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New species records of systellognathan stoneflies (Plecoptera: Systellognatha) for the fauna of the Korean Peninsula[*]

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Abstract. Three species of stoneflies are reported for the first time from the Korean Peninsula: *Pictetiella asiatica* Zwick & Levanidova, 1971, *Xanthoneuria unimaculata* (Zhiltzova, 1979) and a new species of the genus *Sweltsa* Ricker, 1943. The widespread temperate Asian species, *P. asiatica,* represents the first record of the Transpacific genus *Pictetiella* Illies, 1966 from Korea. *Xanthoneuria unimaculata* confirms the presence of *Xanthoneuria* Uchida, 2011 in Korea. This genus was hitherto known only from Japan and the Russian Far East with a dubious record from Korea. The female of *Sweltsa sp.* is formally described but not named because male remained unknown. All the specimens were collected in North Korea by colleagues from the Hungarian Natural History Museum during the 1970's and 1980's. New Korean records of further ten species are also enumerated, with notes about some doubtful records. Distribution area of the genera *Pictetiella* and *Xanthoneuria* are detailed and depicted on maps.

Keywords. Aquatic insects, *Pictetiella asiatica, Xanthoneuria unimaculata, Sweltsa sp.*, distribution, North Korea

INTRODUCTION

Despite that the first Korean stonefly was reported relatively early from the Yalu River (Banks 1920), the Korean Plecoptera fauna was essentially unknown until the seventies (Zwick 1973a, 1973b). The fauna remained poorly known until the 1990s when intensive research was launched (Kim *et al.* 1998). Today, the Korean stoneflies fauna is relatively well known, with 77 species reported however, nearly one third was published only during the last five years (Murányi & Park 2011, Murányi *et al.* 2014, 2015, Stark 2010, Zwick 2010, Zwick & Baumann 2011). Unfortunately, our knowledge on the two Korean countries is very unbalanced, as 61 of the 77 species are known from South Korea (Murányi & Park 2011, Zwick & Baumann 2011) while only 34 species is registered for North Korea (Ham 2008, Murányi *et al.* 2014, 2015).

Between 1970 and 1994, colleagues from the Hungarian Natural History Museum had the opportunity to take 16 collecting expeditions to North Korea (Mahunka & Steinmann 1971, Mészáros & Zombori 1995). These efforts yielded some Plecoptera, but this material was only partially studied (Murányi *et al.* 2014, 2015, Stark & Sivec 2008b, Zwick 1973b). Here, we report on the Systellognathan genera *Xanthoneuria* Uchida, 2011 (in: Uchida *et al.* 2011), *Pictetiella* Illies, 1966 and *Sweltsa* Ricker, 1943 from the collection, including three species (*P. asiatica* Zwick & Levanidova, 1971; *X. unimaculata* (Zhiltzova, 1979) and a new species of the genus *Sweltsa* which represent new records for the Korean peninsula. Consequently, the number of stoneflies recorded from Korea is raised to 80. However, occurrence of some species reported from North Korea are questionable. We also discuss these doubts, and present distribution maps of the genera *Pictetiella* and *Xanthoneuria*.

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MATERIAL AND METHODS

Specimens were stored dry in the Collection of Smaller Insect Orders, Department of Zoology, Hungarian Natural History Museum, Budapest, Hungary (HNHM). They were relaxed and transferred to vials with 70% ethanol, their terminalia were cleared in KOH. The material studied are deposited in the HNHM and in the National Institute of Biological Resources, Incheon, Republic of Korea (NIBR).

Epiproct and aedeagus were everted using the cold maceration technique of Zwick (1983). Illustrations were made with the aid of a drawing tube applied on a Nikon SMZ800 microscope. Terminology mainly follows Li *et al.* (2014), Teslenko & Minakawa (1999), Uchida *et al.* (2011) and Zwick & Weinzierl (1995).

Distributional data were compiled from literature data from various sources referenced in Plecoptera Species File (PSF) (DeWalt *et al.* 2015), but mainly from Teslenko & Zhiltzova (2009) and Uchida (1990).

RESULTS AND DISCUSSION

Perlidae

Xanthoneuria Uchida, 2011

Xanthoneuria Uchida, 2011: Uchida *et al.* 2011: 65. (original description on the basis of male, female and larva, by four species included); DeWalt *et al.* 2015, (catalog).

Japoneuria Uchida, 1990: Uchida 1990: 123. (manuscript name).

Type species. *Acroneuria fulva* Klapálek, 1907, by original designation. Further species included: *Xanthoneuria bolivari* (Klapálek, 1907); *X. jouklii* (Klapálek, 1907), *X. unimaculata* (Zhiltzova, 1981).

This recently described genus contains three species restricted to Japan, and a coastal mainland species known from the Russian Far East and North Korea (Fig. 11).

Xanthoneuria unimaculata (Zhiltzova, 1981)

(Figures 1–3)

Xanthoneuria unimaculata (Zhitzova, 1981): Uchida *et al.* 2011: 65. (comb. n.), DeWalt *et al.* 2015, (catalog).

Acroneuria unimaculata Zhiltzova, 1981: 5. (original description of male and female); Zhiltzova 1995: 14. (type catalogue of RAS specimens).

Acroneuria unimaculata Zhiltzova, 1979: Teslenko & Zhiltzova 2009: 54. (monograph, with mistaken date).

Japoneuria unimaculata (Zhiltzova, 1981): Uchida 1990: 123. (manuscript name, comb. n.).

Type locality. Russia, Primorsky Krai, Komissarovka River, Barabash Settlement, Pogranichny Raion (holotype), "Kedrovaya Pad" Reserve (paratypes).

Material examined. North Korea. North Pyongan Province, Hyangsan-gun, Myohyang Mts, at light on the balcony and garden of Hotel Myohyang-san (locality No. 793), 150 m, N40°00' E126°15', 14.vii.1982, leg. László Forró, László Ronkay: 1♀; North Pyongan province, Hyangsan-gun, Myohyang Mts, singled in the valley below Hwajangam (locality No. 816), 300 m, N40°00' E126°16', 17.vii.1982, leg. László Forró, László Ronkay: 1♀; North Pyongan Province, Hyangsan-gun, Myohyang Mts, at light on the balcony and garden of Hotel Myohyang-san (locality No. 829), 150 m, N40°00' E126°15', 18.vii.1982, leg. László Forró, László Ronkay: 1♂.

Distribution and ecology. The species was described from the southern part of Russian Far East, and hitherto had no concrete data from elsewhere (Teslenko 2012). Uchida *et al.* (2011) reported it also from Korea, but without any detailed locality. Probably, they referred to the data of *X. joukli* from the Baekdu Mts (Kim *et al.* 1993), see below. The present specimens are all from the lower regions of Myohyang Mountains, forming the western chain of the Changbai (Baekdu) range that separates the Korean Peninsula from the Asian continent (Figs. 11, 13). At locality No. 816 it was the only stonefly caught, while at the light trap (No. 793 and 829) it was caught together with other perlids: *Paragnetina flavotincta* (McLachlan, 1872), *Neoperla coreensis* Ra, Kim, Kang & Ham, 1994 and a paratype of *N. goguryeo* Murányi & Li, 2015 (in Murányi *et al,* 2015).

Remarks. The Korean specimens agree well with the original description (Figs. 1–3). The aedeagus bears no spines or hairs, contrary to the Japanese species (Uchida *et al.* 2011). It was not possible to evert because of the poor condition of the specimen, so lobes and shape remained unknown. Unfortunately, the two females had no eggs, so details of the egg also remained unknown.

Perlodidae

Pictetiella Illies, 1966

Pictetiella Illies, 1966: 374. (replacement name for *Pictetia* Banks, 1948 non *Pictetia* Uhlig, 1882 (Mollusca) nec. *Pictetia* Brongniart, 1885 (Insecta); by monotypy, catalog); Zwick 1973: 237. (catalog), Stewart & Stark 2002: 434. (monograph); DeWalt *et al.* 2015, (catalog).

Pictetia Banks, 1948: 281. (original description on the basis of imago somatic features, by monotypy).

Isogenus (Pictetia) Banks, 1948: Ricker 1952: 120. (comb. n., description of male and larva, complementary description of female).

Type species. *Perla expansa* Banks, 1920 inherited from the replaced name by monotypy. Further species included: *Pictetiella asiatica* Zwick & Levanidova, 1971 (in Zwick *et al.* 1971), *P. lechleitneri* Stark & Kondratieff, 2004, *P. zwicki* Zhiltzova, 1976 (in Levanidova & Zhiltzova 1976).

This Transpacific genus contains two western Nearctic and two East Palaearctic species. Despite its wide distribution in the Asian part of Russia, the genus is hitherto unknown from China and Japan (Fig. 12).

Pictetiella asiatica Zwick & Levanidova, 1971

(Figs. 4–8)

Pictetiella asiatica Zwick & Levanidova, 1971: Zwick *et al.* 1971: 853. (original description of male, female and larva), Zwick 1973: 238. (catalog), Zhiltzova & Zapekina-Dulkeit 1986: 183. (complementary description of the imago), Zhiltzova 1995: 7. (type catalogue of RAS specimens), Teslenko & Zhiltzova 2009: 32, 266. (monograph); Judson & Nelson, 2012: 44 (complementary description of male and female).

Type locality. Russia, Kamchatka Peninsula, Kirpichnaya River (Kamchatka River Basin), Mil'kovo settlement.

Material examined. North Korea. Ryanggang province, Samjiyŏn-gun, Baekdu Mts, singled in mixed larch-birch forest along a road (locality No. 197), 1600 m, N41°50' E128°15', 25.viii.1971, leg. Sándor Horvatovich, Jenő Papp: 1♂; Ryanggang province, Samjiyŏn-gun, Baekdu Mts, at light by a small lake behind Hotel Samjiyŏn (locality No. 373), 1700 m, N41°50' E128°15', 18.vii.1977, leg. Olivér György Dely, Ágnes Dely-Draskovits: 1♂.

Distribution and ecology. The species has wide distribution in Russia, from the Altai ranges to Kamchatka, recently was also reported from northern Mongolia. The present specimens are from the Baekdu Mountains, the central and highest chains of the Changbai (Baekdu) ranges. These records constitutes the southernmost distribution of the species (Figs. 12–13). At locality No. 373 it was the only stonefly caught at the light trap, while at locality No. 197 it was singled together with an unassociable *Amphinemura* Ris, 1902 female and with a male of *Kamimuria zwicki* Stark & Sivec, 2008a. The latter species is new for the fauna of North Korea and slightly extends its known range, as hitherto it was only known from South Korea. Perlidae gen. spec. in Zwick (1973a) probably also refers to this species.

Remarks. The Korean specimens mostly agree with the original description, and Dr. Valentina A. Teslenko kindly verified their probable conspecifity with the Russian specimens. However, some slight differences are worth to note (Figs. 4–8): finger-like projection of the epiproct tip is longer, and the epiproct tip possesses stronger dorsal sclerotization on the Korean specimens, resembling more to the epiproct tip of the Nearctic *P. expansa* than those of *P. asiatica*.

Chloroperlidae

Sweltsa Ricker, 1943

Alloperla (Sweltsa) Ricker, 1943: 135. (original description on the basis of male, female and larva, by twelve species included).

Sweltsa Ricker, 1943: Illies 1966: 450. (stat. n. as a genus, catalog), Zwick 1973: 297. (catalog), Surdick 1985: 23. (revision), Stewart & Stark 2002: 280. (monograph), DeWalt *et al.* 2015, (catalog).

Type species. Alloperla oregonensis Frison, 1935, by original designation. Further species included: 48 valid species (according to PSF), among them the followings are from Asia: *Sweltsa abdominalis* (Okamoto, 1912); *S. assam* Zwick, 1971; *S. baiyunshana* Li, Yang & Yao, 2014; *S. colorata* Zhiltzova & Levanidova, 1978; *S. illiesi* Zhiltzova & Levanidova, 1978; *S. insularis* Zhiltzova, 1978 (in Zhiltzova & Levanidova, 1978); *S. kibunensis* (Kawai, 1967); *S. lepnevae* Zhiltzova, 1977; *S. longistyla* (Wu, 1938); *S. nikkoensis* (Okamoto, 1912); *S. recurvata* (Wu, 1938); *S. shibakawae* (Okamoto, 1912); *S. wui* Stark & Sivec, 2009; *S. yunnan* Tierno de Figueroa & Fochetti, 2002; *S. zhiltzovae* Zwick, 2010.

This Transpacific genus contains 33 western Nearctic, 12 East Palaearctic and 3 Oriental species. Among the East Palaearctic species, four poorly known species are restricted to Japan, a further one is known from the Pacific isles Sachalin, Kunashir and Shikotan. Three species are known from Central China, while the remaining four known from the coastal regions: *S. zhiltzovae* is known only from South Korea (Zwick, 2010), *S. colorata* and *S. lepnevae* were reported from the Russian Primorsky Krai and South Korea (Kim *et al.* 1998, Teslenko & Zhiltzova 2009, Zwick 2010), while *S. illiesi* has a wider distribution ranging from the Amurskaya Oblast of Russia through the Primorsky Krai and North Korea to South Korea (Ham 2008, Teslenko & Zhiltzova 2009). *Sweltsa colorata, S. lepnevae* and a further new species are reported from North Korea herein.

Sweltsa colorata Zhiltzova & Levanidova, 1978

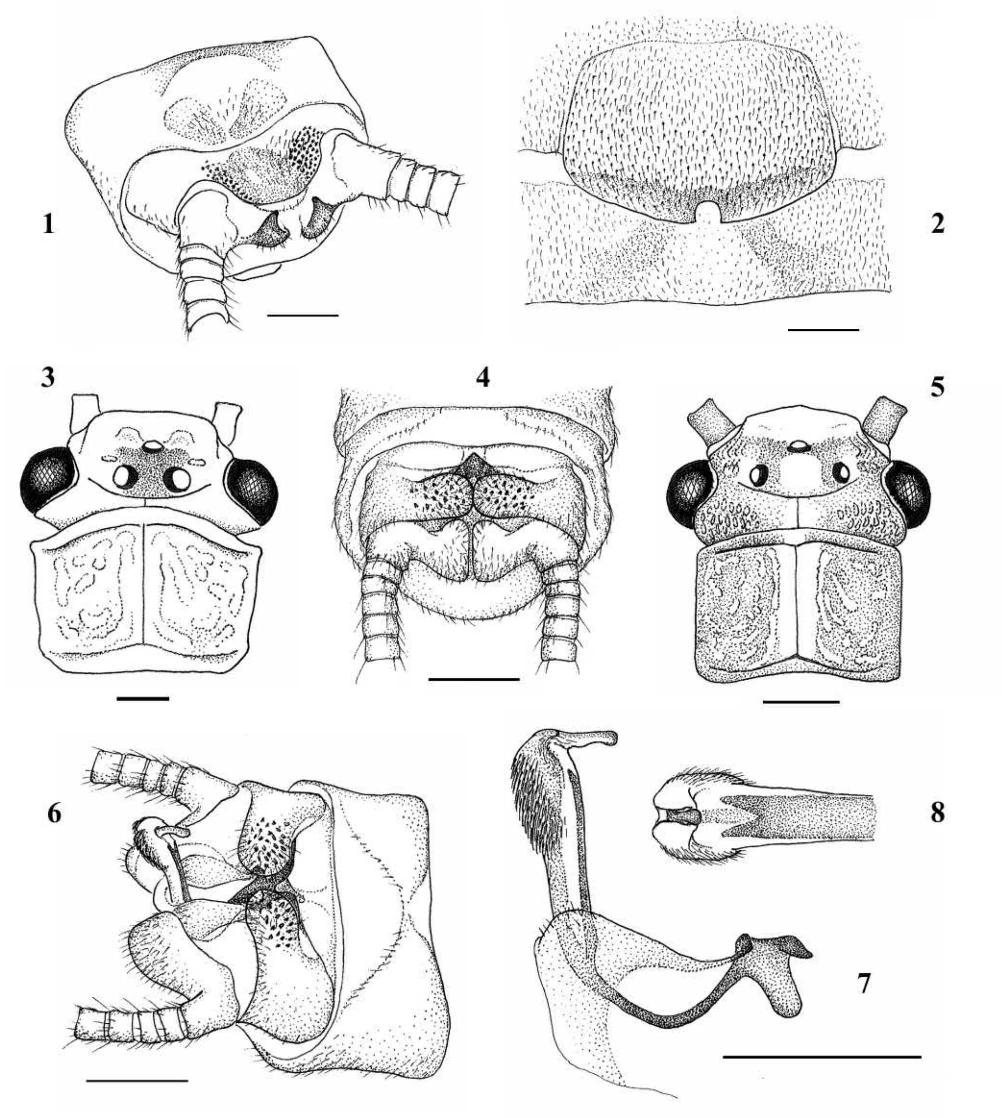
Sweltsa colorata Zhiltzova & Levanidova, 1978: 20. (original description of male, female and larva), Zhiltzova 1995: 15. (type catalogue of RAS specimens), Teslenko & Zhiltzova 2009: 83, 307. (monograph).

