcopulatory state of the animals. Moreover only a little plane change creates significant alteration how we see the very complex structure of paramere under microscope.

Intact genitalia of these tiny hairy creatures are usually concealed by dense pilosity. In our present state of understanding genital appendages or periphallic organs of the hydroptilids cannot be identified with high degree of certainty. Without cleaning in KOH, and without denuding it properly, that is mechanically removing setae at least from pregenital segment VIII as well as removing internal content properly it is rarely possible to identify correctly specimens to species level. The setae mask the otherwise visible free genital structures projecting out of the cover of segment IX. In the case of *Oxyethira*, *Catoxyethira* and several Leucotrichiini the enlarged and enforced segment VIII frequently produces a second layer covering the entire segment IX together with its substructures projecting out free. The setal cover usually hides essential parts of the basal articulating sections of the genital structural elements, especially those of the paraprocts, gonopods and basal plate of the gonopods which are already under cover of segment IX. After macerating the remaining setae should be removed. Perfectly denuded genitalia without setae but with intact alveoli, represents what is required for the observation of fine structures of the periphallic elements, their articulations and interactions. Particularly taxonomically important is the articulation between paraprocts, gonopods and the basal plate of the gonopods.

A high quality stereomicroscope under highest resolution is required to be able to observe important three-dimensional structures, instead of using the higher magnification of compound microscope. Stereomicroscope uses 2 separate optical paths to provide different viewing angles to the left and right eyes. It therefore produces a three-dimensional visualization of the genital structures with great working distance and sufficient depth of field. However, higher resolution induces smaller depth of field and working distance. The stereomicroscope should not be confused with a compound microscope equipped with double eyepieces. In a compound microscope, both eyes see the same image, and the binocular eyepieces simply provide greater viewing comfort. However, the higher magnification potential of the compound microscope may help to detect and understand difficult parts of the genitalia. The shape, connections, interactions and articulations of the small and frequently weakly pigmented structures require experience. Permanent movement and maceration with fine tipped pins of the properly cleared and denuded genitalia under the stereomicroscope, as well as under inverted compound microscope with large working depth, help us to detect the otherwise indiscernible structures of various articulations.

Diagrammatic and habitus drawings

For Trichoptera, illustrations of the genitalia are the most important component in species descriptions. It is especially important to prepare drawings that are clearly understood and complete for visualization of the hydroptilids. These tiny animals dispose difficulties in visual detection and understanding the function of their genitalia. This is reflected by a lack of standard and by the highly varying quality of illustrations of genitalia in species descriptions. There are two basic types of genital drawings in scientific illustration with several intermediate solutions: diagrammatic and habitus drawings.

Diagrammatic, structural line or contour line drawings are symbols of ideas visualized by imagery instead of by linguistic or algebraic means. Diagrammatic drawings explain the genital structure by outlining its parts and their relationships by using lines. A single line creating an outline of an object can show the length, height, width and even details of what is being studied. The word contour refers to an outline of the genital substructures. Traditionally, it presents only their exterior edges. A plain contour is one line that is connected with no shading, emphasizing the shell of the object. Of course line drawing does not capture all of the information of the genitalia, instead it usually only captures either the interior or the exterior contours. Diagrammatic drawings are reasoning by means of simple visual representations and are about the understanding of concepts and ideas: how the researcher understands the structure and function of a species. The idea or concept is visualized with the use of clear-cut drafting, plan, sketch, line-drawing, or outline-drawing. Diagrammatic drawings are designed to demonstrate or explain how genital structure works or to clarify the relationship between the parts of the entire genitalia. The Occam's razor of lex parsimoniae, the principle of parsimony is behind the diagrammatic type of drawings.

Habitus drawings are similar to photos. They could be more precise and exact. They are more descriptive, more detailed, more artistic. However they are less about simple visualization of functional ideas and concepts: how a researcher's understanding helps in simple presentation. Simple structural and functional imagery is frequently masked by detailed surface sculptures or by various setal densities. Connections, interactions and articulations between the periphallic organs is usually not indicated. Habitus drawings are usually preferred by scientists having more artistic ability and practice to elaborate shading by stipple, parallel lines of various spacing.

Preparation of drawings

The plane of view is never perfect and we made no special procedures of grid, matrix or reflection to produce absolute mirror symmetry when illustrating the hydroptilids. Instead, the genital structures were drawn exactly as seen in the microscope. On the drawings, setae were represented only by their alveoli, and their density is only symbolic. If essential, the setae length or setae shape are presented by drawing single or few setae only. The genital structure was traced by pencil on white paper using a drawing tube mounted on a WILD M3Z microscope at 260–416x magnification. Drawings were usually prepared in lateral, dorsal and ventral view. The lateral view is the most complete, comprising the pregenital segments VII-VIII, genital segment IX, postgenital segment X, and the entire set of periphallic organs: cerci, paraprocts, gonopods and the basal palate of the gonopods. The final illustrations were prepared by enlarging the original pencil drawings and re-drawn on transparent paper by Black India Ink.

In our diagrammatic drawings we use different linetypes with various thickness applying standard metric lines of 0.18, 0.35 and 0.70 mm (Rotring, Isograph). Thickness of contour lines represents the visibility of structures depending highly on their sclerotization. To suggest that something is less sclerotized, membranous or weakly visible we apply thinner lines as well as thicker lines for heavily sclerotized structures. Dotted lines are used to contour structure under cover of other structures and to outline segments VII and VIII. The special structural modifications developed on segments VII and VIII, like dentate patches, special processes or spiny outgrowths are emphasized by drawing with continuous lines. Dotted segment VIII with continuous drawn lines of its special structures were frequently slightly or entirely shifted in order not to overlap with segment IX and its periphallic organs. When straight, curved or crooked lines meet or intersect, they form corners and angles, in order to symbolise at least minimal signs of three-dimensional space we apply microcarving for these meeting points, that is usually not applied in diagrammatic drawings.

Nomenclature applied

The terminology applied to grooves, setal warts and genital structures follows that of by Oláh & Johanson (2007, 2008). The following terminologies 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.

In hydroptilids all the basic periphallic structures, together with genital segment IX and postgenital segment X of the genital groundplan are present. Cerci are seldom observed in Hydroptilidae. Segment X frequently obscure and difficult to visualize. Usually located apicad of segment IX and dorsad of phallic organ, frequently fused with segment IX. Less sclerotized, sometimes membranous, especially on cleared specimens difficult to discern its exact shape and boundaries. At higher magnification its surface microsculpture seldom glabrous, frequently coriaceous covered with microtrichia or tomentose, sometimes granulate, foveolate, punctulated often canaliculated, striated longitudinally or transversally, rugulose and narrow folded. The periphallic structures of paraproct, gonopods and basal plate of gonopods are frequently vestigial or strongly modified and were commonly present under various names in literature. The terminology systems by various authors are listed below.

Paraproct. Ventral part of segment X in *Oxyethira* spp. (Ross 1944), according to Kelley (1984) surprising for segment X to be present ventrad of phallus. Process above claspers at *Stactobiella palmata* (Ross 1944). Apophyses supérieure (Vaillant 1951). Semiannular sclerite with two spine-like asymmetric processes (Nielsen 1957). Appendices supérieure (Schmid 1959, 1983). Ventral plate of segment X when fused (Marshall 1979). Parameres at *Orthotrichia* (Wells 1979). Aedeagal sheath at *Paroxyethira* (Kelley 1989). Pair of spines arising basoventrally on segment X at *Hellyethira davidi* (Wells 2005). Subgenital appendages (Marshall 1979). Intermediate appendages (Marshall 1979). Lateral penis-sheets (Marshall 1979). Parameres when paired (Marshall 1979). Subgenital plate (Marshall 1979). Lower penis cover (Marshall 1979).

Gonopods. Inferior appendages (McLachlan 1874–1880). Claspers (Ross 1938). Apophyses inférieure (Vaillant 1951). Appendices inférieure (Schmid 1959, 1983).

Basal plate of gonopods. Bracteole (Ross 1948). Subgenital plate at *Orthotrichia cristata* (Flint 1968). Bilobed process (Marshall 1979). Dorsal process of the inferior appendages (Wells 1979, Malicky & Chantaramongkol 2007).

Depositories and abbreviations. Clemson University Arthropod Collection (CUAC). Institute of Biology and Soil Science, Russian Academy of Sciences, Vladivostok, (IBSS RAS). Natural History Museum and Institute of CHIBA, Japan (CMB-ZI). Nanjing Agricultural University (NAU). Oláh Private Collection (OPC), under national protection by the Hungarian Natural History Museum. Ito Private Collection (IPC)

TAXONOMY

Genus *Oxyethira* Eaton, 1873

Diagnosis. Segment IX completely retracted within segment VIII, venter IX pointed or rounded anteriorly, not truncate or excised mesally, caudal end of venter IX indistinct, fused with gonopods. Based upon a selection of 15 plesiomorphic and apomorphic character states (Oláh & Johanson 2011), the genus *Oxyethira* is defined in the tribe Hydroptilini as having (1) 3 ocelli present. (2) Tentorium vestigial. It means that anterior tentorial pits present with the basal third of anterior tentorial arms and the posterior two third of this arms disappeared; tentorial bridge forming a closed loop together with the posterior tentorial arms. (3) Length of first and second segments of maxillary palp shorter than wide. (4) Number of antennal segments 24–47. (5) Terminal antennal segment with blunt apex. (6) Clothing antennal setae whorled fimbriate. (7) Scapus unmodified. (8) Mesoscutellum subtriangular with convex anterior margin. (9) Mesoscutellum without transversal suture. (10) Metascutellum convexly subtriangular. (11) Spur count 034. (12) Abdominal segments unmodified. (13) Dorsolateral lobes on segment IX present. (14) Segment IX semicylindrical. (15) Segment X indistinct. (16) Cerci absent. (17) Paraproct highly modified. (18) Harpagones absent.

Subgenus *Oxyethira* Eaton, 1873

Diagnosis. The subgenus *Oxyethira* is the largest subgenus within genus *Oxyethira* and is distributed in the Holarctic and Oriental regions. Segment VIII with long ventral and short dorsal excision, pleuron often with blunt lateral processes and spines. Dorsum IX often with anterolateral lobes and/or posterolateral rounded processes. Gonopods fused basad. Spiralling paramere present.

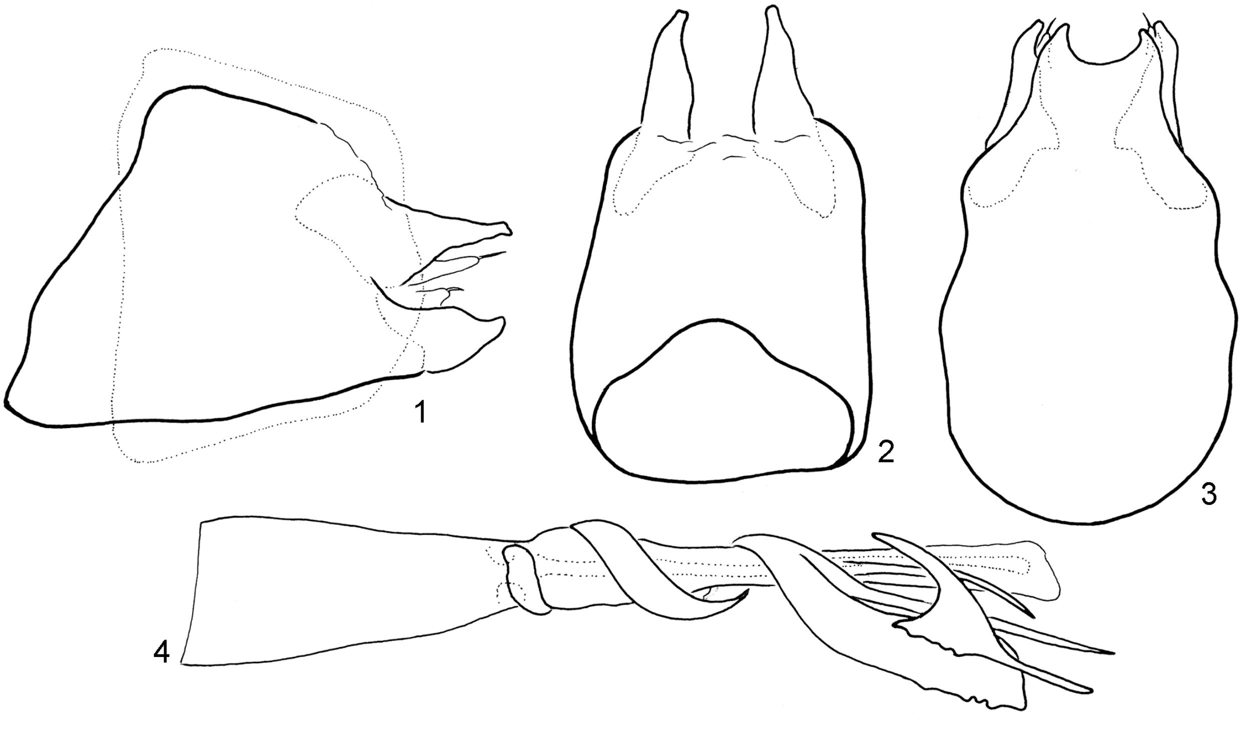
Oxyethira flavicornis species group Kelley, 1984

Diagnosis. The *flavicornis* group of the subgenus *Oxyethira* has evolved a paramere forming flattened band, that is split into two strands. One strand is usually filiform, the other strand is more robust and complex. Dorsum IX without anterolateral and posterolateral processes. Aedeagus lacking distal processes. Distributed in the Palearctic and Oriental regions, species mentioned, but not documented from Alaska and USA (Kelley 1985).

The formation of the parameres is the most reliable character to separate closely related species. The complex strand or arm of the split paramere is very diverse and species specific. This is a direct indication of the intense processes of the sexual selection (Oláh *et al.* 2012). In this species group we have separated five new species clusters: *O. datra, O. ecornuta, O. flavicornis, O. hiroshima, O. tiunovae*.

Oxyethira datra new species cluster

Diagnosis. This species cluster is distinguished by the following combination of characters: simple apical margin of segment VIII without produced lobes or processes; simple pair of paraprocts straight in lateral view with capitate or malleolate apex; deep mesal excision on the fused gonopod; very complex paramere with anterad turning spine. Four species belong to this group: *O. datra* Oláh, 1989; *O. josifovi* Kumanski, 1990; *O. kakida* sp. nov.; *O. sichuanensis* Yang & Kelley, 1997.



Figures 1–4. *Oxyethira datra* Oláh, 1989, male holotype. 1 = genitalia in left lateral view, 2 = genitalia in dorsal view, 3 = genitalia in ventral view, 4 = phallic organ in left lateral view.

Oxyethira datra Oláh, 1989

(Figures 1–4)

Oxyethira datra Oláh, 1989: 287–288, male, Vietnam.

Material examined. Holotype. Vietnam, Cuc Phuong, 400 m, 17.X.1986, light, leg. J. Oláh (1 male, OPC). Holotype is in a rather disintegrated condition. Right forewing and hindwing are mounted in dry preparation under glass cover; rest is in alcohol: body without right wings and abdomen is in separate glass vial; abdomen without phallic organ is in separate glass vial. Dissected phallic organ was lost during redrawing procedure!

Remarks. The Holotype was redrawn. The slightly capitate, malleolate and truncate apex of paraproct is similar to *Oxyethira josifovi*, gonopod less deeply excised in ventral view and the paramere is easily distinguishable by its triple coiling or spiralling and by the fine structure of the complex strand.

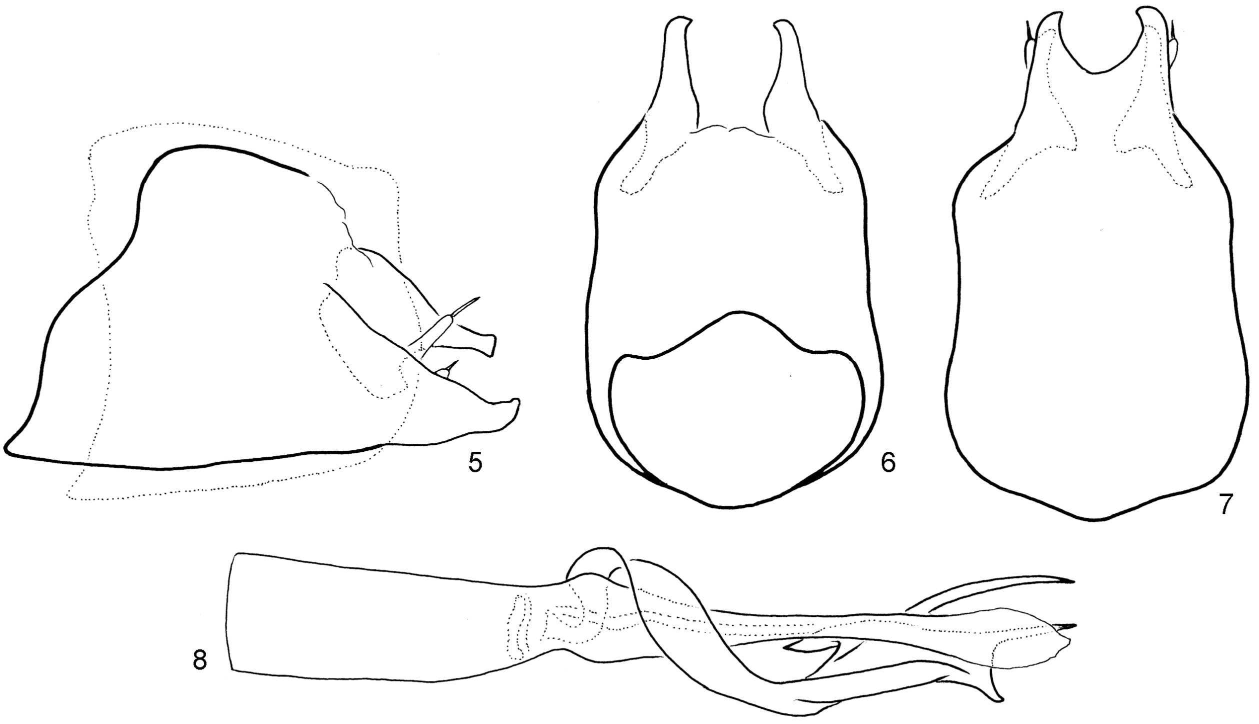
Oxyethira josifovi Kumanski, 1990

(Figures 5–8)

Oxyethira josifovi Kumanski, 1990: 57–59, male, female, Korea.

Material examined. Holotype. Korea, 25 km E of Vonsan, 1–3 km from the sea, near Casan village, stream and small torrents of the plain, 6.X.1978, leg. K. kumanski. According to Y. Vidinova and S. Beshkov (Zoological Institute, Bulgarian Academy of Sciences, Sofia, Bulgaria) all the holotypes in the Kumanski's collection in the Zoological Institute, Sofia is well preserved, however the holotype of *Oxyethira josifovi*, the single specimen of this species is lost, probably during a loaning procedure.

Remarks. Paraproct is similar to *Oxyethira datra*, gonopod more deeply excised and the paramere is easily distinguishable by its single coiling or spiralling and by the fine structure of the complex strand.



Figures 5–8. *Oxyethira josifovi* Kumanski, 1990, male holotype (adapted from original illustration). 5= genitalia in left lateral view, 6 = genitalia in dorsal view, 7 = genitalia in ventral view, 8 = phallic organ in left lateral view.

Oxyethira kakida sp. nov.

(Figures 9–12)

Oxyethira josifovi Nozaki & Tanida, 2007: 246, Honshu (Shizuoka). Misidentification.

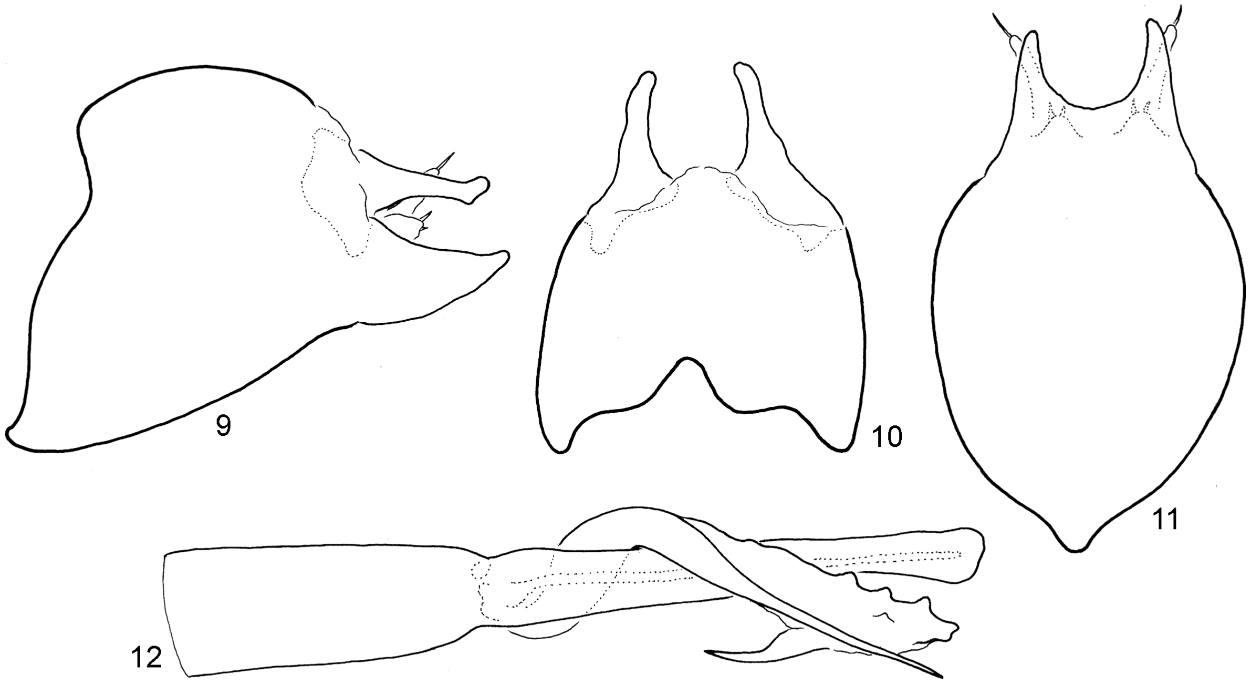
Oxyethira datra Malicky & Chantaramongkol, 2007: 1030, Hokkaido (Chitose). Misidentification.

Diagnosis. This new species belongs to *O. datra* species cluster and has periphallic organs of paraproct, gonopods and basal plate of gonopods similar to *O. sichuanensis* Yang & Kelley, 1997 described from China (Sichuan), but differs by having antennal segment 41, not 47; excision on gonopod rounded, not triangular; the complex strand of the paramere with blunt apex, not spine-like; the anterad directed spine on this strand more axial, not right-angled.

Material examined. Holotype. Japan, Honshu, Shizuoka, Shimizu-cho, Kakida-gawa, N35°06’ 11”, E138°54’10”, 13 m, 11–15.V.2002, Malaise trap, leg T. Nozaki (1 male, CMB-ZI 146972).

Paratypes. Data same as of holotype (4 males, 5 associated females; CMB-ZI 146973–146981). Honshu, Tokyo, Fussa-shi, Fussa, Nagata-bashi, N 33°44’46”, E 139°18’39”, 3.VIII.2011, leg. T. Nozaki & T. Kagaya (1 male, 1 female; CMB-ZI 146982-146983). Honshu, Yamagata, Kaneyama-machi, Kanayama-gawa, 11.X.1999, leg. A. Ohkawa (5 males, 5 females; OPC). Hokkaido, Ishikari, Chitose-shi, Bibi, Lake Chitose-ko, 8. VII.2001, light trap, leg. T. Ito & A. Ohkawa (1 male; OPC).

Other specimens. Honshu, Yamagata, Kaneyama-machi, Kanayama-gawa, Araya-bashi, 14. X.1999, leg. A. Ohkawa (3 males, 5 females; IPC). Hokkaido, Ishikari, Chitose-shi, Bibi, Bibigawa River, Bibi-bashi, light trap, 24.IX. 1999, leg T. Ito (3 males; IPC). Hokkaido, Kushiro-shi, Akan-cho, Ibeshibetsu-gawa, middle area, 13.IX.1999, light trap, leg. T. Ito (2 males, 3 females; IPC). Hokkaido, Kushiro-shi, Akan-cho, Akan-kohan, Ibeshibetsu, 27.VII.2012, light trap, leg. T. Ito (1 male, 1 female; IPC). Hokkaido, Shibetsu-cho, Ichani-gawa, Chishine-bashi, light, 21.VII.1996, leg. T. Ito & A. Ohkawa (2 males, 1 female; IPC). Hokkaido, Obihiro-shi, Izumi-cho, Tobetsu-gawa, Izumi-bashi, 11.VI.1997, leg. A. Ohkawa (1 male; IPC). Hokkaido, Shibecha-cho, Kayanuma, Shirarutoroetoro-gawa, Tomi-bashi, 4.IX.2008, leg. T. Ito (1 male; IPC).



Figures 9–12. *Oxyethira kakida* sp. nov. male holotype. 9 = genitalia in left lateral view, 10 = genitalia in dorsal view, 11 = genitalia in ventral view,12 = phallic organ in left lateral view.

Description. Male (in alcohol). Light brown. Forewing length 2.3 mm. 3 ocelli present. Antennal segments 37–42; terminal segment blunt; clothing antennal setae whorled fimbriate. Spur count 034. Segment VII annular with short ventromesal process. Segment VIII annular; less excised dorsoapicad and more ventroapicad.

Male genitalia. Segment IX completely enclosed within VIII; ventrum longer than dorsum, ovoid in ventral view with small triangle anteromesad. Segment X reduced to short membranous lobe. Pair of paraproct almost straight in lateral view with capiate malleolate apex. Gonopods fused basad to the ventrum IX deeply and roundly excised and produced into lateral narrow lobes. Basal plate of gonopods forming long bilobed process and short setose lobes. Phallic organ with paramere encircling shaft once and split into a filiform and into a more complex arm; the complex arm serrated and armed with an anterad directed, almost axial spine.

Etymology. The name *kakida* is a noon in apposition, coined from the name of the holotype locality.

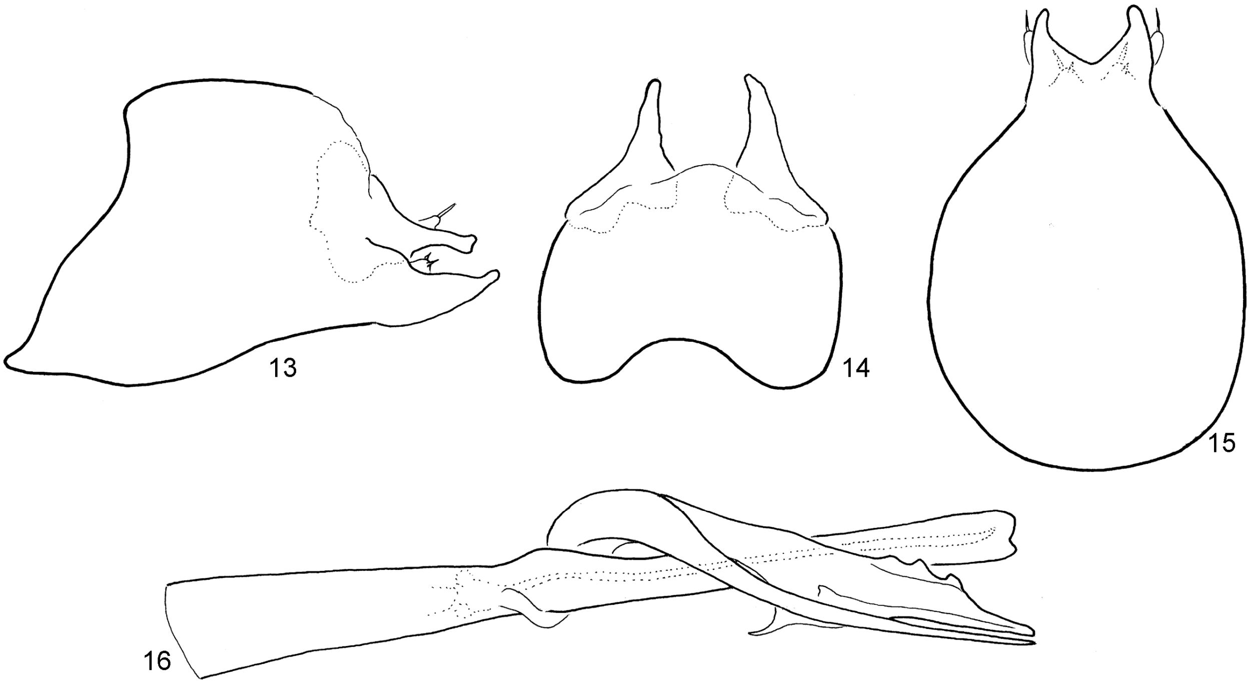
Oxyethira sichuanensis Yang & Kelley, 1997

(Figures 13–16)

Oxyethira sichuanensis Yang, Kelley & Morse, 1997: 92–95, male, China (Sichuan).

Material examined. Paratype. China, Sichuan Province, Nanpingxian, Jiouzhaigou, Shuzhengqunhai, 2250 m, 26.VI.1990, leg. J. C. Morse (deposited in CUAC).

Remarks. In lateral view we have found the dorsal margin of the complex strand of the paramere serrated, not simple as it is indicated on the holotype drawings. Moreover there is a longitudinal ridge running along and ending in a tooth on the middle of the strand.



Figures 13–16. *Oxyethira sichuanensis* Yang & Kelley, 1997, male. 13 = genitalia in left lateral view, 14 = genitalia in dorsal view, 15 = genitalia in ventral view, 16 = phallic organ in left lateral view.

Oxyethira ecornuta **new species cluster**

Diagnosis. This small species cluster is distinguished by the following combination of characters: simple apical margin of segment VIII without produced lobes or processes; simple pair of robust and broad-based paraprocts; wide and shallow mesal excision on the fused gonopod; simple trifid paramere. Two species belong to this species cluster: *O. acuta* Kobayashi, 1977 and *O. ecornuta* Morton, 1893.