Sweltsa nikkoensis (Okamoto, 1912): Kim *et al.* 1998: 422. (synonymy of *S. colorata*, first Korean records; synonymy was disregarded by Teslenko & Zhiltzova 2009 and Zwick 2010), Ham 2008: 186. (complementary description of male and female).

Type locality. Russia, Primorsky Krai, Kedrovaya River, “Kedrovaya Pad” Reserve.

Material examined. North Korea. Pyongyang Capital City, Mt. Taesong, at light (locality No. 923), N39°04’ E125°49’, 17.v.1985, leg. András Vojnits, Lajos Zombori: 1♀; North Pyongan Province, Hyangsan-gun, Myohyang Mts, swept at Hyangsan Stream (locality No. 930), 500 m, N40°00’ E126°15’, 21.v.1985, leg. András Vojnits, Lajos Zombori: 1♀; North Pyongan province, Hyangsan-gun, Myohyang Mts, at light on the hotel balcony (locality No. 933), N40°00’ E126°15’, 21.v.1985, leg. András Vojnits, Lajos Zombori: 10♂ 1♀; North Pyongan province, Hyangsan-gun, Myohyang Mts, singled at Hyangsan Stream (locality No. 935), N40°00’ E126°15’, 22. v.1985, leg. András Vojnits, Lajos Zombori: 1♀; Kangwon Province, Kosŏng-gun, Kumgang Mts, swept along footpath from Kumgang-mun Gate to Kuryong Falls (locality No. 951), N38° 40’ E128° 10’, 27.v.1985, leg. András Vojnits, Lajos Zombori: 2♀; Kangwon province, Kosŏng-gun, Kumgang Mts, Oe-Kumgang rest house, swept in mixed forest (locality No. 952), N38°40’ E128°15’, 27.v.1985, leg. András Vojnits, Lajos Zombori: 1♂ 1♀; Kangwon Province, Kosŏng-gun, Kumgang Mts, swept in forest at Kwinyon-am Rock (locality No. 956), N38°40’ E128°15’, 28.v.1985, leg. András Vojnits, Lajos Zombori: 1♂.

Distribution and ecology. The species was known from the Russian Primorie and numerous places in South Korea, but not yet reported from North Korea (Fig. 13). On Mt. Taesong it was collected together with *Perlomyia martynovi* (Zhiltzova, 1975) and *Amphinemura coreana* Zwick, 1973b. In the Myohyang Mts. it was the only stonefly collected at localities No. 933 and 935, while at Hyangsan Stream (locality No. 930) it was found together with *Perlomyia secunda* (Zapekina-Dulkeit, 1955) and *Sweltsa lepnevae*. In the Kumgang Mts. it was collected together with *Perlomiya sp.* at the Kuryong Falls (locality No. 951), with *A. coreana* at Oe-Kumgang (locality No. 952), while with a wider set of sepcies in the forest at Kwinyon-am Rock (locality No.



Figures 1–8. *Xanthoneuria unimaculata* (Zhiltzova, 1981) from Myohyang Mts, North Korea (1-3) and *Pictetiella asiatica* Zwick & Levanidova, 1971 from Baekdu Mts, North Korea (4-8). 1 = male terminalia, dorso-caudal view; 2 = female sterna 8–9, ventral view; 3 = male head and pronotum, dorsal view; 4 = male terminalia before KOH threatment, dorsal view; 5 = male head and pronotum, dorsal view; 6 = male terminalia after KOH threatment, dorso-lateral view; 7 = everted male epiproct, lateral view; 8 = male epiproct tip, dorsal view. Scales 1 mm.

956): *Perlomyia kiritshenkoi* Zhiltzova, 1974, *P. mahunkai* (Zwick, 1973b), *P. smithae* Nelson & Hanson, 1973, *Perlomyia sp.* an unassociable *Nemoura* Latreille, 1796 female and three females of the same Chloroperlidae species that was published as *Triznaka sp.* by Zwick (1973b). Records of the above *Perlomyia* Banks, 1906 species were already enumerated by Murányi *et al.* (2014).

Sweltsa lepnevae **Zhiltzova, 1977**

(Figure 9)

Sweltsa lepnevae Zhiltzova, 1977: 24. (original description of male and female), Zhiltzova 1995: 16. (type catalogue of RAS specimens), Kim *et al.* 1998: 423. (first Korean records), Ham 2008: 186. (complementary description of male and female), Teslenko & Zhiltzova 2009: 83. (monograph).

Type locality. Russia, Primorsky Krai, Chuguevsky Raion, Bereozovy Creek, Pravaya Sokolovka River (Ussuri River Basin).

Material examined. North Korea. North Pyongan Province, Hyangsan-gun, Myohyang Mts, swept at Hyangsan Stream (locality No. 930), 500 m, N40°00’ E126°15’, 21.v.1985, leg. András Vojnits, Lajos Zombori: 1♀.

Distribution and ecology. The species was known from the Russian Primorsky Krai and South Korea, but not yet reported from North Korea (Fig. 13). In the Myohyang Mts. it was found together with *Perlomyia secunda* and *Sweltsa colorata*.

Remarks. Despite of a single female, the Korean specimen agrees well with the original description. Its head pattern is shown due for comparison with *Sweltsa sp.* (Fig. 9).

Sweltsa sp.

(Figure 10)

Material examined. North Korea. Pyongyang capital city, Pyongyang, singled in the garden of Hotel Pyongyang (locality No. 738), 25 m, N39° 00’ E125°45’, 07.vii.1982, leg. László Forró, László Ronkay: 2♀; Ryanggang province, Samjiyŏn-gun, Baekdu Mts. Baekdu-san-milyong, singled at a brook in mixed larch-birch forest (locality No. 1353), 1500 m, N41°50’ E128°15’, 27.vi.1988, leg. Ottó Merkl, Győző Szél: 3♀.

Diagnosis. Female. Head flat and lacks any dark markings, pronotum with distinct, wide lateral stripes. Median stripe of the abdomen reach anterior margin of tergum IX.

Description. Medium sized species, macropterous. Forewing length: 9–10 mm. Ground colour white in alcohol (probably yellow in life), with dark brown markings on thorax and abdomen. Head wide and flat, completely white and lacks any dark markings (Fig. 10). Ocelli of usual size for the genus, compound eyes small. Antennae and palpi light brown. Pronotum white with distinct, wide dark brown stripes on lateral margins; rugosities indistinct. Meso- and metanotum pale with dark ventrolateral bands, and distinct dorsal U-marks. Legs pale, tarsi brown; wings hyaline, venation yellowish. Pilosity generally short.

Female abdomen. Terga I–VIII with wide dark brown median stripe, markings anteriorly wider on each segments and narrowing on terga VII–VIII; terga IX with transverse dark marking only anteriomedially, tergum X completely white. Sterna all white; subgenital plate large and rounded, posterior margin linear or medially slightly emarginated. Paraproct simple, cerci pale, length usual for the genus.

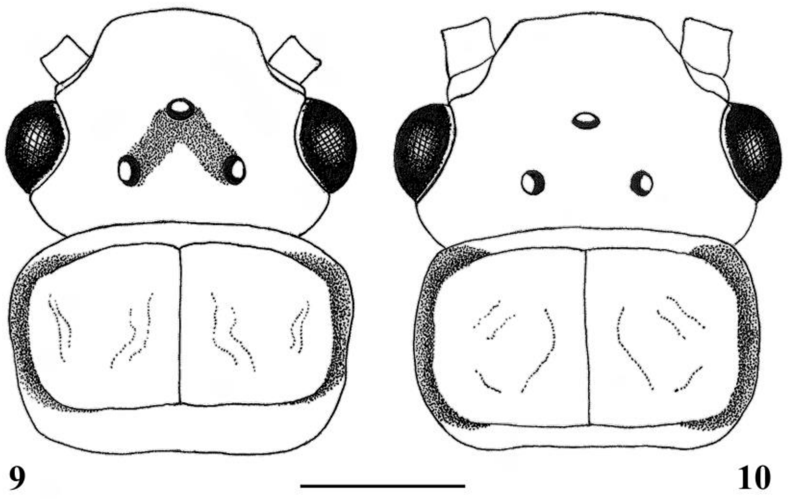
Distribution and ecology. The species was collected at relatively far and different localities in North Korea; from the highest chains of the Baekdu (Changbai) ranges in the North of the peninsula and from the western lowlands (Fig. 13). In Pyongyang it was collected together with a single *Paraleuctra* Hanson, 1941 female (probably *P. malaisei* Zwick, 2010), while in the Baekdu Mts. it was found together with three females of *Megarcys ochracea* (Klapálek, 1912).

Affinities. Among the known Asian *Sweltsa,* only this species and the Oriental *S. yunnan* Tierno de Figueroa & Fochetti, 2002 lacks completely the dark head pattern. *Sweltsa sp.* probably more close to *S. lepnevae*, as their general body colouration and shape of subgenital plate are mostly similar.

Doubtful records from North Korea

Several species that were reported from the Chinese border of North Korea (Yalu River, Wu (1938), and Baekdu Mts., Kim *et al.* (1993)) recently considered to be restricted to Japan. The specimens are not available, so their Korean/ Chinese records are in need of confirmation.

Calineuria jezoensis (Okamoto, 1912). Kim *et al.* (1993) reported it from the Baekdu Mts., under the name *Acroneuria jezoensis* Okam. According to Uchida (1983, 1990), this species is restricted



Figures 9–10. *Sweltsa* Ricker, 1943 species from North Korea, female head and pronotum, dorsal view. 9 = *Sweltsa lepnevae* Zhiltzova, 1977 Myohyang Mts; 10 = *Sweltsa sp.* Baekdu Mts. Scale 1 mm.

to Japan, just like all the other Asian members of the Transpacific genus *Calineuria* Ricker, 1954.

Xanthoneuria jouklii (Klapálek, 1907). Kim *et al.* (1993) reported it from the Baekdu Mts., under the name *Acroneuria jouklii* Klap. Uchida *et al.* (2011) reported this species as restricted to Honshu. The record most probably refers to *X. unimaculata*, and its Korean mention in Uchida *et al.* (2011).

Paragnetina tinctipennis (McLachlan, 1875). Kim *et al.* (1993) reported it from the Baekdu Mts. According to Uchida (1990), this species is also restricted to Japan. The Korean record probably refers to *P. flavotincta*, widespread in the temperate zone of Asian mainland.

Stavsolus tenninus (Needham, 1905). Wu (1938) reported it from the Yalu River, under the name *Togoperla tennina* (Needham) (incorrectly indicated as a paratype). Sivec *et al.* (1988) transferred this species to *Stavsolus* Ricker, 1952, however, it was not included in the revision of the genus (Teslenko & Minakawa 1999) and its validity is not yet cleared. The Yalu River specimen probably belongs to *Stavsolus manchuricus* Terslenko, 1999 (in Teslenko & Minakawa, 1999), and *S. tenninus* should be a species restricted to Japan.

Tadamus scriptus (Klapálek, 1912). Kim *et al.* (1993) reported it from the Baekdu Mts., under the name *Isogenus scriptus* Klap. The genus *Tadamus* Ricker, 1952 is considered to be restricted to Japan, and *T. scriptus* may belongs to *Stavsolus* (DeWalt *et al.* 2015).

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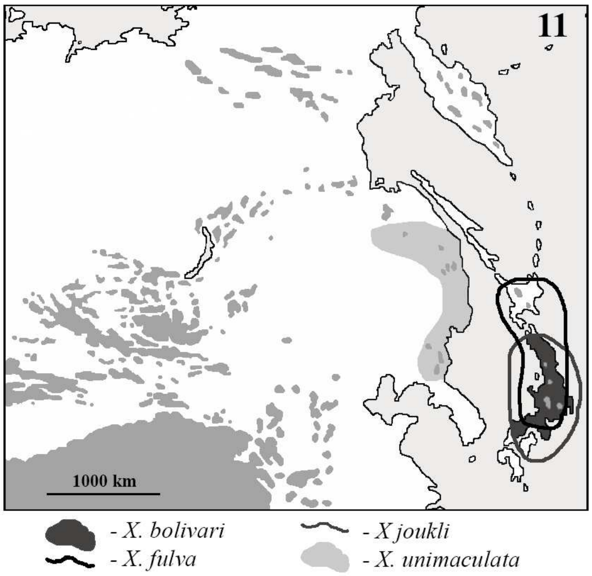

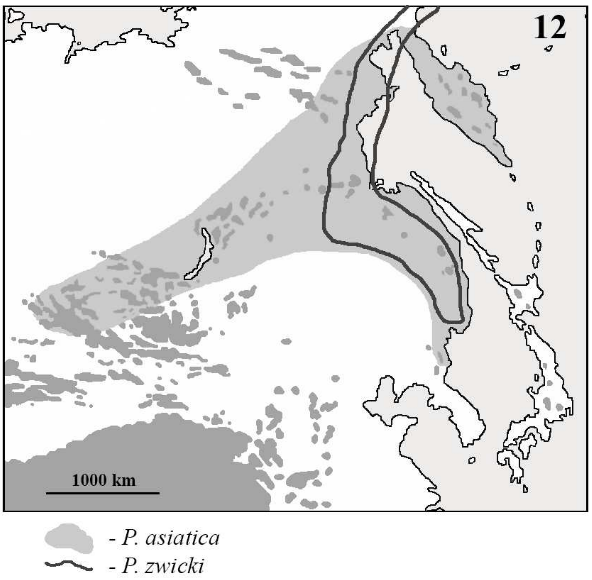

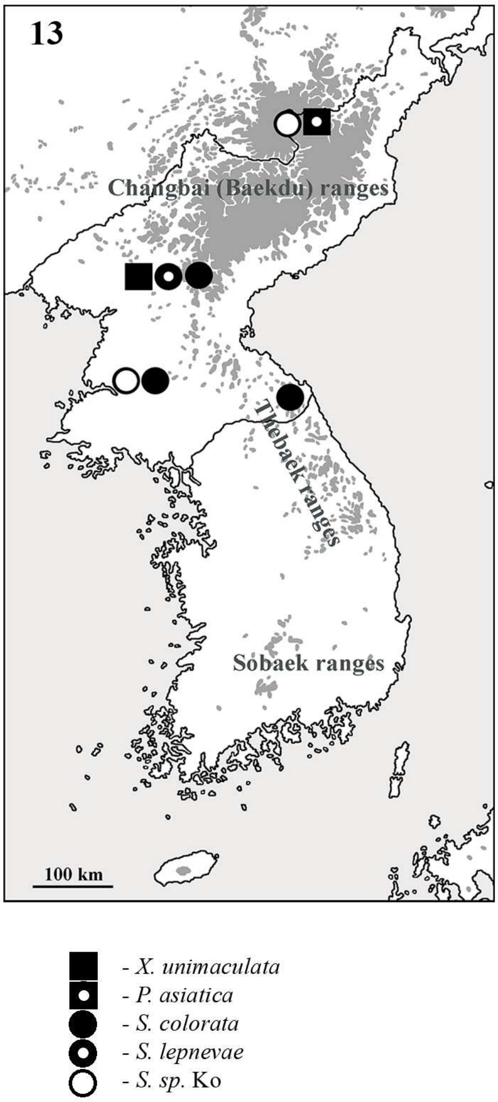

Figures 11–13. Distribution of the genera *Xanthoneuria* Uchida, 2011 and *Pictetiella* Illies, 1966, and the North Korean localities reported in the present paper. 11 = distribution of the genus *Xanthoneuria* Uchida, 2011; 12 = Asian distribution of the genus *Pictetiella* Illies, 1966; 13 = North Korean localities reported in the present paper. Grey areas are above 2000 meters (Figs. 11–12) or 1000 meters (Fig. 13).

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Interesting rotifers (Rotifera: Eurotatoria) from floodplain lakes of lower Brahmaputra river basin of Assam, northeast India

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Abstract. The plankton and semi-plankton samples collected from four floodplain lakes (*beels*) of Barpeta district of lower Brahmaputra river basin, Assam state, northeastern India (NEI) revealed eighteen rotifer species of biodiversity and biogeographic interest belonging to five families and six genera. One species is new to the Indian Rotifera and one species is new to Assam. Our collections are characterized by two Australasian elements, five Oriental endemics, seven paleotropical species, and one cosmo (sub) tropical species. Nine species, restricted to date to NEI, are examples of regional distribution importance in India while six species depicted disjunct distribution in the country. Interestingly, seven species are categorized as Eastern hemisphere elements. All the taxa are illustrated to warrant validation as an increasing magnitude of 'unverifiable records' is a serious impediment for the progress of rotifer biodiversity in India.

Keywords. Biodiversity, distribution, interesting taxa, lower Assam, tropical floodplains.