Oxyethira acuta **Kobayashi, 1977**

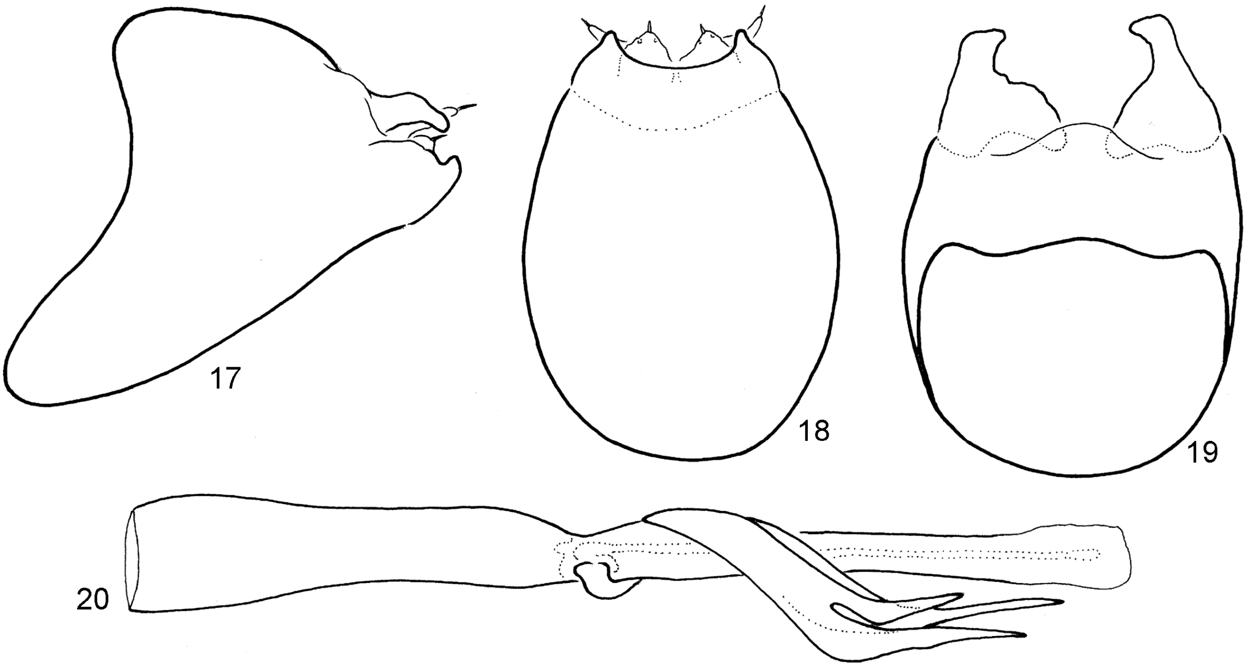
(Figures 17–20)

Oxyethira acuta Kobayashi, 1977: 6–7, pls. 5–6, male, female, Hokkaido (Iburi); Ito & Kawamula 1984: 313–317, pupa, larva, case, life cycle, Hokkaido (Iburi); Ito 2005: 442, 444, larva, case.

Material examined. Holotype. Japan, Lake Utonai-ko, Utonai, Tomakomai-shi, Hokkaido, 17.VIII.1976, leg T. ITO (M.5120, deposited in the form of glass slide specimen CMB-ZI).

Other specimens. Hokkaido, Iburi, Tomakamai-shi, Lake Utonai-ko, 22.VII.2004, leg. T. Ito (10 males, 5 females; OPC). Hokkaido, Iburi, Tomakamai-shi, Bibigawa River, Uenaebashi Bridge, 5.VIII.2010, leg. T. Ito (5 males, 5 females; IPC). Hokkaido, Kushiro, Kushiro-shi, Akan-cho, Lake Akan-panke-to, 14.IX.1999, sweep, leg. T. Ito (5 males, 5 females; IPC). Hokkaido, Kushiro, Shibecha-cho, Lake Shirarutoro-ko, 25.VII.2008, light, leg. T. Ito (3 males, 3 females; IPC). Hokkaido, Ishikari, Sapporo-shi, Nopporo-shinrin-koen Park, 14.VII.2004, light, leg. Y. Nagayasu & T. Ito (10 males, 10 females; IPC).

Remarks. We have examined the holotype embedded in a permanent glass slide. The preparation is in good condition, permitting clear dorsoventral view of the gonopod and paraproct. The fused gonopod and paraprocts on the holotype preparation is identical to the animals collected from the locus typicus. These specimens were used for examination and for producing detailed drawings with lateral view. The examined genital structure clearly relates this species to the *Oxyethira flavicornis* species group and to the *Oxyethira ecornuta* species cluster.



Figures 17–20. *Oxyethira acuta* Kobayashi, 1977, male. 17 = genitalia in left lateral view, 18 = genitalia in dorsal view, 19 = genitalia in ventral view, 20 = phallic organ in left lateral view.

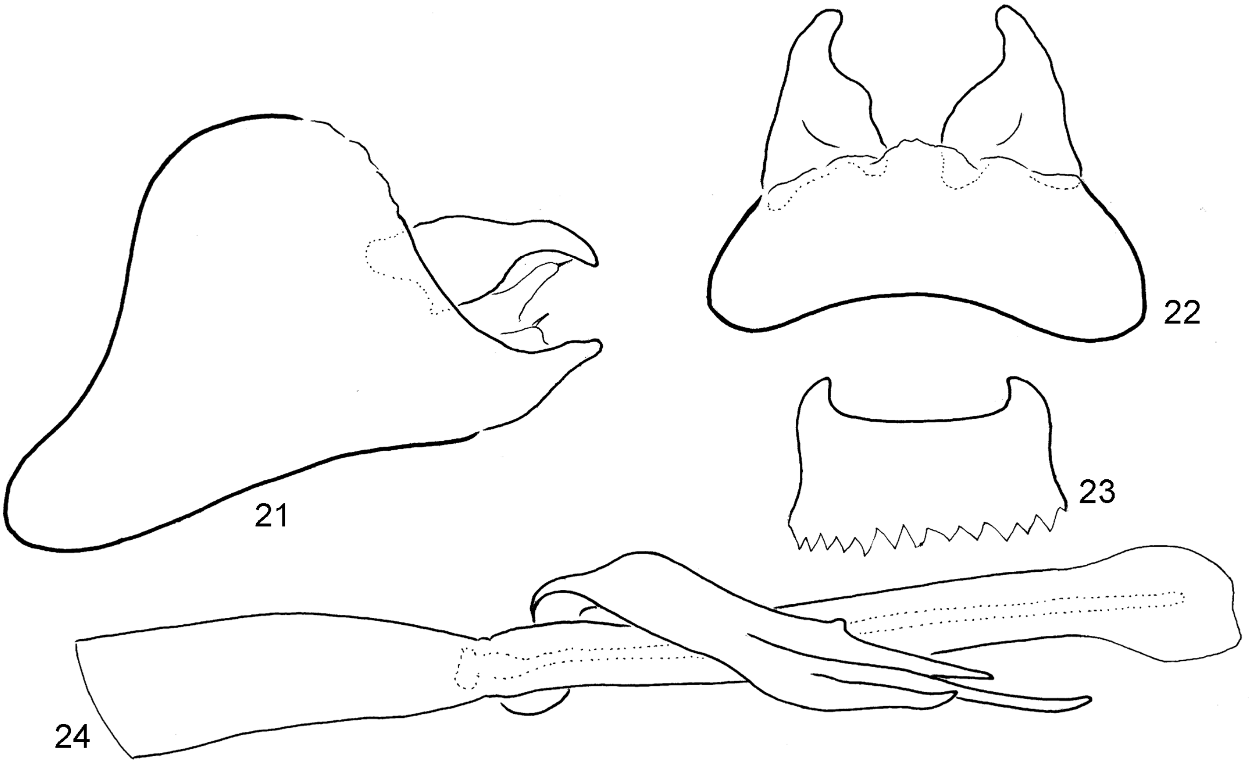
Oxyethira ecornuta Morton, 1893

(Figures 21–24)

Oxyethira ecornuta Morton, 1893: 79–80, male, female, Finland. Botosaneanu & Levanidova 1988: 174–175, male, Russian Far East (South Primorye).

Material examined. Finland. We have examined the type material deposited in the Zoological Museum, Helsinki, Finland. There is only a single male complete specimen with abdomen remained from the three syntypes described by Morton (1893). First syntype is lost. Second syntype is a pinned animal, its abdomen is lost. Documentation. *White label*: Teisko; *White label*: J. Sahlb.; *White label*: 42; *White label, handwriting*: *Oxyethira ecornuta* n. sp.; *White label with black margin*: Mus. Zool. H:fors Spec. typ. No 6531 handwriting: *Oxyethira ecornuta* Mort; *Orange label*: Mus. Zool. Helsinki Loan No. M912; *White label with black margin*: *Oxyethira ecornuta* Morton det. R. W. Kelley 1982. Third Syntype is complete and here is designated as *Lectotype*. It is represented by 2 embedded preparations; first preparation: the intact animal without genital segments; second preparation: the genital segments in dorsoventral plane. Documentation: *White label*: Teisko; *White label*: J. Sahlb.; *White label*: 42; *White label, handwriting*: *Oxyethira ecornuta* n. sp.

New collection from Finland. Kb: Tuupovaara, Ollola, WGS84, N62.3832 °,E30.7826 °, 15.V–15.VI.2008, leg. A. Rinne (1 male; OPC). *Russia*. Far East, Primorye, Khanka Lake, 23.VII.1997, leg. T. S. Vshivkova (1 male, 1 female; OPC; 1 male, 2 females; IPC). *Sweden*. Am Herkepelejaure, Srasse Jokkmokk-Messaure Norbotten, Lappland, 7.VII.1966 leg. W. Tobias (4 males, ex Coll. W. Tobias; OPC).



Figures 21–24. *Oxyethira ecornuta* Morton, 1893, male. 21 = genitalia in left lateral view, 22 = genitalia in dorsal view, 23 = gonopods in ventral view; 24 = phallic organ in left lateral view.

Remarks. In the permanent preparation of the lectotype the cleared genital segments embedded in slightly (10°) leftlateral dorsoventral plane. The preparation is in good condition permitting clear dorsoventral view of the gonopod and paraproct. The slight, 10° torsion in view produces an unclear view of the phallic organ. It is however discernible that the paramere split into filiform and complex strands. The complex strand seems simply bifid on its apical third at least as visible in specimens collected newly in Finland and Sweden not far from the locus typicus. Drawings in lateral view were prepared from newly collected specimens. These drawings well correspond with the holotype. We have examined specimens from Russian Far East and found it identical with the holotype and with the newly collected Scandinavian specimens.

Oxyethira flavicornis new species cluster

The name-bearing species of the *Oxyethira flavicornis* species group stands alone by the following combination of characters: segment VIII with ventroapical and dorsoapical processes; simple paraprocts; small rounded mesal excision on gonopods; simple bifid paramere.

Oxyethira flavicornis (Pictet, 1934)

(Figures 25–28)

Hydroptila flavicornis Pictet, 1834: 225.

Oxyethira flavicornis (Pictet, 1834), possible senior synonym of *Oxyethira costalis* Eaton 1873 nec Curtis, 1834 (Neboiss 1963: 594–595).

Hydroptila costalis Curtis, 1834 sensu Eaton 1873, type species of the genus *Oxyethira* by original designation (Neboiss 1963: 594–595).

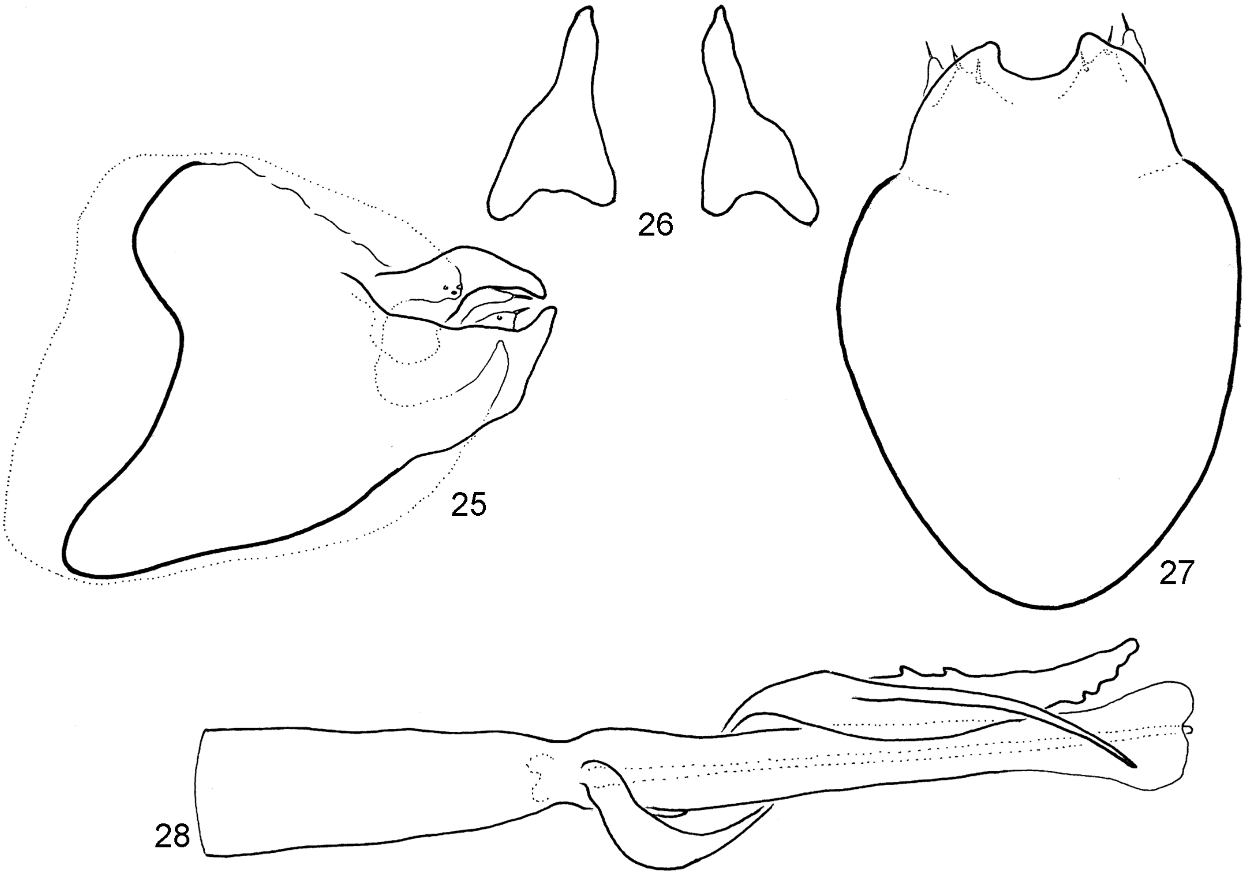
Oxyethira costalis Eaton 1873: 144–145, nec Curtis, 1834, Eaton's description and figures are not those of Curtis species *costalis*. *Oxyethira costalis* Eaton nec Curtis was renamed with some doubt by the first available synonym: *Hydroptila flavicornis* Pictet (Neboiss, 1963: 594–595).

Material examined. Austria, Lunz am See, light, leg. H. Malicky (92 males, 64 females; presented by H. Malicky, OPC). *Finland*, Ta: Valkeakoski, Saarioisjarvi, WGS84, N61.160° E24.022°, 5.VI.2012, leg. J. Salokannel (3 males, 7 females; OPC). Ta: Nokia, Pitkaniemi, WGS84, N61.4827° E23.5897°, 5.VIII.2012, leg. J. Salokannel (4 males; OPC). *Hungary*, Csobánka, 12. V.1976, leg. H. Steinmann, (1 male; OPC). Gyékényes, Lankóci erdő, 29.IV.2001, light, leg. Á. Uherkovich (10 males, 92 females; OPC). River Batár at Magosliget, 20.VII.2010, light, leg. J. Oláh (1 female; OPC). *Norway*, Finnmark, Kautokeino, Lahpoluoppal, ved innsjo, N69.20992° E23.757661° 320 m, 25.VI–9.VII.2010, Malaise trap, leg. Finnmarks Prosjektet (4 males, present by T. Andersen, Bergen Museum; OPC). *Sweden*, SÖ, Botkyrka km., Salem k:a, bank at Bornsjön, 4.VII.2003, light trap, leg. K. A. Johanson (1 male, present by K. A. Johanson; OPC). SÖ, Södertalje, Lake Uttran, at SW shore, 17.VI.2009, light trap, leg. K. A. Johanson (1 male, 3 females; present by K. A. Johanson; OPC). UP, Lövstabruk, 20-23.VIII.1992, Malaise trap, leg. Hippa & Gufstansson (1 male; 2 females; present by K. A. Johanson; OPC). UP, Nesodden, Frangerstrand, 10-11.VIII.1997, light trap, leg. S. Kobro (1 male; present by K. A. Johanson; OPC).

Remarks. Routine examination of the paramere of this widely distributed species produced excellent drawings, but without clear indication of the split bifid state of the flat paramere (Kimmins 1958). Kelley (1985) has redrawn the phallic organ with bifid paramere, however both strands look filiform. We have examined several specimens from Austria, Finland, Hungary, Norway and Sweden and have detected the split bifid paramere with filiform and complex strands. The flat and broad complex strand has two teeth on the dorsum middle and 2–3 teeth on the ventrum subapicad.

Oxyethira hiroshima new species cluster

Diagnosis. Several apomorphic and plesiomorphic characters distinguish this species cluster having the following combination of characters: development of ventroapical processes on segment VIII; presence of the produced ventroapical mesal region on the segment IX; very complex paraproct; simple bifid paramere.



Figures 25–28. *Oxyethira flavicornis* (Pictet, 1934), male. 25 = genitalia in left lateral view, 26 = paraproct in dorsal view, 27 = genitalia in ventral view, 28 = phallic organ in left lateral view.

Oxyethira hiroshima sp. nov.

(Figures 29–33)

Diagnosis. Having the ventroapical lateral corner of segment VIII and the ventroapical mesal region of segment IX produced, as well as very complex paraproct this new species is similar to *O. mekunna* sp. nov., but differs by the ventroapical lateral corner produced into a long stout process with spiny head, not into a short truncate process without spiny head; the ventroapical mesal region of segment IX produced into short blunt outgrowth, not into a long slender process; paraproctal complex more complicated; paramere simply split into two strands, not trifid.

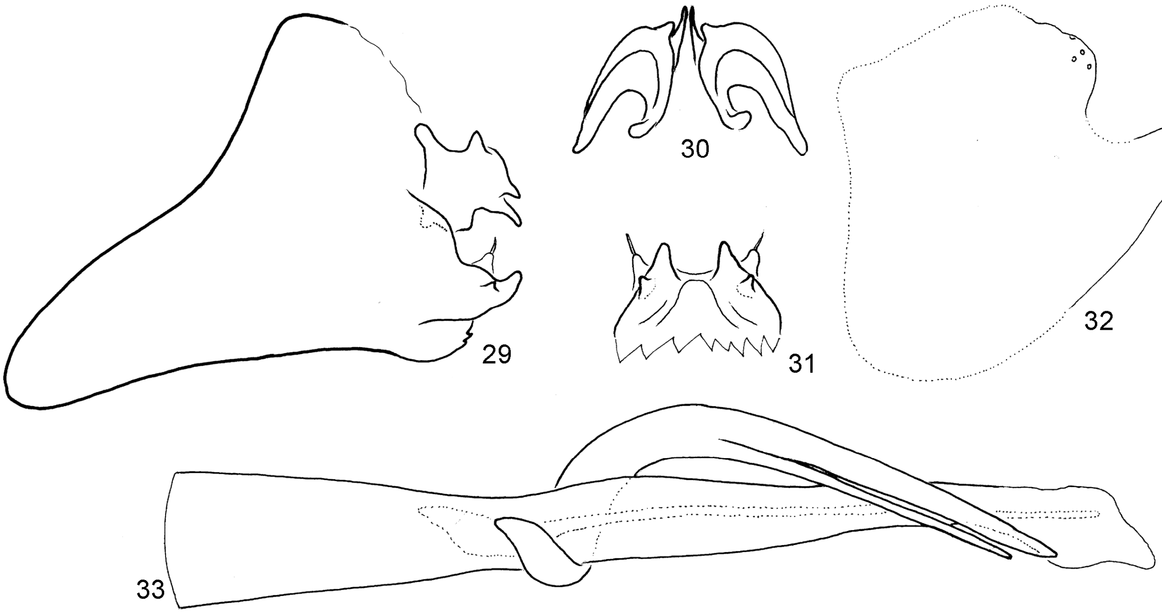
Material examined. Holotype. Japan, Honshu, Hiroshima, Hatsukaichi-shi, Yoshiwa, Hosomi-dani, N34° 33’01”, E132°06’44”, 820 m, 11.V–7.VI.2005, Malaise trap, leg. I. Mori (1 male; CMB-ZI 146984).

Other specimen. Honshu, Hiroshima, Hatsukaichi-shi, Yoshiwa, Hosomi-dani, N34°33’01”, E132°06’44”, 820 m, 9.X.2004-11.V.2005, Malaise trap, leg. I. Mori (1 male; IPC).

Description. Male (in alcohol). Light brown. Forewing length 3.1 mm. 3 ocelli present. Antennal segments 31; terminal segment blunt; clothing antennal setae whorled fimbriate. Spur count 034. Segment VII annular with short ventromesal process. Segment VIII annular; less excised dorsoapicad and more ventroapicad; dorsoapical lobes short rounded, ventroapical lateral processes long with spiny apex.

Male genitalia. Segment IX completely enclosed within VIII; ventrum long and rounded ovoid in ventral view; dorsum short. Segment X reduced to short membranous lobe. Pair of paraproct very complex both in dorsal and lateral view, mesad almost touching. Gonopods heavily sclerotized pair of elongated triangle with short lateral tooth, fused together mesobasad as well as to ventrum IX; ventrum IX produced into a mesal hump. Basal plate of gonopods forming long bilobed process and short setose lobes. Phallic organ with paramere encircling shaft once and split into a filiform and into a more robust straight arm.

Etymology – The name *hiroshima* is a noon in apposition coined from the name of the holotype locality.



Figures 29–33. *Oxyethira hiroshima* sp. nov. male holotype. 29 = genitalia in left lateral view, 30 = paraproct complex indorsal view, 31 = gonopods in ventral view, 32 = segment VIII in lateral view, 33 = phallic organ in left lateral view.

Oxyethira mekunna sp. nov.

(Figures 34–38)

Diagnosis. Having the ventroapical lateral corner of segment VIII and the ventroapical mesal region of segment IX produced, as well as a complex paraproct this new species is similar to *O. hiroshima* sp. nov., but differs by the ventroapical lateral corner of segment VIII produced into a short truncate process without spiny head, not into long stout process with spiny head; the ventroapical mesal region of segment IX produced into a long slender process not into short blunt outgrowth; paraproctal complex not so much complicated; paramere trifid, not simply split into two strands.

Material examined. Holotype. Japan, Hokkaido, Shiribeshi, Iwanai-cho, Mekkunai-shitsugen, marsh, N42°52'24", E140°30'17", 900 m, 1.VIII. 1998, leg. M. Ôhara *et al.* (1 male; CMB-ZI 146985).

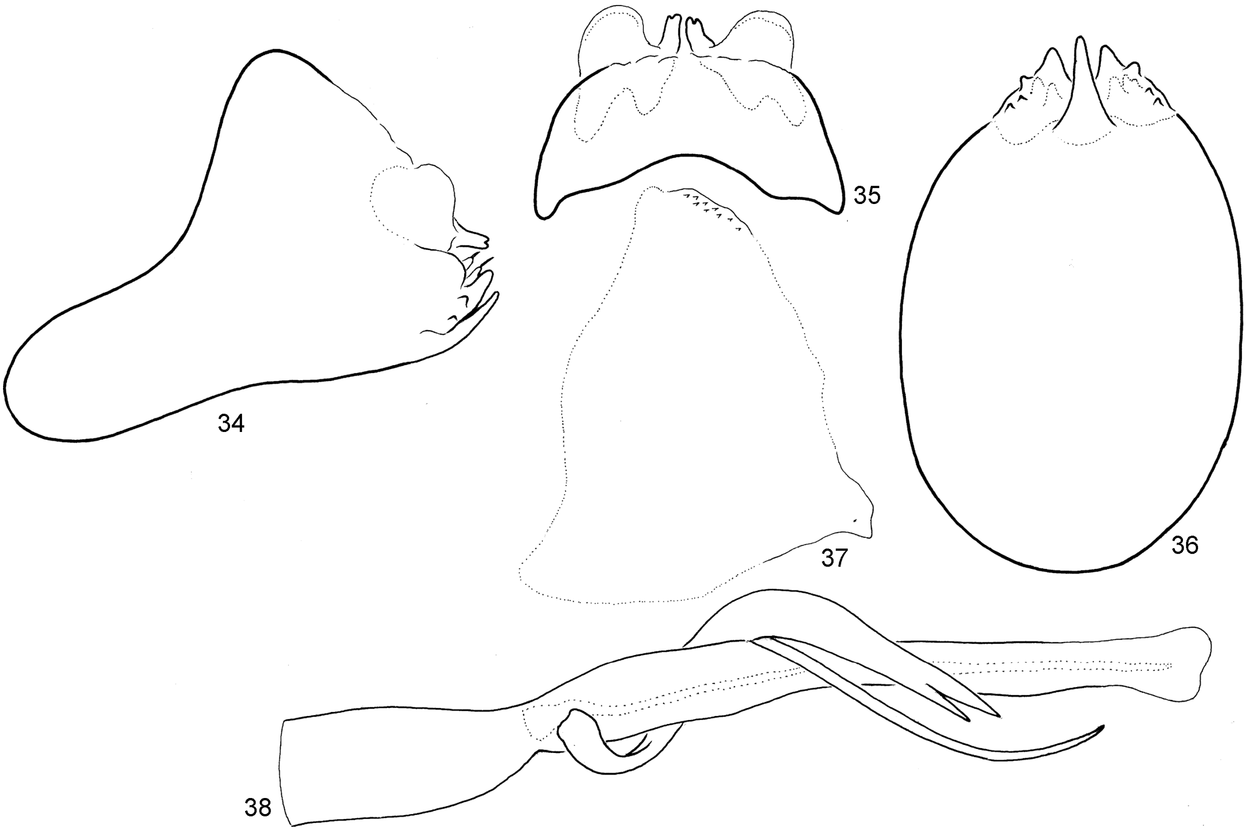
Paratypes. Locality same as of holotype (2 males, 3 females; CMB-ZI 146986-146990). Hokkaido, Shiribeshi, Iwanai-cho, Pankemekunnai-shitsugen, marsh, 13.VII.1997, leg. A. Yamamoto *et al.* (5 males, 2 females; OPC).

Other specimens. Same as of holotype (2 males, 2 females, IPC). Hokkaido, Uryu-cho, Uryu-numa, Shokambetsu, 4-6.VIII.1976, leg. T. Hattori (1 male, mounted; IPC). Hokkaido, Kamishihoro-cho, Tokachi-mitsumata, Karafuto-daio, small stream, 13.VI.1996, leg. A. Ohkawa (2 males; IPC).

Description. Male (in alcohol). Light brown. Forewing length 2.6 mm. 3 ocelli present. Antennal segments 31; terminal segment blunt; clothing antennal setae whorled fimbriate. Spur count 034. Segment VII annular with short ventromesal process. Segment VIII annular; less excised dorsoapicad and more ventroapicad; dorsoapical lobes lacking, ventroapical lateral processes short obliquely truncate.

Male genitalia. Segment IX completely enclosed within VIII; ventrum long and rounded ovoid in ventral view; dorsum short. Segment X reduced to short membranous lobe. Paraproct complex with a rounded body accompanied by mesal pair of more sclerotized digitiform processes ending in shallowly bifid apex. Gonopods heavily sclerotized pair of triangle with short lateral teeth, fused together mesobasad as well as to ventrum IX; ventrum IX produced into an apicomesal long process. Basal plate of gonopods discernible as a bilobed process. Phallic organ with paramere encircling shaft once and split into a longer filiform and into a more robust straight arm, robust arm bifid.

Etymology. The epithet *mekunna* is coined from the name of the holotype locality.



Figures 34–38. *Oxyethira mekunna* sp. nov. male holotype. 34 = genitalia in left lateral view, 35 = paraproct complex in dorsal view, 36 = genitalia in ventral view, 37 = segment VIII in lateral view, 38 = phallic organ in left lateral view.

Oxyethira tiunovae new species cluster

Diagnosis. This species cluster is distinguished by the following combination of characters: simple apical margin of segment VIII without produced lobes or processes; simple pair of slender paraprocts downward curving in lateral view; medium deep mesal excision on the fused gonopod; trifid paramere with right-angled turning spine. Three species belong to this group: *O. chitosea* sp. nov.; *O. hena* sp. nov.; *O. tiunovae* Arefina & Armitage, 2003.

Oxyethira chitosea sp. nov.

(Figures 39–42)

Diagnosis. This new species has periphallic organs of paraproct, gonopods and basal plate of gonopods similar to *O. tiunovae* described from the Ussuri River Basin and Sakhalin, but differs by having paramere differently formed.

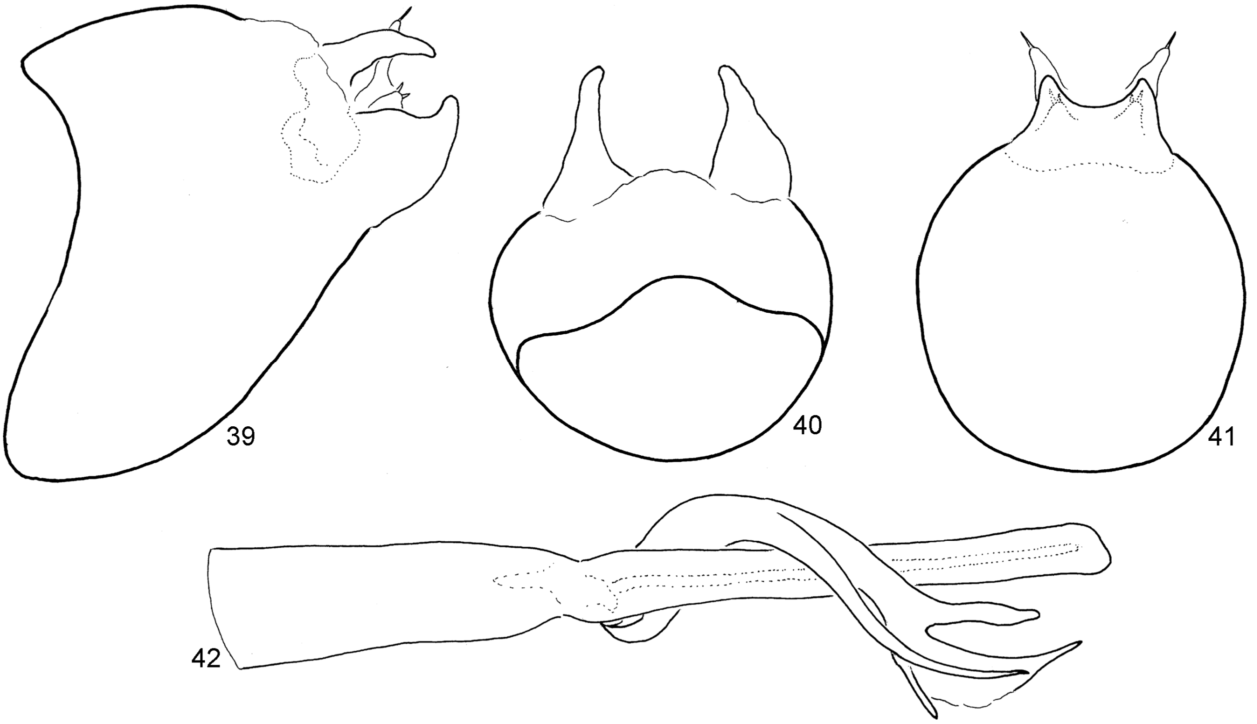
Material examined. Holotype. Japan, Hokkaido, Ishikari, Chitose-shi, Bibi, Lake Chitose-ko, N42°46’24”, E141°43’29”, 15 m, 8.VII.2001, light trap, leg. T. Ito (1 male; CMB-ZI 146991).

Paratypes. Data same as of holotype (1 male; CMB-ZI 146992; 1 male; OPC).

Other specimens. Hokkaido, Chitose-shi, Mombetsu-gawa, 240 m, 14.VII.2000, light trap, leg. T. Ito (1 male; IPC). Hokkaido, Eniwa-shi, I-chankoppe-zawa, 300 m, 10.VIII.2010, light, leg. T. Ito (1 male; IPC). Hokkaido, Kushiro-shi, Akan-cho, Ibeshibetsu-gawa, headwater, 1.VII. 1996, leg. T. Ito & A. Ohkawa (1 male, 2 females; IPC). Hokkaido, Shibecha-cho, Kayanuma, Shira-rutoroetoro-gawa, Tomi-bashi, 4.IX.2008, light trap, leg. T. Ito (1 male; IPC).

Description. Male (in alcohol). Light brown. Forewing length 2.3 mm. 3 ocelli present. Antennal segments 35; terminal segment blunt; clothing antennal setae whorled fimbriate. Spur count 034. Segment VII annular with short ventromesal process. Segment VIII annular; less excised dorsoapicad and more ventroapicad.

Male genitalia. Segment IX completely enclosed within VIII; ventrum longer than dorsum almost,



Figures 39–42. *Oxyethira chitosea* sp. nov. male holotype. 39 = genitalia in left lateral view, 40 = genitalia in dorsal view, 41 = genitalia in ventral view, 42 = phallic organ in left lateral view.

circular in ventral view. Segment X reduced to short membranous lobe. Pair of paraproct downward curving hook-shaped in lateral view. Gonopods fused basad to the ventrum IX and produced into lateral triangular lobes. Basal plate of gonopods forming long bilobed process and short setose lobes. Phallic organ with paramere encircling shaft once and split into a filiform and into a more complex arm; the complex arm split into three unequal branches as visible in ventral view.

Etymology. The epithet *chitosea* is coined from the name of the holotype locality.

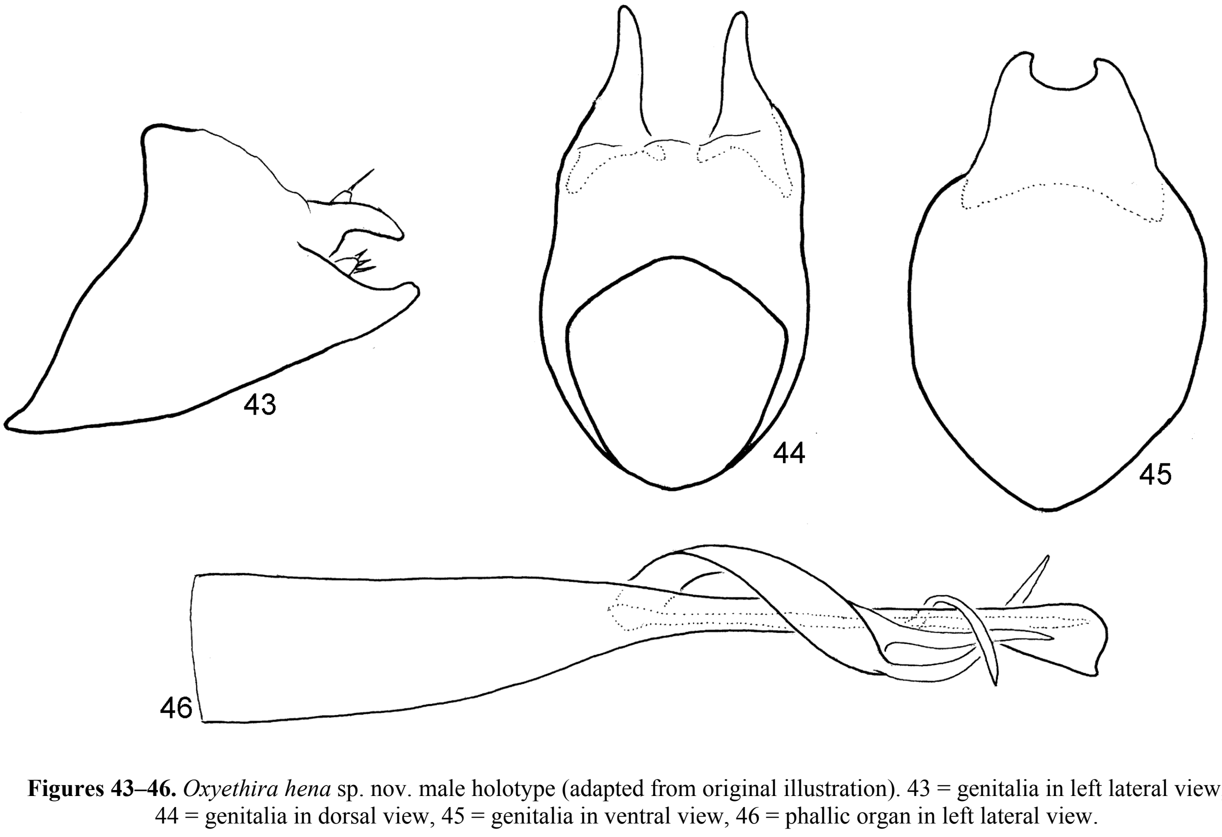
Oxyethira hena **sp. nov.**

(Figures 43–46)

Oxyethira ecornuta Xue & Yang 1991: 20–21, male, China (Henan). Misidentification.

Diagnosis. This new species was described as *O. ecornuta* from Henan Province. After examining the details of the genital structure of the *O. ecornuta* holotype as well as the newly collected specimens from nearby the locus typicus and compared them with the drawings of the Chinese specimen from Henan we concluded that this Chinese specimen is a new species. It has simple apical margin of segment VIII without produced lobes or processes; simple pair of slender paraprocts downward curving in lateral view; medium deep mesal excision on the fused gonopod; trifid paramere with right-angled turning spine. This character combination relates it to the *O. tiunovae* new species cluster, but differs from both *O. chitosea* sp. nov. and *O. tiunovae* by the different structure of the complex strand of the paramere.

Material examined. Holotype. China, Henan Province, Lin county, Qi river, N36.06°, E 113.81°, 27.VIII.1988, leg. Y. Xue. (1 male; NAU).



Figures 43–46. *Oxyethira hena* sp. nov. male holotype (adapted from original illustration). 43 = genitalia in left lateral view, 44 = genitalia in dorsal view, 45 = genitalia in ventral view, 46 = phallic organ in left lateral view.

Paratype. Guangdong Prov, Bo-luo County, Luo-fu Shan, unnamed stream, 400 m on trail to Shan-bei-shui,strailhead 3.2 km W of ridge of Cha Shan, N23.31900°, E114.01157°, 290 m, 1.VI.2004, leg. J. C. Morse, X. Zhou, J. Geraci (1 male; NAU).

Etymology. The epithet *hena* is coined from the name of the holotype locality.

Oxyethira tiunovae **Arefina & Armitage, 2003**

(Figures 47–49)

Oxyethira tiunovae Arefina & Armitage, 2003: 16–17, male, female, Russian Far East (Khabaovsk). Holotype. *Russia*, Khabarovsk Territory, Ussuri River Basin, Kiya River at Ekaterinoslavka Village, 26. VII. 1996, leg. T. I. Arefina.

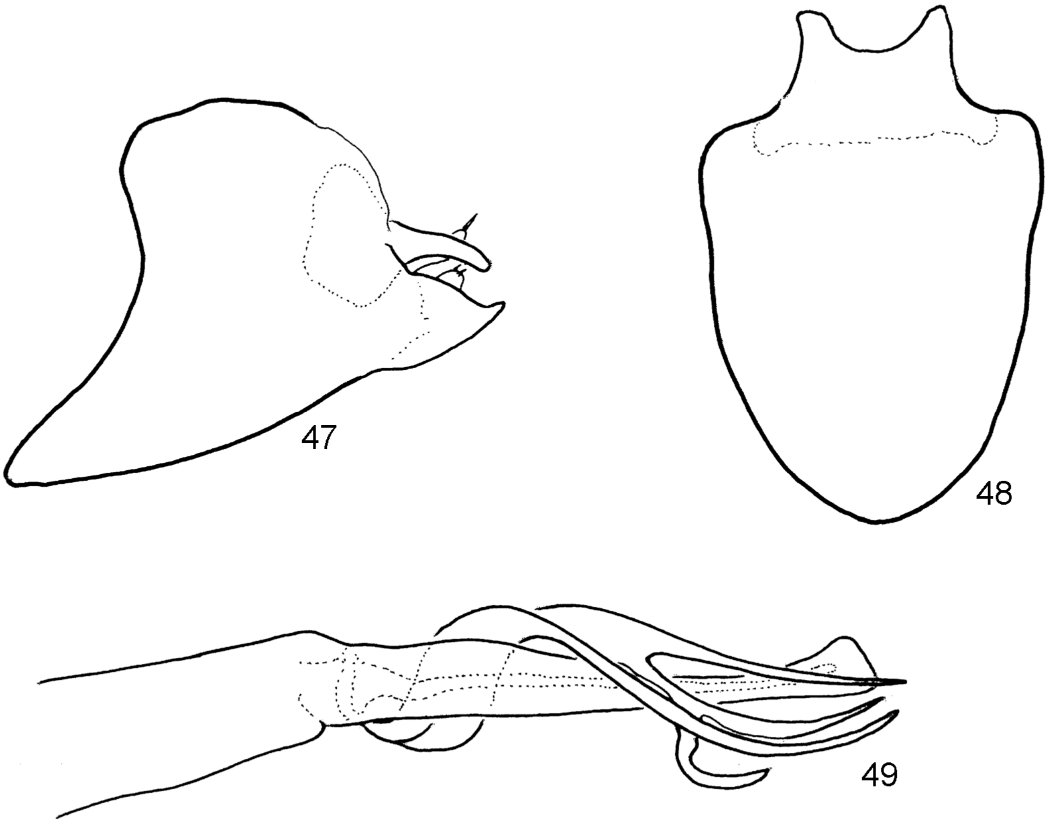
Paratypes. Same data as of holotype (IBSS RAS).

Material examined. New Collection from *Russia*, Jewish Autonomous Oblast, Khabarovsk Krai, Bidjan River (Amur River Basin), 15.VIII. 2004, leg. T. Tiunova (donated by Arefina & Armitage: 3 males, 3 females; OPC).

Remarks. There is a well developed curving spine on the complex strand of the paramere, that is straight at *O. chitosea* sp. nov. and differently formed at *O. hena* sp. nov.

Oxyethira grisea **species group Kelley, 1984**

Diagnosis. Paraproct convergent, broadly based and sharply pointed in lateral view. Aedeagus with a pair of distal sclerotized processes.



Figures 47–49. *Oxyethira tiunovae* Arefina & Armitage, 2003, male. 47 = genitalia in left lateral view; 48=genitalia in ventral view; 49=phallic organ in left lateral view.

***Oxyethira ozea* sp. nov.**

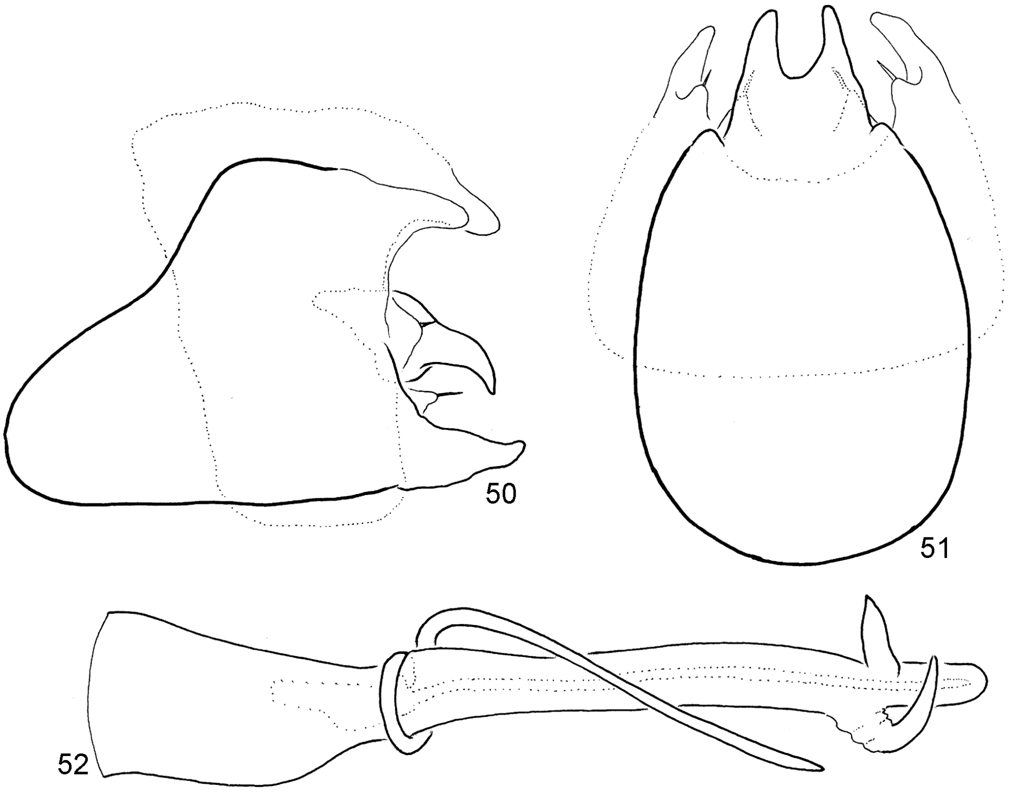
(Figures 50–52)

Diagnosis. Having two distal spines on the aedeagus this new species belongs to the *Oxyethira grisea* species group distributed in the Nearctic Region. Nybom (1983) has described *O. klingstedti* from Finland with nearest relations to species found in North America. This new Japanese species is close to *O. klingstedti*, but differs by having apical lobes on segment VIII differently formed; ventrum IX high, not low; the hook formation of paraproct in lateral view more distinct; gonopods long and tapering in ventral view; distal spine pattern on the aedeagus different.

Material examined. Holotype. Japan, Honshu, Gumma, Oze, Yamanohama, N36°55', E139° 13', 1400 m, 2.IX.1996, light, leg. T. Nozaki (1 male; CMB-ZI 146993).

Description. Male (in alcohol). Light brown. Forewing length 2.2 mm. 3 ocelli present. Antennal segments 29; terminal segment pointed conical; clothing antennal setae whorled fimbriate. Spur count 034. Segment VII annular with short ventromesal process. Segment VIII annular; round excised both dorsoapicad and ventroapicad; larger dorsoapical and smaller apicolateral setal lobes in lateral view.

Male genitalia. Segment IX completely enclosed within VIII; ventrum long and rounded ovoid in ventral view; dorsum short. Segment X reduced to short membranous lobe. Pair of paraproct hook-shaped in lateral view, mesad curving, almost with touching apices. Gonopods heavily sclerotized, fused together mesobasad as well as to ventrum IX; tapering bifid distally. Phallic organ with a pair of sclerotized spine-like structures apicad and paramere encircling shaft once at basal third.



Figures 50–52. *Oxyethira ozea* sp. nov. male, holotype. 50 = genitalia in left lateral view, 51 = genitalia in ventral view, 52 = phallic organ in left lateral view.

Etymology. The epiteth *ozea* is coined from the name of the holotype locality.

Oxyethira ramosa species group Kelley, 1984

Diagnosis. Segment VIII deeply excised ventrad, protruded apicad as blunt dorsolateral lobes or finger like processes and with mesal excision dorsad. Venter IX pointed and elongate anteriorly, dorsum IX reduced to a short band producing prominent anterodorsal lateral lobes. Posterodorsal lateral processes of segment IX rounded or pointed. Gonopods short, blunt.

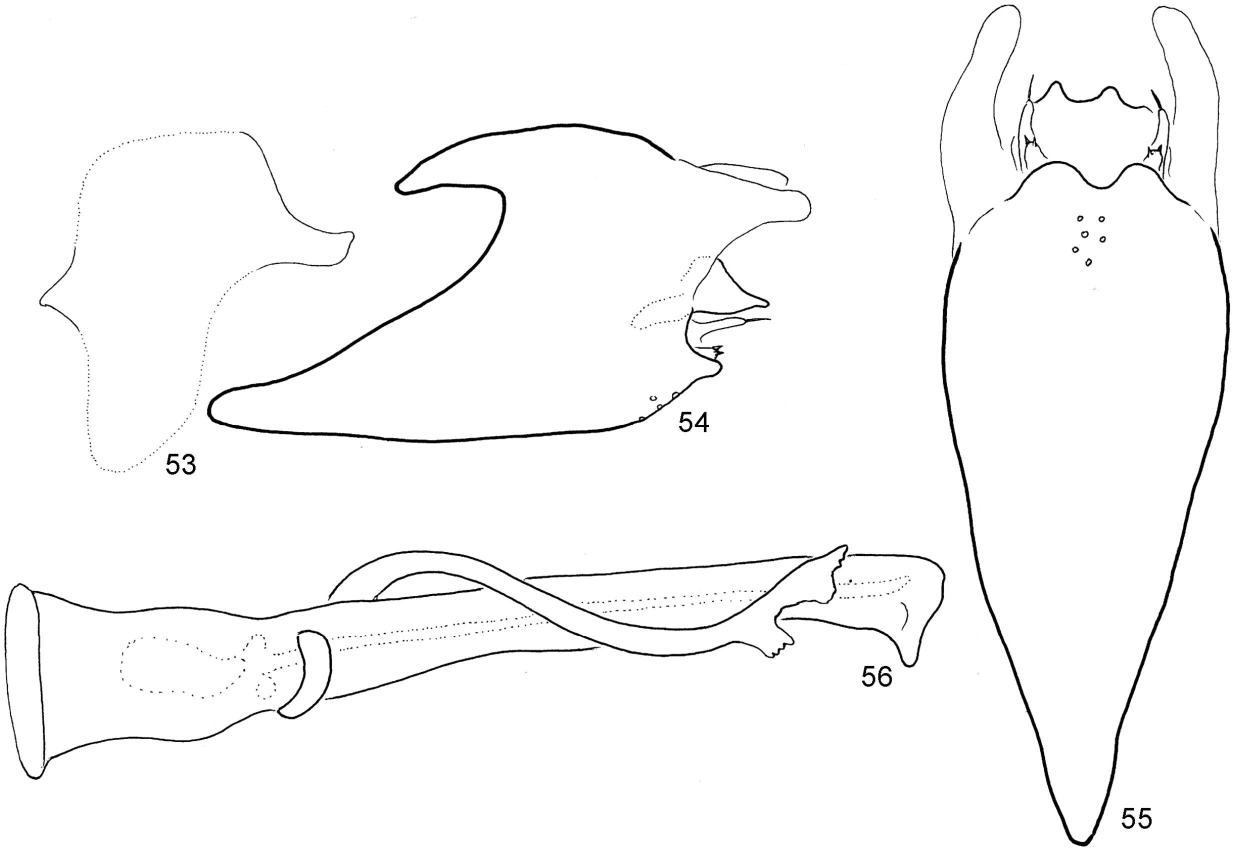
Oxyethira miea sp. nov.

(Figures 53–56)

Diagnosis. This new species belongs to the *Oxyethira ramosa* species group of Kelley (1984, 1985) and close to the *O. campanula* species, but differs by having dorsolateral processes on the posterior margin of segment VIII digitate and truncate, not narrowing pointed; anterolateral lobes on segment IX short, not long; posterodorsal lateral processes of segment IX high, not low; paramere with subapical serrated lobes.

Material examined. Holotype. Japan, Honshu, Mie, Taisei-cho, N36°19’, E136°26’, 30.V.1999, leg. H. Morita (1 male; CMB-ZI 146994).

Description. Male (in alcohol). Light brown. Forewing length 2.1 mm. 3 ocelli present. Clothing antennal setae whorled fimbriate. Spur count 034. Segment VII annular with short ventromesal process. Segment VIII annular; with digitate and truncate dorsolateral processes.



Figures 53–56. *Oxyethira miea* sp. nov. male, holotype. 53 = segment VIII in lateral view, 54 = genitalia in left lateral view, 55 = genitalia in ventral view, 56 = phallic organ in left lateral view.

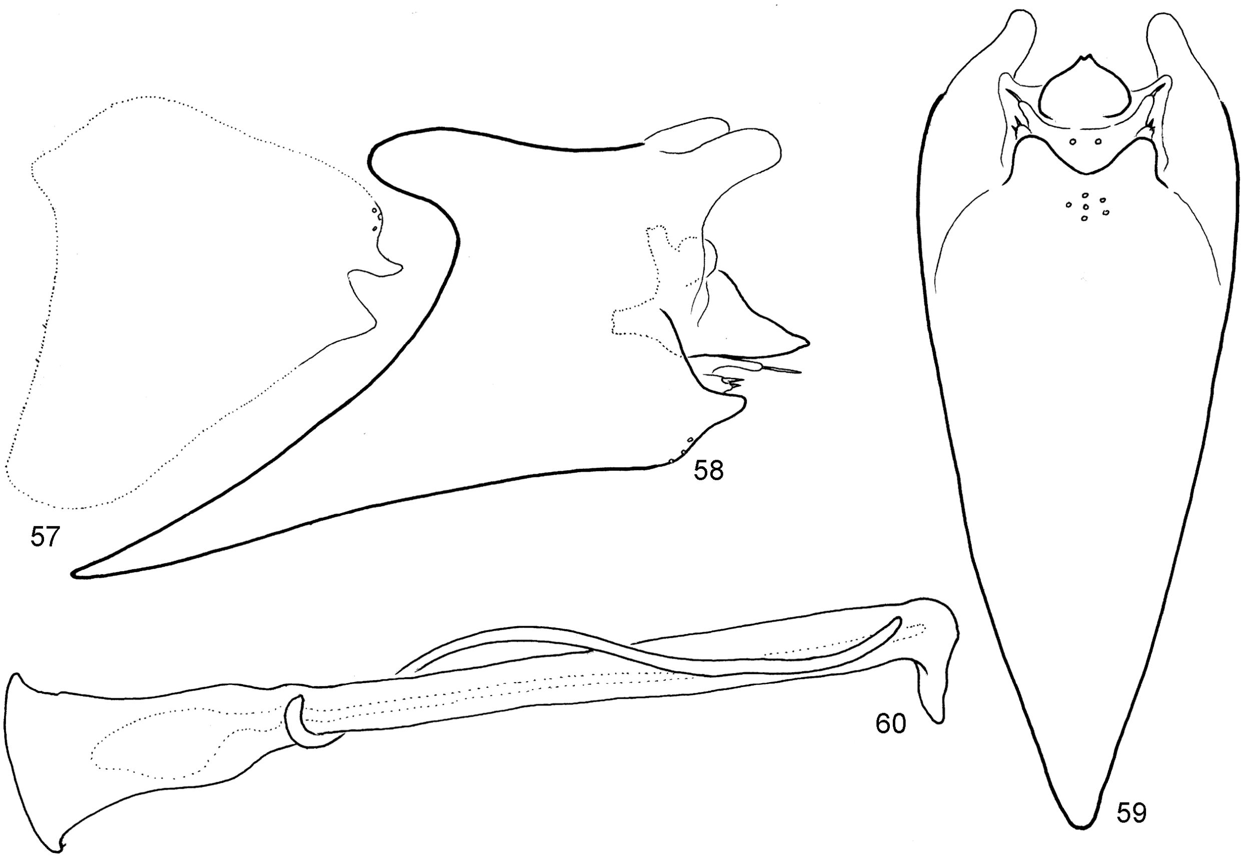
Male genitalia. Segment IX completely enclosed within VIII; ventrum long and narrowing in ventral view; dorsum short band producing short dorsolateral narrowing lobes anterad and dorsolateral, slightly mesad directed lobes posterad. Segment X reduced to short membranous lobe. Paraproct complex dominated by the median plate protruding posterad with narrowing apex in lateral view and widely excised in ventral view; its basal part indispensible. Gonopods heavily sclerotized pair of rounded widely separated lobes in ventral view. Basal plate of gonopods composed of the widely set bilobed processes dorsad and of the shorter pair of setose processes. Phallic organ with paramere encircling the aedeagus once and armed with two subapical lobes; basal lobe serrated, the head of the aedeagus producing heavily sclerotized short beak-shaped process.

Etymology. The epithet *miea* is coined from the name of the holotype locality.

Oxyethira okinawa **sp. nov.**

(Figures 57–60)

Diagnosi. This new species belongs to the *Oxyethira ramosa* species group of Kelley (1984, 1985) and close to the *O. campanula* species, but differs by having dorsolateral processes on the posterior margin of segment VIII differently shaped and doubled, not single; anterolateral lobes on segment IX short, not long; posterodorsal lateral processes of segment IX high, not low; freely protruded mesal plate of the paraproct complex inverted heart-shaped with small excision on the dorsal tip, not widely separated bifid.



Figures 57–60. *Oxyethira okinawa* sp. nov. male, holotype. 57 = segment VIII in lateral view, 58 = genitalia in left lateral view, 59 = genitalia in ventral view, 60 = phallic organ in left lateral view.

Material examined. Holotype. *Japan*, Ryukyu Islands, Okinawa, Nago-shi, Genka-kawa, near Hogen-hashi, N 26°36', E 128°05', 22–24.XI. 2010, pan trap, leg. T. Ito (1 male; CMB-ZI 146995).

*Other specimens***.** Ryukyu Islands, Okinawa, Kunigami-son, Nishime-dake, headwater of Zatsun-gawa, 28.VII.1997, leg. R. B. Kuranishi (1 male; deposited in personal collection of R. B. Kuranishi). Ryukyu Islands, Okinawa, Kunigami-son, Yona, Yona-gawa, Nakafiji-hashi, 23.XI. 2010, pan trap, leg. T. Ito (1 male; IPC).

Description. Male (in alcohol). Light brown. Forewing length 2.2 mm. 3 ocelli present. Antennal segments broken, more than 30; terminal segment lacking; clothing antennal setae whorled fimbriate. Spur count 034. Segment VII annular with short ventromesal process. Segment VIII annular; with double dorsolateral processes.

Male genitalia. Segment IX completely enclosed within VIII; ventrum long and narrowing in ventral view; dorsum short band producing short dorsolateral lobes anterad and dorsolateral, slightly mesad directed lobes posterad. Segment X reduced to short membranous lobe. Paraproct complex composed of an inverted heart-shaped median plate freely protruded posterad in lateral view and of basal part quadratic in caudal view and bipartite in lateral view. Gonopods heavily sclerotized pair of rounded widely separated lobes in ventral view. Basal plate of gonopods composed of the widely set bilobed processes dorsad and of the shorter pair of setose processes. Phallic organ with paramere encircling shaft once; the head of the aedeagus producing heavily sclerotized long beak-shaped process.

Etymology. The epithet *okinawa* is a noon in apposition coined from the name of the holotype locality.

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Zooplankton diversity of a sub-tropical reservoir of Mizoram, Northeast India

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Abstract. This study on zooplankton diversity from the state of Mizoram of northeast India, based on plankton samples collected from Khawiva reservoir during November 2005-October 2007, recorded a total of 46 species. Zooplankton indicated monthly richness ranging between 19-36 and 25-34 species; registered 52.8-88.9 and 60.0-89.3% community similarities (*vide* Sørensen's index); and comprised between 31.2±12.7 and 46.7±11.3% of net plankton abundance during two years, respectively. Copepoda and Rotifera, together, influenced zooplankton abundance. Rhizopoda and Cladocera showed limited importance while Nematoda and Ciliata recorded poor densities. *Mesocyclops* spp. > *Keratella tropica* are important taxa. Our results are characterized by moderate species diversity, high evenness and low dominance except in some months. Richness, abundance and species diversity followed no definite patterns of monthly variations. Individual abiotic parameters exerted limited influence on zooplankton richness and abundance, and on abundance of its constituent groups. The canonical correspondence analysis with fifteen abiotic parameters explained high cumulative variance (84.8%) of zooplankton assemblages along axis 1 and 2 with importance of water temperature, rainfall, free carbon dioxide, conductivity and phosphate. Sladecek's $Q_{B/T}$ quotient and Shannon's diversity index reflected mesotrophic nature of Khawiva reservoir.

Keywords. Richness, diversity, ecology, hydal reservoir, trophic status.

INTRODUCTION

Reservoirs, an important component of inland aquatic resources of India, are known for their rich biogenic production potential (Sugunan 1997) which can be significantly augmented based on information on diversity of fish-food organisms. The limnological studies in India began in the early part of the last century and culminated in several works on ecology and plankton in diverse aquatic biotopes (Gopal & Zutshi 1998, Jana 1998). Our knowledge of zooplankton diversity and their role biological productivity in reservoirs of this country is yet limited. This generalization holds true to reservoirs of northeast India in particular. The related studies from this region are restricted to a preliminary report from the tropical Gumti reservoir of Tripura state (Bhattacharya & Saha 1986, 1990) while zooplankton are analyzed in detail till date only from three sub-tropical reservoirs of the state of Meghalaya (Sharma 1995, Sharma & Lyngskor 2003, Sharma & Lyngdoh 2004).

The present two-year study on zooplankton diversity, the first such contribution from Mizoram state of northeast India, deserves special ecological importance due to the stated lacunae. The monthly qualitative and quantitative net plankton collections of a subtropical hydal reservoir are analyzed with reference to composition, species richness, abundance, community similarities, species diversity, dominance and evenness of zooplankton. Individual and cumulative influence of abiotic factors on richness and abundance of zooplankton and on abundance of its constituent groups are analyzed. Comments are made on trophic status of the reservoir *vide* Sladecek's quotient and Shannon's diversity index.

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MATERIALS AND METHODS

This study is part of a limnological survey of Khawiva reservoir (22^o 35'N; 93^o 47'E) undertaken from November 2005 – October 2007. This small reservoir is located at a distance of 12 km from Lunglei town in Lunglei district, south Mizoram (Fig. 1, A–C). It was commissioned in 1986 for generating hydal power and is fed by Khawiva River. The reservoir is devoid of aquatic macrophytes and it is surrounded by forest with *Phyllanthus* sp., *Cyperus* sp., *Eupatorium* sp., *Farmaria* sp., and *Centella* sp.