INTRODUCTION

Tropical and subtropical floodplain lakes are hypothesized to be Rotifera rich habitats (Segers *et al.* 1993). The rotifer assemblages of these ecotones are poorly documented in India in general except for the floodplain lakes (*beels*) of the Brahmaputra river basin of Assam state which are known for their rich and interesting rotifer diversity (Sharma & Sharma 2005, 2008, 2013, 2014a, 2014b, 2014c, 2015a) in the Indian subregion. The present limnological reconnaissance is undertaken to further explore the biodiversity importance of 'managed *beels'* (for fisheries) of Barpeta district of lower Assam. During the course of the study, we observed eighteen Rotifera species of biodiversity and biogeographic value. The recorded species are listed and comments are made on their status, occurrence, and distribution. All the taxa are illustrated to warrant validation as the Indian literature is flooded with 'ad-hoc unverifiable' reports lacking validations (BKS, unpublished).

MATERIALS AND METHODS

This study is a part of limnological reconnaissance undertaken in four floodplain lakes (*beels*) of Barpeta district of Assam (Table 1) during August 2011 – July 2013. These beels are 'managed' locally to harvest their fishery potential. Plankton and semi-plankton samples were collected from various *beels* by towing a nylobolt plankton net (# 50 µm) and were preserved in 5% formalin. Individual collections were screened with a Wild stereoscopic binocular microscope; the rotifer taxa were isolated and mounted in Polyvinyl alcohol–lactophenol, and were observed with Leica (DM 1000) stereoscopic phase contrast microscope fitted with an image analyzer. The different rotifers were identified following the works of Koste (1978), Segers (1995), Sharma (1983, 1987, 1998), Sharma & Sharma (1997, 1999, 2000, 2008, 2013, 2015a, 2015b, 2015c). The reference materials are in the holdings of Freshwater Biology laboratory, Department of Zoology, North-Eastern Hill University, Shillong.

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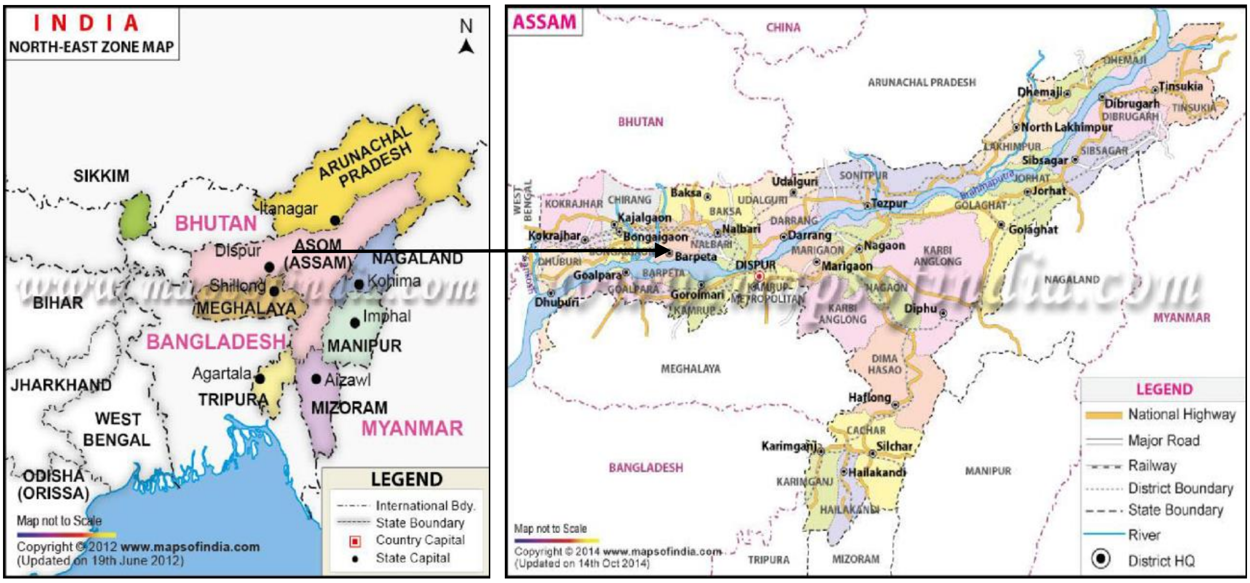
Table 1. List of the sampled beels.

Sl. No.	Beel	Latitude	Longitude	Elevation (m)
1	Fingua	N26°17’08.7”	E91°02’00.2”	37.9
2	Baria	N 26°21’35.9”	E 91°02’43.1”	43.7
3	Sorbhog	N26°30’22.2”	E90°53’20.6”	48.3
4	Balaisuti	N26°21’19.7”	E90°52’12.8”	54.6



A B

Figure 1. A = Map showing Northeast India (NEI), B = Map of Assam indicating Barpeta district (the sampling area marked by an arrow)

RESULTS

A total of eighteen interesting rotifer species belonging to five Eurotatoria families and six genera are reported in the systematic list given below:

Phylum Rotifera
Class Eurotatoria
Subclass Monogononta
Order Ploima
Family Brachionidae

1. *Brachionus bennini* Leissling, 1924 **
2. *B. dichotomus reductus* Koste & Shiel, 1980
3. *B. durgae* Dhanapathi, 1974
4. *B. kostei* Shiel, 1983
5. *Keratella edmondsoni* Ahlstrom, 1943
6. *K. javana* Hauer, 1937

Family Lepadellidae

7. *Lepadella discoidea* Segers, 1993
8. *L. vandenbrandei* Gillard, 1952

Family Lecanidae

9. *Lecane blachei* Berzins, 1973
10. *L. bulla diabolica* (Hauer, 1936)
11. *L. lateralis* Sharma, 1978
12. *L. niwati* Segers, Kothetip & Sanoamuang, 2004
13. *L. simonneae* Segers, 1993

Family Testudinellidae

14. *Testudinella amphora* Hauer, 1938
15. *T. brevicaudata* Yamamoto, 1951
16. *T. dendradena* de Beauchamp, 1955*
17. *T. greeni* Koste, 1981

Family Trochosphaeridae

18. *Filinia camasecla* Myers, 1938

** New record for India; **new record for Assam state*

Testudinella dendradena de Beauchamp (Fig. 2) is a new record for India and *Brachionus bennini* Leissling (Fig. 3) is new record from Assam state. *B. dichotomus reductus* Koste & Shiel (Fig. 4) and *B. kostei* Shiel (Fig. 5) are Australasian elements; *Keratella edmondsoni* Ahlstrom (Fig. 6), *Lecane blachei* Berzins (Fig. 7), *Lecane bulla diabolica* (Hauer) (Fig. 8), *L. niwati* Segers, Kothetip & Sanoamuang (Fig. 9) and *Filinia camasecla* Myers (Fig. 10) are Oriental endemics. *Brachionus durgae* Dhanapathi (Fig. 11), *Keratella javana* Hauer (Fig. 12), *Lepadella discoidea* Segers (Fig. 13), *L. vandenbrandei* Gillard (Fig. 14), *Lecane lateralis* Sharma (Fig. 15), *L. simonneae* Segers (Fig. 16), *Testudinella amphora* (Fig. 17), *T. brevicaudata* Yamamoto (Fig. 18), and *T. greeni* Koste (Fig. 19) are other species with interesting distributions.

DISCUSSION

Our collections from the sampled *beels* of lower Assam, NEI revealed eighteen interesting species of Rotifera spread over five eurotatorian families and six genera. *Testudinella dendradena* is a new record to the Indian Rotifera and *Brachionus bennini* is a new addition to the rotifer fauna of Assam. The former is treated as a distinct species following Segers (2007) though Jersabek & Leitner (2013) considered it as *T. patina dendradena*. We also followed analogies of resurrection of *Lecane nitida*; *Mytilina michelangellii* and *M. brevispina vide* Segers & Savatenalinton (2010), Pourriot (1996) and Luo & Segers (2014), respectively for the said treatment. *T. dendradena* is diagnosed by its characteristic vitellarium and it co-occurred with *T. patina* in some collections. Further, these two species differed in size and habitat; the former being distinctly larger and preferred the littoral-periphytonic regions. *T. dendradena* is known from the Afrotropical, Neotropical and Oriental regions (Segers 2007); the present report extended its distribution within the last to the Indian sub-region. *B. bennini* is reported from the Afrotropical, Australasian, Neotropical, Oriental, and Palaearctic regions (Segers 2007). This brachionid is examined from NEI from Mizoram (Sharma 1987, Sharma & Sharma 2014d, 2015c) and is also observed from Madhya Pradesh in central India (Sharma & Naik 1996); the present report extended its distribution within NEI.

The biogeographically interesting elements included: (i) the Australasian *Brachionus dichotomus reductus* and *B. kostei*; (ii) five Oriental endemics namely *Keratella edmondsoni*, *Lecane blachei*, *Lecane bulla diabolica, L. niwati* and *Filinia camasecla*; and (iii) the paleotropical *Keratella javana, Lepadella discoidea*, *L. vandenbrandei*, *Lecane lateralis*, *L. simonneae*, *Testudinella brevicaudata* and *T. greeni*. Besides, *Brachionus durgae, Testudinella amphora* and *T. dendradena* merit distribution interest.

Referring to the first category, Segers (2001) remarked on occurrence of *reductus* vicariant of *B. dichotomus* outside Australia, hinted at a possible Australian origin of this taxon and hypothesized its recent expansion to Southeast Asia. The disjunct populations of this brachionid known from India only from NEI (Meghalaya, Tripura and Assam) are hypothesized (Sharma & Sharma 2014a, 2014c, 2014d, 2015b, 2015c) to their possible recent expansions to the Indian subregion. This taxon is reported from the Oriental region from Vietnam (Zhdanova 2011) and from Thailand (Athibai *et al.* 2013, Sa-Ardrit *et al.* 2013). *Brachionus kostei,* described from Australia, is known from Papua Guinea and Thailand while Segers (2007) considered its unpublished report from northeast China as a possible example of introduction. This species is known from India exclusively from Assam state of NEI (Sharma 2004, 2014, Sharma & Sharma 2008, 2014d, 2015b, Sharma *et al.* 2015). Nevertheless, these two Australasian elements affirmed affinity of Rotifera assemblage of Assam state as well as of NEI with the faunas of Southeast Asia and Australia, and thus supported remarks of Sharma (2005) and Sharma and Sharma (2005, 2008, 2013, 2014a, 2014c, 2014d).

Our collections are characterized by five Oriental endemics namely *Keratella edmondsoni*, *Lecane blachei*, *Lecane bulla diabolica, L. niwati* and *Filinia camasecla* and thus affirmed affinity of Assam Rotifera with the Oriental fauna. The first species was described from Tamil Nadu (Ahlstrom 1943) as *K. quadrata* var. *edmondsoni* while Nayar (1965) raised it to the status of a distinct species. This brachionid indicated disjunct occurrence in India with reports from Assam (NEI), Rajasthan, Orissa, and Tamil Nadu. It is reported in the Oriental region from Thailand (Sa-Ardrit *et al.* 2013) and Cambodia (Meas & Sanoamuang 2010, Sor *et al*. 2015). *L. blachei*, described from Cambodia is also known from Thailand, while its Indian reports are restricted till date to Assam (NEI) and West Bengal (Sharma & Sharma 2014b). *L. bulla diabolica,* originally described from Tamil Nadu (Hauer 1936), was known globally by its sole non-illustrated Oriental record from Thailand (Segers & Savatenalinton 2010) till Sharma & Sharma (2014b) extended its distribution within India to NEI (Assam, Manipur); the current second Indian report from Assam re-affirmed its distribution in NEI. *L. niwati* is an interesting lecanid described from Thailand (Segers *et al*. 2004). Sharma (2014) and Sharma & Sharma (2014b) recently extended its distribution to NEI based on specimens from the Majuli River Island of upper Assam and Loktak Lake (a Ramsar site), Manipur, respectively while the present study further extended its distribution to lower Brahmaputra river basin. The Oriental *F. camasecla* indicated disjunct occurrence in India with reports from Assam, Manipur and Tripura states of NEI and Kerala (South India).

Amongst the palaeotropical elements, *Keratella javana* (Assam, Meghalaya, Tripura), *Lepadella vandenbrandei* (Assam, Mizoram), *Testudinella brevicaudata* (Assam, Manipur, Tripura) and *T. greeni* (Assam) merit regional biogeographical interest with their reports so far only from NEI. *Lecane simonneae* (Assam, Kerala, Manipur, Tripura) exhibited disjunct yet restricted distribution in India while *Lepadella discoidea* (Assam, Delhi, Kerala, Manipur, Meghalaya) and *Lecane lateralis* (Assam, Kerala, Meghalaya, Orissa, Tamil Nadu, Tripura, West Bengal) indicated disjunct but relatively wider occurrence. Besides, the cosmo (sub) tropical *Brachionus durgae* (Andhra Pradesh, Assam, Goa, Kerala, Maharashtra, Orissa, Tamil Nadu) and *Testudinella amphora* (Assam) are examples of regional distribution of interest. The latter is known from the Australian, Neotropical and Oriental regions (Segers, 2007); it is examined from the last region from Thailand (Sa-Ardrit *et al*. 2013) and Vietnam (Trinh Dang *et al*. 2013), and Sharma *et al*. (2015) extended its distribution to the Indian sub-region based on collections from the Majuli River Island, upper Assam while Sharma & Sharma (2015c) recorded it from Mizoram state of NEI. The present report further extends its occurrence to lower Assam.

Keratella javana, Lecane lateralis, *L. simonneae*, *L. unguitata*, *Lepadella discoidea*, *L. vandenbrandei*, and *Testudinella greeni* are categorized as Eastern hemisphere elements *vide* Segers (2001). In addition, three other members of this category: *Brachionus diversicornis*, *B. forficula* and *L. unguitata*, though not listed in this report, are observed in our lower Assam samples (BKS, unpublished).The report of the stated taxa imparts yet another interesting character to the rotifer fauna of Assam and NEI.

We categorize all the documented species into three groups: (a) Restricted to NEI: *Brachionus dichotomus reductus, B. kostei, Keratella javana, Lepadella vandenbrandei, Lecane blachei, L. niwati, Testudinella amphora, T. brevicaudata, T. dendradena* and *T. greeni*; (b) Disjunct and restricted distribution in India: *Brachionus bennini, Keratella edmondsoni, Lecane bulla diabolica, L. simonneae* and *Filinia camasecla*; (c) Disjunct with relatively wide distribution in India: *Brachionus durgae, Lecane lateralis, Lepadella discoidea*.

To sum up, the reports of new records, species of global and regional distribution importance and Eastern Hemisphere elements merit biodiversity and biogeographic interest. The Australasian and Oriental species impart special affinity of Assam

Rotifera with Southeast Asia as well as Australia. The study highlights interesting elements of NEI rotifers as compared with other regions of India. Further, this report is useful addition for meta-analysis of Rotifera diversity of northeast India – a global biodiversity region in general and of the floodplain lakes of the Brahmaputra river basin in particular.