Water samples were collected monthly at two sampling stations of Khawiva reservoir. Water temperature, specific conductivity and pH were recorded by the field probes; dissolved oxygen was estimated by Winkler's method while other abiotic parameters were analyzed following APHA (1992). Monthly qualitative and quantitative net plankton samples were collected, at both sampling stations, by nylobolt plankton net (# 55 µm) and were preserved in 5% formalin; the former were collected by towing plankton net and the later by filtering 25 l water each. The qualitative samples were screened and zooplankton taxa were identified following identified following Koste (1978), Michael & Sharma (1988), Sharma (1998) and Sharma & Sharma (1999a, 1999b, 2000, 2008). Quantitative samples were analyzed with a Sedgewick-Rafter counting cell for abundance (ind.l^{-1}) of zooplankton and its constituent groups; their average monthly densities at two sampling stations were taken for detailed analysis.

The community similarities (Sørensen's index), species diversity (Shannon's index), dominance (Berger-Parker's index) and evenness (Pileou's index) were calculated following Ludwig & Reynolds (1988) and Magurran (1988). ANOVA (two-way) was used to ascertain the significance of temporal variations of biotic parameters. The hierarchical cluster analysis, based on the community similarities, was done using SPSS (version 11.0). Ecological relationships between abiotic and biotic parameters were determined by Pearson's correlation coefficients during the study period (r); their P values were calculated and significance was ascertained after use of Bonferroni correction. The canonical correspondence analysis (XLSTAT version 2012) was done to observe cumulative influence of fifteen abiotic parameters (rainfall, water temperature, specific conductivity, pH, dissolved oxygen, free CO_2, alkalinity, hardness, chloride, sulphate, phosphate, nitrate, silicate, dissolved organic matter and total dissolved solids) on zooplankton communities. Comments on trophic status of the reservoir were based on $Q_{B/T}$ quotient following Sladecek (1983) and Shannon's diversity index.

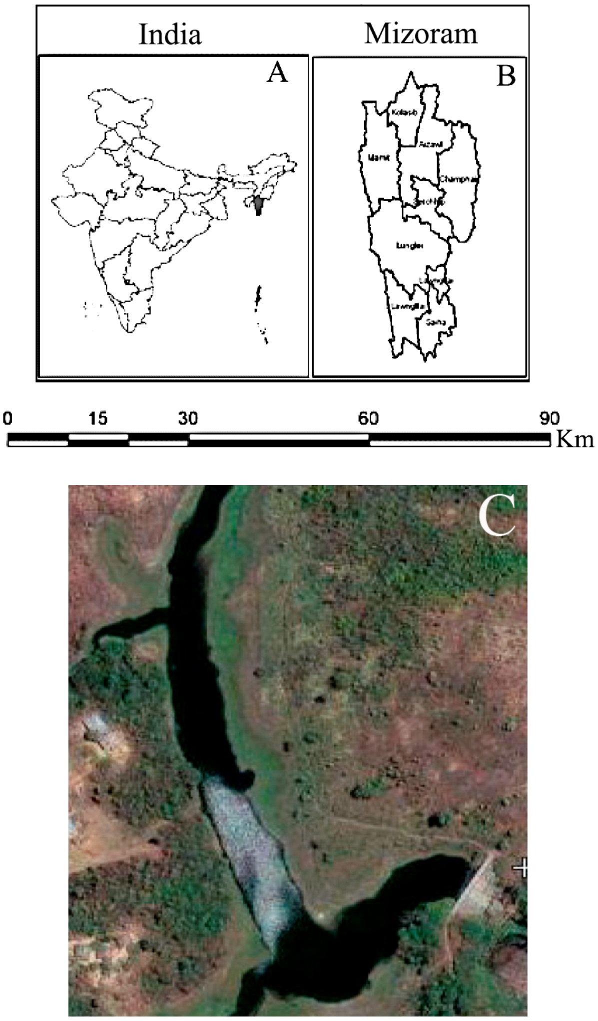

Figure 1. A = Map of India showing Mizoram state;
B = District map of Mizoram showing Lunglei District
C = Khawiva reservoir (Google photo)

RESULTS

The annual variations in abiotic parameters (annual ranges and average ± SD) of Khawiva reservoir as well as during the study period are indicated in Table 1. The details of occurrence and abundance of zooplankton taxa are included in Appendices I and II and their annual variations (ranges and average ± SD) are summarized in Table 2. A total of 46 species of zooplankton are recorded in this study. Their monthly richness ranged between 19–36 and 25–34 species and community similarities (Sørensen's index) varied between 46.6–80.4% and 37.0–95.9% (Tables 2–3) during two years, respectively. The monthly variations in species richness are shown in Fig. 2 while annual variations in the hierarchical cluster analysis, based on Sørensen's community similarities, are shown in Figs. 3-4, respectively.

The monthly variations in zooplankton abundance are shown in Fig. 5. They (159 ± 59 ind. l^{-1} and 242 ± 90 ind. l^{-1}) comprised between 31.2 ± 12.7 % and 46.7 ± 11.3 % of net plankton abundance during two years, respectively (Table 2). Copepoda and Rotifera abundance ranged between 51 ± 59 ind. l^{-1}, 116 ± 87 ind. l^{-1} and 75± 17 ind. l^{-1}, 86 ± 19 ind. l^{-1} during two years, respectively. The monthly variations in quantitative variations of these groups are shown in Figs. 6–7. Cladocera (17 ± 8 ind. l^{-1}) and Rhizopoda (18 ± 10 ind. l^{-1}) indicated relatively low abundance while Nematoda and Ciliata (2 ± 2 ind. l^{-1}, 2 ± 1 ind. l^{-1}) showed poor densities during the study period. The zooplankton species diversity (Table 1) ranged between 2.618 ± 0.274 during first year and between 2.360 ± 0.546 during second year; the monthly variations of species diversity are shown in Fig. 8. The dominance varied between 0.285 ± 0.127 and 0.245 ± 0.127 while evenness ranged between 0.756 ± 0.107 and 0.764 ± 0.130 during two years, respectively (Table 1). The canonical correspondence analysis (CCA) ordination biplot of fifteen abiotic parameters and zooplankton assemblages, during the study period, is shown in Fig. 9.

Table 1. Temporal variations (range, average and SD) of abiotic parameters

	Nov. 2005-Oct. 2006			Nov. 2006-Oct. 2007			Study Period		
Parameters ↓	**Range**	**Mean**	**SD**	**Range**	**Mean**	**SD**	**Range**	**Mean**	**SD**
Rainfall mm	0-901.8	268.7	283.4	0–901.8	272.4	320.7	0–901.8	270.5	302.6
Water temperature ^{0}C	14.5–28.0	22.4	4.0	14.0–27.0	21.7	3.9	14.0–28.0	22.1	4.0
Specific conductivity µS cm^{-1}	20.0–62.0	42.8	13.5	28.0–50.0	38.3	7.2	20.0–62.0	40.5	11.0
pH	6.34–7.18	6.81	0.24	5.86–6.83	6.48	0.29	5.86–7.18	6.64	0.31
Dissolved Oxygen mg l^{-1}	5.6–10.4	8.1	1.5	4.8–9.6	7.2	1.6	4.8–10.4	7.7	1.6
Free Carbon dioxide mg l^{-1}	8.0–16.0	12.8	2.6	6.0–14.0	10.2	2.8	6.0–16.0	11.5	3.0
Alkalinity mg l^{-1}	24.0–40.0	32.3	5.5	26.0–34.0	30.8	3.6	24.0–40.0	31.6	4.7
Hardness mg l^{-1}	18.0–46.0	30.3	9.5	22.0–38.0	29.7	6.2	18.0–38.0	30.0	8.0
Chloride mg l^{-1}	1.0–12.0	9.2	3.6	4.0–11.0	6.6	2.8	1.0–11.0	7.9	3.5
Sulphate mg l^{-1}	0.714–2.584	1.055	0.640	0.285–4.638	2.725	1.601	0.285–4.638	1.890	1.478
Phosphate mg l^{-1}	0.017–0.445	0.079	0.115	0.017–0.221	0.100	0.061	0.017–0.445	0.089	0.093
Nitrate mg l^{-1}	0.074–0.392	0.199	0.105	0.074–0.238	0.171	0.065	0.074–0.392	0.185	0.088
Silicate mg l^{-1}	0.037–1.384	0.482	0.456	0.037–0.664	0.353	0.221	0.037–1.384	0.417	0.364
DOM mg l^{-1}	0.016–2.236	0.413	0.797	0.025–0.452	0.192	0.138	0.016–2.236	0.302	0.582
Total Dissolved Solids mg l^{-1}	0.018–0.296	0.191	0.221	0.075–0.347	0.183	0.081	0.018–0.347	0.187	0.166

Table 2. Temporal variations (range, average ± SD) of Zooplankton

	Nov. 2005-Oct. 2006	Nov. 2006-Oct. 2007	Study Period
RICHNESS	Phytoplankton > Zooplankton		
Zooplankton	46 species: 19–36 28±4	45 species: 25–34 29±3	46 species: 29–36 28±4
% similarity	52.8–88.9	60.0–89.3	
Rotifera	27 species: 11–22 16±3	27 species: 11–20 17±3	27 species: 11–22 16±3
ABUNDANCE	Phytoplankton > Zooplankton		
Zooplankton ind.l^{-1}	114–322 159±59	127–483 242±90	114–483 201± 87
% composition	10.8–58.7 31.2±12.7	22.4–60.9 46.7±11.3	20.8–60.9 38.9 ±14.3
Species diversity	2.049–2.969 2.618±0.274	1.339–3.152 2.360±0.546	1.339–3.152 2.489±0.412
Dominance	0.144–0.590 0.285±0.127	0.080–0.649 0.245±0.127	0.080–0.649 0.336±0.134
Evenness	0.545–0.919 0.756±0.107	0.472–0.921 0.764±0. 130	0.472–0.921 0.746±0.122
Different groups	Copepoda > Rotifera > Rhizopoda > Cladocera		
Rotifera ind.l^{-1}	43–103 75±17	60–130 86±19	43–130 81±19
% composition	23.6–74.8 50.0±15.6	20.7–64.6 40.6±12.9	20.7–74.8 45.3±15.1
Copepoda ind.l^{-1}	15–172 51±49	43–365 116±87	15–365 84±78
% composition	11.3–59.3 28.0±14.1	14.2–75.6 43.2± 15.6	11.3–75.6 35.6±16.7
Rhizopoda ind.l^{-1}	1–49 16±11	8–31 19±8	1–49 18±10
% composition	0.8–15.7 9.8±4.4	1.9–21.2 9.1±5.3	0.8–21.2 9.5±4.9
Cladocera ind.l^{-1}	7–24 14±5	8–31 19± 10	0–192 17±8
% composition	4.8–14.4 9.1±3.0	1.7–14.8 8.6± 3.6	01.7–14.8 8.8±3.3
Nematoda ind.l^{-1}	1–7 2±2	1=2 1±2	1–7 2±2
Ciliata ind.l^{-1}	0–1 0±0	0–1 0±0	0–1 0±0
Important taxa			
Mesocyclops spp. ind.l^{-1}	10–151 42±45	11–333 101±79	10–333 71 ± 71
Keratella tropica ind.l^{-1}	5–61 23±18	8–109 28± 28	5–109 26 ± 24
Nauplii ind.l^{-1}	3–25 10±7	2–32 16± 10	2–32 13 ± 9
Chydorus sphaericus ind.l^{-1}	3–14 7±3	2–34 10± 9	2–34 9 ± 7

Table 3. Percentage similarities of Zooplankton (First year)

Months	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.
Nov.	-	70.8	66.7	67.9	52.8	64.3	62.5	64.1	82.1	83.9	76.7	75.5
Dec.		-	81.2	78.3	63.3	85.7	61.8	78.7	75.8	75.4	86.6	73.3
Jan.			-	80.8	73.1	76.4	63.8	64.2	62.1	75.4	81.4	69.2
Feb.				-	70.8	66.7	55.5	61.2	63.0	70.2	69.1	75.0
March					-	78.4	60.5	57.1	55.6	56.1	65.6	62.5
April						-	78.3	65.4	63.2	73.3	75.9	58.8
May							-	81.8	65.3	65.4	64.0	55.8
June								-	80.6	72.4	75.0	57.1
July									-	88.9	78.7	77.8
Aug.										-	77.6	77.8
Sept.											-	72.7
Oct.												-

Table 4. Percentage similarities of Zooplankton (Second year)

Months	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.
Nov.	-	84.4	73.0	78.0	78.0	81.4	78.1	60.0	76.8	72.7	81.8	77.6
Dec.		-	71.2	72.7	72.7	83.6	70.0	67.9	77.4	77.4	80.6	79.4
Jan.			-	77.8	70.4	70.4	74.6	69.1	68.8	75.4	75.4	74.2
Feb.				-	84.0	68.0	76.4	62.7	63.2	73.7	73.7	72.4
March					-	72.0	72.7	62.7	70.2	77.2	77.2	75.9
April						-	72.7	66.7	73.7	77.2	80.7	72.4
May							-	78.6	67.7	67.7	77.4	76.2
June								-	86.2	72.4	65.5	89.0
July									-	78.1	81.2	89.3
Aug.										-	78.1	87.5
Sept.											-	80.0
Oct.												-

DISCUSSION

Abiotic parameters

The slightly acidic-circum neutral, soft and well oxygenated waters of sub-tropical Khawiva reservoir are characterized by low ionic concentrations which, in turn, warranted its inclusion under 'Class I' category of trophic classification *vide* Talling & Talling (1965). This study showed low free CO_2, low chloride content as well as low concentrations of nutrients and other abiotic factors. ANOVA recorded significant annual variations of only pH ($F_{1, 23}$ = 7.553, P = 0.019) and sulphate ($F_{1, 23}$ = 9.465, P = 0.011) while specific conductivity ($F_{11, 23}$ = 3.589, P = 0.022) registered significant monthly variations.

Richness and community similarities

The zooplankton of Khawiva reservoir is fairly more speciose than the reports from other subtropical ecosystems of India i.e., from Uttrakhand (Negi & Pant 1983, Sharma & Pant 1985), Kashmir (Vass & Zutshi 1983, Yousuf & Qadri 1985, Yousuf *et al.* 1986) and Karnataka (Patil & Gouder 1985) as well as from the neighboring countries of Nepal (Nakanishi *et al.* 1988) and Myanmar (J. Green, personal communication). Referring to northeast India, the richness is high than that from the tropical Gumti reservoir, Tripura (Bhattacharya & Saha 1990) and from sub-tropical water bodies of Meghalaya (Alfred & Thapa 1985, Sharma 1995, Das *et al.* 1996, Sharma & Lyngskor 2003, Sharma & Lyngdoh 2004, Sharma & Wanswett 2006). The qualitative importance of Rotifera concurred with the stated works although Khawiva rotifers are more species-rich than various reports from northeast region. The stated comparisons hypothesized relatively more environmental heterogeneity of the sampled reservoir.

Our results indicated a narrow range of zooplankton richness which followed no definite monthly pattern during the study; the former aspect is affirmed by its insignificant annual and monthly variations. The occurrence of nearly all species during both years and limited monthly richness differences reflected homogeneity in zooplankton composition in spite of the fact that only six and eight species indicated perennial nature during two years respectively. In general, the monthly richness during the second year is relatively higher than that of during first year except in December, April and August. Peak richness observed during December (winter) and November (autumn) respectively, during two years coincided with the periods of low water temperatures while lowest species number is reported during pre-monsoon *i.e.*, in the months of May (first year) and April (second year) respectively.

The annual community similarities ranges, suggesting high similarity in zooplankton composite-on, are attributed to common occurrence of various cosmopolitan and cosmotropical species. These remarks are re-affirmed by the fact that

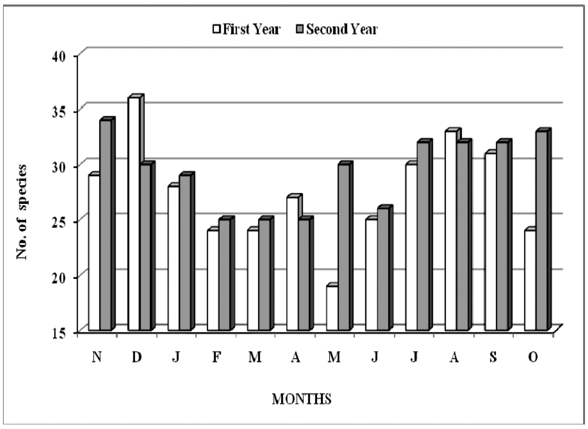

Figure 2. Monthly variations of zooplankton species richness

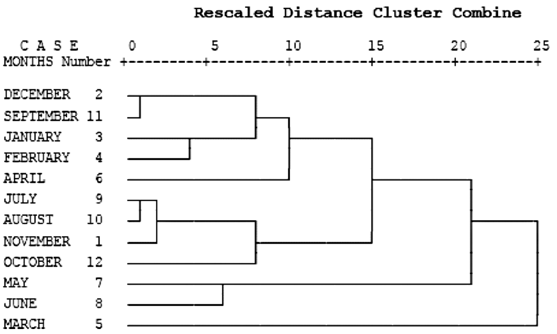

Figure 3. Hierarchical cluster analysis of Zooplankton (First year)

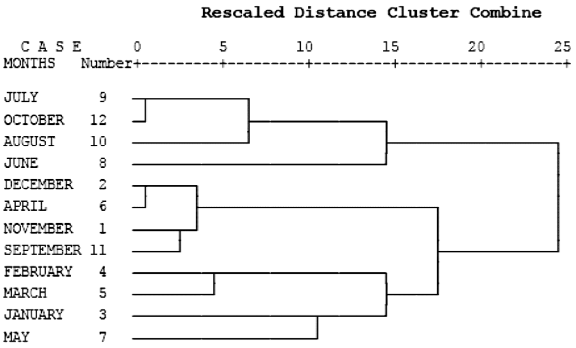

Figure 4. Hierarchical cluster analysis of Zooplankton (Second year)

Sørensen's similarity varied between > 60-80% in majority of instances (72.7 %) during first year while 80.3% instances affirmed > 60-80 similarity in the following year. Hierarchical cluster analysis showed differences in monthly groupings between two years which, in turn, is primarily influenced by the occurrence or absence of different members of the species-rich Rotifera and Rhizopoda. High zooplankton affinities between July–August and December-September collections during first year and between July–October and December–April communities during second year exhibited more homogeneity in their species composition. The divergence exhibited by March and June communities during first year and, January, February and May collections in the following year is due to variations in the richness of rotifers and cladocerans.

Abundance

The zooplankton formed sub-dominant quantitative component of net plankton during the study and thus concurred with the reports from certain water bodies of Kashmir (Kaul & Pandit 1982), Bihar (Baruah *et al.* 1993, Sanjer & Sharma 1995), Assam (Yadava *et al.* 1987) and West Bengal (Sugunan 1989). This generalization differed from their dominance observed from flood-plain lakes of northeast India (Sharma & Hussain 2001, Sharma 2011a, 2011b, Sharma & Sharma 2011, Sharma & Sharma 2012). Our results recorded relatively high zooplankton abundance with wider variations during second year than the preceding year and registered significant annual density variations ($F_{1,\ 23}$ = 5.271, P = 0.042). The abundance is high than the reports from certain other reservoirs of northeast India (Bhattacharya & Saha 1990, Sharma 1995, Sharma & Lyngskor 2003, Sharma & Lyngdoh 2004), Nepal (Nakanishi *et al.* 1988) and Myanmar (J. Green, personal communication) with broadly similar abiotic parameters. However, it is lower than the reports from various sub-tropical ecosystems of Kashmir (Zutshi *et al.* 1980, Vass & Zutshi 1983, Vass *et al.* 1988, 1989).

This study showed oscillating monthly zooplankton density variations with peaks during December and March respectively, during two years. The former feature concurred with the reports of Sharma (1995), Sharma & Lyngskor (2003) and Sharma & Lyngdoh (2004) while it differed from bimodal patterns noticed by Yousuf & Qadri (1985) and Das *et al.* (1996). Khawiva zooplankton lacked quantitative importance of any individual constituent group. Copepoda and Rotifera, together, influenced their density variations and mainly contributed to annual peaks during the study period. This pattern differed from the stated orders of significance of Rotifera > Cladocera in Malse (Sharma 1995), Copepoda > Cladocera in Nongmahir (Sharma and Lyngskor 2003) and Rotifera > Cladocera in Umiam (Sharma & Lyngdoh 2004) reservoirs of Meghalaya.

The copepods, represented exclusively by the cyclopoids, indicated relatively high abundance during second year and recorded annual peaks during December and March respectively. The importance of the group corresponded with the results of Negi & Pant (1983), Das *et al.* (1996), Sharma & Hussain (2001) and while it differed from its sub-dominance observed by Yadava *et al.* (1987) and Alfred & Thapa (1995). The quantitative significance of the copepods reflected the prevalence of stable environmental conditions for these 'k-strategists' as suggested by Allen (1976) and Schmidt-Araya & Zuniga (1992). The occurrence of nauplii throughout the study indicated periods of active reproduction. This generalization affirmed the results of Sharma & Hussain (2001), Sharma & Lyngskor (2003) and Sharma & Lyngdoh (2004). *Mesocyclops* spp. with its sporadic abundance on several occasions deserved mention in this study.

Rotifera recorded relatively wide density variations with broad range during second year. This group registered significant monthly ($F_{11,23}$=3.522, P=0.022) but insignificant annual quantitative variations. The rotifer abundance is high than the reports from various sub-tropical ecosystems of northeast India (Sharma 1995, Das *et al.* 1996, Sharma & Lyngskor 2003, Sharma & Lyngdoh 2004)

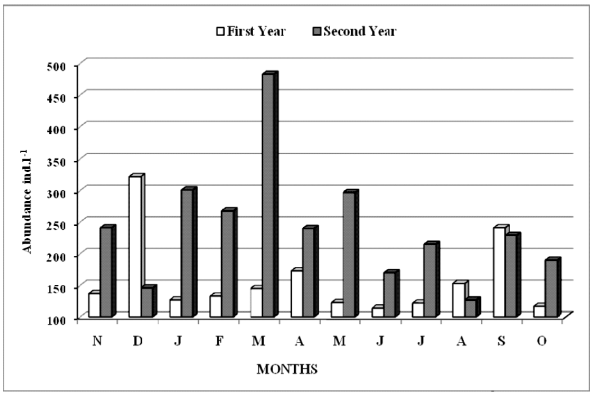

Figure 5. Monthly variations of zooplankton abundance (ind. l^{-1})

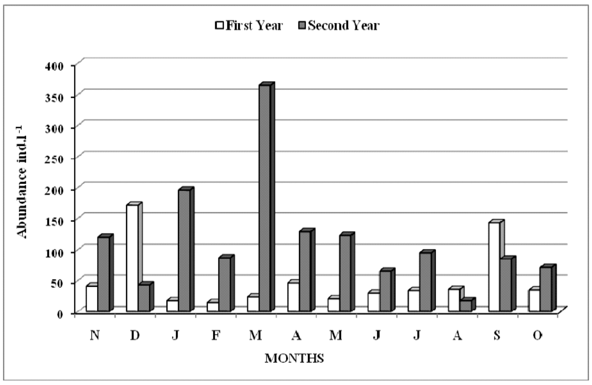

Figure 6. Monthly variations in abundance (ind. l^{-1}) of Copepoda

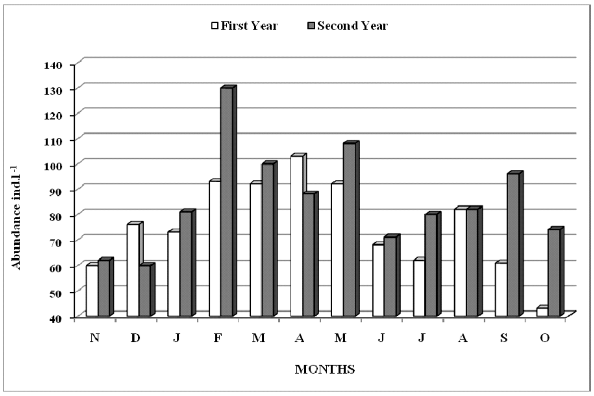

Figure 7. Monthly variations in abundance (ind. l^{-1}) of Rotifera

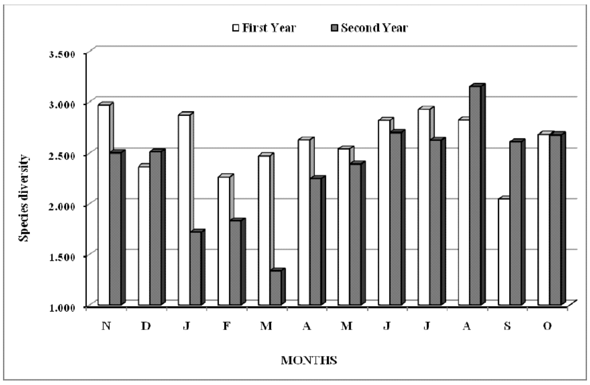

Figure 8. Monthly variations in Species diversity of Zooplankton

with broadly similar abiotic conditions. They followed oscillating monthly density variations and relatively high abundance from February through March; their peak abundance is observed during April and February respectively, during two years. *Keratella tropica* significantly influenced Rotifera abundance ($r = 0.664$, $P=0.0004$) during the study in general and contributed to its peaks in particular. This brachionid showed importance during December through March in particular and is positively correlated with hardness ($r = 0.588$, $P=0.0025$).

Rhizopoda and Cladocera showed limited quantitative role and comprised between 9.5±4.9 % and 8.8±3.3 % of zooplankton. Of the members of these groups, only *Chydorus sphaericus* showed certain importance. Among other groups, Nematoda and Ciliata indicated poor densities.

Species diversity, evenness and dominance

The species diversity is influenced by richness and equitability or relative abundance of species (Sager & Hasler 1969). Zooplankton species diversity followed oscillating monthly patterns and registered insignificant annual and monthly variations. It showed relatively wide variations (1.339–3.152) during second year rather than the preceding year (2.049–2.969). The peak and lowest diversity values are observed during August and March respectively, during the second year. The annual differences are affirmed by the ranges of density variations during two years and that the periods of high abundance concurred with low diversity in general. The latter feature is endorsed by inverse correlation of species diversity with abundance of zooplankton ($r= -0.812$, $P < 0.0001$) and Copepoda ($r= -0.802$, $P < 0.0001$). The diversity is also inversely influenced by abundance of *Mesocyclops* spp. ($r= -0.803$, $P < 0.0001$) and *Keratella tropica* ($r= -0.642$, $P < 0.0004$). The salient features of high species diversity with relatively lower densities of majority of species of our study may be ascribed to fine niche portioning amongst zooplankton species in combination with high micro- and macro-scale habitat heterogeneity as hypothesized by Segers (2008) and affirmed by Sharma (2011a, 2011b) and Sharma & Sharma (2011, 2012).

Our results showed notable variations of zooplankton evenness (0.472-0.921); equitable occurrence and low densities of majority of species resulted in high evenness. It is positively correlated with species diversity ($r = 0.961$, $P < 0.0001$) and is inversely correlated with their abundance ($r = - 0.886$, $P < 0.0001$) as well as abundance of Copepoda ($r= -0.863$, $P < 0.0001$), *Mesocyclops* spp. ($r= -0.865$, $P < 0.0001$) and *Keratella tropica* ($r= -0.642$, $P < 0.0004$). This is particularly true during period of annual evenness maxima in November and August respectively, during two years. On the other hand, low evenness is observed in the month of September during first year and again from January through March during second year.

Modde & Drewes (1990) asserted dominance to be the most effective approaches to describe the responses of biotic communities to environmental changes. This index is always higher in community dominated by a fewer number of species and lower where dominance is shared by a large number of species (Whittaker 1965), or the total population of the community is uniformly distributed among different species (Osborne *et al.* 1976). Interestingly, this study showed wide variations in dominance index (0.080–0.649). Following MacArthur's (1965) explanation, it is hypothesized that the habitat of Khawiva reservoir has resources for utilization by fewer and majority of species and thus providing variable conditions from low to high amount of niche overlap.

Trophic status

Sladecek (1983) proposed $Q_{B/T}$ quotient, an analogue of phytoplankton indices and based on ratios of *Brachionus* and *Trichocerca* species, to establish trophic status of lentic or lotic water bodies or even individual plankton samples. Sharma & Dudani (1992), Sharma (2001), Sharma & Lyngskor (2003) and Sharma & Lyngdoh (2004) ascertained its reliability under Indian conditions. The monthly $Q_{B/T}$ quotient values for

Khawiva reservoir varied from 1.0–2.0 during the study period and thus affirmed its 'mesotrophic' nature following Sladecek's classification. Wilham & Dorris (1968) and Staub *et al.* (1970) suggested the utility of the species diversity index in assessing water quality. According to Whittaker (1965), the index is actually not a real assessment of the species diversity in a community but it represented the relative importance value of the species taken into account. Trivedi (1981) and Datta (2001) emphasized the importance of species diversity in assessing the water quality. Our diversity results re-affirmed 'mesotrophic' status of Khawiva reservoir following Datta (loc cit.).

Ecological correlations

Individual abiotic factors exerted limited influence on richness and abundance of zooplankton and on abundance of its constituent groups during the study period. The richness is inversely correlated with specific conductivity (r = -0.649, P=0.0006) and hardness (r = -0.581, P=0.0029). The zooplankton and Copepoda abundance are not significantly influenced by any individual abiotic parameter. The density of Rotifera is positively correlated with hardness (r = 0.567, P= 0.0039) while that of Rhizopoda and Cladocera is inversely correlated with specific conductivity (r = -0.563, P = 0.0042) and alkalinity (r = -0.564, P=0.0041), respectively. The canonical correspondence analysis with fifteen abiotic factors explained high (84.8%) cumulative variance of zooplankton assemblages along axis 1 and 2 during the study period with importance of water temperature, rainfall, free carbon dioxide, conductivity and phosphate. The abundance of zooplankton, Rotifera and nauplii are influenced by water temperature and free carbon dioxide; zooplankton richness is influenced by rainfall; *Keratella tropica* is influenced by low specific conductivity; and Copepoda and *Mesocyclops* spp. densities are influenced phosphate.