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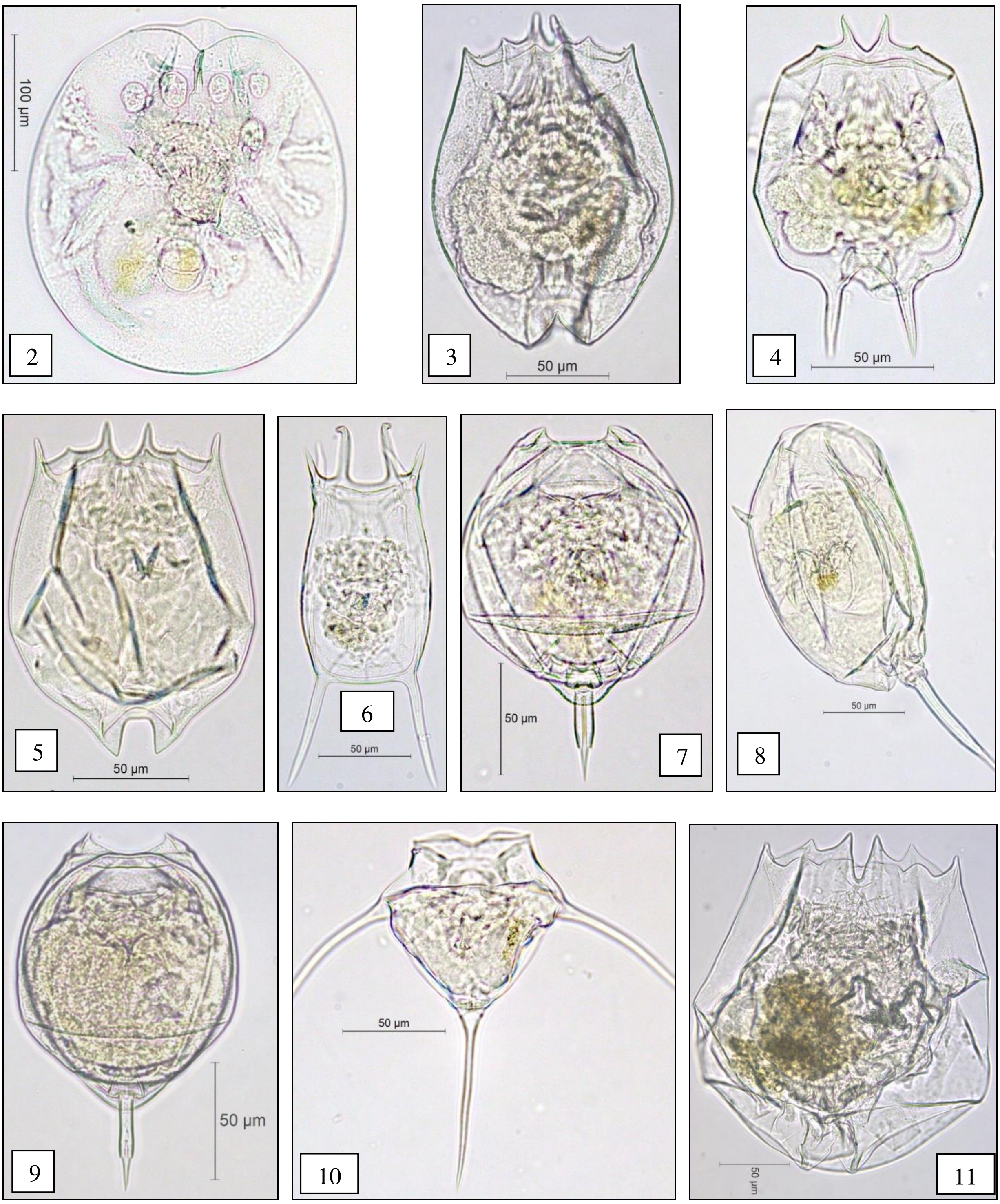
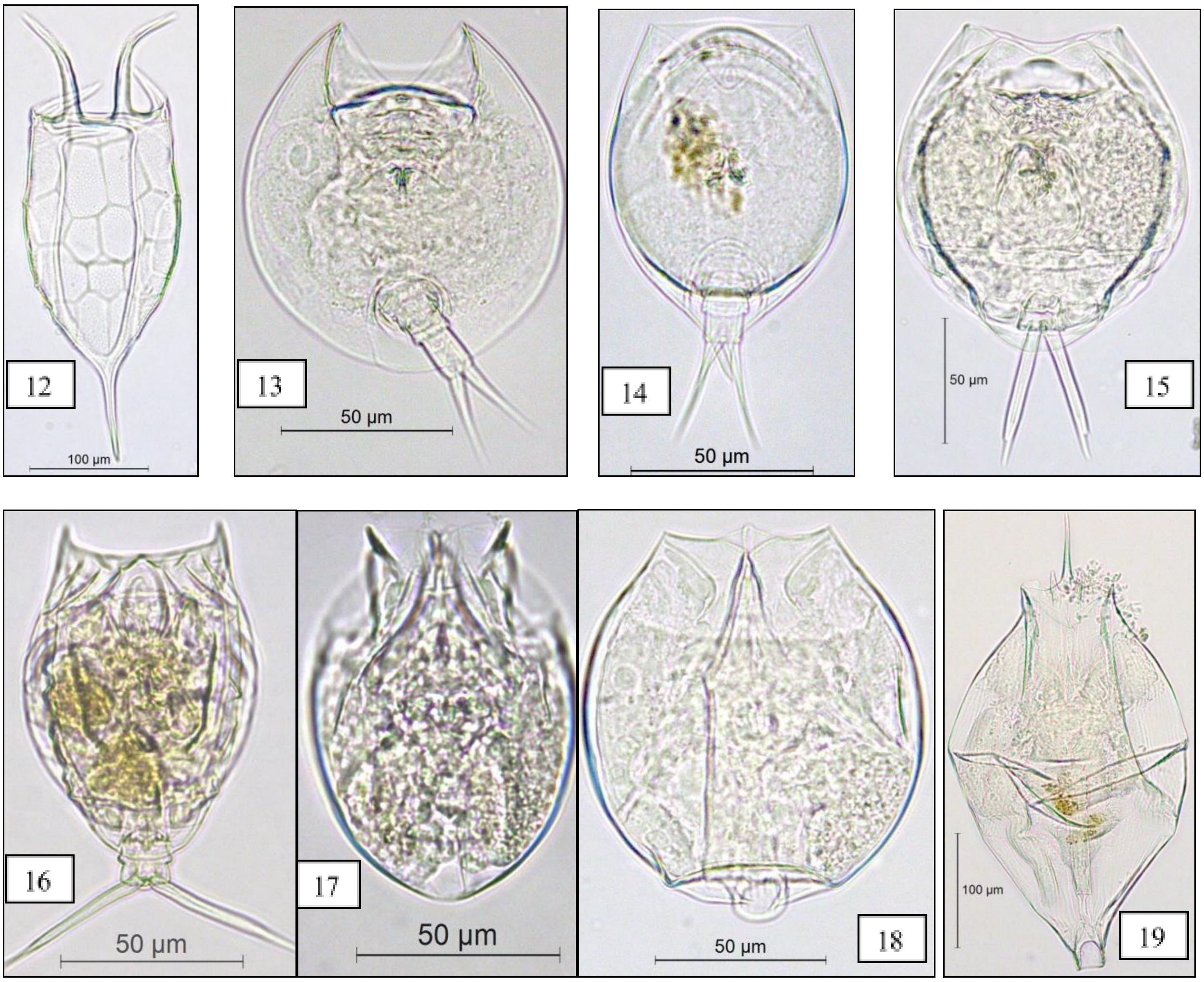


Figures 2-11. 2 = *Testudinella dendradena* de Beauchamp (ventral view); 3 = *Brachionus bennini* Leissling (dorsal view); 4 = *Brachionus dichotomus reductus* Koste & Shiel (ventral view); 5 = *Brachionus kostei* Shiel (dorsal view); 6 = *Keratella edmondsoni* Ahlstrom (dorsal view); 7 = *Lecane blachei* Berzins (ventral view); 8 = *Lecane bulla diabolica* (Hauer) (lateral view); 9 = *Lecane niwati* Segers, Kothetip & Sanoamuang (dorsal view); 10 = *Filinia camasecla* Myers (dorsal view);11 = *Brachionus durgae* Dhanapathi (ventral view).



Figures 12-19. 12 = *Keratella javana* Hauer (ventral view); 13 = *Lepadella discoidea* Segers (ventral view); 14 = *Lepadella vandenbrandei* Gillard (ventral view); 15 = *Lecane lateralis* Sharma (dorsal view); 16 = *Lecane simonneae* Segers (dorsal view); 17 = *Testudinella amphora* Hauer (dorsal view); 18 = *Testudinella brevicaudata* Yamamoto (ventral view); 19 = *Testudinella greeni* Koste (dorsal view).

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Two new families (Acari: Alicorhagiidae and Platyhelminthes: Prorhynchidae) reported for the Hungarian fauna From leaf litter in the Bükk Mountains

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Abstract. Two new members of the Hungarian fauna are reported, both of them were collected in beech forest leaf litter in the Bükk Mountains, North-East Hungary: *Alicorhagia fragilis* Berlese, 1910 (Arthropoda: Arachnida: Acari: Sarcoptiformes: Endeostigmata: Alicorhagiidae) and *Geocentrophora baltica* (Kennel, 1883) (Platyhelminthes: Rhabditophora: Trepaxonemata: Amplimatricata: 'Lecithoepitheliata': Prorhynchida: Prorhynchidae). The families Alicorhagiidae and Prorhynchidae both represent new taxa in the fauna of the country.

Keywords. Lecithoepitheliata, Endeostigmata, soil fauna, new record, Bükk National Park

INTRODUCTION

The authors report on the finding of two interesting species of soil biota representing groups that are relatively under-studied in the Hungarian fauna. Both species represent new families for Hungary and were collected from beech leaf litter in the Bükk National Park, North-East Hungary, from the exact same location where a new species of mite for the Hungarian fauna (Pfliegler & Bertrand 2011) and members of the Pauropoda with new faunistic records and a new species to science (Scheller *et al.* 2015) were found recently.

This particular area near the village Ómassa is located at the foot of a steep slope and the soil is covered with high stacks of beech (*Fagus sylvatica*) leaf litter (Fig. 1a.), while nearby areas have much shallower leaf litter coverage. The climate of the area is rather cool and it receives a very limited amount of sunlight year-round. The Garadna-spring is located some 10 meters downhill from the collection area, but it is very humid nevertheless, due to snowmelt and rainwater from the surrounding slopes flowing through it (personal observations).

Endeostigmata is among the most enigmatic groups of mites (along with the Sphaerolichina) and their distribution records are still very scarce. The taxon Endeostigmata includes mites with numerous primitive (plesiomorphic) characters and they are probably paraphyletic (Walter 2009). Within the Endeostigmata, the family Alicorhagiidae is characterized by a single pair of prodorsal trichobothria and absence of lateral claws on all of the pretarsi. *Alicorhagia* spp. are known to be thelytokous and they are omnivorous (Walter 2009). Within the family, this genus is characterized by the presence of five solenidia on tarsus I and also on tibia I in the adult stage. One family of the Endeostigmata, the vermiform Nematalycidae has been reported from Hungary so far, although this is an unpublished record (Norton *et al.* 2008). This mite was identified as *Gordialycus tuzetae* Coineau, Fize & Delamare Deboutteville, 1967 from the Kiskunság National Park. These often extremely small and relatively species-poor soil mite groups are probably widespread across different habitats in the country.

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The Lecithoepitheliata is a relatively species-poor group of flatworms split into the freshwater Prorhynchida and marine Gnosonesimida, but in fact the group is non-monophyletic according to recent molecular phylogenetic analyses (Laumer & Giribet 2014, Laumer *et al.* 2015). Prorhynchidae is shown to be a sister group of the marine Polycladida (Laumer & Giribet 2014, Egger *et al.* 2015, Laumer *et al.* 2015). Superficially they resemble minute freshwater Tricladida. The family Prorhynchidae is rather widespread in Europe (von Graff 1882, 1913). The species recorded in this work, *Geocentrophora baltica* (Kennel, 1883) can easily be distinguished from related flatworms (other members of Prorhynchidae), and generally, every other microscopic free-living flatworm by its hooked stylet opening into the mouth tube, which is visible even in low magnification (Fig. 3a–b.), lack of eyes, and tongue-shaped anterior (von Graff 1913; Steinböck 1927, Luther 1960). The species *G. sphyrocephala* de Man, 1876 has a very similar stylet but possesses eyes and has a very broad anterior (less characteristic in longer specimens). Relatively recently, Bauchness (1971) treated *G. baltica* as a synonym of *G. sphyrocephala* based on the subtle differences and overlapping characters, although this synonymyzation is not widely accepted. von Graff (1913) and Luther (1960) give the maximal length of *G. baltica* as 10–10.5 mm (fully extended). The species inhabits small forest waters formed after thaw, and puddles that form after flooding of meadows, and rarely soils and mosses (Bauchness 1971).

Research on the free-living flatworms ('Turbellaria' in traditional literature) of the Hungarian fauna dates back to the 19th century and several species of every major freshwater group of these animals have been recorded from the country. However, the ever-changing systematics of Platyhelminthes, and the border changes of Hungary in the 20th century makes evaluating older records problematic. The Fauna Regni Hungariae (Parádi 1896) lists a handful of species from locations mostly in Transylvania (now Romania), but none from the family Prorhynchidae. The family is also not listed in the earlier works of Parádi (1875, 1883). In the monograph of Rhabdocoelida, von Graff (1882) mentioned records of some flatworms from Hungary, but all of them are from the village Pancsova (now Pančevo in Serbia) and there is no mention of Prorhynchidae. In his extensive work in the series “Das Tierreich”, von Graff (1913) mentioned the Hungarian distribution of the species *Prorhynchus stagnalis* Schultze M., 1851 without specific references. Publications from Hungarian authors did not mention the family Prorhynchidae, neither in the years between von Graff's works, nor later. Most articles focused on Tricladida (Fülep 2012 and references therein) and few discussed the members of less-known taxa; Gelei (1930) almost entirely re-wrote the Turbellaria section of Brehm's Tierleben with an emphasis on the Hungarian fauna. Dudich (1942) and Andrássy (1984) shortly discussed all major flatworm taxa in Hungary – no mention of Prorhynchidae are given in these works. Thus the listing of the country in von Graff (1913) seems to be based on an unpublished and later forgotten record or may be an error. Steinböck (1927) gives a less accurate distribution of the species in the family (mostly as Europe), and he does not mention any Hungarian record. Luther (1960) mentions the record of *P. stagnalis* from Hungary and cites the Monographie der Turbellarien of von Graff, which is obviously an erroneous citation, as only von Graff's later work (in Das Tierreich) refers to the country. It can thus be concluded that the only relevant data of the family from Hungary was published by von Graff (1913) without specific information or reference, and it is impossible to determine whether von Graff's record comes from a location that is in present-day Hungary. Earlier literature therefore does not support the undoubtful occurrence of the family in the country.

MATERIALS AND METHODS

Samples of leaf litter were collected and stored in plastic containers for extended periods and regularly sprinkled with water. The samples were manually searched through and specimens were removed with a fine brush, photographed alive and conserved in 75% ethanol (both speci-

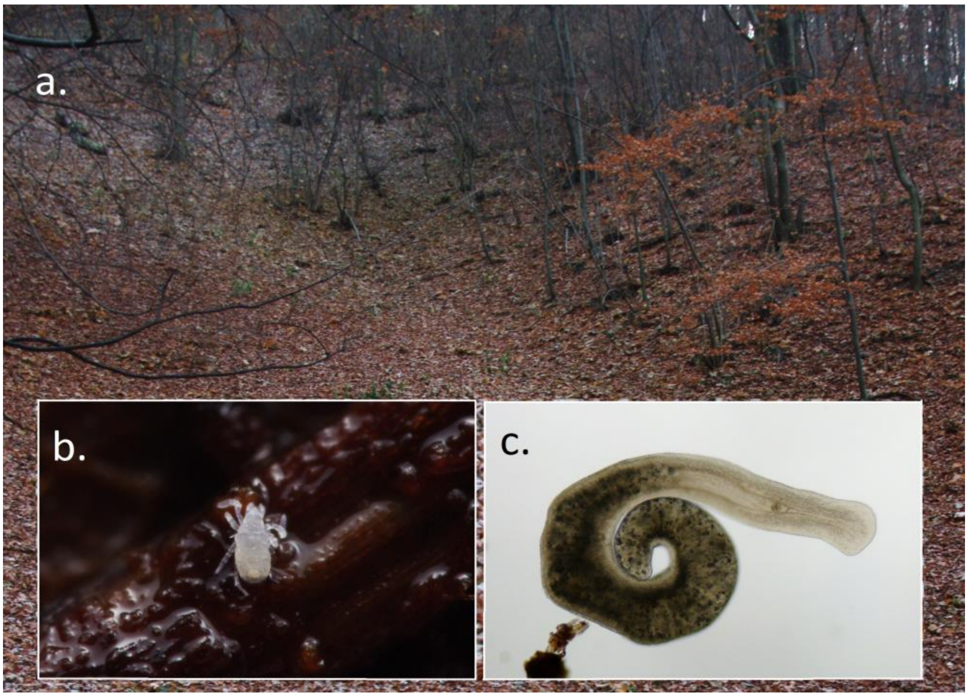

Figure 1. a = Collection locality near Ómassa, Bükk Mountains, N-E. Hungary. Date: 24.11.2011. b = habitus of *Alicorhagia fragilis*. c = habitus of *Geocentrophora baltica*.

es). In the case of *Geocentrophora*, one specimen was fixed in 4% formaldehyde, washed and mounted in glycerol, and sealed with euparal to allow photography with high magnification. Mites were subsequently washed and prepared onto slides in Heinz-PVA. Photographs were taken with a Pentax k7 DSRL camera, equipped with a macro lens setup and with the camera placed on a microscope equipped with a 10× Olympus Plan lens using transmitted light. Higher magnification photos were taken with an Olympus BD40 microscope equipped with Olympus 20×, 40× and 100× phase contrast lenses (Olympus Corporation, Tokyo, Japan) and an Olympus digital microscope camera with the software DP Controller (Olympus). Phase contrast microscopy images were focus-stacked using ZereneStacker (Zerene Systems LLC, Richland, WA, USA). Leg I of *Alicorhagia fragilis* was imaged using an Olympus Spectral FV1000 confocal laser scanning microscope. A 3D model of the leg was generated via a z-stack of the autofluorescence emission (laser = 488 nm). An image of this model (Fig. 2b.) was created using Imaris (Bitplane, Zurich, Switzerland).

Images were enhanced in Photoshop CS6 (Adobe Systems Inc., San Jose, CA, US) and have been deposited in Morphbank (2015). Slide-mounted specimens are deposited in the Zoology Collection of the Hungarian Natural History Museum (HNHM) and The Ohio State University Acarology Laboratory (OSAL). Taxonomy follows Walter *et al.* (2013) and Egger *et al.* (2015).

RESULTS

Alicorhagiidae Grandjean, 1939

Alicorhagia fragilis Berlese, 1910

(Figures 1b, 2a–b)

Material examined. 2♀, Borsod-Abaúj-Zemplén county, Bükk Mountains, Ómassa village, 48° 06'28.5"N 20°31'51.4"E, beech forest, in leaf-litter, ~500 m a.s.l., leaf litter sample collected on 24.11.2011, specimens collected on 02.01.2013 from the sample. Leg. W.P. Pfliegler.

Slide catalogue numbers. OSAL0099079 and OSAL0099080.

Accession numbers of photos in Morphbank. 856222 to 856225 (OSAL0099079) and 856226 to 856229, 856232, 856234, 856235 (OSAL 0099080).

Remarks. The specimens collected are in concordance with the characters of the widespread species *A. fragilis*. *A. fragilis* can be distinguished from the relatively similar *A. usitata* Theron, Meyer & Ryke, 1971 based on the solenidia of the first leg. In *A. usitata*, the most distal solenidion on tibia I is clavate (Theron *et al.* 1969), whereas in *A. fragilis* this solenidion is relatively baculiform (Fig. 2b.). Another important distinguishing feature is the positions of the three long, thin solenidia on tarsus I. In *A. usitata*, one of these solenidia is near the long, broad solenidion (Theron *et al.* 1969), whereas in *A. fragilis* all three of these solenidia have distinctly proximal positions relative to the long, broad solenidion (Fig. 2b.).

The original description of *A. fragilis* provides inadequate information for a confident and robust identification (Berlese 1910). Unfortunately, the holotype is in poor condition. However, topotypes from the same botanical garden have been collected and deposited at the Museum of Biological Diversity, Ohio State University (OSAL nos. 0104484, 0104485, 0104486). These appear to be identical to the two Hungarian specimens, which are both adult females. These specimens also very closely resemble the Japanese specimen of *A. fragilis* that was drawn by Shiba (1983).

Prorhynchidae Hallez, 1894

Geocentrophora baltica (Kennel, 1883)

(Figures 1b, 3–b)

Material exmined. 1 specimen, Borsod-Abaúj-Zemplén county, Bükk Mountains, Ómassa village, 48°06'28.5"N 20°31'51.4"E, beech forest, in leaf-litter, ~500 m a.s.l., leaf litter sample collected on 24.11.2011, specimens collected on 05.02. 2012 from the sample. Leg. W.P. Pfliegler. Slide-preparate.

Accession numbers of photos in Morphbank. (856230, 856231).

Slide catalogue number. HNHM Gyn. 878.

Remarks. A high definition video of the specimen collected on 05.02.2012 is available at the following URL: https://www.youtube.com/watch?v=ytmsmEgeHTg showing the animal moving under a coverslip with transmitted light.

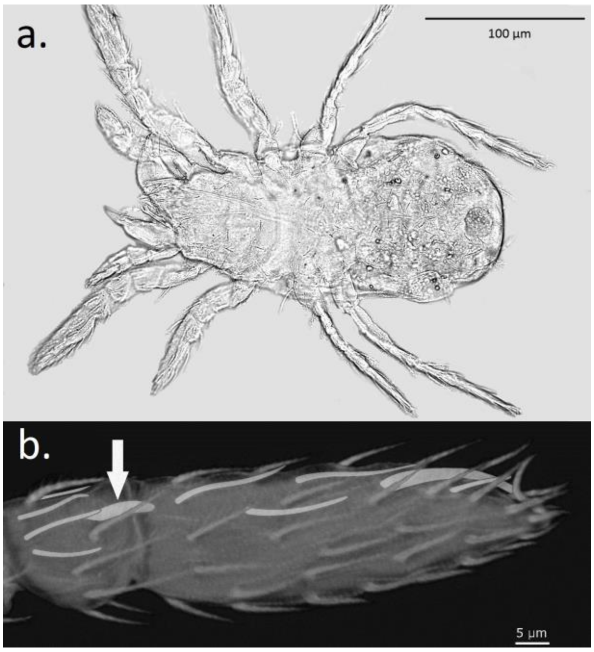

Figure 2. Microscopic anatomy of *Alicorhagia fragilis* (specimen OSAL0099080). a = mounted specimen, ventral view (phase contrast image). b = View of tibia I and tarsus I (same specimen). This is an image of a 3D model generated using a confocal laser scanning microscope. The solenidia have been artificially highlighted because of their weak autofluorescence. The arrow points to the relatively baculiform solenidion (which is distinctly clavate in *A. usitata*).

DISCUSSION

Both species reported in this work (and also the families they are classified in, Alicorhagiidae and Prorhynchidae) are widespread but under-studied, minute animals inhabiting soil and leaf litter, and in the case of *Geocentrophora*, mostly small water bodies. Both of the species belong in species-poor families that would nevertheless greatly benefit from a taxonomic revision; *G. baltica* is sometimes considered a synonym of *G. sphyrocephala* (*e. g.* Luther 1960, Bauchness 1971) based on the fact that the presence or absence of eyes in these flatworms is, as well as the body shape, variable (loss of eyes may occur gradually during their ontogeny), while the shape of the stylet does not adequately distinguish the two species. In contrast to this, the recent multigene phylogenetic analysis of Laumer & Giribet (2014) placed these species on two different clades of the family Prorhynchidae. *G. baltica* and *G. sphyrocephala* are often found sympatrically (Bauchness 1971). Both *Geocentrophora* species are cosmopolitan and typically found in periodically flooded or muddy areas and on the banks of watercourses (Timoshkin 1991, Young 2001).

G. baltica is the second terrestrial flatworm recorded from Hungary – the other being the triclad (Tricladida: Geoplanidae) *Microplana terrestris* (Müller O.F., 1773) known from Budapest (Parádi 1896). The mite *Alicorhagia fragilis* represents the second known species of the Endeostigmata in Hungary.

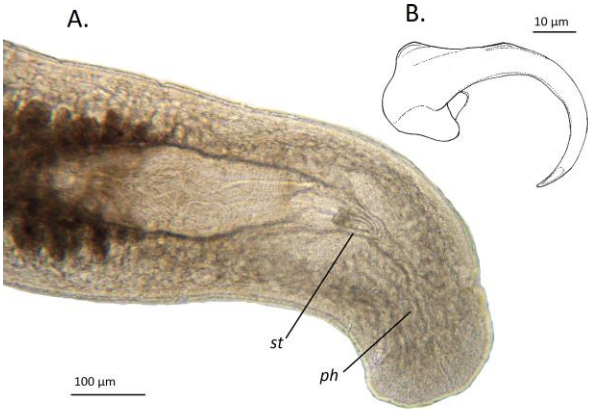

Figure 3. Microscopic anatomy of *Geocentrophora baltica*. A = alive specimen, anterior part. B = stylet of the mounted specimen (drawing). *ph*: pharynx. *st*: stylet.

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Diversity of earthworms (Clitellata: Lumbricidae) from Sredna Gora Mountain (Bulgaria)

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Abstract. In the current study the diversity, zoogeographical position and distribution of earthworms from Sredna Gora Mountain (Bulgaria) is presented. During the present investigation, altogether ten earthworm species belonging to seven genera were collected. Among them, seven taxa are reported for the first time from the Sredna Gora Mt.: *Cernosvitovia rebeli*, *Dendrobaena alpina*, *Allolobophoridella eiseni*, *Dendrodrilus rubidus rubidus*, *Aporrectodea caliginosa*, *Aporrectodea rosea* and *Lumbricus terrestris*. On the basis of the new and literature data here we provide the first list of lumbricid earthworms from Sredna Gora Mountain.

Keywords. Soil fauna, Clitellata, earthworms, zoogeography, distribution

INTRODUCTION

The Sredna Gora Mountain is situated in the central part of Bulgaria, bounded on the north by the Sub-Balkan plains and on the south the Thracian valley. The mountain is bordered by the Iskar River to the west and Tundzha River to the east. The Sredna Gora Mountain is some 285 km long and about 50 km wide with highest peak Goliam Bogdan 1603 m a.s.l. The mountain's land area covers 5950 km^2 and the average height is 608 m a.s.l. The Mountain is divided to three parts: Ihtimanska Sredna Gora (western part), Sashtinska Sredna Gora (central part) and Surnena Sredna Gora (eastern part) (Michev *et al.* 1980).

Earthworm biodiversity in Sredna Gora Mountain is almost unexplored. Its lumbricid fauna hasn't been studied so far; there are only sporadic data from this area. Previous data from Sredna Gora Mountain of Mihailova (1966), Šapkarev (1986) and Valchovski & Szederjesi (2016) altogether recorded 8 earthworm species and subspecies: *Aporrectodea longa* (Ude, 1885), *Aporrectodea jassyensis* (Michaelsen, 1891), *Dendrobaena hortensis* (Michaelsen, 1890), *Dendrodrilus rubidus subrubicundus* (Eisen, 1874), *Eisenia fetida* (Savigny, 1826), *Eiseniella tetraedra* (Savigny, 1826), *Lumbricus rubellus* Hoffmeister, 1843 and *Octolasion lacteum* (Örley, 1881).

The aim of this paper is to summarize the new data as well as the literature records on the earthworm fauna to present the lumbricid diversity of the Sredna Gora Mountain.

MATERIALS AND METHODS

The field investigations were carried out during the spring of 2016. Earthworms were collected by the diluted formaldehyde method (Raw 1959) complemented with digging and hand-sorting. The combination of both methods provides a more complete sampling of species, because the formalin method alone is not efficient in collecting species living in horizontal burrows. All the specimens were killed in 96% ethanol, fixed in 4% formalin solution and in 96% ethanol, and then transferred into 75% ethanol. The material is deposited in the Institute of Soil

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Science, Agrotechnologies and Plant Protection “N. Poushkarov”, Sofia, Bulgaria in private earthworm collection of Hristo Valchovski (PC HV). Identification of species was done in accordance to Mršić (1991).

The collecting sites are as follows:

1. Bunovo – Ihtimanska Sredna Gora Mt., Mirkovo County, mixed forest roadside east of the village, 907m.
2. Dolno Kamartsi – Ihtimanska Sredna Gora Mt., Gorna Malina County, mixed forest south of the village, 839m.
3. Koprivshtitsa – Sashtinska Sredna Gora Mt., coniferous forest north of the village, 980m.
4. Miromir – Sashtinska Sredna Gora Mt., Hisarya County, pine forest, 365m.
5. Miromir – Sashtinska Sredna Gora Mt., Hisarya County, oak forest, 345m.
6. Dolna Banya - Ihtimanska Sredna Gora Mt., north of the village, brook near Maritsa River, 613m.
7. Dolna Banya - Ihtimanska Sredna Gora Mt., north of the village, oak forest, 677m.
8. Dolna Banya - Ihtimanska Sredna Gora Mt., north of the village in burned coniferous forest, 679m.

RESULTS

Family Lumbricidae Rafinesque-Schmaltz, 1815

Genus *Allolobophoridella* Mršić, 1990

Allolobophoridella eiseni (Levinsen, 1884)

Lumbricus eiseni Levinsen, 1884: 241.
Eisenia eiseni: Zicsi & Csuzdi 1986: 114.
Allolobophoridella eiseni: Mršić 1991: 255.

Material examined. PCHV/64 one ex., Mirkovo County, Bunovo, under bark of fallen birch, mixed forest roadside east of the village, 907m, N 42° 42’ 17”, E 23° 54’ 33”, leg. H. Valchovski, 03.04.2016.

Genus *Aporrectodea* Örley, 1885

Aporrectodea caliginosa caliginosa (Savigny, 1826)

Enterion caliginosum Savigny, 1826: 180.
Allolobophora nocturna Evans, 1946: Mihailova 1966: 189 (misidentification).
Allolobophora caliginosa f. typica: Mihailova 1966: 187.
Allolobophora caliginosa: Plisko 1963: 429.
Allolobophora caliginosa caliginosa: Šapkarev 1986: 82.
Aporrectodea caliginosa caliginosa: Stojanović *et al.* 2012: 11; Valchovski 2012: 88.
Aporrectodea caliginosa: Stojanović *et al.* 2013: 637.

Material examined. PCHV/69 5 ex., Dolna Banya, brook near Maritsa River, 613m, N 42° 19’ 13”, E 23° 46’ 28”, leg. H. Valchovski and E. Velizarova, 13.04.2016.

Aporrectodea jassyensis jassyensis (Michaelsen, 1891)

Allolobophora jassyensis Michaelsen, 1891: 15; Mihailova 1966: 188; Šapkarev 1986: 83.
Aporrectodea jassyensis jassyensis: Valchovski 2014: 3.
Aporrectodea jassyensis: Szederjesi 2013: 77.

Material examined. PHCV/66 2 ex., Hisarya Miromir district, pine forest, 365m, N 42° 28’ 47”, E 24° 43’ 46”, leg. H. Valchovski, 09.04.2016.

Aporrectodea rosea rosea (Savigny, 1826)

Enterion roseum Savigny, 1826: 182.
Allolobophora prashadi (Stephenson, 1922): Mihailova 1964:167.
Eisenia rosea var. *typica*: Mihailova 1966: 185.
Eisenia rosea var. *macedonica* (Rosa, 1893): Mihailova 1966: 186.
Eisenia rosea var. *bimastoides* (Cognetti, 1901): Mihailova 1966: 186.
Allolobophora rosea: Plisko 1963: 428.
Allolobophora rosea rosea: Šapkarev 1986: 81.
Aporrectodea rosea rosea: Valchovski 2014: 3
Aporrectodea rosea: Stojanović *et al.* 2012: 9.

Material examined. PHCV/66 eight ex., Hisarya Miromir district, pine forest, 365m, N 42° 28’ 47”, E 24° 43’ 46”, leg. H. Valchovski, 09.04. 2016; PCHV/67 three ex., Dolna Banya, north of the village in burned coniferous forest, 679m, N 42° 19’ 30”, E 23° 46’ 41”, leg. H. Valchovski & E. Velizarova, 13.04.2016; PCHV/68 one ex., Dolna Banya, oak forest, 677m, N 42° 19’ 13”, E 53° 46’ 43”, leg. H. Valchovski & E. Velizarova, 13.04.2016.

Genus *Cernosvitovia* Omodeo 1956

Cernosvitovia rebeli (Rosa, 1897)

(Figure 1)

Allolobophora rebeli Rosa, 1897: 2.
Octolasium rebeli: Černosvitov 1934: 77; 1937: 89; Mihailova 1966: 194.
Cernosvitovia rebeli: Valchovski 2012: 91; Szederjesi 2013: 78.

Material examined. PCHV/64 one ex., Mirkovo County, Bunovo, mixed forest roadside east of the village, 907m, N 42° 42' 17", E 23° 54' 33", leg. H. Valchovski, 03.04.2016; PHCV/66 two ex., Hisarya Miromir district, oak forest, 345m, N 42° 28' 55", E 24° 43' 43", leg. H. Valchovski, 09.04.2016.

Genus *Dendrobaena* Eisen, 1873

Dendrobaena 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.

Material examined. PCHV/64 one ex., Mirkovo County, Bunovo, mixed forest roadside east of the village, 907m, N 42° 42' 17", E 23° 54' 33", leg. H. Valchovski, 03.04.2016; PCHV/63 four ex., Gorna Malina county, Dolno Kamartsi, mixed forest south of the village, 839m, N 42° 42' 47", E 23° 52' 55", leg. H. Valchovski, 03.04. 2016; PCHV/65 , three ex., Koprivshtitsa, coniferous forest north of the village, 980m, N 42° 40' 00", E 24° 20' 34", leg. H. Valchovski, 03.04. 2016; PCHV/67 three ex., Dolna Banya, north of the village in burned coniferous forest, 679m, N 42° 19' 30", E 23° 46' 41", leg. H. Valchovski & E. Velizarova, 13.04.2016; PCHV/68 one ex., Dolna Banya, oak forest, 677m, N 42° 19' 13", E 53° 46' 43", leg. H. Valchovski & E. Velizarova, 13.04.2016.

Genus *Dendrodrilus* Omodeo, 1956

Dendrodrilus rubidus rubidus (Savigny, 1826)

Enterion rubidum Savigny, 1826: 182.
Dendrodrilus rubidus: Perel 1979: 200.
Dendrobaena rubida: Plisko 1963: 434.
Bimastus tenuis: Mihailova 1966: 192.
Dendrobaena rubida tenuis: Zicsi & Csuzdi 1986: 119.
Dendrodrilus rubidus rubidus: Šapkarev 1986: 79.

Material examined. PCHV/64 three ex., Mirkovo County, Bunovo, under bark of fallen birch, mixed forest roadside east of the village, 907m, N 42° 42' 17", E 23° 54' 33", leg. H. Valchovski, 03.04. 2016.

Genus *Lumbricus* Linnaeus, 1758

Lumbricus rubellus Hoffmeister, 1843

Lumbricus rubellus Hoffmeister, 1843: 187; Plisko 1963: 438; Mihailova 1966: 194; Zicsi & Csuzdi 1986: 120; Šapkarev 1986: 85; Stojanović *et al.* 2012: 9; Valchovski 2014: 5.