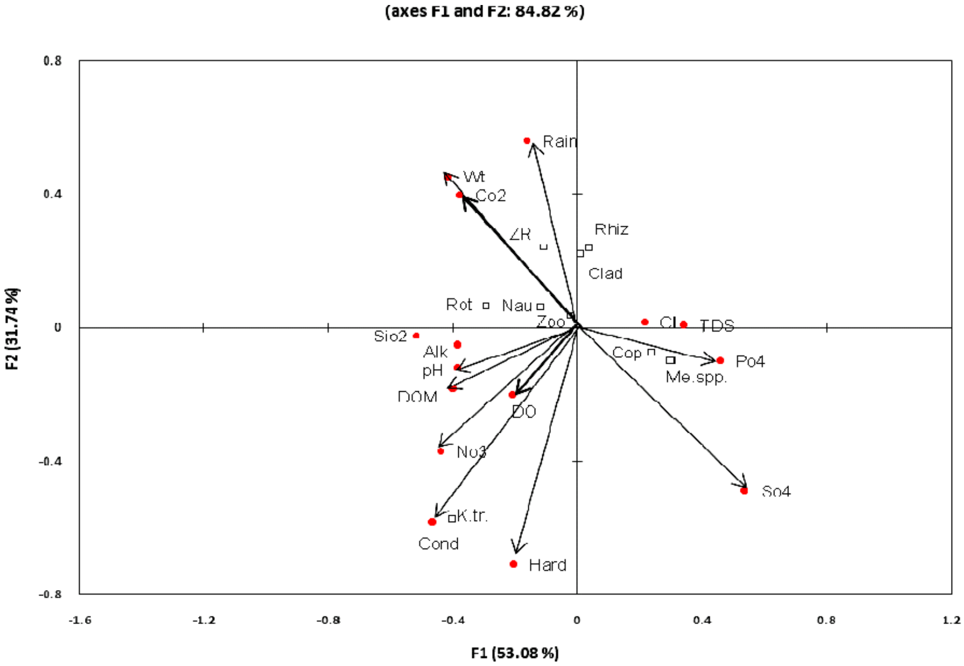

Figure 9. CCA ordination biplot of Zooplankton and abiotic factors

Abbreviations. ***Abiotic*.** Alk (alkalinity), Co2 (free carbon dioxide), Cl (Chloride), Cond (conductivity), DO (dissolved oxygen), DOM (dissolved oxygen matter), pH (hydrogen-ion concentration), No3 (nitrate), PO_4 (phosphate), Rain (rainfall), Sio2 (silicate), So4 (sulphate), TDS (Total dissolved solids), Trans (transparency), Wt (water temperature). ***Biotic*.** ZR (Zooplankton richness), Rot (Rotifera), Clad (Cladocera), Cop (Copepoda), Rhiz (Rhizopoda), K tr. (*Keratella tropica*), Me spp. (*Mesocyclops* spp.), Nau (Nauplii)

CONCLUSION

The fairly species-rich zooplankton of Khawiva reservoir formed sub-dominant quantitative component of net plankton. Copepoda and Rotifera influenced their abundance; while *Mesocyclops* spp. and *Keratella tropica* are important taxa. Richness and abundance and species diversity of zooplankton and abundance of its constituent groups followed no definite patterns of monthly variations. This study indicated moderate average species diversity, high evenness and low dominance of zooplankton. Our results indicated limited influence of individual abiotic factors and CCA with fifteen abiotic parameters explained high cumulative variance of zooplankton assemblages. Sladecek's $Q_{B/T}$ quotient and Shannon's diversity index affirmed mesotrophic nature of Khawiva reservoir.

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Appendix 1. Monthly variations in abundance of Zooplankton (First Year)

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct
ROTIFERA												
Brachionus angularis Gosse	0	2	2	4	5	9	2	1	10	23	6	0
B. quadridentatus (Hermann)	4	1	2	3	0	5	30	7	2	3	1	3
Keratella tropica (Apstein)	5	17	29	61	49	42	11	5	9	15	21	10
Plationus patulus (Muller)	5	2	0	0	5	5	9	7	2	0	5	3
Colurella uncinata (Gosse)	1	1	1	1	0	1	0	0	0	1	1	0
C. sulcata (Stenroos)	0	2	1	0	0	1	0	0	0	1	1	0
Lepadella patella (Muller)	2	0	0	0	0	0	0	1	2	0	1	0
Euchlanis dilatata Ehrenberg	3	5	1	0	0	0	7	8	5	4	1	1
Lecane bulla (Gosse)	7	5	7	3	2	1	3	3	1	1	1	2
L. closterocerca (Schmarda)	1	0	0	0	0	0	0	0	1	1	0	1
L. hamata (Stokes)	0	3	2	1	1	0	0	0	0	0	1	3
L. leontina (Turner)	7	5	0	5	3	4	6	9	7	2	1	4
L. lunaris (Ehrenberg)	2	3	0	0	0	0	0	3	2	3	2	3
L. pertica (Harring & Myers)	0	0	0	0	0	0	0	0	2	2	1	0
L quadridentatus (Ehrenberg)	0	3	2	0	4	2	0	0	0	0	0	3
Cephalodella forficula (Ehrenberg)	0	0	0	0	0	0	0	0	0	1	0	0
C. gibba (Ehrenberg)	1	0	1	1	1	0	0	1	0	1	0	0
Monommata grandis Tessin	2	1	0	0	0	1	1	1	1	1	0	0
Polyarthra vulgaris Carlin	5	7	7	3	0	0	0	0	5	3	9	5
Dicranophorus sp.	0	1	1	1	0	1	0	0	0	1	0	0
Testudinella emarginula (Stenroos)	5	7	3	5	9	6	7	0	0	5	4	0
T patina (Hermann)	3	5	7	5	11	15	9	7	5	7	1	3
Trichotria tetractis (Ehrenberg)	0	1	0	0	0	3	3	13	5	2	1	0
Trichocerca similis (Wierz.)	5	3	2	0	0	4	3	1	0	1	1	0
Philodina citrina Ehrenberg	0	1	5	0	2	2	1	1	1	2	2	0
P. roseola Ehrenberg	0	1	0	0	0	1	0	0	0	0	0	0
Rotaria neptunia (Ehrenberg)	2	0	0	0	0	0	0	0	2	2	0	2
RHIZOPODA												
Arcella megastoma Ehrenberg	6	14	7	3	0	0	0	1	1	1	2	3
A. discoides Ehrenberg	0	4	3	2	0	0	0	2	3	0	5	3
A. hemispherica (Bernard)	2	3	0	0	0	0	0	2	2	0	0	0
A. vulgaris Ehrenberg	5	15	3	2	2	1	1	2	1	1	1	1
Assulina muscorum Greet	0	0	1	0	1	1	0	0	0	0	0	0
Centropyxis aculeata (Ehrenberg)	2	2	1	1	2	3	0	0	3	6	7	11
Difflugia urceolata Carter	2	10	5	3	5	6	0	1	1	4	1	2
Euglypha ciliata Ehrenberg	0	1	0	0	4	1	0	0	0	0	1	0
E. tuberculata Dujardin	0	0	0	0	1	0	0	0	0	0	0	0
CLADOCERA												
Coronatella anodonta (Daday)	0	3	5	2	1	0	0	0	0	0	0	2
Bosmina longirostris (Muller)	7	5	5	7	3	2	0	0	3	2	5	1
Karualona karua (King)	0	3	0	0	0	2	3	1	0	0	0	0
Ephemeroporus barroisi (Richard)	5	4	0	0	0	0	0	3	3	5	0	0
Chydorus faviformis Birge	1	0	0	0	0	0	0	0	1	1	2	0
C. sphaericus (Muller)	5	9	5	3	3	7	5	3	7	14	9	10
COPEPODA												
Mesocyclops spp.	31	151	13	10	17	21	14	20	28	33	128	32
Nauplii	10	21	5	5	7	25	7	10	6	3	15	3
CILIATA												
Epistylis	0	0	0	1	0	0	0	0	0	0	1	0
NEMATODA	1	1	1	1	7	1	1	1	1	1	3	6
Rotifera ind.l^{-1}	**60**	**76**	**73**	**93**	**92**	**103**	**92**	**68**	**62**	**82**	**61**	**43**
Rhizopoda ind.l^{-1}	**17**	**49**	**20**	**11**	**15**	**12**	**1**	**8**	**11**	**12**	**17**	**20**
Cladocera ind.l^{-1}	**18**	**24**	**15**	**12**	**7**	**11**	**8**	**7**	**14**	**22**	**16**	**13**
Copepoda ind.l^{-1}	**41**	**172**	**18**	**15**	**24**	**46**	**21**	**30**	**34**	**36**	**143**	**35**
Nematode ind.l^{-1}	**1**	**1**	**1**	**1**	**7**	**1**	**1**	**1**	**1**	**1**	**3**	**6**
Ciliata ind.l^{-1}	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**
ZOOPLANKTON ind.l^{-1}	**137**	**322**	**127**	**133**	**145**	**173**	**123**	**114**	**122**	**153**	**241**	**117**

Appendix 2. Monthly variations in abundance of Zooplankton (Second Year)

	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct
ROTIFERA												
B. quadridentatus (Hermann)	5	1	0	0	9	15	30	9	3	2	0	1
Keratella tropica (Apstein)	9	33	48	109	50	17	16	13	9	8	18	11
Plationus patulus (Muller)	7	0	1	0	0	4	5	3	7	2	1	5
Colurella uncinata (Gosse)	2	0	1	1	1	0	1	0	0	0	0	0
C. sulcata (Stenroos)	2	0	0	0	0	0	0	0	3	2	0	2
Lepadella patella (Muller)	1	0	0	1	1	0	0	0	0	1	0	2
Euchlanis dilatata Ehrenberg	2	3	1	0	1	0	0	2	3	3	1	1
Lecane bulla (Gosse)	1	5	2	1	2	8	3	3	7	4	3	5
L. closterocerca (Schmarda)	3	0	0	0	0	0	0	3	2	3	2	3
L. hamata (Stokes)	1	1	2	0	0	2	0	4	2	3	0	3
L. leontina (Turner)	5	2	9	3	5	2	2	0	7	5	4	5
L. lunaris (Ehrenberg)	3	1	1	1	2	1	1	0	0	3	2	2
L. pertica (Harring & Myers)	0	0	0	0	0	0	0	2	3	2	0	1
L. quadridentatus (Ehrenberg)	2	0	1	0	2	2	3	1	2	0	1	2
Cephalodella forficula Ehrenberg)	0	0	0	0	0	0	0	0	0	0	1	0
C. gibba (Ehrenberg)	1	0	0	0	0	0	1	0	0	0	0	0
Monommata grandis	0	0	0	0	0	0	2	3	2	2	1	2
Polyarthra vulgaris Carlin	3	1	1	1	5	3	3	2	1	4	3	3
Dicranophorus sp.	0	0	1	0	0	0	1	0	0	0	0	0
Testudinella emarginula (Stenroos)	3	2	0	2	3	10	23	9	7	9	5	7
T. patina (Hermann)	3	5	7	3	9	11	7	5	4	7	5	5
Trichotria tetractis (Ehrenberg	0	1	0	0	0	1	5	9	3	0	2	5
Trichocerca similis (Wierz.)	2	1	0	0	1	2	0	0	3	2	1	0
Philodina citrina Ehrenberg	0	0	1	1	2	0	1	1	0	1	1	1
P. roseola Ehrenberg	0	0	0	0	0	0	0	0	2	0	1	0
Rotaria neptunia (Ehrenberg)	2	1	0	0	0	1	0	0	0	0	1	0
RHIZOPODA												
Arcella megastoma Ehrenberg	7	11	5	7	1	3	6	0	2	1	3	1
A. discoides Ehrenberg	2	1	0	3	5	3	4	0	3	3	5	2
A. hemispherica (Bernard)	2	2	1	0	0	3	2	0	0	2	2	0
A. vulgaris Ehrenberg	7	9	1	3	1	1	7	1	5	1	1	1
Assulina muscorum Greet	1	0	1	1	0	0	0	0	0	1	0	0
Centropyxis aculeata (Ehrenberg)	5	1	1	1	1	1	1	4	1	2	9	20
Difflugia urceolata Carter	6	5	1	4	1	0	0	0	5	5	7	3
Euglypha ciliata Ehrenberg	0	0	0	0	0	0	0	3	2	0	0	0
E. tuberculata Dujardin	0	2	1	0	0	0	0	0	0	0	1	1
CLADOCERA												
Coronatella anodonta (Daday)	3	3	1	1	0	0	2	3	2	0	2	1
Bosmina longirostris(Muller)	3	2	1	4	0	3	4	8	5	3	5	5
Karualona karua (King)	6	1	2	1	3	2	0	0	0	2	3	0
Ephemeroporus barroisi (Richard)	0	3	2	0	0	0	0	3	5	2	0	3
Chydorus faviformis Birge	0	0	1	1	0	0	4	2	0	0	0	0
C. sphaericus (Muller)	15	2	6	24	5	7	34	5	9	5	5	7
COPEPODA												
Mesocyclops spp.	105	41	165	81	333	100	110	52	85	11	59	66
Nauplii	15	2	31	6	32	29	13	13	10	7	26	5
CILIATA												
Epistylis	1	0	0	0	0	0	1	0	0	0	0	0
NEMATODA	1	1	0	1	1	0	1	5	1	0	5	1
Rotifera ind.l^{-1}	**62**	**60**	**81**	**130**	**100**	**88**	**108**	**71**	**80**	**82**	**96**	**74**
Rhizopoda ind.l^{-1}	**30**	**31**	**11**	**19**	**9**	**11**	**20**	**8**	**18**	**15**	**28**	**28**
Cladocera ind.l^{-1}	**27**	**11**	**13**	**31**	**8**	**12**	**44**	**21**	**21**	**12**	**15**	**16**
Copepoda ind.l^{-1}	**120**	**43**	**196**	**87**	**365**	**129**	**123**	**65**	**95**	**18**	**85**	**71**
Nematode ind.l^{-1}	**1**	**1**	**0**	**1**	**1**	**0**	**1**	**5**	**1**	**0**	**5**	**1**
Ciliata ind.l^{-1}	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**
ZOOPLANKTON ind.l^{-1}	**241**	**146**	**301**	**268**	**483**	**240**	**297**	**170**	**215**	**127**	**229**	**190**

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New earthworm records from the former Yugoslav countries (Oligochaeta, Lumbricidae)

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Abstract. A rich earthworm material from different countries of the former Yugoslavia has been elaborated. Altogether 39 species and subspecies are reported including six new records. *Aporrectodea cemernicensis* proved to be new to the fauna of Serbia, *Eisenia spelaea* to Bosnia-Herzegovina, *Aporrectodea sineporis* is new to Croatia and *Denrobaena hrabei* to Macedonia. *Dendrobaena cognettii* represents a new record to the fauna of Croatia and Macedonia. *Dendrodrilus rubidus subrubicundus* is new to the fauna of Montenegro.

Keywords. Earthworms, faunistics, new records, former Yugoslavia

INTRODUCTION

The earthworm fauna of the former Yugoslavian countries is more or less well explored. The beginning of the researches goes back to the turn of the last century (Rosa 1897, Szüts 1919, Černosvitov 1930, 1935, 1938). These early researches were later followed by local scientists as well (Karaman 1972, Šapkarev 1972, 1977, 1979).

The most complete summary of the earthworms of the Balkan Peninsula including Yugoslavia was presented by Mršić (1991), recording altogether 135 species and subspecies from this region; by countries 57 from Serbia, 68 from Slovenia, 59 from Croatia, 47 from Macedonia, 45 from Bosnia-Herzegovina and 36 from Montenegro.

After this comprehensive work, only a few papers dealt with the earthworm fauna of the former Yugoslav states (Šapkarev 1993, Stojanović & Karaman 2006, 2007, Stojanović *et al.* 2008). The recent data are mainly from Serbia (Karaman & Stojanović 1996, 2002, Stojanović & Karaman 2003a, 2005a, 2005b, Milutinović *et al.* 2010), Macedonia (Šapkarev 1991, 2001) and Montenegro (Stojanović & Karaman 2003b).

In the last decade, researchers of the Hungarian Natural History Museum organized several collecting trips to the Balkan Peninsula (Fehér et al. 2004, Murányi *et al.* 2011). The rich earthworm material collected from the former Yugoslav countries has recently been elaborated and the results are presented herein.

MATERIAL AND METHODS

Earthworms were collected by the diluted formaldehyde method (Raw 1959), complemented with digging and searching under stones and the bark of fallen logs. The specimens were killed and fixed in 96% ethanol then transferred into 75% ethanol and deposited in the earthworm collection of the Hungarian Natural History Museum (HNHM). For later molecular studies, tail parts of specimens of taxonomic importance were placed into 96% ethanol.

RESULTS

Allolobophora mehadiensis voivodinensis (Šapkarev, 1989)

Allolobophora (Serbiona) mehadienis voivodinensis Šapkarev, 1989: 40.
Serbiona mehadiensis voivodinensis: Mršić 1991: 189.

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Material examined. HNHM/16029, 3 ex., Serbia, Đerdap Mts., Donji Milanovac, 335 m, oak forest, N44°28,551' E22°04,406', 28.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16038, 3 ex., Serbia, Đerdap Mts., Rudna Glava, 151 m, meadow with a nut tree, N44°18,662' E22°07,016', 26.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16051, 2 ex., Serbia, Đerdap Mts., Golubinje, 194 m, orchard around a house, N44°30,996' E22°12,913', 26.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16053, 1 ex., Serbia, Đerdap Mts., Golubinje, 191 m, dry oak forest, N44°33,922' E22°14,893', 26. 10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári.

Allolobophora robusta robusta Rosa, 1895

Allolobophora robusta Rosa, 1895: 2., Zicsi 1982: 437.
Serbiona robusta robusta: Mršić 1991: 193., Stojanović & Karaman 2007: 23.
Allolobophora robusta robusta: Csuzdi *et al.* 2011: 12.

Material examined. HNHM/16020, 6 ex., Serbia, Đerdap Mts., Miroč, 502 m, beech forest fragment on a pasture, N44°30,154' E22°15,018', 26.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16026, 4 ex., Serbia, Đerdap Mts., Lepenski Vir, small valley at the Eastern end of Tunnel 10, 127 m, mixed forest, N44°33,959' E22°01,202', 28.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16028, 10 ex., Serbia, Đerdap Mts., Donji Milanovac, 335 m, oak forest, N44°28,551' E22°04,406', 28.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16031, 4 ex., Serbia, Đerdap Mts., between Miroč and Brza Palanka, 407 m, beech forest, N44°28,616' E22° 21,074', 27.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16036, 2 ex., Serbia, Đerdap Mts., Golubinje, 194 m, orchard around a house, N44°30,996' E22°12,913', 26.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16054, 2 ex., Serbia, Đerdap Mts., Miroč, 502 m, beech forest fragment on a pasture, N44°30,154' E22° 15,018', 26.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári.

Remarks. The new specimens from the Đerdap Mts. are smaller than those of Băile Herculane, Romania (Csuzdi *et al.* 2011) but morphologically fit well in the description of the nominal subspecies.

Allolobophora sturanyi sturanyi Rosa, 1895

(Figure 1)

Allolobophora sturanyi Rosa, 1895: 5., Zicsi 1982: 439.
Karpatodinariona sturanyi: Mršić 1991: 250., Stojanović *et al.* 2008: 59.
Allolobophora sturanyi sturanyi: Csuzdi & Pop 2008a: 26.

Material examined. HNHM/16046, 1 ex., Serbia, Đerdap Mts., Golubinje, 191 m, dry oak forest, N44°33,922' E22°14,893', 26.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16052, 1 ex., Serbia, Đerdap Mts., Golubinje, 191 m, dry oak forest, N44°33,922' E22°14,893', 26. 10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári.

Allolobophoridella eiseni (Levinsen, 1884)

Lumbricus eiseni Levinsen, 1884: 241.
Allolobophoridella eiseni: Mršić 1991: 254., Csuzdi *et al.* 2011: 12.
Eisenia eiseni: Karaman & Stojanović 2002: 224.

Material examined. HNHM/15899, 1 ex., Macedonia, Prov. Veles, Babuna valley, between Omorani and Martolci, 04.04.2004., leg. Z. Erőss, Z. Fehér, A. Hunyadi; HNHM/15903, 2 ex., Macedonia, Prov. Gostivar, along the Mavrovi Anovi–Galičnik road, 2,6 km after the junction to Mavrovo, beech forest, 1500 m, 09.04.2004., leg. Z. Erőss, Z. Fehér, A. Hunyadi; HNHM/15877, 2 ex., Montenegro, 3 km SE of Grnčar along the Gushinje–Shkodër road, beech forest, 962 m, 04. 10.2005., leg. D. Murányi; HNHM/15885, 1 ex., Montenegro, E of Velika, Murino 18 km toward Čakor-pass, mixed pine forest, subalpine grassland, 1554 m, 05.10.2005., leg. D. Murányi; HNHM/15682, 1 ex., Serbia, Fruska Gora, Petrovarazdin, mesic forest, 2 km E from the pass, 19. 04.2004., leg. J. Kontschán; HNHM/15957, 1 ex., Serbia, 9 km E of Surdulica, dam of Vrla stream, 20 km from Vladičin Han, non limestone rocks, 890 m, 08.04.2006., leg. Z. Erőss, Z. Fehér, A.

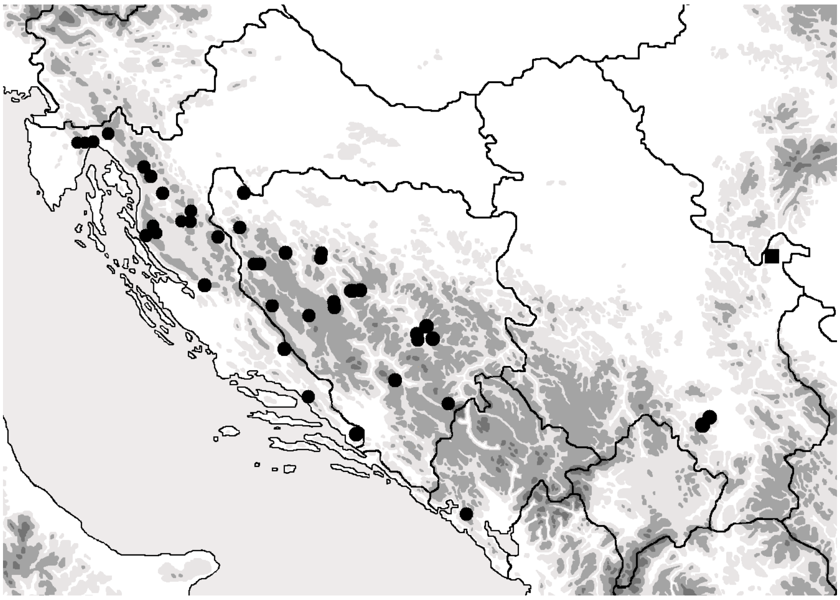

Figure 1. Distribution of *A. sturanyi sturanyi* Rosa, 1895. Black dots = literature data, black square = new record.

Hunyadi, D. Murányi; HNHM/16024, 1 ex., Serbia, Đerdap Mts., Golubinje, foot of Mt. Mali Štrbac, 120 m, old beech forest, N44°38,201’ E22°18,418’, 27.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16039, 1 ex., Serbia, Đerdap Mts., Majdanpek, 326 m, alder forest along a stream, N44°22,823’ E21°59,162’, 26.10. 2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári.

Remarks. This species is quite common in the Balkan found almost exclusively under bark of fallen logs.

Aporrectodea cemernicensis Mršić, 1991

(Figure 2)

Aporrectodea (Aporrectodea) cemernicensis Mršić, 1991: 284.

Material examined. HNHM/15927, 6 ex., Serbia, Đerdap Mts., Golubinje, stream valley with young forest N of the village, 88 m, N44°30,993’ E22°12,692’, 13.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi.

Remarks. This species was described from Bosnia-Herzegovina and this is its first record from Serbia.

Aporrectodea georgii (Michaelsen, 1890)

Allolobophora georgii Michaelsen, 1890: 3.

Aporrectodea (Aporrectodea) georgii: Mršić 1991: 315.

Aporrectodea georgii: Milutinović *et al.* 2010: 629.

Material examined. HNHM/15940, 2 ex., Macedonia, Valandovsko Basin, Rabrovo, grassland along the Anska River S of the village, 104 m, N41°18,248’ E22°35,185’, 18.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi.

Aporrectodea handlirschi (Rosa, 1897)

Allolobophora handlirschi Rosa, 1897: 3.

Aporrectodea (Aporrectodea) handlirschi: Mršić 1991: 292.

Aporrectodea handlirschi: Csuzdi & Zicsi 2003: 84.

Aporrecodea handlirschi handlirschi: Stojanović *et al.* 2008: 59.

Material examined. HNHM/15935, 4 ex., Macedonia, Demir Kapija, Vardar River, gallery forest and dry grassland E of the city, 115 m, N41°24,348’ E22°15,938’, 17.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15938, 4 ex., Macedonia, Belasica Mts., Kolešino, rude-

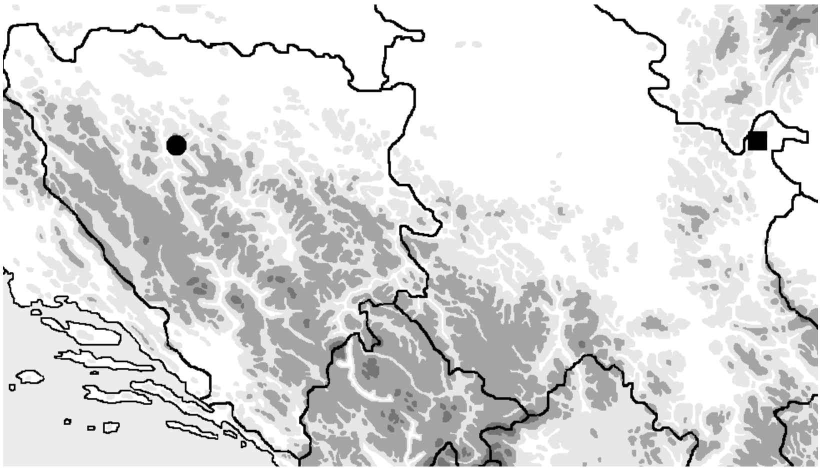

Figure 2. Distripution of *Ap. cemernicensis* Mršić, 1991. Black dot = type locality, black square = new record.

ral vegetation above the village, 300 m, N41° 22,780' E22°48,580', 18.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15654, 1 ex., Serbia, Đerdap Mts., Dobra, limestone rocks and secondary forest, 105 m, N44°34,913' E22° 01,190', 12.10.2006 leg. L. Dányi, J. Kontschán, D. Murányi.

Aporrectodea rosea (Savigny, 1826)

Enterion roseum Savigny, 1826: 182.
Aporrectodea (Aporrectodea) rosea rosea: Mršić 1991: 296.
Aporrectodea rosea: Šapkarev 2001: 111., Stojanović & Karaman 2003b: 55., 2005a: 128.

Material examined. HNHM/15645, 1 ex., Serbia, Gamzigrad, Crni Timok River and its gallery, 183 m, N43°55,510' E22°07,770', 14.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi.

Remarks. *Aporrectodea rosea* is a common peregrine species distributed all over the Balkans but its collection was not forced.

Aporrectodea sineporis (Omodeo, 1952)

(Figure 3)

Eiseniella balcanica sine-poris Omodeo, 1952: 31.
Aporrectodea (Aporrectodea) sineporis: Mršić 1991: 287.
Aporrectodea sineporis: Csuzdi & Zicsi 2003: 99., Stojanović & Karaman 2005b: 133., Milutinović *et al.* 2010: 629.

Material examined. HNHM/15598, 1 ex., Croatia, Ivanscica, ~250 m below the mountain ridge, sparse northern side, 01.04.2006. leg. Á. Garai, J. Kontschán, D. Murányi; HNHM/15599, 2 ex., Croatia, Ivanscica, Lobor, beech-oak mixed forest, 01.04.2006. leg. Á. Garai, J. Kontschán, D. Murányi; HNHM/15695, 1 ex., Croatia, Papuk, 20.04.2004., leg. J. Kontschán; HNHM/15699, 1 ex., Croatia, Papuk, Drenovac, stream bank, near the bridge, 21.04.2004., leg. J. Kontschán; HNHM/15712, 1 ex., Croatia, Papuk, Jankovac pass, beech forest, 24.10.2004., leg. D. Murányi; HNHM/15633, 1 ex., Serbia, Đerdap Mts., Mosna, stream valley with oak forest at the edge of the village, 99 m, N44°25,777' E22°10,633', 12.10. 2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15648, 1 ex., Serbia, Đerdap Mts., Mosna, stream valley with oak forest at the edge of the village, 99 m, N44°25,777 E22°10,633', 12.10. 2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/16042, 2 ex., Serbia, Đerdap Mts., Majdanpek, 326 m, alder forest along a stream, N44° 22,823' E21°59,162', 26.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16050, 3 ex., Serbia, Đerdap Mts., Golubinje, 135 m, beech for est, N44°30,913' E22°12 831', 26.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári.

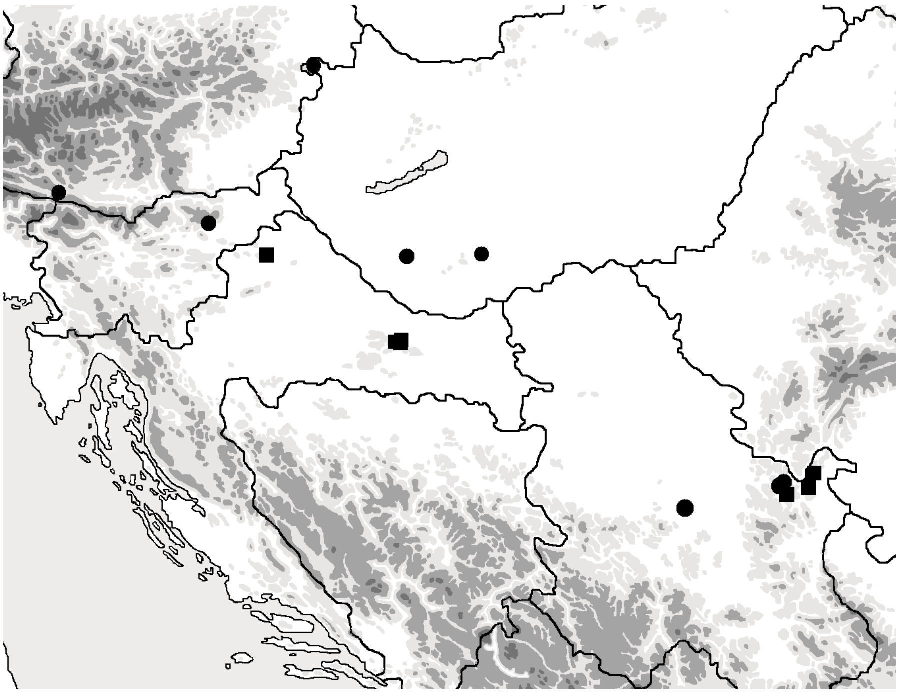

Figure 3. Distribution of *Ap. sineporis* (Omodeo, 1952). Black dots = literature data, black squares = new records.