Material examined. PHCV/66 one ex., Hisarya Miromir district, pine forest, 365m, N 42° 28' 47" E 24° 43' 46", leg. H. Valchovski, 09.04.2016; PCHV/68 four ex., Dolna Banya, oak forest, 677m, N 42° 19' 13" E 53° 46' 43", leg. H. Valchovski & E. Velizarova, 13.04.2016.

Lumbricus terrestris Linnaeus, 1758

Lumbricus terrestris Linnaeus, 1758: 647; Černosvitov 1937: 90; Plisko 1963: 438; Šapkarev 1986: 85; Zicsi & Csuzdi 1986: 120; Stojanović *et al.* 2012: 9; Szederjesi 2013: 80; Valchovski 2014: 5.

Material examined. PCHV/65 two ex., Koprivshtitsa, coniferous forest north of the village, 980m, N 42° 40' 00", E 24° 20' 34", leg. H. Valchovski, 03.04.2016; PCHV/69 seven ex., Dolna Banya, brook near Maritsa River, 613m, N 42° 19' 13", E 23° 46' 28", leg. H. Valchovski & E. Velizarova, 13.04.2016.

Genus *Octolasion* Örley, 1885

Octolasion lacteum (Örley, 1881)

Lumbricus terrestris var. lacteum 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: Šapkarev 1986: 84; Szederjesi 2013: 81; Stojanović *et al.* 2012: 9; Valchovski 2014: 6.

Material examined. PCHV/63 one ex., large form, Gorna Malina county, Dolno Kamartsi, mixed forest south of the village, 839m, N 42° 42' 47", E 23° 52' 55", leg. H. Valchovski, 03.04. 2016.

DISCUSSION

The list of earthworm species and subspecies recorded for Sredna Gora Mountain contains 15 taxa (Table 1). Out of the 10 earthworm species found in the present survey 7 proved to be new to the fauna of the explored area; these are *Cernosvitovia rebeli*, *Dendrobaena alpina*, *Allolobophoridella eiseni*, *Dendrodrilus rubidus rubidus*, *Aporrectodea caliginosa*, *Aporrectodea rosea* and *Lumbricus terrestris*.

The Balkan endemic species *Cernosvitovia rebeli* has not been registered previously from this region. In Bulgaria rare *Cernosvitovia rebeli* was recorded only from a few localities so far: Balkan Mts. (Rosa 1897, Černosvitov 1934), Strandja Mt. (Černosvitov 1937, Szederjesi 2013) and Rhodope Mts. (Mihailova 1966, Szederjesi 2013). Sredna Gora Mountain is situated between the Rhodope Mts. and Balkan Mts. representing the southern and northern localities of *Cernosvitovia rebeli* respectively (Fig. 1).

According to the zoogeographical composition, the earthworm fauna of the Sredna Gora Mountain is highly peregrine. From the 15 lumbricid species recorded 11 (73.3%) belong to this chorological group. From the four autochthonous species (26.7%) *C. rebeli* is a Balkanic endemism, *D. alpina* possesses a Balkanic-Alpine distribution, *Ap. jassyensis* is Trans-Aegean and *Ai. eiseni* has a larger Holarctic range.

It is to be expected that in the future further new lumbricid species will be found in the region, because large areas have not been explored yet including the territory of the wildlife sanctuary of the Sredna Gora Mountain.

Figure 1. Distribution of *Cernosvitovia rebeli* (Rosa, 1897) on the Balkan Peninsula. Black dots = new records, black squares = literature data.

Table 1. List of earthworm species from Sredna Gora Mountain

Earthworm species	Zoogeographical position	Distribution in Sredna Gora Mt.
Allolobophoridella eiseni	Holarctic	Ihtimanska Sredna Gora
Aporrectodea caliginosa	Peregrine	Ihtimanska Sredna Gora
Aporrectodea jassyensis	Trans-Aegean	Sashtinska Sredna Gora
Aporrectodea longa	Peregrine	Surnena Sredna Gora
Aporrectodea rosea	Peregrine	Sashtinska and Ihtimanska Sredna Gora
Cernosvitovia rebeli	Endemic	Sashtinska and Ihtimanska Sredna Gora
Dendrobaena alpina	Balkanic-Alpine	Sashtinska and Ihtimanska Sredna Gora
Dendrobaena hortensis	Peregrine	Surnena Sredna Gora
Dendrodrilus rubidus rubidus	Peregrine	Ihtimanska Sredna Gora
Dendrodrilus rubidus subrubicundus	Peregrine	Surnena Sredna Gora
Eisenia fetida	Peregrine	Sashtinska Sredna Gora
Eiseniella tetraedra	Peregrine	Surnena and Sushtinska Sredna Gora
Lumbricus rubellus	Peregrine	Sashtinska and Ihtimanska Sredna Gora
Lumbricus terrestris	Peregrine	Sashtinska and Ihtimanska Sredna Gora
Octolasion lacteum	Peregrine	Ihtimanska and Surnena Sredna Gora

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Präferenzen der *Proctodrilus*-Arten (Lumbricidae: Oligochaeta) auf einem Hang des unteren Kokel-Hochlandes in Rumänien

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Abstract. *Preferences of the Proctodrilus species (Lumbricidae: Oligochaeta) on a slope of the lower 'Kokel' uplands in Romania.* On a slope in the 'Kokel' uplands in Romania (Transylvanian Piedmont at the foot of the eastern Carpathians) the earthworm species *Proctodrilus tuberculatus* (Černosvitov, 1935), *P. thaleri* Höser & Zicsi, 2009 and *P. opisthoductus* Zicsi, 1985 were found at different points in the soil catena. The colluvial soil clearly has the distinctive characteristics of an inverse profile. *P. tuberculatus* occurs at the top of the slope and in the colluvial soil, while *P. thaleri* was found exclusively in the area at the foot of the slope towards the valley, in the section of greater colluvial horizon diversity. *P. opisthoductus* occurs towards the valley floor, in the relatively humus-rich mineral layer of the inverse profile. The pedological findings indicate that *P. tuberculatus* prefers the leached horizons of the lessived soils. Where *P. thaleri* occurs is a colluvial soil with a probable tendency to a soil-type interference of lessive soil and brown loam (terra fusca), where these two types are within one and the same soil profile. Possibly the sedimentary lessivage complexes of a terra fusca character (plasma flow) make it easier for the *Proctodrilus* species to move through the solum.

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

EINLEITUNG

Ein Nachweis von *Proctodrilus thaleri* Höser & Zicsi, 2009 bei Celei im Getischen Piedmont wurde anhand der pedologischen Befunde dem Habitat einer Pseudogley-Lessivé-Braunlehm-Interferenz zugeordnet (Höser 2013). Lessivé-Braunlehm-Interferenzen sind im warm-humiden Südosteuropa mit rezenten Lessivés vergesellschaftet (Reuter 1999). Regelmäßige Vergesellschaftungen von Bodentypen in der Hangcatena werden von der Hanggestalt, dem lokalen Grund- und Stauwasser und der Mächtigkeit und Art der Sedimentdecke bestimmt (Schmidt 1997). Der Fund von Celei führte zur Erwartung, südosteuropäische Hänge zu finden, auf denen *P. tuberculatus* und *P. thaleri* ökologisch vikariant an unterschiedlichen Stellen der Bodencatena leben. Ein derartiger Hang wurde im Kokel-Hochland in Rumänien gefunden. Davon wird im Folgenden berichtet.

Untersuchtes Gebiet

Das untersuchte Hanggelände (440 – 520 m ü. NN), das teilweise bewaldet ist, liegt *ca.* 2 km östlich von Betfalva / Beteşti (Kreis Harghita) im Großkokler-Homoroder Piedmont (Heltmann & Servatius 1991) des östlichen Kokel-Hochlands in Rumänien. Es befindet sich an der östlichen Seite eines ungefähr in Nord-Süd-Richtung verlaufenden rechten Seitentals (Fâneaţa Îngustă) der Großen Kokel (Nagy-Küküllő, Târnava Mare).

Das Bodensubstrat besteht hier aus gelblichem Mergel und Löss, der tertiäre Schichten überlagert und verhüllt (Hauer & Stache 1863). Die Böden des Gebietes sind teils mitteleuropäische Braunerden, zumeist aber (und in den mehr ebenen Lagen) fast skelettlose Lessivés und Lessivé-Pseudogleye (Ganssen & Hädrich 1965, Stefanovits 1971, Conea *et al.* 1973). In Dellen und an Hangfüßen lagern mächtige bindige Kolluvien.

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Die mittlere Jahrestemperatur der Region beträgt *ca*. 9°C, infolge der südexponierten Lage am wärmebegünstigten Kokeltal sicher lokal etwas mehr, der mittlere Jahresniederschlag 700 bis 800 mm.

Das untersuchte Gelände liegt am Rand des Weinanbaugebiets und gehört zum Buchengebiet des rumänischen Karpatenvorlandes (Rubner & Reinhold 1953); es liegt in der dakisch-karpatischen Buchenwaldzone (Duty 1985, Dierschke 1990).

Das untersuchte Hanggelände

Das untersuchte Hanggelände hat ein komplexes Profil, bestehend aus mehreren Segmenten. Im oberen Teil befindet sich ein Steildellen-Talanfang (Ahnert 1999, S. 274). Diese Steildelle (Abb. 1) und das aufnehmende Tal Fâneaţa Îngustă sind nicht gleichsohlig. An mehreren Hangstellen wurden im Boden Tonhäutchen als Merkmale der Lessivierung gefunden.

Der Hangscheitel ist hier ein Plateau. Im bewaldeten Bereich dieses Hanggeländes herrscht Hainbuche (*Carpinus betulus*) vor, begleitet von Traubeneiche (*Quercus petraea*), Vogelkirsche (*Cerasus avium*) und Feldahorn (*Acer campestre*). Auf dem Hangplateau tritt auch spärlich Rotbuche (*Fagus sylvatica*) auf.

Augenscheinlich wächst im untersuchten Transekt das Lathyro-Carpinion Boşcaiu 1974, in dem *Stellaria holostea* und aus der transylvanischen „Carpinion"-Artengruppe *Scilla bifolia* und *Dactylis polygama* auffallen. Zwei regionaltypische Assoziationen (Kovács 2007) sind vertreten: Auf dem Hang überwiegt das Lathyro hallersteinii-Carpinetum Coldea 1975 mit *Brachypodium sylvaticum, Mercurialis perennis, Crataegus monogyna* und *Ligustrum vulgare*, auf dem Hangplateau das Carpino-Fagetum Paucă 1941 mit *Aegopodium podagraria, Alliaria petiolata* und *Daphne mezerum.* Der untere Teil des Geländes und die Sohle der Steildelle werden als Mähwiesen genutzt.

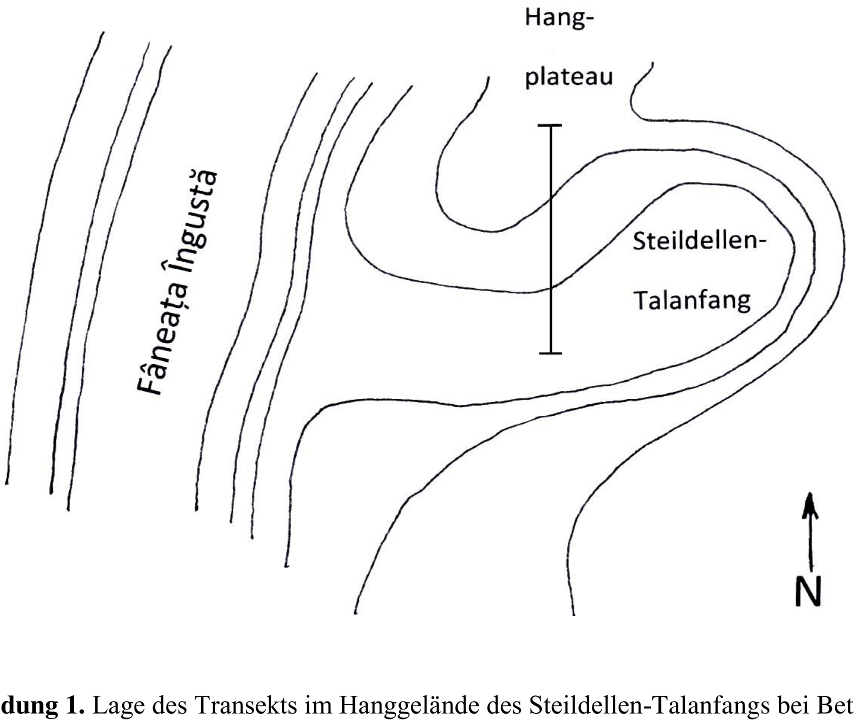

Abbildung 1. Lage des Transekts im Hanggelände des Steildellen-Talanfangs bei Betfalva. Schematischer Verlauf der Isohypsen.

MATERIAL UND METHODEN

Die Regenwurmfauna wurde auf jeweils 0,25 m^2 großen Untersuchungsflächen in mehreren Teilen des Hanggeländes erfasst. Im vorliegenden Beitrag vorgestellt werden die Ergebnisse vom Transekt, das entlang der Fall-Linie des südexponierten Hangs der Steildelle führt (Abb. 1, 2). Dieser Hang hat ein sigmoides Profil und ist mittelstark (*ca.* 15 % oder 8 Grad) geneigt. Weitere Probeflächen im Hanggelände, sowohl zufällig verteilte als auch mehrere entlang eines anderen Transekts im unteren Geländeteil bis zum Bach (Fâneaţa Îngustă), dienten der Übersicht und Ergänzung.

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.

Jede 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. Die genetisch-morphologische Horizontkennzeichnung des Bodens berücksichtigt die von Reuter (1999) begründete. Von einzelnen Standorten wurde der Glührückstand des Bodens bestimmt.

ERGEBNISSE

Bodenprofile des Hangs der Steildelle

Im Bodenprofil auf dem Plateau (Scheitel) des Hangwaldes folgt unter dem schwachen L-Horizont, der überwiegend aus Hainbuchen- und Eichenblättern besteht, eine dünne Humusauflage (Of, Oh). An diese schließt sich ein 3–8 cm mächtiger dunkelbrauner, humoser, bindiger Mineralboden (Ah-Horizont) an. Dem folgt tonig-schluffiger Lösslehm, oben hellbraun aufgehellt (Al- bzw. El-Horizont), unten mittelbraun und merklich mit Ton angereichert (Bt- bzw. It-Horizont).

Auf dem Mittelhang beträgt der Ah-Horizont 3 cm über geköpften Profilen, auf dem Unterhang 5 cm. Am baumbestandenen Unterhang wird dieser Horizont von geröllhaltigem hellbraunem Lösslehm unterlagert, der ab *ca.* 20 cm Tiefe in einen Skelettboden übergeht.

Das Kolluvium des Hangfußes hat hangseitig den größten Feinsand-Anteil. Dort existiert unter dem mittelbraunen Boden ein in 36 cm Tiefe begrabener, mehr als 15 cm mächtiger dunkler Horizont des Inversprofils, der bis zur Sohlenmitte hin aushält und aufsteigt und dort schließlich zutage tritt. Infolgedessen zeigt sich im A-Horizont der Wiese vom Hangfuß zur Sohlenmitte hin ein deutlicher Wechsel vom hell mittelbraunen, feinsandreichen Substrat des Schwemmfächers zum nahezu schwarzen, klebrigen Boden, der von höherem Anteil der Tonfraktion zeugt. In derselben Richtung nimmt die mittlere Bodenfeuchte zu, ebenso mit zunehmender Tiefe, so von erdfeucht zu gut durchfeuchtet, aber nicht nass. Jenseits der Sohlenmitte fallen die Tonhäutchen und der Wasserfilm des polyedrischen Gefüges stärker auf.

Artenspektrum und Lebensformen der Regenwurmfauna

Entlang des vorgestellten Transekts wurden 10 Arten gefunden (Abb. 1, Tabelle 1), von denen die Mehrheit zur endogäischen Lebensform gehört. Als Vertreter der epigäischen Arten wurden nur *D. octaedra* und *L. rubellus* angetroffen. Eine tiefgrabende (anözische) Art wurde gefunden, nämlich *Fitzingeria platyura*. In größter Stetigkeit kommen die endogäischen Arten *Ap. rosea, Ap. georgii* und *O. lacteum* vor. Auffällig ist, dass *Ap. caliginosa* fehlt.

Verteilung der Regenwurmarten am Hang

Unter dem nahezu geschlossenen Baumbestand des südexponierten Hangs der Steildelle konnten weder epigäische Arten noch der epi-endogäische *L. rubellus* nachgewiesen werden. Am Fuße dieses Hangsegments beginnt der sonnenexponierte Bereich der Steildellen-Wiese. Im anschließenden Teil dieser Wiese leben die epigäische *D. octaedra* und der *L. rubellus* auf der Steildellen-Sohle im Einflussbereich des Hangzugwassers. Andererseits treten die beiden Arten außerhalb des hier vorgestellten Transekts auch im nordwestexponierten Boden des Hangwaldes spärlich auf.

O. lacteum kommt in allen Teilen des Hangprofils vor. Die gefundenen Vertreter der Gattung *Octodrilus* wurden in unterschiedlichen Reliefpositionen des Hangs angetroffen, nicht jedoch im vielschichtigen Bereich des Schwemmfächers. *F. platyura* bevorzugt im Transekt die weit entwickelten, tiefgründigen Bodenprofile auf dem Hangscheitel. *A. georgii* und *A. rosea* sind auf die Wiesenböden des Hanggeländes beschränkt. *P. tuberculatus* lebt auf dem Hangscheitel und im Kolluvium, während *P. thaleri* ausschließlich im talseitigen Bereich des Hangfußes, im Abschnitt größter Schichtenvielfalt, gefunden wurde.

Am artenreichsten ist die Regenwurmfauna auf den nahezu ebenen Wiesen-Standorten des Steildellen-Talanfangs. Ihre Individuendichte ist im Einflussbereich des Hangzugwassers und am schattigen Fuß des nicht abgebildeten, nordexponierten Gegenhangs der Steildelle größer als am Hang, der in Abb. 2 vorgestellt wird. Das betrifft vor allem die epigäischen Arten.

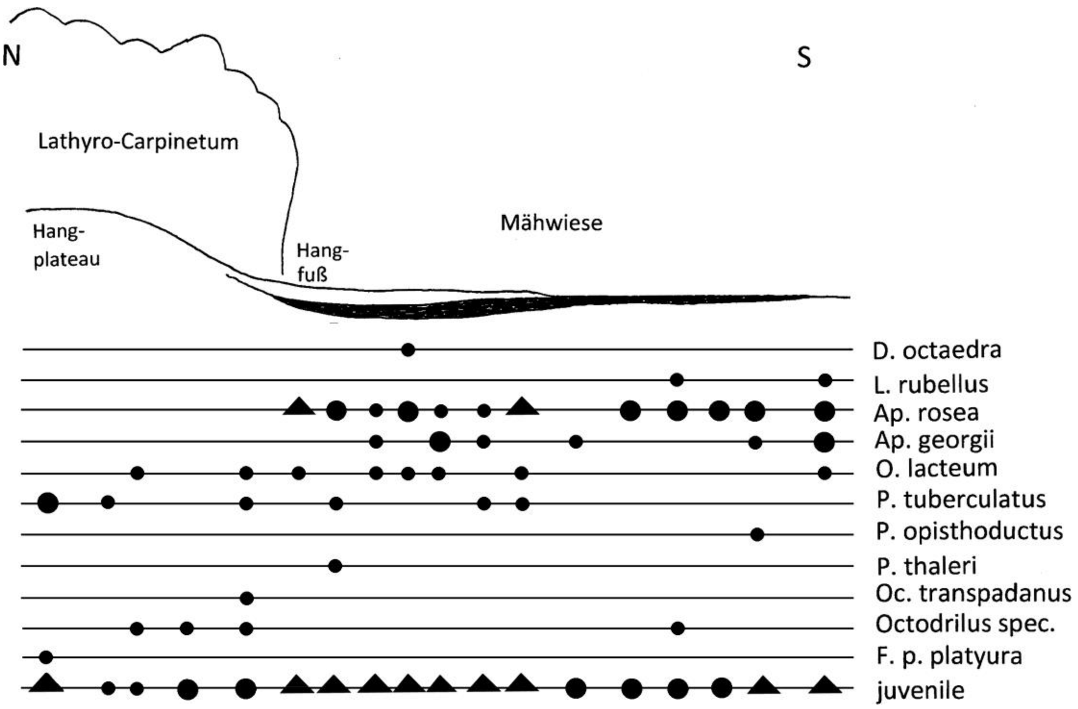

Abbildung 2. Regenwurmfauna der untersuchten Bodenstandorte im Hang-Transekt bei Betfalva. Mit dunklem Horizont des Inversprofils. Die Punkte bzw. Dreiecke repräsentieren die Individuendichte der adulten Regenwürmer und der Juvenilen in drei Größenklassen: • 1-3, ● 4–10, ▲ >10 Individuen auf 0,25 m² untersuchter Fläche. Transektlänge *ca.* 80 m.

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

Art im Transekt (Abb. 2)	Verbreitungs-typ	Lebensform	Individuendichte Adulte auf 0,25m^2	
			maximal	Mittelwert
Aporrectodea georgii (Michaelsen, 1890)	atlanto-mediterran	endogäisch	5	0,9 ± 0,35
Aporrectodea rosea (Savigny, 1826)	peregrin	endogäisch	12	4,2 ± 0,96
Dendrobaena octaedra (Savigny, 1826)	peregrin	epigäisch	1	< 0,1
Fitzingeria platyura (Fitzinger, 1833)	zentraleuropäisch montan	anözisch	1	< 0,1
Lumbricus rubellus Hoffmeister, 1843	peregrin	epigäisch	3	0,2 ± 0,17
Octolasion lacteum (Örley, 1881)	peregrin	endogäisch	3	0,7 ± 0,22
Octodrilus transpadanus (Rosa, 1884)	trans-ägäisch	endogäisch	1	< 0,1
Proctodrilus opisthoductus Zicsi, 1985	zentraleuropäisch	endogäisch	2	< 0,1
Proctodrilus tuberculatus (Černosvitov, 1935)	trans-ägäisch	endogäisch	6	0,7 ± 0,34
Proctodrilus thaleri Höser & Zicsi, 2009	karpatisch-endemisch	endogäisch	2	< 0,1

Bodenstandorte der *Proctodrilus*-Arten

P. tuberculatus besiedelt den Lessivé auf dem nahezu ebenen Hangscheitel (= Hangplateau) und das anschließende Kolluvisol des Unterhangs, des Hangfußes und der anschließenden Fußfläche. An diesen Stellen wurde die Art ausschließlich im hell- bis mittelbraunen, teils dunkelgrauen, bindigen Mineralboden gefunden. So tritt sie auf dem Hangscheitel im obersten Dezimeter dieses Mineralbodens auf, im El-Horizont, der den dunklen Mull-Horizont (Ah) unterlagert, während sie am Hangfuß im grobkörnigeren Teil der geschichteten Schwemmfächerdecke angetroffen wird.

Zwei adulte *P. thaleri* konnten im vielfältig geschichteten Kolluvium des Hangfußes entdeckt werden, so im oberflächennahen mittelbraunen Boden, der den begrabenen, nahezu schwarzen Horizont des Bodenprofils überlagert. Dieser Standort befindet sich am talseitigen Rand der Schwemmfächerdecke, wo der horizontale Gradient des Ton- und Schluff-Anteils sein Maximum erreicht.

In der Sohlenmitte tritt im dunklen, aus dem Inversprofil aufgestiegenen, relativ humosen Mineralboden (Glühverlust 15,0 %) *P. opisthoductus* auf.

DISKUSSION

Die Regenwurmarten des untersuchten Hangs sind ebenfalls im Artenspektrum der Fauna siebenbürgischer Flussauen zu finden (Höser 2003, 2011), auch *Octodrilus transpadanus* (Erratum in Höser 2000, 2003: syn. *Oc. exacystis*).

Die vertikalen und horizontalen Feuchtegradienten der untersuchten Hangcatena sind wahrscheinlich geprägt vom Hangzugwasser, das die Bodengenese, z.B. auch die Lessivierung, erheblich zu intensivieren vermag (Blume 1973) und die feuchteren, von epigäischen Arten (*D. octaedra, L. rubellus*) angezeigten Geländebereiche des Hangs und der Steildellen-Sohle verursacht.

Nach bisherigen Erfahrungen tritt *P. tuberculatus* auf erosionsdisponierten Bodenstandorten der Hanglagen und flussnahen Auenböden auf (Höser 2008, 2012), die von intensiver Lessivierung geprägt wurden. Er bevorzugt anscheinend eluviale Horizonte. Auch im untersuchten Transekt Betfalva trägt das Hangplateau diese Merkmale der typischen Lessivierung und auf dem zugehörigen Unterhang und Talboden gibt es als lessivierte Abkömmlinge die geköpften Profile bzw. kolluvialen Sedimente. Folgerichtig konnte an diesen drei Hangstandorten *P. tuberculatus* nachgewiesen werden (Abb. 2).

Im talseitigen Schwemmfächer-Teil des Hangfußes bei Betfalva vermuten wir als Resultat kolluvialer Sedimentation besondere Standortbedingungen zugunsten von *P. thaleri*: Im Zuge des Hangabtrags erfolgte dort wahrscheinlich an sedimentär bedingten dichteren Bodenschichten eine Tonanreicherung, die feldmethodisch gut nachgewiesen ist. Möglicherweise enthält das dort abgelagerte Maximum von Ton und Schluff eine relevante Menge von Schlämmstoffablagerungen, die aus dem Braunlehmgefüge stammen, das sowohl aus den im Löss stets vorgebildet enthaltenen Resten alter Bodendecken (Kubiena 1956) als auch aus der in Südosteuropa häufigen Vergesellschaftung des Lessivé mit Braunlehm (Reuter 1964) stammen kann. Braunlehm entwickelte sich in hügeligen Gebieten zumeist auf Verebnungen und breiteren Sattellagen (Kösel 2008). Also nehmen wir an, dass am Hangfuß bei Betfalva ein Kolluvisol mit Tendenz zur Lessivé-Braunlehm-Interferenz (Reuter 1999) vorliegt. Zu diesen Deutungen passen auch die pedologischen Befunde der von *P. thaleri* besiedelten Verebnung eines Hangs bei Celei (Höser 2013) und die festgestellte Präferenz der Art für Grenzen von feinkörnigeren Schichten (Höser & Zicsi 2009).

Unsere Beobachtungen lassen vermuten, dass ein spezifischer Zusammenhang der *Proctodrilus*-Gruppe mit jenen besonderen Böden besteht, die sich durch stark bewegliche Feinsubstanz und Fließstrukturen der Feinsubstanz auszeichnen. In Lössböden tritt diese Feinsubstanz als Braunlehmteilplasma auf, so in den Leitbahnen im Braunerde-Grundgefüge des Lessivé oder, wenn dieses Grundgefüge durch Staunässe verloren gegangen ist, in unregelmäßigen Flecken im Pseudogley und Stagnogley (Kubiena 1956). An die Fließstrukturen des Lessivé, so bevorzugt in dessen eluvialem Horizont, ist offenbar *P. tuberculatus* gebunden, während *P. antipai* den beiden anderen Böden nahe steht. Die Befunde bei Celei (Höser 2013) und die vorliegenden von Betfalva sprechen dafür, dass *P. thaleri* mehr als die vorgenannten beiden Arten dem vom Braunerde-Grundgefüge freien, feindispersen Gefügeplasma des Braunlehms zugeneigt zu sein scheint. Möglicherweise erleichtern die Schlämmstoffkomplexe von Braunlehmcharakter den *Proctodrilus*-Arten, sich im Solum zu bewegen.

Dank – Herr Prof. Dr. András Zicsi (†) überprüfte einige Artbestimmungen, Herr Prof. Dr. Csaba Csuzdi gab Hinweise zum Beitrag, Herr Michael Höser übernahm die technische Assistenz im Freiland und Herr Brian Hillcoat (Berlin) die Übersetzung ins Englische.

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New distribution data for two species of the Neotropical genus *Lathecla* Robbins, 2004 (Lepidoptera, Lycaenidae, Eumaeini)

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Abstract. The species *Lathecla carolyna* Busby, 2015 described recently from Ecuador is reported to occur also in Venezuela and Colombia. An additional Peruvian occurrence of *L. mimula* (Draudt, 1920) is also documented.

Keywords. Colombia, Ecuador, wet forests, Peru, sampling, Venezuela.

INTRODUCTION

The purpose of this present note is to contribute with new data to the knowledge of Lycaenidae faunistics in the light of recent publications, in this case for the genus *Lathecla* established by Robbins (in Robbins & Duarte 2004). The genus was subsequently monographed (Robbins & Busby 2015) and seven species have been diagnosed on the basis of 121 individuals assembled from the collections of eleven institutes.

In this paper we report on three specimens deposited in the collections of two institutes not inspected by the mentioned authors: Zoological Museum of the Jagiellonian University, Krakow (MZUJ) and the Department of Zoology, Hungarian Natural History Museum, Budapest (HN HM). Although the sample is small, it contributes importantly to the knowledge on the distribution of a recently described species and on another's with historically confused nomenclature, therefore both poorly known, as well as their recently established genus.

The new records indicate that how undersampled is the Neotropical eumaeine fauna in the Neotropics and any reliable distributional data is worth to publish for a better understanding of the diversity of the tribe.

Lathecla carolyna Busby, 2015

(Figure 1)

Lathecla carolyna Busby, new species – Robbins & Busby 2015: 70, type locality: "Ecuador, Pichincha, Province Pandapi, 1800 m", (holotype, male, National Museum of Natural History, Washington, USA), fig. 6 (male and female wing surfaces), fig. 19 (male genitalia), fig. 24 (female genitalia).

Material examined. (2) VENEZUELA: "Edo. Táchira, P. N. Tamá, Fundo Piedra Blanca, 2450 m, 15-20.IX.1996, leg. F. Rey" (MZUJ: male; dissected); COLOMBIA: "Valle, Rio Aguacatal, S. Antonio, 2200 m, 3.2.2004." (HNHM: male, dissected, gen. prep. Bálint no. 1551).

Remarks. The species was described on the basis of the male holotype, and five male and three female paratypes, all from Ecuador, provinces Pichincha (holotype, plus three males, three females) and Morona-Santiago (two males). Although the Venezuelan specimen is slightly

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worn, the distinguishing characters are well visible: it has no black androconial patch in the anterior portion of dorsal hindwing surface, but a dark patch can be observed on the medial area of the ventral forewing inner margin, and blue scaling extends into the anterior portion of the dorsal forewing surface (*cf.* Robbins & Busby 2015, fig. 6).

As the Colombian specimen is heavily worn, a genital dissection was necessary to have more evidences for a positive identification. The male genitalia structures show all the diagnostic characters of *L. carolyna* illustrated in the figures accompanying the description, in particular a long and narrow shaped valva with pointed terminus in lateral aspect without terminal pincer-like extension, and an aedeagus deeply open dorsally (*cf.* Robbins and Busby 2015, fig. 19).

Lathecla mimula (Draudt, 1920)

(Figure 2)

Thecla mimula sp. nov. – Draudt 1920: 793, type locality: "Pachitea (Peru)" (syntype(s), female, Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt am Main, Germany), pl. 157g, fig. "mimula U".

Thecla latagus Godman & Salvin, 1887 – d'Abrera 1995: 1258, 1259 fig. "T. latagus" [misidentification].

Lathecla mimula (Draudt, 1920) [new combination] – Robbins 2004: 126, in synonymy of *Lathecla latagus* (Godman & Salvin, 1887).

Lathecla mimula (Draudt, 1920), revised status – Robbins & Busby, 2015: 66, fig. 3 (male and female wing surfaces), fig. 15 (male genitalia), fig. 21 (female genitalia).

Material examined. (1) PERU: "San Martin, Juanjui, 18.X.2003." (coll. Pierre Boyer, to be deposited in MZUJ).

Remarks. The identity of the species and its generic placement has been clarified by Robbins & Busby (2015), on the basis of 22 male and 14 female specimens. They described and documented both sexes for the first time. The male is distinctive having black coloured androconia on the dorsal wing surface, a character shared only with a single congener, *L. latagus*; but they can be easily differentiated on the basis of wing shape, coloration and pattern as *L. mimula* has less rounded outer margin, brighter blue dorsal structural colour with narrower black forewing border (*cf.* figures in d'Abrera 1995).

DISCUSSION

Lathecla carolyna in Venezuela

The report of *L. carolyna* in Venezuela is an important extension of the species' distribution range. In Venezuela, the species was found in a similar biotope as in Ecuador, in moist montane forest at 1800 m asl. The exact collecting place, the Fundo de Piedras Blancas above the locality of San Vicente de la Revancha in the Tama range on the Venezuela-Colombia border, the northern extremity of the Andean Eastern Cordillera (= GPS coordinates: N 7.502068; W 72.343147) is a place where several geographically extremely restricted species of butterflies are found including the unusual *Catasticta revancha* Rey & Pyrcz, 1996, which is hitherto known only from this locality. The forest in Piedras Blancas is restricted to a river gulley and is surrounded by extensive potato and other crops plantations, and is therefore under a severe anthropogenic pressure. Interestingly, in the neighbouring Betania valley *L. carolyna* has not been collected so far, even though that this region has been much more intensely sampled for butterflies.

L. carolyna is the second species of the genus *Lathecla* recorded from Venezuela alongside *Lathecla fernandezi* Robbins & Busby, 2015. The two species can easily be distinguished on the basis of different wing shape and scaling as *L. fernandezi* has a more rounded inner forewing margin, and tan grey or white coloured androconia (see Robbins & Busby 2015).