Remarks. Csuzdi & Zicsi (2003) described *Ap. sineporis* as a typical Southern-Alpine species. Later findings in Serbia (Stojanović & Karaman 2005b) and the present records in Croatia corroborates the view of Stojanović & Karaman (2005b) that this species has a wider distribution in the Balkan, and fits better in the Illyric type of distribution.

Aporrectodea smaragdina (Rosa, 1892)

Allolobophora smaragdina Rosa, 1892: 5.
Aporrectodea (Aporrectodea) smaragdina: Mršić 1991: 308.
Aporrectodea smaragdina: Stojanović & Karaman 2003b: 55.
Aporrectodea smaragdinoides Šapkarev, 1989: 42. **syn. nov.**
Aporrectodea (Aporrectodea) smaragdinoides: Mršić 1991: 312.

Material examined. HNHM/15854, 1 ex., Bosnia-Herzegovina, Zelengora, Suha, spring above the settlement, 1112 m, N43°15,892’ E18° 35,595’, 10.05.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15861, 2 ex., Bosnia-Herzegovina, Zelengora, Tjentište, sidebrook of the Sutjeska River above the settlement, 765 m, N43°17,372’ E18°37,067’, 09.05.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15884, 1 ex., Montenegro, Lim valley, River Lim 4 km S of Brodarevo, river, limestone rocks, roadside bush, 530 m, 03.10.2005., leg. D. Murányi; HNHM/15980 1 ex., Slovenia, Moste, near the lake, 630 m, beech forest with pine trees, N46°24,418’ E14°08,767’, 13.04.2006., leg. L. Dányi, J. Kontschán.

Remarks. Šapkarev (1989) described *Ap. smaragdinoides* because it has not expressed the intensive emerald-green colour, characteristic for *Ap. smaragdina,* and possessed slightly longer clitellum (24–33 vs. 25, 26–33). Already Mršić (1991: 313) raised the question of validity the species *Ap. smaragdinoides* but formally did not synonymise the two names. In our material all colour forms (from turquoise green to much paler greenish-grey) occur and all clitellar positions can be observed therefore, *Ap. smaragdinoides* Šapkarev, 1989 is only a synonym name of *Ap. smaragdina* (Rosa, 1892).

Dendrobaena alpina alpina **(Rosa, 1884)**

Allolobophora alpina Rosa, 1884: 28.
Dendrobaena alpina alpina: Mršić 1991: 627., Csuzdi *et al.* 2005: 127.
Dendrobaena alpina: Šapkarev 2001: 112., Stojanović & Karaman 2005a: 129.

Material examined. HNHM/15953, 2 ex., Macedonia, Ogražden Mts., beech forest with a brook at the Prevedena Pass, 1167 m, N41° 33,960' E22°50,643', 18.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/16030, 1 ex., Serbia, Đerdap Mts., Donji Milanovac, 335 m, oak forest, N44°28,551' E22°04,406', 28.10. 2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16033, 6 ex., Serbia, Đerdap Mts., between Miroč and Brza Palanka, 407 m, beech forest, N44°28,616' E22°21,074', 27.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/ 16041, 1 ex., Serbia, Đerdap Mts., Majdanpek, 326 m, alder forest along a stream, N44°22,823' E21°59,162', 26.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári.

Remarks. D. alpina is a polytypic species distributed from France across Central and Southern Europe to Turkey. In the Balkan, apart from *D. alpina alpina* occurs also the subspecies *D. a. popi* mainly in mountainous habitats. The other subspecies *D. a. mavrovensis* Šapkarev, 1971 described from Macedonia according to the online database of Csuzdi (2012) is a synonym of *D. clujensis*.

Dendrobaena alpina popi **Šapkarev, 1971**

Dendrobaena alpina popi Šapkarev, 1971: 160., Mršić 1991: 634., Csuzdi *et al.* 2011: 13.

Material examined. HNHM/15902, 1 ex., Macedonia, Prov. Gostivar, along the Mavrovi Anovi – Galičnik road, 2,6 km after the junction to Mavrovo, beech forest, 1500 m, 09.04.2004., leg. Z. Erőss, Z. Fehér, A. Hunyadi.

Dendrobaena attemsi **(Michaelsen, 1902)**

Helodrilus (Dendrobaena) attemsi Michaelsen, 1902: 74.
Dendrobaena attemsi: Mršić 1991: 604., Šapkarev 2001: 112., Stojanović & Karaman 2005a: 129., Csuzdi *et al.* 2011: 14.

Material examined. HNHM/15853, 1 ex., Bosnia-Herzegovina, Zelengora, Suha, forest spring above the settlement, 1112 m, N43°15,892' E18° 35,595', 10.05.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15905, 1 ex., Macedonia, Prov. Ohrid, Galičica Mts.,19 km W of Carina, along the Carina – Trpejča road, spring, 1370 m, 06.04.2004., leg. Z. Erőss, Z. Fehér, A. Hunyadi; HNHM/15906, 1 ex., Macedonia, Prov. Ohrid, Galičica Mts., 16.6 km W of Carina, along the Carina – Trpejča road, rocky beech forest, 1450 m, 06.04.2004., leg. Z. Erőss, Z. Fehér, A. Hunyadi; HNHM/15907, 1 ex., Macedonia, Prov. Gostivar, 2 km SE of Gorno Jelovce, Planinarski dom Šarski Vodi, beech forest,1275 m, 09.04.2004., leg. Z. Erőss, Z. Fehér, A. Hunyadi; HNHM/ 15936, 4 ex., Macedonia, Ogražden Mts., beech forest with a brook at the Prevedena Pass, 1167 m, N41°33,960' E22°50,643', 18.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15951, 1 ex., Macedonia, Galičica Mts., Leskoec, oak forest above the Prespa Lake, 1217 m, N40° 58,577' E20°53,122', 16.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15952, 1 ex., Macedonia, Peštani, karstic forest above the Ohrid Lake, S of the village, 829 m, N40°58,598' E20° 47,645', 16.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/16022, 1 ex., Serbia, Đerdap Mts., between Majdanpek and Donji Milanovac, 621 m, beech forest, N44°26,659' E21°58,858', 28.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári.

Remarks. D. attemsi is a widely distributed Balkanic-Alpine species (Csuzdi *et al.* 2011). In the Romanian literature it was frequently lumped under the name of *D. alpina* (Pop *et al.* 2007).

Dendrobaena auriculifera **Zicsi, 1969**

Dendrobaena auriculifera Zicsi, 1969: 381., Mršić 1991: 574.

Material examined. HNHM/15981, 1 ex., Slovenia, Moste, near the lake, 630 m, beech forest with pine trees, N46°24,418’ E14°08,767’, 13.04. 2006., leg. L. Dányi, J. Kontschán.

Dendrobaena byblica byblica **(Rosa, 1893)**

Allolobophora byblica Rosa, 1893a: 4.
Dendrobaena byblica (part.): Mřsić 1991: 566., Csuzdi *et al.* 2011: 14.
Dendrobaena byblica: Šapkarev 2001: 113., Stojanović & Karaman 2005a: 129.

Material examined. HNHM/15649, 1 ex., Serbia, Đerdap Mts., Mosna, stream valley with oak forest at the edge of the village, 99 m, N44° 25,777’ E22°10,633’, 12.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi.

Remarks. *D. byblica* is a widely distributed polytypic species complex which urgently needs revision (Csuzdi & Pavlíček 1999). Zicsi (1991) resurrected the species *D. ganglbaueri* (Rosa, 1894) which clearly differs from *D. byblica* in the position of the clitellum (24–29 vs. 25–30). In the present work *D. ganglbaueri* is also recognized as a valid species.

Dendrobaena cognettii **(Michaelsen, 1903)**

Helodrilus cognettii Michaelsen, 1903: 130.
Dendrobaena cognettii: Zicsi 1982: 426., Csuzdi & Zicsi 2003: 114.
Dendrobaena pygmaea: Mršić 1991: 643., Blakemore 2004: 2.

Material examined. HNHM/15620, 1 ex., Croatia, Krk Island, Glavotok, oak forest, 30.04. 2006., leg. L. Dányi; HNHM/15950 1 ex., Macedonia, Šar Planina, Tetovo, Popova Šapka, beech forest, 1153 m, N42°00,940’ E20°55,597’, 15.10. 2006., leg. L. Dányi, J. Kontschán, D. Murányi.

Remarks. This species has not been recorded from the former Yugoslavia (Mršić 1991) therefore it is new to the fauna of Croatia and Macedonia as well.

Dendrobaena ganglbaueri **(Rosa, 1894)**

Allolobophora (Dendrobaena) ganglbaueri Rosa, 1894: 1.
Dendrobaena byblica (part.): Mršić 1991: 566.
Dendrobaena ganglbaueri: Zicsi 1991: 176., Csuzdi & Zicsi 2003: 116.

Material examined. HNHM/15595, 1 ex., Croatia, Ivanscica, near the mountain foot, mixed beech forest, 01.04.2006. leg. Á. Garai, J. Kontschán, D. Murányi; HNHM/15628, 1 ex., Croatia, Papuk, Drenovac, stream bank, 21.04.2004., leg. J. Kontschán; HNHM/15629, 1 ex., Croatia, Papuk, Novo Zvecevo, after the village, stream bank, 22.04.2004., leg. J. Kontschán; HNHM/ 15687, 2 ex., Croatia, Papuk, Novo Zvecevo, after the village, stream bank, 22.04.2004., leg. J. Kontschán; HNHM/15693, 4 ex., HNHM/15692, 6 ex., Croatia, Papuk, 20.04.2004., leg. J. Kontschán; HNHM/15893, 1 ex., Serbia, 14 km S of Valjevo, 500 m, 19.10.2002., leg. J. Kontschán.

Dendrobaena hortensis **(Michaelsen, 1890)**

Allolobophora subrubicunda var. *hortensis* Michaelsen, 1890: 15.
Dendrobaena hortensis: Mršić 1991: 622., Stojanović & Karaman 2005a: 129.

Material examined. HNHM/15647, 3 ex., Macedonia, Ohrid Lake and lakeshore N of Peštani, 695 m, N41°02,857’ E20°48,093’, 16.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/ 15904, 1 ex., Macedonia, Prov. Resen, Krani, the upper end of the village, stream bank, spring, 990 m, 05.04.2004., leg. Z. Erőss, Z. Fehér, A. Hunyadi; HNHM/15933, 4 ex., Macedonia, Sveti Naum, springs and spring lake above the Ohrid Lake, 704 m, N40°54,595’ E20°44,868’, 16.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15945, 1 ex., Macedonia, Sveti Naum, springs and spring lake above the Ohrid Lake, 704 m, N40°54,595’ E20°44,868’, 16.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15954, 1 ex., Macedonia, Pelister Mts, Nižepole, brooks in alpine grasslands and beech forests around the ski course, 1375 m, N40°58,812’ E21°15,165’, 17.10. 2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15948, 1 ex., Serbia, Đerdap Mts., quarry N of Golubinje, 100 m, N44°34,143’ E22° 14,735’, 13.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi.

Dendrobaena hrabei (Černosvitov, 1934)

(Figure 4)

Eisenia veneta var. *hrabei* Černosvitov, 1934: 72.
Dendrobaena hrabei: Mršić 1991: 631.

Material examined. HNHM/15935, 5 ex., Macedonia, Ogražden Mts., beech forest with a brook at the Prevedena Pass, 1167 m, N41°33,960' E22° 50,643', 18.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi

Remarks. This species was described from Bulgaria and this is the first record from Macedonia.

Dendrobaena octaedra (Savigny, 1826)

Enterion octaedrum Savigny, 1826: 183.
Dendrobaena octaedra: Mršić 1991: 607., Stojanović & Karaman 2003: 55., 2005a: 130.

Material examined. HNHM/15694, 1 ex., Croatia, Papuk, 20.04.2004., leg. J. Kontschán; HN HM/15934, 2 ex., Macedonia, Jakupica Mts., Bogomila, Babuna River and its softwood gallery below the village, 460 m, N41°35,610' E21° 30,260', 19.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15941, 1 ex., Macedonia, Šar Planina, Tetovo, Popova Šapka, brook in alpine grassland, 1792 m, N42°00,910' E20° 52,612', 15.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15651, 2 ex., Serbia, Đerdap Mts., Majdanpek, dry beech forest, 141 m, N44° 24,983' E21°56,277', 13.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15897, 1 ex., Serbia, 14km S of Valjevo, 500m, 19.10.2002., leg. J. Kontschán; HNHM/15876, 1 ex., Serbia, Ibar River valley, 1 km SW of Spiljani, river and the littoral alders, limestone rocks, karstic forest, 829 m, 12.10.2005., leg. D. Murányi.

Dendrobaena papukiana Mršić, 1988

Dendrobaena papukiana Mršić, 1988: 16., Mršić 1991: 579.

Material examined. HNHM/15698, 2 ex., Croatia, Papuk, Novo Zvecevo, after the village, stream bank, 22.04.2004., leg. J. Kontschán; HN HM/15711, 8 ex., Croatia, Papuk, Jankovac pass, beech forest, 24.10.2004., leg. D. Murányi.

Rermark. This species has not been reported so far since the original description.

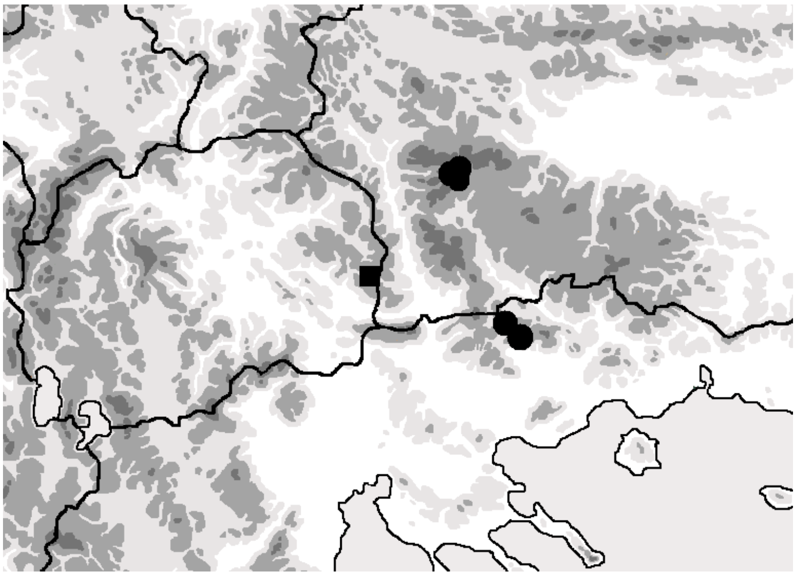

Figure 4. Distribution of *D. hrabei* (Černosvitov, 1934). Black dots = literature data, black square = new record.

Dendrobaena veneta veneta (Rosa, 1886)

Allolobophora veneta Rosa, 1886: 674.
Dendrobaena veneta veneta: Mršić 1991: 613.

Material examined. HNHM/15646, 4 ex., Macedonia, Ohrid Lake and lakeshore N of Peštani, 695 m, N41°02,857' E20°48,093', 16.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15932, 2 ex., Macedonia, Sveti Naum, springs and spring lake above the Ohrid Lake, 704 m, N40°54,595' E20°44,868', 16.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15947, 4 ex., Macedonia, Sum, spring lake, grassland and pine forest above the Ohrid Lake, 707 m, N41°10,972' E20°37,928', 16.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15949, 3 ex., Serbia, Đerdap Mts., quarry N of Golubinje, 100 m, N44°34,143' E22°14,735', 13.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi

Dendrodrilus rubidus rubidus (Savigny, 1826)

Enterion rubidum Savigny, 1826: 182.
Dendrodrilus rubidus rubidus: Mršić 1991: 263., Šapkarev 2001: 111., Stojanović & Karaman 2005a: 130., Blakemore 2008: 584.
Dendrodrilus rubidus tenuis: Šapkarev 2001: 111., Stojanović & Karaman 2003b: 56., 2005a: 130., Blakemore 2008: 584.

Material examined. HNHM/15643, 1 ex., Serbia, Gamzigrad, Crni Timok River and its gallery, 183 m, N43°55,510' E22°07,770', 14.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15688, 1 ex., Serbia, Fruska Gora, Grgurevci, mesic forest, 2 km E from the pass, 19.04.2004., leg. J. Kontschán.

Dendrodrilus rubidus subrubicundus (Eisen, 1873)

Allolobophora subrubicunda Eisen, 1873: 51.
Dendrodrilus rubidus subrubicundus: Mršić 1991: 267., Šapkarev 2001: 111., Blakemore 2008: 585.
Dendrodrilus rubidus subrubicunda: Karaman & Stojanović 2002: 224.

Material examined. HNHM/15942, 1 ex., Macedonia, Šar Planina, Tetovo, Popova Šapka, brook in alpine grassland, 1792 m, N42°00,910' E20°52,612', 15.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15946, 1 ex., Macedonia, Sveti Naum, springs and spring lake above the Ohrid Lake, 704 m, N40°54,595' E20°44,868', 16.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/16007, 2 ex., Macedonia, Polog region, Reka Mts., Vrben, stream in the village 1285 m, N41°43,359' E20°44,149', 16.05.2010., leg. Z. Fehér, D. Murányi, Zs. Ujvári; HNHM/15886, 1 ex., Montenegro, Lim valley, River Lim 4 km S of Brodarevo, limestone rocks, roadside bush, 530 m, 03.10.2005., leg. D. Murányi; HNHM/15683, 1 ex., Serbia, Fruska Gora, Petrovarazdin, mesic forest, 2 km E from the pass, 19.04.2004., leg. J. Kontschán; HNHM/15928, 1 ex., Serbia, Đerdap Mts., Golubinje, stream valley with young forest N of the village, 88 m, N44°30,993' E22°12,692', 13.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/16034, 2 ex., Serbia, Đerdap Mts., Golubinje, foot of Mt. Veliki Štrbac, 93 m, beech forest, N44°35,690' E22°16,073', 26.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16035, 1 ex., Serbia, Đerdap Mts., Dobra, 502 m, beech forest, N44°34,987' E21°58,736', 28.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16040, 3 ex., Serbia, Đerdap Mts., Majdanpek, 326 m, alder forest along a stream, N44°22,823' E21°59,162', 26.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16045, 2 ex., Serbia, Đerdap Mts., Mala Orlova, 91 m, beech-alder forest with stream, N44°38,730' E21°48,769', 25.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16055, 2 ex., Serbia, Đerdap Mts., Majdanpek, 326 m, alder forest along a stream, N44°22,823' E21°59,162', 26.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári.

Remarks. Acording to Mršić (1991) and Stojanović & Karaman (2003), this peregrine subspecies has not been reported so far from Montenegro.

Eisenia fetida (Savigny, 1826)

Enterion fetidum Savigny, 1826: 182.
Eisenia fetida: Mršić 1991: 497., Blakemore 2008: 587.
Eisenia foetida: Šapkarev 2001: 111.

Material examined. HNHM/16006, 6 ex., Macedonia, Polog region, Reka Mts., Vrben, stream in the village, 1285 m, N41°43,359' E20°44,149', 16.05.2010., leg. Z. Fehér, D. Murányi, Zs. Ujvári.

Eisenia lucens (Waga, 1857)

Lumbricus lucens Waga, 1857: 161.
Eisenia lucens: Mršić 1991: 500., Šapkarev 2001: 111., Csuzdi & Zicsi 2003: 146., Stojanović & Karaman 2005a: 130.

Material examined. HNHM/15926, 5 ex., Macedonia, Osogovski Planina, Sasa, valley of a sidebrook of the Kamenica Stream above the village, 1007 m, N42°06,507' E22°31,555', 19. 10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15544, 2 ex., Serbia, Đerdap Mts., Golubinje, foot of Mt. Mali Štrbac, 120 m, old beech forest, N44°38,201' E22°18,418', 27.10. 2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/15653, 4 ex., Serbia, Đerdap Mts., Donji Milanovac, Grgeči spring and its outlet in a beech forest, ~500 m, N44°28' E22°02', 13.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/ 15691, 6 ex., Serbia, Fruska Gora, Petrovarazdin, ruderal habitat, 3 km under the pass, 19.04.2004. leg. J. Kontschán; HNHM/15918, 2 ex., Serbia, 6 km E of Surdulica, 17 km from Vladičin Han, forest, 750 m, 08.04.2006., leg. Z. Erőss, Z. Fehér, A. Hunyadi, D. Murányi; HNHM/15939, 1 ex., Serbia, Krajište Mts., Surdulica, Vrla River above the city, 712 m, N42°41,288' E22°15,125', 20.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15956, 3 ex., Serbia, 9 km E of Surdulica, dam of Vrla stream, 20 km from Vladičin Han, non limestone rocks, 890 m, 08.04. 2006., leg. Z. Erőss, Z. Fehér, A. Hunyadi, D. Murányi; HNHM/16027, 2 ex., Serbia, Đerdap Mts., Lepenski Vir, small valley at the Eastern end of Tunnel 10 , 127 m, mixed forest, N44° 33,959' E22°01,202', 28.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16047, 12 ex., Serbia, Đerdap Mts., Golubinje, foot of Mt. Veliki Štrbac, 93 m, beech forest, N44°35,690' E22° 16,073', 26.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16048, 1 ex., Serbia, Đerdap Mts., Golubinje, foot of Mt. Mali Štrbac, 105 m, rocky roadside under an oak forest, N44°36,561' E22°16,465', 27.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári.

Eisenia spelaea (Rosa, 1901)

Allolobophora spelaea Rosa, 1901: 36.
Eisenia spelaea: Mršić 1991: 503., Csuzdi & Zicsi 2003: 149.

Material examined. HNHM/15852, 3 ex., Bosnia-Herzegovina, Zelengora, Suha, forest spring above the settlement, 1112 m, N43°15,892' E18° 35,595', 10.05.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15594, 3 ex. Croatia, Ivanscica, near the mountain foot, mixed beech forest, 01.04.2006. leg. Á. Garai, J. Kontschán, D. Murányi; HNHM/15597, 1 ex., Croatia, Ivanscica, above Prigorec, stream bank, 01.04.2006., leg. Á. Garai, J. Kontschán, D. Murányi; HNHM/15627, 1 ex., Croatia, Papuk, Drenovac, stream bank, 21.04.2004., leg. J. Kontschán; HNHM/15686, 1 ex., Croatia, Papuk, Novo Zvecevo, after the village, stream bank, 22.04.2004., leg. J. Kontschán; HNHM/15978, 10 ex., Slovenia, Golnik, 460 m, mixed beech forest, N46°19,700' E14° 20,585', 14.04.2006., leg. L. Dányi, J. Kontschán.

Remarks. This species is new to the fauna of Bosnia-Herzegovina.

Fitzingeria platyura platyura (Fitzinger, 1833)

Enterion platyurum Fitzinger, 1833: 553.
Fitzingeria platyura platyura: Mršić 1991: 542., Stojanović & Karaman 2005a: 130.

Material examined. HNHM/15955, 1 ex., Serbia, 9 km E of Surdulica, dam of Vrla stream, 20 km from Vladičin Han, non limestone rocks, 890 m, 08.04.2006., leg. Z. Erőss, Z. Fehér, A. Hunyadi, D. Murányi.

Fitzingeria platyura depressa (Rosa, 1893)

Allolobophora platyura depressa Rosa, 1893b: 439.
Fitzingeria platyura depressa: Mršić 1991: 543.
Fitzingeria viminiana Mršić 1986: 111. (Csuzdi & Zicsi 2003).

Material examined. HNHM/15697, 1 ex., Croatia, Papuk, Novo Zvecevo, after the village, stream bank, 22.04.2004., leg. J. Kontschán; HNHM/15650, 1 ex., Serbia, Đerdap Mts., Mosna, stream valley with oak forest at the edge of the village, 99 m, N44°25,777' E22°10,633', 12.10. 2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15929, 1 ex., Serbia, Đerdap Mts., Golubinje, stream valley with young forest N of the village, 88 m, N44°30,993' E22°12,692', 13.10. 2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/16021, 1 ex., Serbia, Đerdap Mts., between Majdanpek and Donji Milanovac, 621 m, beech forest, N44°26,659' E21°58,858', 28.10. 2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16025, 4 ex., Serbia,, Đerdap Mts., Dobra, 314 m, beech forest, N44°35,755' E21° 51,483', 28.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16044, 1 ex., Serbia, Đerdap Mts., Mala Orlova, 91 m, beech-alder forest with stream, N44°38,730' E21°48,769', 25.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/ 16049, 2 ex., Serbia, Đerdap Mts., Golubinje, 135 m, beech forest, N44°30,913' E22°12,831', 26.10. 2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári.

Lumbricus castaneus (Savigny, 1826)

Enterion castaneum Savigny, 1826: 180.
Lumbricus castaneus: Mršić 1991: 466., Karaman & Stojanović 2002: 224., Blakemore 2008: 623.

Material examined. HNHM/15596, 1 ex., Croatia, Ivanscica, above Prigorec, stream bank, 01.04.2006., leg. Á. Garai, J. Kontschán, D. Murányi; HNHM/15630, 1 ex., Croatia, Papuk, Villic Selo, stream bank, 21.04.2004., leg. J. Kontschán; HNHM/15684, 1 ex., Croatia, Papuk, Drenovac, stream bank near the bridge, 21.04. 2004., leg. J. Kontschán; HNHM/15692, 6 ex., Croatia, Papuk, 20.04.2004., leg. J. Kontschán; HNHM/15700, 3 ex., Croatia, Papuk, Drenovac, stream bank, near the bridge, 21.04.2004., leg. J. Kontschán.

Lumbricus polyphemus (Fitzinger, 1833)

Enterion polyphemum Fitzinger, 1833: 552.
Lumbricus polyphemus: Mršić 1991: 473., Karaman & Stojanović 2002: 224., Stojanović & Karaman 2005a: 128.

Material examined. HNHM/15652, 1 ex., Serbia, Đerdap Mts., Majdanpek, mixed beech forest, 604 m, N44°25,752' E21°57,292', 13.10. 2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15689, 1 ex., Serbia, Fruska Gora, Petrovarazdin, ruderal habitat, 3 km under the pass, 19. 04.2004. leg. J. Kontschán; HNHM/15690, 1 ex., Serbia, Fruska Gora, Petrovarazdin, ruderal habitat, 3 km under the pass, 19.04.2004. leg. J. Kontschán; HNHM/15898, 1 ex., Serbia, Prov. Paracin, along the Paracin – Zaječar road, 1 km W of the junction to Grza, riverside, 280 m, 11.04. 2004., leg. Z. Erőss, Z. Fehér, A. Hunyadi; HNHM/16032, 4 ex., Serbia, Đerdap Mts., between Miroč and Brza Palanka, 407 m, beech forest, N44°28,616' E22°21,074' 27.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári.

Lumbricus rubellus Hoffmeister, 1843

Lumbricus rubellus Hoffmeister, 1843: 187., Mršić 1991: 474., Šapkarev 2001: 112., Stojanović & Karaman 2003b: 56., 2005a: 130.

Material examined. HNHM/15622, 1 ex., Croatia, Krk Island, Glavotok, oak forest, 30.04. 2006., leg. L. Dányi.

Remark. This is a common peregrine species distributed all over the Balkans but its collection was not forced.

Octodriloides kamnensis (Baldasseroni, 1919)

Octolasium complanatus f. *kamnensis* Baldasseroni, 1919: 3.
Octodriloides kamnensis: Zicsi 1986: 107., Mršić 1991: 458.

Material examined. HNHM/15979, 6 ex., Slovenia, Golnik, 460 m, mixed beech forest, N46°19,700' E14°20,585', 14.04.2006., leg. L. Dányi, J. Kontschán.

Remarks. Mršić (1991) regarded *Oi. karawankensis* (Zicsi, 1969) as a synonym of *Oi. kamnensis*. The present material constantly shows the characteristics of *Oi. kamnensis* (tb. 30–39) and differs from *Oi. karawankensis* (tb. 30–40). Recent taxonomic analysis (Pop *et al.* 2008) also suggests the independence of the two species.

Octodriloides kovacevici **(Zicsi, 1970)**

Octolasium (Octodrilus) kovacevici Zicsi, 1970: 169.
Octodriloides kovacevici: Zicsi 1986: 107., Mršić 1991: 452.

Material examined. HNHM/15685, 1 ex., Croatia, Papuk, Kokocak, alder forest, 20.04.2004., leg. J. Kontschán; HNHM/15696, 5 ex., Croatia, Psunj, Strmac, mesic forest, 21.04.2004., leg. J. Kontschán.

Octodrilus complanatus **(Dugès, 1828)**

Lumbricus complanatus Dugès, 1828: 289.
Octodrilus complanatus: Mršić 1991: 398., Karaman & Stojanović 2002: 224., Stojanović & Karaman 2003b: 56., 2005a: 130.

Material examined. HNHM/15623, 1 ex., Croatia, Krk Island, Rudine, near the Biserujka cave, under stone, 29.04.2006., leg. L. Dányi; HNHM/15624, 1 ex., Croatia, Krk Island, Krk, pine and holm oak forest, 29.04.2006., leg. L. Dányi; HNHM/15625, 1 ex., Croatia, Krk Island, Krk, pine and holm oak forest, 29.04.2006., leg. L. Dányi.

Octodrilus lissaensis **(Michaelsen, 1891)**

Allolobophora lissanesis Michaelsen, 1891: 18.
Octodrilus lissaensis: Mršić 1991: 381.
Non *Octodrilus lissaensis*: Zicsi 1991: 179.

Material examined. HNHM/15621, 2 ex., Croatia, Krk Island, Glavotok, oak forest, 30.04. 2006., leg. L. Dányi.

Remarks. The present specimens fit the originnal description form Vis Island (Lissa), Croatia. The above sited Hungarian material (Zicsi 1991) together with the other Carpathian specimens (Zicsi & Pop 1984, Csuzdi & Pop 2006, 2008b) belongs to *Octodrilus compromissus* Zicsi & Pop, 1984. The main difference between the two species is the position of the tubercles. It is on 29–36 in case of *Oc. lissaensis* and 29–37 in *Oc. compromissus.*

Octodrilus transpadanus **(Rosa, 1884)**

Allolobophora transpadana Rosa, 1884: 45.
Octodrilus transpadanus: Mršić 1991: 371.

Material examined. HNHM/15931, 1 ex., Macedonia, Sveti Naum, springs and spring lake above the Ohrid Lake, 704 m, N40°54,595' E20° 44,868', 16.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15943, 5 ex., Macedonia, Prespa Lake and lakeshore S of Oteševo, 852 m, N40°57,930' E20°54,352', 16.10.2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/15944, 1 ex., Macedonia, Sveti Naum, springs above the Ohrid Lake, 704 m, N40°54,595' E20°44,868', 16.10. 2006., leg. L. Dányi, J. Kontschán, D. Murányi.

Octolasion lacteum **(Örley, 1881)**

Lumbricus terrestris var. *lacteus* Örley, 1881: 584.
Octolasium lacteum: Zicsi 1982: 431., Šapkarev 2001: 111., Stojanović & Karaman 2003b: 56., 2005a: 130.
Octolasion tyrtaeum: Mršić 1991: 347.

Material examined. HNHM/15644, 1 ex., Serbia, Gamzigrad, Crni Timok River and its gallery, 183 m, N43°55,510' E22°07,770', 14.10. 2006., leg. L. Dányi, J. Kontschán, D. Murányi; HNHM/16023, 1 ex., Serbia, Đerdap Mts., between Majdanpek and Donji Milanovac, 621 m, beech forest, N44°26,659' E21°58,858', 28.10. 2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári; HNHM/16043, 2 ex., Serbia, Đerdap Mts., Mala Orlova, 91 m, beech-alder forest with stream, N44°38,730' E21°48,769', 25.10.2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári.

Proctodrilus opisthoductus **Zicsi, 1985**

Proctodrilus opisthoductus Zicsi, 1985: 285., Mršić 1991: 130.

Material examined. HNHM/16037 2 ex., Serbia, Đerdap Mts., Rudna Glava, 151 m, meadow with a nut tree, N44°18,662' E22°07,016', 26.10. 2010, leg. L. Dányi, J. Kontschán, Zs. Ujvári.

DISCUSSION

During the recent expeditions altogether 39 earthworm species and subspecies were collected from the former Yugoslavian countries, including six new records. *Ap. cemernicensis* proved to be new to the fauna of Serbia, *E. spelaea* to Bosnia-Herzegovina, *Ap. sineporis* to Croatia as well as *D. hrabei* is new to Macedonia. *D. cognettii* has not been previously reported from the former Yugoslavian countries therefore it represents a new record for the fauna of Croatia and Macedonia. Surprisingly, the peregrine *Dd. rubidus subrubicundus* has also not been reported so far from Montenegro.

Considering the recent data, the number of the known earthworm species and subspecies from the former Yugoslavia is now 147; by countries 70 from Serbia, 69 from Slovenia, 63 from Croatia, 53 from Macedonia, 47 from Bosnia-Herzegovina and 43 from Montenegro.

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New earthworm records from Bulgaria (Oligochaeta, Lumbricidae)

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Abstract. Elaboration of a small earthworm material collected in different parts of Bulgaria resulted in recording altogether 15 species. Surprisingly, the peregrine *Dendrobaena veneta veneta* proved to be new to the fauna of Bulgaria and with this, the present list of Bulgarian earthworms consists of 42 confirmed species and subspecies.

Keywords. Earthworms, faunistics, new records, Bulgaria.

INTRODUCTION

The earthworm fauna of Bulgaria is far from well known, although the beginning of the researches goes back to the end of the 19th century. Rosa (1897) was the first who published data on the Bulgarian earthworms. His work was followed by Černosvitov (1934, 1937), Plisko (1963) Mihailova (1964, 1965, 1966) and Zicsi & Csuzdi (1986). Recently, Valchovski (2012) summarized the knowledge about the Bulgarian earthworm fauna and reported the presence of 50 species and subspecies including several unconfirmed records as well.

In the last decade, researchers of the Hungarian Natural History Museum organized several collecting trips to the Balkan Peninsula. The earthworm material collected from Bulgaria has been elaborated and the results are hereby presented.

MATERIAL AND METHODS

Earthworms were collected by the diluted formaldehyde method (Raw 1959), complemented with digging and searching under stones and the bark of fallen logs. The specimens were killed and fixed in 96% ethanol, then transferred into 75% ethanol and deposited in the earthworm collection of the Hungarian Natural History Museum (HNHM). For later molecular studies, tail parts of specimens of taxonomic importance were placed into 96% ethanol.

The sampling localities in Bulgaria are shown in Figure 1 and in the text the site numbers are indicated in brackets.

RESULTS

Aporrectodea jassyensis (Michaelsen, 1891)

Allolobophora jassyensis Michaelsen, 1891: 15., Plisko 1963: 430., Mihailova 1966: 188.
Aporrectodea (Aporrectodea) jassyensis: Mršić 1991: 316.
Aporrectodea jassyensis jassyensis: Valchovski 2012: 89.

Material examined. HNHM/16074 1 ex., (No. 16) Haskovo province, Gorata Mts., Borislavci, brook in a beech forest W of the village, 225m, N41°39.542' E25°53.406', 29.05.2012., leg. J. Kontschán, D. Murányi, T. Szederjesi; HNHM/16085 1 ex., (No. 16) Haskovo province, Gorata Mts., Borislavci, brook in a beech forest W of the village, 225m, N41°39.542' E25°53.406', 29.05.2012., leg. J. Kontschán, D. Murányi, T. Szederjesi; HNHM/16088 3 ex., (No. 15) Kărdžhali province, Šarta Mts., Pelin, mixed pine forest NE of the village, 645m, N41°31.070' E25°47.010', 29.05.2012., leg. J. Kontschán, D. Murányi, T. Szederjesi.

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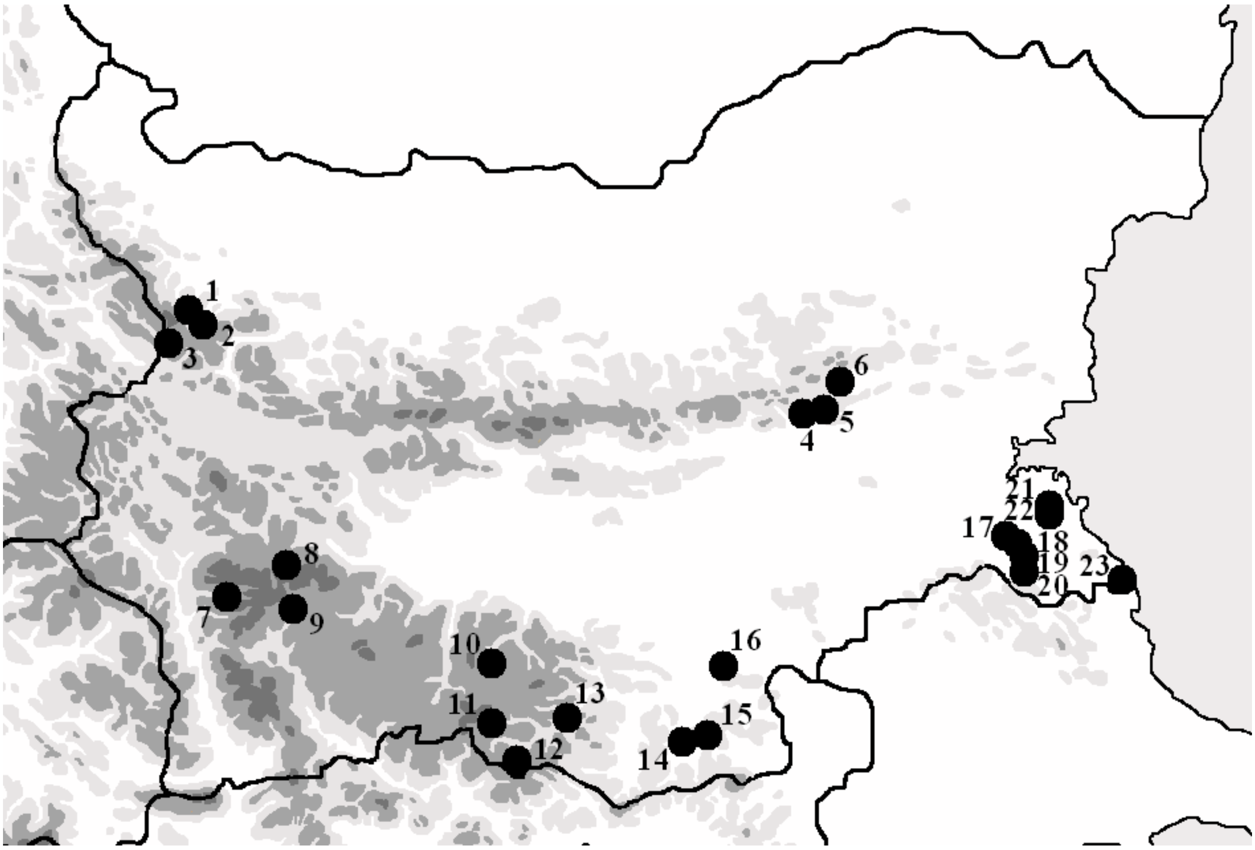

Figure 1. Collecting sites in Bulgaria (for explanations see the text)

Cernosvitovia rebeli (Rosa, 1897)

Allolobophora rebelii Rosa, 1897: 3., Csuzdi & Pop 2007: 20.
Octolasium rebeli: Černosvitov 1934: 77., 1937: 89., Mihailova 1966: 194.
Cernosvitovia (Cernosvitovia) rebeli: Mršić 1991: 148.
Cernosvitovia rebeli: Valchovski 2012: 91.

Material examined. HNHM/15789 1 ex., (No. 22) Burgas province, Strandcha Mts., sidebrook of Ropotamo Stream in an oak forest, 2km N of Jasna poljana, 80m, N42°17.819’ E27°37.246’, 08.04.2007., leg. L. Dányi, Z. Erőss, Z. Fehér, J. Kontschán, D. Murányi; HNHM/16072 1 ex., (No. 16) Haskovo province, Gorata Mts., Borislavci, brook in a beech forest W of the village, 225m, N41°39.542’ E25°53.406’, 29.05.2012., leg. J. Kontschán, D. Murányi, T. Szederjesi; HNHM/16073 1 ex., (No. 16) Haskovo province, Gorata Mts., Borislavci, brook in a beech forest W of the village, 225m, N41°39.542’ E25° 53.406’, 29.05.2012., leg. J. Kontschán, D. Murányi, T. Szederjesi; HNHM/16084 1 ex., (No. 16) Haskovo province, Gorata Mts., Borislavci, brook in a beech forest W of the village, 225m, N41° 39.542’ E25°53.406’, 29.05.2012., leg. J. Kontschán, D. Murányi, T. Szederjesi.

Dendrobaena alpina alpina (Rosa, 1884)

Allolobophora alpina Rosa, 1884: 28.
Eisenia alpina f. *typica*: Černosvitov 1937: 80., Mihailova 1966: 185.
Dendrobaena alpina: Plisko 1963: 437., Zicsi & Csuzdi 1986: 118., Valchovski 2012: 91.
Dendrobaena alpina alpina: Mršić 1991: 627., Csuzdi *et al.* 2006: 127.

Material examined. HNHM/16077 1 ex., (No. 10) Smoljan province, Radjuva Planina, Pavelsko, beech forest and alpine grassland SE of the village, 1545m, N41°49.826’ E24°44.657’, 31.05.

2012., leg. J. Kontschán, D. Murányi, T. Szederjesi.

Dendrobaena attemsi (Michaelsen, 1902)

Helodrilus (Dendrobaena) attemsi Michaelsen, 1902: 74.
Dendrobaena attemsi: Černosvitov 1937: 83., Plisko 1963: 436., Mihailova 1966: 190., Zicsi & Csuzdi 1986: 118., Mršić 1991: 604., Valchovski 2012: 91.

Material examined. HNHM/16071 3 ex., (No. 13) Kărdžhali province, Zălti Djal Mts., Sedlarci, spring and limestone gorge NW of the village, 585m, N41°33.073’ E25°01.783’, 30.05.2012., leg. J. Kontschán, D. Murányi, T. Szederjesi; HNHM/16089 1 ex., (No. 11) Smoljan province, Perelik Mts., Smoljan, forest stream and spruce forest above (N of) the city, 1370m, N41°36.524’ E24°41.498’, 31.05.2012., leg. J. Kontschán, D. Murányi, T. Szederjesi.

Dendrobaena byblica byblica (Rosa, 1893)

Allolobophora byblica Rosa 1893: 4–5.
Dendrobaena ganglbaueri var. *byblica*: Černosvitov 1934: 74., 1937: 84.
Dendrobaena byblica: Plisko 1963: 437., Mršić 1991: 566., Valchovski 2012: 92.

Material examined. HNHM/15579 1 ex., (No. 9) Blagoevgrad province, Rila Mts., Mesta basin, sidebrook of the Stream Ropalica below the Grăničar mountain hut, 2100m, 07.09.2005., leg. M. Földvári, J. Kontschán, D. Murányi, T. Szüts; HNHM/15790 1 ex., (No. 22) Burgas province, Strandcha Mts, sidebrook of Ropotamo Stream in an oak forest, 2km N of Jasna poljana, 80m, N42°17.819’ E27°37.246’, 08.04.2007., leg. L. Dányi, Z. Erőss, Z. Fehér, J. Kontschán, D. Murányi; HNHM/15808 2 ex., (No. 17) Burgas province, Strandcha (Bosna) Mts, Karamlâk stream, gallery and rocks above Mladežko, 210m, N42° 09.080’ E27°21.918’, 07.04.2007., leg. L. Dányi, Z. Erőss, Z. Fehér, J. Kontschán, D. Murányi.

Dendrobaena hortensis (Michaelsen, 1890)

Allolobophora subrubicunda var. *hortensis* Michaelsen, 1890: 15.
Eisenia veneta var. *hibernica*: Mihailova 1966: 187.
Dendrobaena hortensis: Mršić 1991: 622., Valchovski 2012: 92.

Material examined. HNHM/15803 2 ex., (No. 21) Burgas province, Strandcha Mts, Ropotamo Stream and its shore vegetation, 3km N of Jasna poljana, 30m, N42°18.644’ E27°37.428’, 08.04. 2007., leg. L. Dányi, Z. Erőss, Z. Fehér, J. Kontschán, D. Murányi; HNHM/15804 2 ex., (No. 19) Burgas province, Strandcha Mts, Veleka River S of Zvedec, 200m, N42°05.009’ E27°25.662’, 07.04. 2007., leg. L. Dányi, Z. Erőss, Z. Fehér, J. Kontschán, D. Murányi; HNHM/15817 1 ex., (No. 18) Burgas province, Strandcha (Bosna) Mts, Karamlâk stream and its gallery 3km W of Mladežko, 180m, N42°08.817’ E27°24.950’, 07. 04.2007., leg. L. Dányi, Z. Erőss, Z. Fehér, J. Kontschán, D. Murányi.

Dendrobaena octaedra (Savigny, 1826)

Enterion octaedrum Savigny, 1826: 183.
Dendrobaena octaedra: Černosvitov 1937: 83., Plisko 1963: 435., Zicsi & Csuzdi 1986: 118., Mršić 1991: 607., Valchovski 2012: 93.

Material examined. HNHM/16070 4 ex., (No. 13) Kărdžhali province, Zălti Djal Mts., Sedlarci, spring and limestone gorge NW of the village, 585m, N41°33.073’ E25°01.783’, 30.05.2012., leg. J. Kontschán, D. Murányi, T. Szederjesi; HNHM/16078 2 ex., (No. 10) Smoljan province, Radjuva Planina, Pavelsko, beech forest and alpine grassland SE of the village, 1545m, N41°49.826’ E24°44.657’, 31.05.2012., leg. J. Kontschán, D. Murányi, T. Szederjesi; HNHM/ 16083 1 ex., (No. 12) Smoljan province, Ardinski Djal Mts., Koritata, stream and mixed forest SW of the village, 995m, N41°24.089’ E24°46.786’, 30.05.2012., leg. J. Kontschán, D. Murányi, T. Szederjesi; HNHM/16091 3 ex., (No. 11) Smoljan province, Perelik Mts., Smoljan, forest stream and spruce forest above (N of) the city, 1370m, N41° 36.524’ E24°41.498’, 31.05.2012., leg. J. Kontschán, D. Murányi, T. Szederjesi.

Dendrobaena veneta veneta (Rosa, 1886)

Allolobophora veneta Rosa, 1886: 674.
Dendrobaena veneta veneta: Mršić 1991: 613.

Material examined. HNHM/15580 1 ex., (No. 6) Sliven province, Stara Planina, Vârbishka Mts., above Medven, 420m, N42°50.543’ E26°33.950’, 04-05.09.2005., leg. M. Földvári, J. Kontschán, D. Murányi, T. Szüts.

Remark. This peregrine species is new to the fauna of Bulgaria.

Eisenia lucens (Waga, 1857)

Lumbricus lucens Waga, 1857: 161.
Eisenia submontana: Černosvitov 1934: 71., 1937: 79., Mihailova 1966: 184.
Allolobophora latens: Mihailova 1964: 164.
Eisenia lucens: Plisko 1963: 428., Mršić 1991: 500., Valchovski 2012: 94.

Material examined. HNHM/15569 1 ex., (No. 3) Montana province, Stara Planina, 892m, N43°12.319’ E23°03.095’, 28.06.2006., leg. Z. Barina, D. Pifkó, L. Lőkös; HNHM/15570 1 ex., (No. 2) Montana province, Stara Planina, 1002m, N43°08.381' E23°13.095', 28.06.2006., leg. Z. Barina, D. Pifkó, L. Lőkös; HNHM/15593 2 ex., (No. 1) Montana province, Berkovica, 15km along the road to the Petrohanski prohod, 1000m, 25.07.2009., leg. Z. Erőss, Z. Fehér; HNHM/15792 1 ex., (No. 5) Sliven province, Stara Planina (Slivenska Planina), beech forest N of Sinite Kamâni, 830m, N42°44.766’ E26°25.243’, 08.04.2007., leg. L. Dányi, Z. Erőss, Z. Fehér, J. Kontschán, D. Murányi; HNHM/15801 3 ex., (No. 20) Burgas province, Strandcha Mts, stream, gallery, rocks in secondary forest 5km of Malko Târnovo, 280m, N42°01.761’ E27°28.418’, 07.04.2007., leg. L. Dányi, Z. Erőss, Z. Fehér, J. Kontschán, D. Murányi; HNHM/16090 3 ex., (No. 11) Smoljan province, Perelik Mts., Smoljan, forest stream and spruce forest above (N of) the city, 1370m, N41°36.524’ E24°41.498’, 31.05.2012., leg. J. Kontschán, D. Murányi, T. Szederjesi.

Eisenia storkani (Černosvitov, 1934) stat. nov.

Eisenia rosea var. *storkani* Černosvitov 1934: 74., 1937: 80.
Eisenia (Dendrobaena) grandis storkani: Zicsi & Csuzdi 1986: 119.
Eisenia grandis storkani: Mršić 1991: 510., Valchovski 2012: 94.

Material examined. HNHM/15334 1 ex., (No. 4) Sliven province, Stara Planina, Slivenska Mts., Sinite Kamâni Natural Park, Karandila, karstic spring, 05.09.2005., leg. M. Földvári, J. Kontschán, D. Murányi, T. Szüts; HNHM/15582 1 ex., (No. 8) Sofia province, Rila Mts., Marica basin, Stream Prava Marica at Zavračica mountan hut, 2189m, N42°10.073’ E23°38.483’, 08.09.2005., leg. M. Földvári, J. Kontschán, D. Murányi, T. Szüts

Remarks. This species was described by Černosvitov (1934) as *Eisenia rosea* var. *storkani* from Belasica Mts., South-Western Bulgaria. Because of its fasciculated longitudinal musculature and the position of its clitellum (26–32) later, Zicsi & Csuzdi (1986) placed it into the *Eisenia grandis* species group, which unites large bodied species that live mainly in the Caucasus region and possess striped pigmentation. Considering the clitellum and musculature, this species may also belong to the *E. grandis* species group, but its small size and the lack of pigmentation shows that *E. storkani* should be regarded as a separate species. Probably *E. storkani* has closer relations with *E. ebneri* (Michaelsen, 1914), *E. kattoulasi* Zicsi & Michalis, 1981 and *E. oreophila* Szederjesi & Csuzdi 2012, all from Greece.

Eiseniella tetraedra (Savigny, 1826)

Enterion tetraedrum Savigny, 1826: 184.
Eiseniella tetraedra f. *typica*: Černosvitov 1934: 71., 1937: 78., Mihailova 1966: 183.
Eiseniella tetraedra mut. *hercynia*: Černosvitov 1937: 79., Mihailova 1966: 184.
Eiseniella tetraedra pupa: Valchovski 2012: 95.
Eiseniella tetraedra tetraedra: Zicsi & Csuzdi 1986: 120., Mršić 1991: 514., Valchovski 2012: 95.
Eiseniella tetraedra: Plisko 1963: 433., Csuzdi & Zicsi 2003: 153. (for complete synonymy)

Material examined. HNHM/15805 1 ex., (No. 19) Burgas province, Strandcha Mts., Veleka River S of Zvedec, 200m, N42°05.009’ E27°25.662’, 07.04.2007., leg. L. Dányi, Z. Erőss, Z. Fehér, J. Kontschán, D. Murányi.

Lumbricus terrestris Linneaus, 1758

Lumbricus terrestris (part.) Linneaus, 1758: 647.
Lumbricus terrestris: Černosvitov 1937: 90., Plisko 1963: 438., Zicsi & Csuzdi 1986: 120., Mršić 1991: 481., Valchovski 2012: 96.

Material examined. HNHM/15561 1 ex., (No. 7) Sofia province, Rila Mts., Rilski Manastir, 11.08.2005., leg. D. Murányi; HNHM/16081 1 ex., (No. 12) Smoljan province, Ardinski Djal Mts., Koritata, stream and mixed forest SW of the village, 995m, N41°24.089' E24°46.786', 30.05. 2012., leg. J. Kontschán, D. Murányi, T. Szederjesi.

Octodrilus complanatus (Dugès, 1828)

Lumbricus complanatus Dugès, 1828: 289.
Octolasium complanatum: Černosvitov 1937: 90., Mihailova 1966: 193.
Octodrilus complanatus: Mršić 1991: 398., Valchovski 2012: 96.

Material examined. HNHM/16087 1 ex., (No. 14) Kărdžhali province, Boljarsko, Vransko, Krumovica River and a pasture E of the village, 200m, N41°29.505' E25°37.269', 29.05.2012., leg. J. Kontschán, D. Murányi, T. Szederjesi.

Octodrilus transpadanus (Rosa, 1884)

Allolobophora transpadana Rosa, 1884: 45., 1897: 4.
Octolasium rectum: Černosvitov 1934: 76., 1937: 90.
Octodrilus transpadanus: Mršić 1991: 371., Valchovski 2012: 97.

Material examined. HNHM/15809 1 ex., (No. 23) Burgas province, Rezovo, spring and puddles in secondary forest at the mouth of Rezovska River, 6m, N41°59.007' E28°01.648', 08.04. 2007., leg. L. Dányi, Z. Erőss, Z. Fehér, J. Kontschán, D. Murányi.

Octolasion lacteum (Örley, 1881)

Lumbricus terrestris var. *lacteus* Örley, 1881: 584.
Octolasium lacteum: Černosvitov 1934: 76., 1937: 89., Plisko 1963:432., Mihailova 1966: 193., Zicsi & Csuzdi 1986: 120.,
Octolasion tyrtaeum: Mršić 1991: 347.
Octolasion lacteum: Valchovski 2012: 98.

Material examined. HNHM/16082 1 ex., (No. 12) Smoljan province, Ardinski Djal Mts., Koritata, stream and mixed forest SW of the village, 995m, N41°24.089' E24°46.786', 30.05. 2012., leg. J. Kontschán, D. Murányi, T. Szederjesi.

DISCUSSION

According to the present and literature data, the number of recorded earthworm species and subspecies known from Bulgaria is 51. This seems to be relatively few, but we have to consider that Bulgaria is an under-researched area and there have been no focused earthworm collections except a few regions.

Besides, there are some uncertainties in the data published. Mihailova (1968) reported the presence of three Dacian endemisms from Bulgaria; *Octodrilus frivaldszkyi* (Örley, 1885), *Oc. exacystis* (Rosa, 1896) and *Oc. gradinescui* (Pop, 1938). However, *Oc. frivaldszkyi* lives solely in the Transylvanian Island Mts. (Apuseni) (Pop *et al.* 2010) so its presence in Bulgaria is inconceivable. *Oc. gradinescui* (Pop, 1938) occurs only inside the Carpathian Basin and doesn't cross the Carpathians (Csuzdi *et al.* 2011). Although *Oc. exacystis* (Rosa, 1896) is present on the outer side of the Carpathians (Pop 1949) as a typical montane species its occurrence in Bulgaria requires further corroboration.

Aporrectodea carpathica (Cognetti, 1927) a Carpathian endemism was also listed by Mihailova (1964) but this species is missing even from the Southern Carpathians (Csuzdi & Pop 2006).

Again Mihailova (1964) indicated the presence of *Perelia phoebea* (Cognetti, 1913) in Bulgaria. This species was described from Rhodos Isl., Greece and its occurrence in Bulgaria is not plausible.

Another uncertain data is *Allolobophora mehadiensis mehadiensis* (Rosa, 1895), which is also of Dacian origin, but it possesses a wider range, so its occurrence in Bulgaria is feasible, but needs confirmation.

The presence of *Bimastos parvus* (Eisen, 1874) a peregrine species of North American origin is also need to be corroborated. The previously published Hungarian and Romanian records all proved to be misidentifications of *Allolobophoridella eiseni* (Levinsen, 1884) (Csuzdi & Zicsi 2003).

The list of Valchovski (2012) contains also some highly disputed subspecies like *Dd. rubidus tenuis* and *Eis. tetraedra pupa* which are commonly regarded only as parthenogenetic forms (Csuzdi & Zicsi 2003). Consequently the present list of Bulgarian earthworms consists of 42 confirmed species and subspecies.

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Proctodrilus thaleri (Oligochaeta: Lumbricidae) auf einem Hang in Oltenien

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Abstract. The earthworm species *Proctodrilus thaleri* Höser & Zicsi, 2009, a Carpathian endemic, was found in the loess-like sediment of a slope in Oltenia region of Romania. On the basis of the pedological findings at the site it was concluded that there the species inhabits a pseudogley-lessived-terra fusca interference zone, characterized by recent clay translocation, and very rare in Central Europe. Consequently the species differs with respect to habitat from *P. tuberculatus* (Černosvitov, 1935), which was encountered on other slopes and is probably tied to soils with advanced, relict, or recent clay translocation, as is the case in interference-free lessived soils or pseudogley-lessived soils.

Keywords. Earthworms, slope soil catena, lessivage, Romania, endemic species, ecological vicariants.

EINLEITUNG

Bisher kennen wir vier Regenwurm-Arten aus der Gattung *Proctodrilus*. Zuletzt wurde *P. thaleri* beschrieben (Höser & Zicsi 2009), ein karpatischer Endemit (Pop *et al*. 2012). Die vier *Proctodrilus*-Arten unterscheiden sich deutlich in ihren Bindungen an das Habitat. Daraus resultiert, dass sie distinkten Indikatorwert besitzen und sowohl im Transekt von Hang und Aue als auch gelegentlich im Bodenprofil ökologisch vikariieren. Grundlage dieser Tatsachen sind die Diskontinuitäten und Gradienten, die bei der Sedimentation von Bodensubstrat, z.B. als Bodenschichtung, und bei der Bodenbildung auftreten.

Aus bisherigen Beobachtungen (Höser 1986, 2008, 2010, 2011) wurde geschlussfolgert, dass *P. tuberculatus* (Černosvitov, 1935) an lessivierte Böden der Auen und Hänge, *P. opisthoductus* Zicsi, 1985 an umgelagerte Planosole und *P. antipai* (Michaelsen, 1891) an ton- und humusreiche, zumeist durch einen Sd-Horizont gekennzeichnete hydromorphe Mineralböden gebunden ist. Im Folgenden werden neue Beobachtungen zum Habitat des *P. thaleri* vorgestellt und diskutiert.

Untersuchungsgebiet

Untersucht wurden Bodenstandorte eines Hangs westlich von Celei im südlichen Vorland der Südkarpaten (Judetul Gorj, Rumänien). Der untersuchte Hang liegt bei etwa 290 m über NN im Hügelland des Übergangs von den Subkarpaten zum Getischen Piedmont. Er befindet sich im Parabraunerde-Vorkommen (Stefanovits 1971, Ganssen 1972) des nordwestlichen Teils der Kleinen Walachei (Oltenia). Die hier vorherrschenden Bodensubstrate sind Mergel, Tone und Sande. Dieses Gebiet liegt am Rande der südöstlich anschließenden Lössdecken (Grahmann 1932, Pécsi & Richter 1996), deren Substrat perimediterraner Löss der pontischen Provinz ist (Maruszczak 1996), speziell die für das untere Donaubecken charakteristische, von Kalkkonkretionen freie Löss-Variante.

Im Untersuchungsgebiet herrscht mäßig kontinentales, vom Föhn beeinflusstes, relativ wintermildes und niederschlagsreiches Klima mit Jahresmitteln von 9,3 °C bzw. 925 mm in Baia de Aramă – Tismana (Meusel & Niedermaier 1985). Das Gebiet gehört zur Subzone der Traubeneichenwälder, die meist auf Parabraunerden und Braunerden stocken (Mavrocordat 1971).

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Untersuchte Bodenstandorte

Die untersuchten Bodenstandorte befinden sich auf einem NNW-exponierten Hang, so auf dessen Oberhang, Mittelhang-Verebnung und Unterhang. Am Oberhang (Neigung 8–15 Grad) stockt submontan-hügeliger Hainbuchen-Buchenwald (Carpino–Fagetum) auf kalkhaltigem, lößbedecktem Geschiebemergel. Auf der schwach bis sanft, 2–5 Grad, geneigten Hangverebnung wächst auf lößähnlicher Deckbildung dakischer Traubeneichen-Hainbuchenwald (Lathyro–Carpinetum). Dieser meso-hygrophile Breitlaubwald enthält wärmebedürftige und trockenheits-resistentere Arten, so u.a. *Quercus cerris* und *Quercus pubescens* in geringer Abundanz. An diesen Hangwald grenzt in derselben Höhenlage und Exposition ein Trespen-Halbtrockenrasen. Der Unterhang trägt eine Glatthaferwiese (Arrhenatheretum) mit Feuchtwiesensaum (Filipendulion) und wenigen Stieleichen am Hangfuß.

Untersucht wurden Bodenstandorte auf dem bewaldeten Hangteil und auf der Glatthaferwiese (Abbildung 1). Die Böden tragen Lessivé-Merkmale, die feuchtesten unter ihnen auch Pseudogley-Merkmale. Die höchste Bodenfeuchte (Stufe erdfeucht) wurde auf der bewaldeten Verebnung des Mittelhangs und in einer Delle an der Traufe des Waldrands festgestellt.

METHODIK

Die Regenwurmfauna wurde auf jeweils mehreren Untersuchungsflächen entlang eines Transekts erfasst, das der Fall-Linie des Hangs folgt. Daneben liegen Ergebnisse von einzelnen zufällig verteilten Flächen vor. Auf jeder Untersuchungsfläche von 0,5 x 0,5 m wurden bis in 0,5 m Tiefe alle Regenwürmer ausgegraben und in zweimaliger Durchsicht des ausgegrabenen Bodens von Hand ausgelesen. Für die Auswertung wurden ausschließlich die adulten Tiere herangezogen. Die taxonomische und zoogeographische Nomenklatur folgt Csuzdi & Zicsi (2003), Csuzdi *et al.* (2011) und Pop *et al.* (2012). Konserviertes Material befindet sich in der Sammlung des Autors.

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

ERGEBNISSE

Die Individuendichte der Regenwurmfauna variiert stark entlang des Hang-Transekts. Sie ist auf dem relativ trockenen Oberhang am geringsten. Dort tragen die Bodenprofile unter einer nahezu geschlossenen Laubstreuschicht die Humusformen Moder bis rohhumusartigen Moder. Die Individuendichte aus der Summe adulter und juveniler Tiere wächst mit der Bodenfeuchte. Sie erreicht die höchsten Werte im bewaldeten Boden des verebneten Hangabschnitts, wo die Laubstreu gering und die Humusform mullartiger Moder ist (32 Individuen / 0,25 m²), und im Wiesenboden an der Regentraufe des Waldrands (20 Individuen / 0,25 m²). An diesen feuchtesten Stellen, auf der Feuchtestufe „erdfeucht“, herrschen unter den endogäischen Regenwürmern die peregrinen Arten *Ap. rosea* und *O. lacteum* sowie der karpatische Endemit *P. thaleri* vor (Tabelle 1, Abbildung 1).

Epigäische Regenwürmer treten nur spärlich und an den feuchtesten Stellen auf. Sie fehlen in den meisten untersuchten Hangabschnitten. Tiefgrabende Arten oder ihre Lebensspuren (Kothäufchen, Gänge) und *Ap. caliginosa* (Savigny, 1826) wurden nicht gefunden.

P. thaleri lebt in diesem Hang-Transekt im obersten Dezimeter des feinlehmigen Mineralbodens der feuchtesten Stellen. Die meisten adulten Individuen dieser Art wurden hier im Lathyro-Carpinetum der Hang-Verebnung gefunden, überwiegend in 2–4 cm Tiefe, im schwach plattigen und farblich grau/hellbraun geschichteten Gefüge des sehr bindigen Pseudogley–Lessivés. An diesen Standorten bevorzugte die Art den unteren Bereich des relativ geringmächtigen Ah-Horizonts, der bis drei schwach gleyfleckige zentimeterdünne Schichten enthielt, die sich auch schon dem unterlagernden Stauwasser-Horizont (Sw) des Bodenprofils zurechnen lassen. An der Regentraufe im Grünland desselben Transekts trat die Art bei 8 cm Tiefe, am oberen Rand der gleyfleckigen Zone des farblich schwach zeichnenden, hell- bis gelbbraunen Bodens auf.

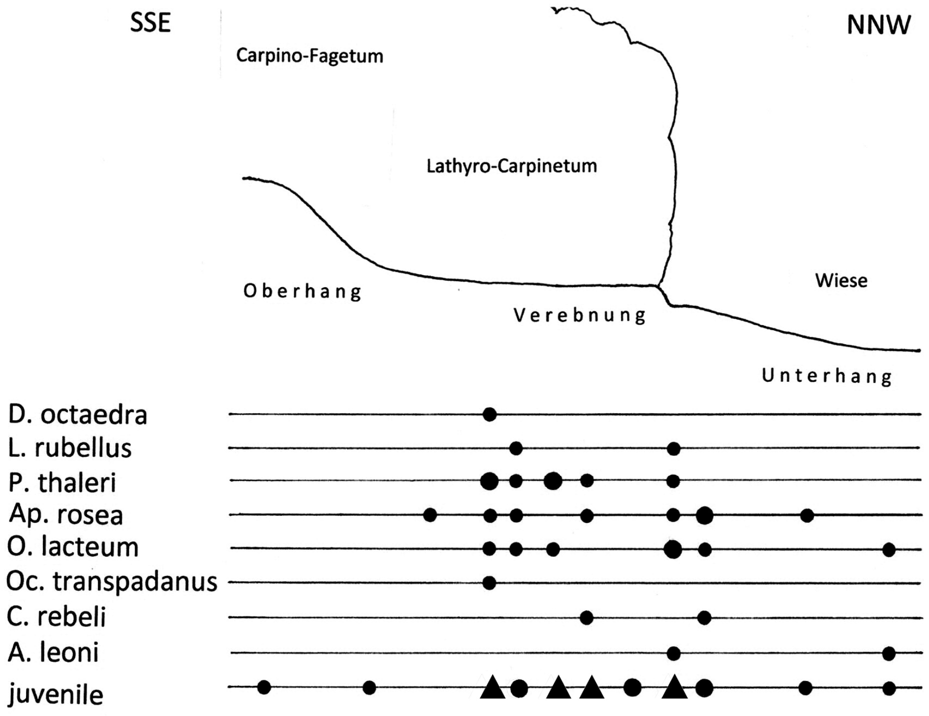

Abbildung 1. Regenwurmfauna der untersuchten Bodenstandorte im Hang-Transekt bei Celei. Die Punkte bzw. Dreiecke repräsentieren die Individuendichte der adulten Regenwürmer und der Juvenilen in drei Größenklassen: • 1–3, ● 4–10, ▲ >10 Individuen auf 0,25 m^2 untersuchter Fläche. Transektlänge ca. 160 m.

Tabelle 1. Übersicht über die am Hang bei Celei gefundenen Regenwurmarten mit Angaben zum Verbreitungstyp (Csuzdi *et al.* 2011, Pop *et al.* 2012), zur ökologischen Lebensform (Bouché 1977) und maximalen Individuendichte

Art im Transekt	Verbreitungs-typ	Lebensform	Maximale Individuendichte Adulte auf 0,25 m^2
Allolobophora leoni Michaelsen, 1891	trans-ägäisch	endogäisch	1
Aporrectodea rosea (Savigny, 1826)	peregrin	endogäisch	4
Cernosvitovia rebeli (Rosa, 1897)	mösisch	endogäisch	2
Dendrobaena octaedra (Savigny, 1826)	peregrin	epigäisch	1
Lumbricus rubellus Hoffmeister 1843	peregrin	epigäisch	1
Octolasion lacteum (Örley, 1881)	peregrin	endogäisch	5
Octodrilus transpadanus (Rosa, 1884)	trans-ägäisch	endogäisch	2
Proctodrilus thaleri Höser & Zicsi, 2009	karpatisch-endemisch	endogäisch	4

DISKUSSION

Die Lage der Fundpunkte von *P. thaleri* im Hang-Transekt weist hin, dass diese Regenwurmart stark abhängig von der Bodenfeuchte ist, die hier durch Texturdifferenzierung, perkolierbare Feinschichten und eine Stauwasserzone gewährleistet wird. Diese Bedingungen sind offensichtlich eine Folge der Hangverebnung (Catt 1992). Das Bodenprofil lässt auch Zeichen eines sekundären Pseudogleys erkennen (Scheffer & Schachtschabel 1989). Zeitweiliges, im Sommer weitgehend vermindertes Stauwasser und das hängende Kapillarwasser (Mückenhausen 1993), das dann das sommerliche Pessimum der Bodenfeuchte überbrückt, tragen wesentlich zur Gunst dieser Bodenstandorte innerhalb des Transekts bei. Die Bedeutung des hängenden Kapillarwassers ist hier wie an jenen Standorten evident, an denen *P. tuberculatus* lebt (Höser 2003).

Die Funde von *P. thaleri* und das Fehlen von *P. tuberculatus* am Hang bei Celei werfen ein neues Licht auf die Bindungen beider Arten an das Habitat.

Aus Beobachtungen im Lössgürtel Mitteldeutschlands wurde geschlussfolgert, dass *P. tuberculatus* die von der Tonverlagerung geprägten Böden bevorzugt (Höser 1986). Das sind der flussnahe Auenboden, der im Zuge der Hochflut perkoliert wird (Kopp 1964), und der Lössboden erosionsdisponierter Hanglagen, der in Mitteleuropa als interferenzfreier Lessivé auftritt (Reuter 1999). Ausschließlich in derartigen Böden wurde *P. tuberculatus* bisher nachgewiesen (Höser 2011, 2012).

Da *P. tuberculatus* auf dem Hang bei Celei fehlt, nehmen wir an, dass dort eine Lessivé-Braunlehm-Interferenz vorliegt, die im warm-humiden Südosteuropa auftritt (Reuter 1999) und anscheinend *P. tuberculatus* nicht zusagt. Diese Interferenz ordnen wir dem Habitat von *P. thaleri* zu. Sie ist eine harmonische Entwicklungsinterferenz, da Braunlehm die Vorstufe zur harmonischen, in Südosteuropa rezenten Lessivierung ist (Reuter 1964, 1999). Diese Entwicklungsinterferenz, so sie vorliegt, ist unseren bodenmorphologischen Befunden zufolge am Hang bei Celei offenbar zusätzlich von einer standörtlich (bzw. relief-) bedingten Interferenz des Bodentyps überprägt, erkennbar an den gefundenen Pseudogley-Merkmalen. Wir deuten also, dass *P. thaleri* am Hang bei Celei in einer Pseudogley-Lessivé-Braunlehm-Interferenz lebt.

Da Lessivé-Braunlehm-Interferenzen im warm-humiden Südosteuropa in Vergesellschaftung mit rezenten Lessivés auftreten (Reuter 1999), erwarten wir auch südosteuropäische Hänge, auf denen *P. tuberculatus* und *P. thaleri* ökologisch vikariant an unterschiedlichen Stellen der Catena leben.

Die bisher andernorts in Rumänien aufgefundenen *P. thaleri* stammen sämtlich von solchen Bodenstandorten, an denen *P. tuberculatus* nicht nachgewiesen werden konnte. So lebt *P. thaleri* in der Kokel-Aue bei Copşa Mică im flussferneren Auenboden und bei Alma in einer vom Hang beeinflussten Auenterrasse (Höser & Zicsi 2009, Höser 2011), an beiden Orten im schwach gleyfleckigen Mineralboden. An diesen Standorten findet wahrscheinlich wie auf der hochflutfreien Niederterrasse (Paas 1961) noch rezente Tonverlagung statt, ausgehend von Anteilen perkolierbaren Braunlehms. Demgegenüber kommt in Siebenbürgen *P. tuberculatus* z.B. bei Hoghilag im jüngeren Auenboden eines Mäanderhalses vor (Höser 2011), wo zu erwarten ist, dass dort wie gewöhnlich die Sedimentation des Hochflutlehms mit intensivster Tonverlagerung gekoppelt war (Kopp 1964) und damit dieser Auenboden im hier relevanten Ergebnis einem weitest vorangeschrittenen, interferenzfreien Lessivé entspricht.

Die bisherigen Ergebnisse von der Habitatbindung der *Proctodrilus*-Arten sind Beispiele oder Details der Strukturen und Parameter des Bodens, die von Auendynamik, kolluvialer Dynamik und pedogenetischen Prozessen geschaffen werden und zu der hohen Biodiversität alluvialer (Salomé *et al.* 2011) und kolluvialer Böden beitragen.

Dank – Ich danke Herrn Prof. Dr. Csaba Csuzdi (Hungarian Natural History Museum, Budapest) für seine Expertise zu *C. rebeli*, Herrn Michael Höser für technische Assistenz im Freiland und Herrn Brian Hillcoat (Berlin) für die Übersetzung ins Englische.

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Notes on the morphology and the Romanian distribution of *Uroobovella hungarica* Hirschmann & Zirngiebl-Nicol, 1962 (Acari: Uropodina)

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Abstract. A very rare Uropodina mite species; *Uroobovella hungarica* Hirschmann & Zirngiebl-Nicol, 1962 was discovered in several parts (e.g. Transylvania, Oltenia) of Romania. A new description is given accompanied with several characters not investigated earlier.

Keywords. Uropodina, *Uroobovella hungarica*, first record, redescription, Romania.

INTRODUCTION

The mites of the suborder Uropodina occur worldwide in soil, moss and leaf. The Central European countries (Germany, Hungary, Poland, Romania, and Slovakia) are intensively studied. Currently more than 80 species are recorded from these countries (Wiśniewski 1993, Mašán 2001, Kontschán 2008). Despite of the intensive studies, several interesting and characteristic species are not recorded from these countries yet.

Uroobovella hungarica is one of these rare and poorly investigated species which was described by Hirschmann & Zirngiebl-Nicol (1962) on the basis of specimens collected in Hungary. However, the description of this species is very incomplete; several characters are not mentioned nor illustrated. No detailed redescription of this species is available in the literature and no other records have been added to its distribution, until current addition of two new occurrences from Bosnia-Herzegovina by Kontschán (2013).

Examining a rich material from different part of Romania I have fund many other, well-preserved specimens of *Uroobvella hungarica* which are described herein.

MATERIAL AND METHODS

Specimens were cleared in lactic acid and drawings were made with the aid of a drawing tube. After the investigation, specimens are stored in 75% ethanol and deposited in the Soil Zoology Collections of the Hungarian Natural History Museum, Budapest (HNHM).

RESULTS

Uroobovella hungarica Hirschmann & Zirngiebl-Nicol, 1962

(Figures 1–12)

Uroobovella hungarica Hirschmann & Zirngiebl-Nicol, 1962: 58.

Diagnosis. Dorsal setae spine-like, dorsal shield covered by small oval pits. Marginal shield reduced caudally, three pairs of caudal setae situ-

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ated on small platelets. Ventral shield covered by small oval pits, preanal line present. Peritremes long, prestigmatid part S-shaped, poststigmatid part short. Genital shield linguliform with small oval pits on its surface and with wide process on anterior margin.

Material examined. Two females: Romania, before Mădrigeşti, Drum Forestier Leurda, beech forest, from leaf litter, N46º11.085', E22º15.606' 410 m, 27.X.2009. leg. Cs. Csuzdi, J. Kontschán, V.V. Pop, and Zs.Ujvári. *One female:* Romania, Tarcaica, young mixed beech forest, from leaf litter, N46º33.165', E22º15.950', 478 m, 28.X. 2009. leg. Cs. Csuzdi, J. Kontschán, V.V. Pop, and Zs.Ujvári. *Two females:* Romania, Meziad cave, beech leaf litter and moss from stone, N46º 45.765', E22º28.504' 390 m, 29.X.2009.10.29. leg. Cs. Csuzdi, J. Kontschán, V.V. Pop and Zs. Ujvári. *One female:* Maramureş Muntii Ignis. Runki. Stream, spruce fir forest, and meadow at the Cabana Colibi. N47°52.457'E23°43.397'.832 m, leaf litter, 13.VIII.2004. leg. D. Murányi. *Two females:* Romania, jud. Caraş-Severin, Munții Locvei, 5km E Moldova Nouă, Gaura Haiducească, entry of p. Ogasul Găurii, 420 m, wet soil + rock chips at cave entrance, soil-washing, N44° 43' 27", E21°44' 13", 07.X.2009., leg. Gy. Makranczy, *Two females:* Romania, Muntii Bihor, under Cetătile Rădesei (Aragyásza Cave), 1117 m, spruce forest on sandstone, from sphagnum bog, 23.IX.2009. leg. L. Dányi. *One female:* Romania, Bucovina, above Broşteni, mixed beech forest, from decayed wood and moss, N47° 18,607'; E25°41,716' 935 m, 03.XI.2011. leg. Cs. Csuzdi, J. Kontschán, V.V. Pop, and Zs. Ujvári. *Three females:* Romania, Oltenia, near Lelești, oak forest and meadow, N45°04,102', E23° 12,525', 265 m, from leaf litter, 04.XI.2007. leg. Cs. Csuzdi, J. Kontschán, and V.V. Pop. *One female:* Romania, Oltenia, Poiana Mărului, beech forest, N45°23,362', E22°34,475', 890 m, from lichens, 02.XI.2007. leg. Cs. Csuzdi, J. Kontschán and V.V. Pop. *Two females:* Romania, Oltenia, after Poiana Mărului, beech forest, N45°25,978', E22°27,550', 501 m, beech leaf litter, 02.XI.2007. leg. Cs. Csuzdi, J. Kontschán, and V.V. Pop.

Description. Female. Length of idiosoma 650–670 µm, width 540–570 µm (n=17). Shape oval, posterior margin rounded.

Dorsal idiosoma (Fig. 1). Dorsal and marginal shield fused anteriorly. Dorsal setae thin and spine-like (*ca.* 16–20 µm), dorsal shield covered by small oval pits. Marginal shield reduced caudally, marginal setae smooth and needle-like (*ca.* 17–20 µm), surface of marginal shield with iregular pits. Three pairs of caudal setae situated on small platelets.

Ventral idiosoma (Fig. 2). Sternal shield without sculptural pattern. All sternal setae short (*ca.* 10 µm), smooth and needle-like. St1 situated near anterior margin of sternal shield, St2 at level of anterior margin of coxae II, St3 at level of anterior margin of coxae III, St4 at level of posterior margin of coxae III, St5 placed near posterior edges of genital shield.

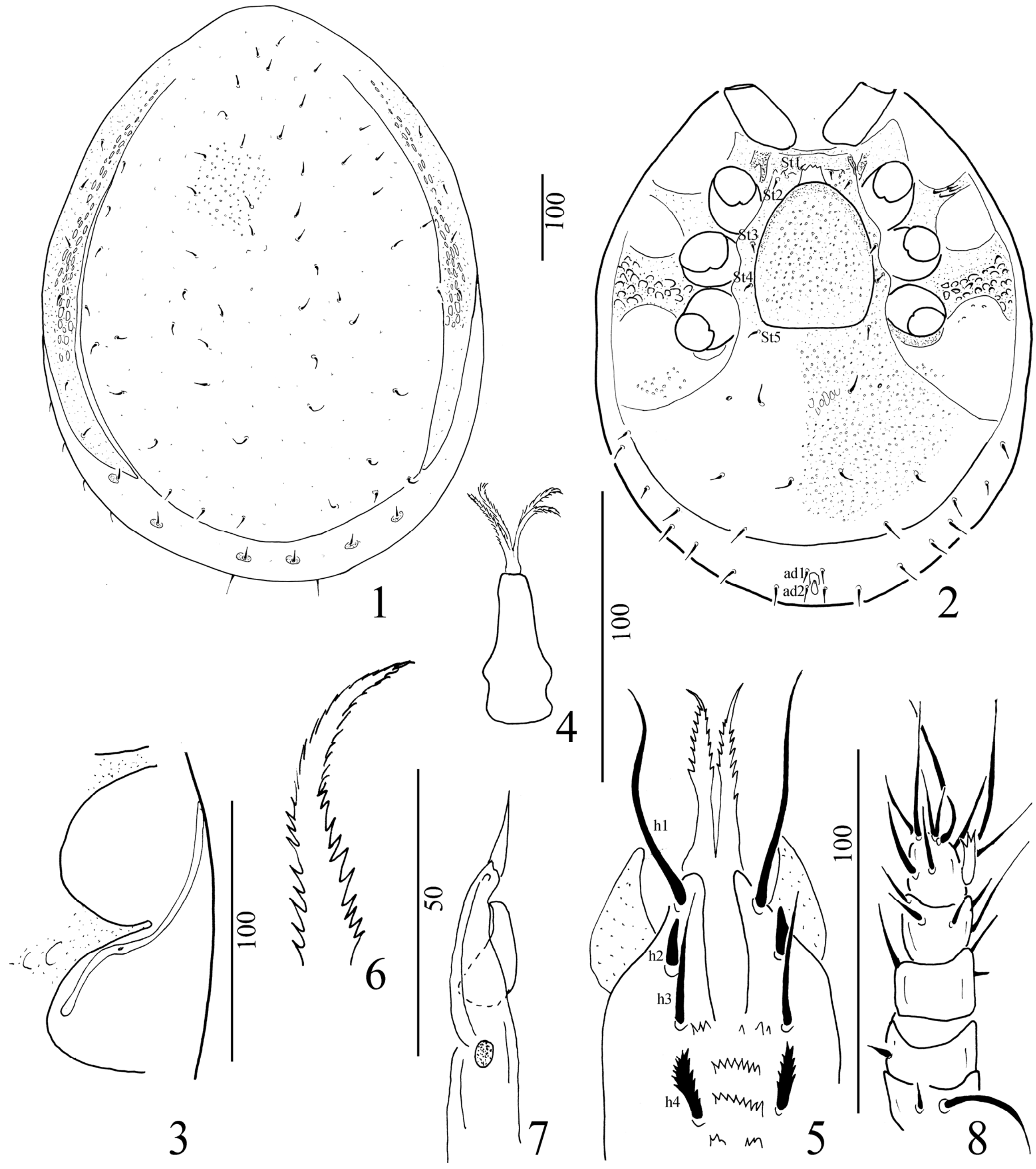
Ventral shield covered by small oval pits, preanal line present. Four pairs of ventral setae situated anteriorly to preanal line, other setae can be seen posteriorly to preanal line. All ventral setae smooth, short (*ca.* 20–21 µm) and needle-like. Adanal setae (ad1, ad2) similar in shape and length to other ventral setae. Pedofossae deep, their surface covered by numerous oval pits, separate furrows for tarsi IV absent. Surface between pedofossae III and IV covered by large oval pits.

Peritremes (Fig. 3). Long, prestigmatid part S-shaped, poststigmatid part short. Stigmata situated between coxae II and III.

Genital shield. Linguliform, its surface covered by small oval pits, on its anterior margin a wide process present which bears two-three small apical rounded spines. Genital shield situated between coxae II and IV.

Tritosternum (Fig. 4). With narrow base, tritosternal lacinia divided into four, marginally pilose branches.

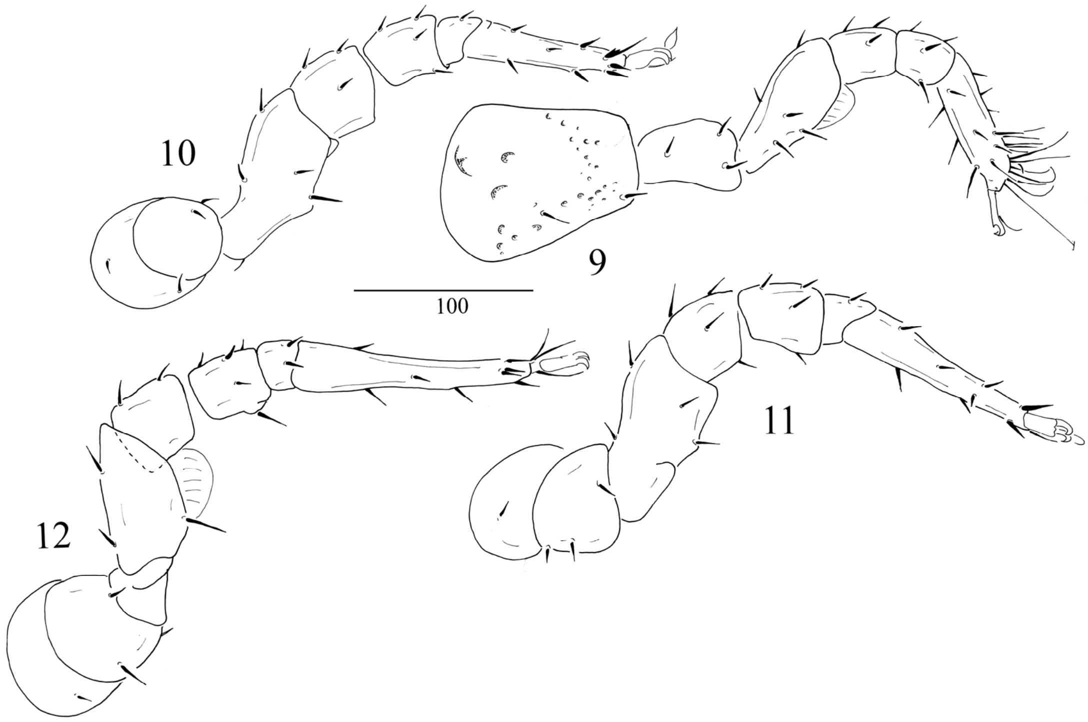
Gnathosoma (Fig. 5). Corniculi horn-like, internal malae long and apically serrate. Hypostomal setae h1 smooth and long (*ca.* 66 µm), h2 smooth, robust and very short (*ca.* 12 µm), h3 long and needle-like (*ca.* 37 µm), h4 apically serrate (*ca.* 20 µm). Four rows of denticles pre-



Figures 1–8. *Uroobovella hungarica* Hirschmann & Zirngiebl-Nicol, 1962. 1 = Dorsal view of body, 2 = ventral view, 3 = peritreme, 4 = tritosternum, 5 = ventral view of gnathosoma, 6 = epistome, 7 = chelicera, 8 = ventral view of palp.

sent on gnathosomal surface between h3 and h4. Epistome with serrated basal margin, apically pilose (Fig. 6). Digitus fixus of chelicerae bearing long apical process, with one tooth and bulbiform apical sensillum. Digitus mobilis short, without tooth, internal sclerotized node present (Fig. 7). Palp with smooth and needle-like setae (Fig. 8).

Legs (Figs 9–12). All legs with paired ambulacral claws and bearing smooth setae on all seg-



Figures 9–12. *Uroobovella hungarica* Hirschmann & Zirngiebl-Nicol, 1962. 9 = Leg I, 10 = leg II, 11 = leg III, 12 = leg IV.

ments except tarsi. Tarsi II–IV bearing robust setae. Coxae I covered by several oval pits, leg I–IV with large lateral flaps on femura (visible in present position only in Figs 9 and 12).

Remarks. Hirschmann & Zirngiebl-Nicol (1962) placed this species into the *rackei* species group which needs urgent revision. Currently 14 species are listed in this group, from which 13 species occur in the Palearctic region, and only one species is reported from Neotropical area (Chile). *Uroobovella hungarica* is easy to distinguish from other European species based on the following characters: shape of the apical process of genital shield, the absence of pygidial shield and the ornamentation and setation of dorsal and ventral parts of the idiosoma.

ECOLOGICAL AND ZOOGEOGRAPHICAL NOTES

Uroobovella hungarica is a rare species; it has previously been recorded only in Bosnia-Herzegovina (Kontschán 2013: Bjelašnica Mts and Grmeč Mts), Hungary (Hirschmann & Zirngiebl-Nicol 1962: without exact locality) and Romania. The species was collected in the mountainous regions of these countries, between 400 and 1100 m in Romania and between 500 and 1350 m in Bosnia-Herzegovina, but it can be found at lower altitude (205 m) as well, e.g. in the Oltenia region of Romania. The Romanian specimens live mostly in leaf litter (especially in beech forests), but they were found in moss and sphagnum bogs as well; specimens found in Bosnia-Herzegovina were from soil, moss and leaf litter.

The distribution of this species is very interesting. On the basis of the recent data *Uroobovella hungarica* can be found in the southern part of the Carpathian Basin and northern part of the Balkan Peninsula, except of the record from Maramures, which belongs to the Eastern Carpathians. Despite of the different origins of the Carpathians and the Apuseni Mountains, this species can be found in both regions (Fig. 13), therefore this species must have colonized this region after the formation of the Carpathians and the Apuseni Mountains.

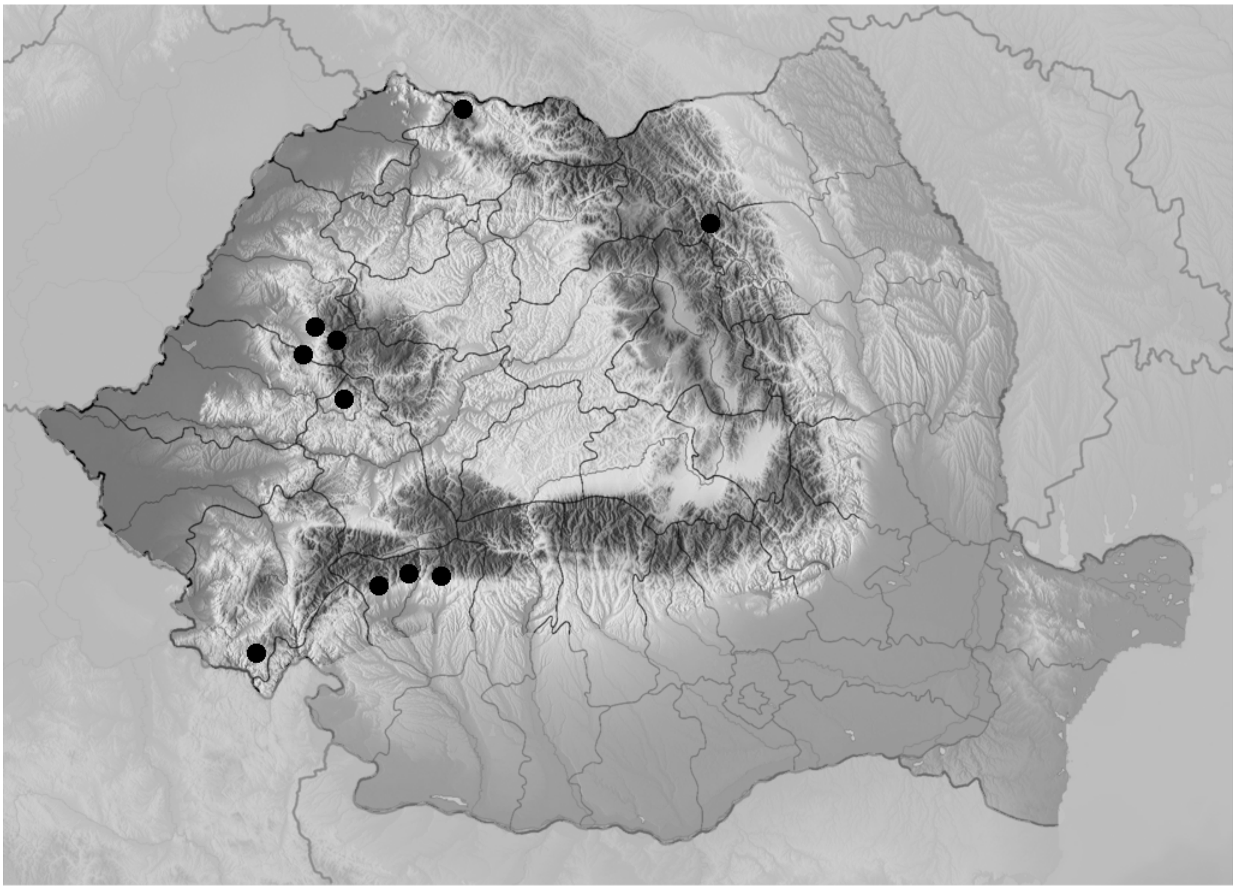


Figure 13. Occurrences of *Uroobovella hungarica* Hirschmann & Zirngiebl-Nicol, 1962 in Romania.

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