Based on the known distribution patterns indicated by Robbins & Busby (2015) two more species belonging to *Lathecla* can be expected to

Figure 1. Distribution of *Lathecla carolyna* Busby, 2015; dark (red) squares: records of Robbins & Busby (2015); light (yellow) squares: new records (copyright: GoogleMaps).

Figure 2. Distribution of *Lathecla mimula* (Draudt, 1920); dark (red) squares: records of Robbins & Busby (2015); light (yellow) square: new record (copyright: GoogleMaps).

occur in Venezuela, namely *L. latagus* (Godman & Salvin, 1887) and *L. mimula*, both are lowland representatives of the genus considered to be primarily montane.

Lathecla carolyna in Colombia.

The collecting site of *L. carolyna* in Colombia is one of the best documented ones concerning the Lycaenidae fauna in the Neotropics (= GPS coordinates: N 3.496089; W 76.627479). It has been sampled over several years by several lepidopterists specializing in Lycaenidae (Prieto & Dahners 2006, 2009). San Antonio is a hilltop in a montane wet forest, similar to the one where the type material of the species was collected in western Ecuador and in Venezuela.

Based on the known distribution patterns indicated by Robbins & Busby (2015) two more species belonging to *Lathecla* can be expected to occur in Colombia, namely *L. fernandezi* and *L. latagus*; the former in montane, the latter in lowland wet forests.

Lathecla mimula in Peru

Robbins & Busby (2015: 66) indicated that *L. mimula* is a lowland forest species representing the genus in the Amazonian biogeographic zone, and widely distributed in the South American continent from Trinidad via French Guyana to Brazil, and from Ecuador via Peru to Bolivia. However, it has been recorded only in two Peruvian sites, namely from Huánuco (Pachitea) and from Loreto (Contamana), rather close to each other geographically. The occurrence we recorded extends the known distribution in Peru somewhat 200 km northwest.

The site which claims the locality label, Juanjui (GPS coordinates: S 7.20785; W 76.739609), is a lowland town situated at the footsteps of the Peruvian Eastern Cordillera of the Andes in the far north of the country. The professional butterfly collector from whom the specimen originating operates in this area at lower elevation, so the specimen may well come from a premontane locality situated certainly far below the Abra Pardo Miguel pass (2300 m), in consistence with the data available.

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New species and records of Trichoptera collected by Mr. A. G. Duff. More phenomics and less genomics!

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Abstract. Seven species are recorded and ten new species are described from Oriental, Afrotropical and Neotropical Fauna Regions: *Abacaria dufforum* sp. nov., *Cyrnellus kesken* sp. nov., *C. kozepes* sp. nov., *Orthotrichia palama* sp. nov., *Marilia annae* sp. nov., *Phylloicus kinovos* sp. nov., *Atanatolica homora* sp. nov., *Oecetis fura* sp. nov., *O. siska* sp. nov., *Contulma duffi* sp. nov. Based on theoretical outline of how to delineate young incipient sibling species with more phenomics and less genomics, the new species complex of *Oecetis amazonica* is erected as well as an instantiated failure of neutral DNA markers are presented on *Allogamus auricollis* and *A. alpinus* siblings.

Keywords. Trichoptera, phenomics, genomics, species delimination, adaptive traits

INTRODUCTION

Andrew G. Duff, the author of Beetles of Britain and Ireland, the first comprehensive account of the beetles of the British Isles since Joy's "A Practical Handbook of British Beetles" published in 1932, is a devoted birdwatcher with a keen interest to see and enjoy biodiversity of birds in various biomes of faunal regions. During his travelling and birdwatching together with his wife he has collected caddisfly adults. This small but interesting Trichoptera collection composed of mostly undescribed species is elaborated and described here. Some theoretical aspects of the sibling species concept realised by fine structure analysis is briefly outlined here to support the *Oecetis amazonica* new species complex recognised here.

MATERIAL AND METHODS

The last abdominal segments of specimens are cleared for finer structure analysis and stored in small vials together with the rest of the animals in alcohol. All types and specimens are deposited in Oláh Private Collection under protection of Hungarian Natural History Museum.

THEORETICAL PART

More phenomics and less genomics

Specimens collected by Mr Duff from different localities in Argentina and determined here as *Oecetis amazonica* may represent two undescribed incipient sibling species (see taxonomic part). We have compared them with all the published drawings: (1) drawing of lectotype from Manaos (Flint 1967), (2) drawings of specimens from Bolivia (Martin *et al.* 2011) (3) drawings of specimens from north-eastern Brazil (Quinteiro & Calor 2015). The lateral profiles of the phallic organ on the drawings as well as on our specimens suggest that *Oecetis amazonica* (Banks, 1924) is not a single species. It represents a species complex probably with several contemporary diverged, but undiscovered young species. In the six examined specimens the disposition of the forewing crossvein in the anastomosis, the shape of cerci and segment X is apparently unstable, varying. However the lateral profile of the gonopods and especially the ventrum of the phallic organ are stable. Unfortunately in the listed drawings the resolution and drawing principles and styles of the phallic organ are not stan-

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dardized like to the drawings of Blahnik & Holzenthal (2014). Moreover, the basic architecture of the bilobed phallobase with the exact lateral position of the foramen for ductus ejaculatoricus is not indicated in all of the published drawings. The exact lateral profile of the phallobase ventrum needs to be clearly indicated on the drawings starting from the ventral lip of the foramen and covering the entire ventral tip of the phallobase up to the fuse of the left and right lobes apicad. This part of the phallic organ seems more sclerotized and more stable, and not liable to be influenced neither by natural copulatory movements, accidents or injuries nor by artefacts occurring during storage and preparation. The shape of the phallobase was found most stable and applicable to delineate young species also in the *Oecetis avara* group (Blahnik & Holzenthal, 2014).

Much more information on phenomics is available and readable from the fine structure analysis of the phallic organ also in the new species complex of *Oecetis amazonica*: (1) lateral ratio of length/height dimension (2) dorsal ratio of phallus to genital capsule; (3) dorsal ratio of left and right lobe, (4) position and displacement of foramen; (4) asymmetry of foramen disposition; (5) development of foramen ring or phallic apodeme; (6) dorsal profile asymmetry of left and right lobes; (7) lateral profile asymmetry of the left and right lobes; (8) entire lateral profile of the ventrum; (9) lateral shape of the downward projecting ventral apex; (10) apical shape of ventral apex; (11) ratio of ventral apex length to height of the phallus; (12) position of paramere base; (13) discernibility and shape of paramere shape; (14) curvature of paramere spine; (15) length of paramere spine; (16) thickness of paramere, (17) head shape of paramere spine.

Compared to the simple structure of the phallic organ in the *Oecetis* (*Oecetis*) subgenus, even much more taxonomic information is encoded in the very complex sclerotized fine structure of the vaginal sclerite complex, not utilised yet in species delineation and delimitation. This structure coevolves with the phallic organ in the various sexual selection processes. Its phenomics is an “easy to explore” empirical reality waiting to be realized in the taxonomy of contemporary divergences compared to the virtual availability of combined effects of genomics, epigenomics, transcriptomics, primary and structural proteomics.

This combined reality with formidable complexity is almost undetectable for the initial splits of speciation traits in routine practice of the taxonomy to discover incipient siblings of biodiversity. Barcoding or trials to replace taxonomy with primitive oversimplified models of the expensive, fashionable, but inherently blind neutral markers of various DNA sequences proved to be a highly financed fatal reductionism.

In present day taxonomy, but not in molecular genetics, this is a deleterious ontological, theory and methodological reductionism: a philosophical position that connects phenomena or theories by unjustified reduction of complex to simple, of biological phenomena to chemistry, assuming that complex is nothing but the sum of its parts or maximum may have features that none of the parts have. This conceptual or epistemological reductionism (1) replaces entities of reality with other entities presuming non-existing relationship between them; (2) operates higher level reducebility to lower levels with different properties; (3) and even works with certain perspective of causality. These epiphenomena, like Huxley’s steam whistle or the neutral markers in taxonomy, exert no real causal agency on more fundamental phenomena of speciation trait. The taxonomic waste of epiphenomenalism in DNA marker industry however may have important by-product value like association of sex and life stages in fingerprint industry of applied taxonomy. Any historically selected neutral markers so vehemently introduced and fashionably applied in taxonomy (1) has no direct relation to traits acting in contemporary speciation processes; (2) horribly replaces speciation traits with neutral markers; (3) reduce speciation process to alien DNA sequence divergences; (4) compute and model non-existing perspectives of causalities.

Instantiated failure of neutral markers

This impasse of molecular genetic to dominate taxonomy has created more problems than solved in the science of biodiversity (Oláh *et al.* 2015). A recently published cladogram of *Allogamus auricollis* populations from Barcode of Life Database demonstrates the limits of these blind sequences and the taxonomic blindness of their advocates in biodiversity (Malicky 2016).

This dark coloured species is a widely distributed and an abundant autumnal caddisfy in the European mountains demarcated by Spain, England, Ukraine, and Albania. In his monograph Schmid (1951) examined only a limited number of populations and distinguished two geographic races based on paramere spine pattern and sclerite shape of the aedeagus: (1) race of the Jura Mts. and Silesia, and (2) race of the Alps Mts. In his European Trichoptera atlas Malicky (2004) has routinely applied an excuse theory and practice: the variability of widely distributed species.

Applying the sexual selection-driven, therefore adaptive, non-neutral traits of the phallic organ as well as the phylogenetic species concept of incipient siblings we have examined many populations of *A. auricollis* from the entire distributional area and distinguished two incipient sibling species (Oláh *et al.* 2014). (1) The ancestral *Allogamus auricollis* (Pictet, 1834) species widely distributed on the entire distributional area demarcated above, but populating also significant territories in the Alps. (2) We have separated a new species *Allogamus alpensis* Oláh, Lodovici & Valle, 2014 distributed mostly in western parts of the Alps. It was a great experience to realise again how stable are the speciation traits also in this couple of incipient siblings evolved in contemporary sexually adaptive divergences through integration of reproductive barriers and by reinforcement in contact zones. The ancestral species *A. auricollis* has very stable adaptive speciation traits on the huge distributional area from Spain and England to Ukraine and Albania. This species is not much variable.

TAXONOMY

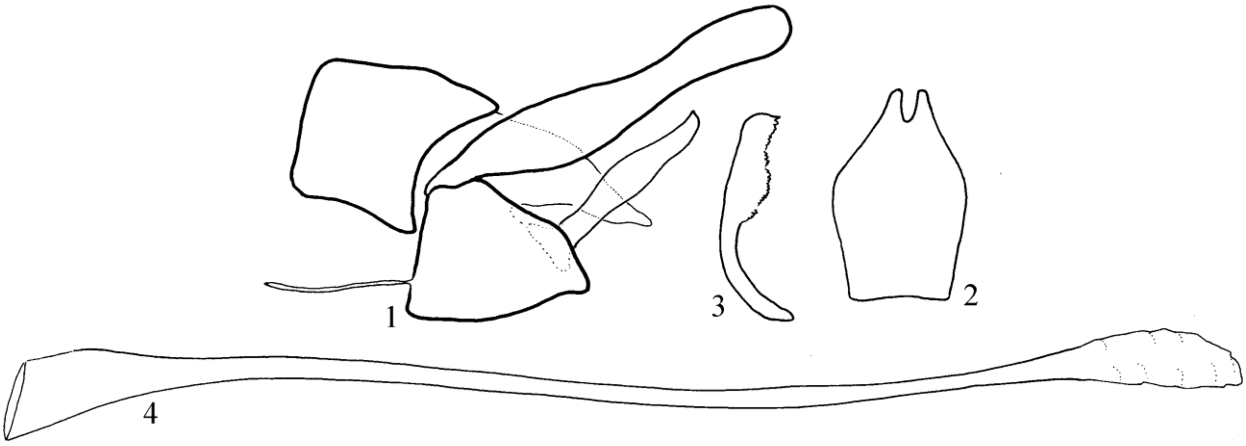
Family Xiphocentronidae

Abaria dufforum sp. nov.

(Figures 1–4)

Diagnosis. According to the unique shape of excision on the apical margin of tergum VIII, this species is close to *A. dusyanta* Schmid, 1982 described from Madras, India. The gonopod ventral profile is also similar. However the setal neoformations present on femur of the foreleg and on the 5th to 8th antennal segments lacking in the new species as well as the ventral dentate profile of the gonopods is also different.

Description. Male (in alcohol). Small pale brown animal. Head dorsum highly bulging, domed and pale brown; pronotal and mesonotal sclerites only slightly darker, sutures darker. Antennae without neoformation of long setal fringes. Maxillary palp formula is I- II-III-IV-V, gradually increasing from segment I to segment IV, segment V shorter than segment I-II-III-IV together. A pair of enlarged frontal lateral compact setose warts dominates on the face, occupying almost the entire surface of frontal area and touching medially on their posterior or dorsal section and untouched and diverting laterad on their anterior or ventral area. On head dorsum four pairs of compact setose warts are present: (1) postgenal compact setose warts, (2) occipital compact setose warts, (3) vertexal ocellar compact setose warts, (4) vertexal lateroantennal compacts setose warts are present; frontal interantennal compact setose wart not discernible. There is no any compact setal wart present nor on the cervix neither on the cervical sclerite. Proepisternal and precoxal setal warts present and packed with long and strong setae. Spur formula is 043; anterior spurs much shorter; apical spur on hindleg not modified. Forelegs without neoformations of long and black setal fringes on mesal surfaces of both femurs and tibiae. Forewing length 3 mm.



Figures 1−4. *Abaria dufforum* sp. nov. 1 = male genitalia in left lateral view, 2 = tergite VIII in dorsal view, 3 = left gonopod in ventral view, 4 = phallic organ in lateral view.

Male genitalia. Abdominal segment IX represented by subtriangular sternite and by some remnant cavity structure of tergite withdrawn under the apical margin of tergite VIII; sternite IX in lateral view as long as high, subtriangular and convex on dorsum; its long and very thin apodeme horizontal; tergite IX rudimentary, almost indiscernible as modified into cavity wall at the base of segment X and retracted under tergite VIII. Tergite VIII more pigmented, its contour is well-defined and well-visible; its dorsoapical margin deeply excised; pleurotergal groove well developed. Segment X roof-shaped with tapering ventroapical end in lateral view. Cerci are elongated digitiform with well-developed constriction after middle; basal half bellied. Gonopods strongly pigmented, its coxopodite and harpago fused without any visible suture; almost straight in lateral view; laterad curving in ventral view; mesal spiny surface of gonopod with evenly sized teeth, slightly S-forming dentate along apical half of the gonopod. Phallic organ long and thin, with broad basal part and simple dilating apex, no any special structure discernible.

Material examined. Holotype. India, Kerala State, Palamattom, Birds Lagoon Village Resort, 10°06'N, 76°42'E, 30. XI- 1. XII.2010, light leg. A. G. Duff (1 male, OPC). *Paratype*. Same as of holotype (1 male, OPC).

Etymology. It is with great pleasure that I name this species for Andrew G. Duff who has collected the type specimens.

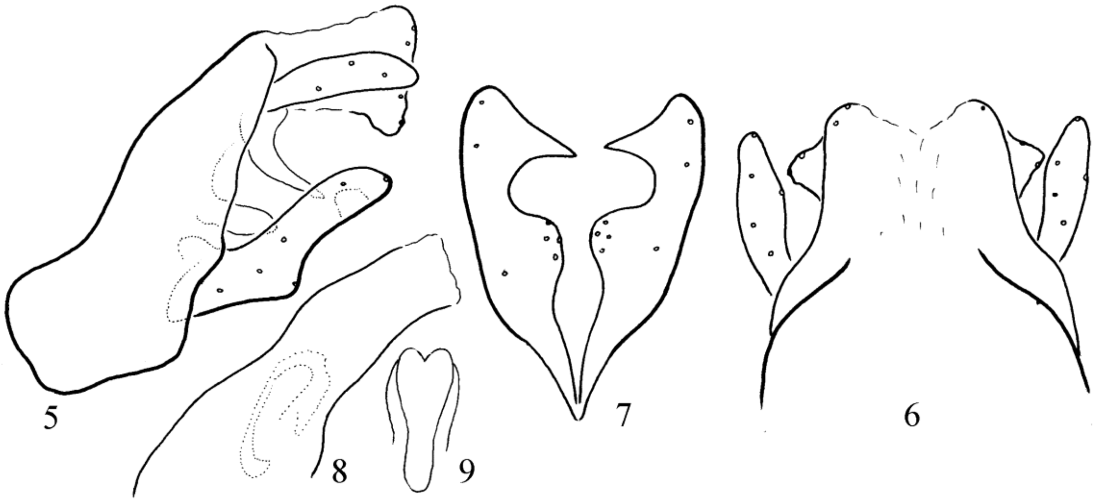
Family Polycentropodidae

Cyrnellus kesken sp. nov.

(Figures 5–9)

Diagnosis. It seems that the so called widely distributed and highly varying *Cyrnellus fraternus* is rather a species complex. *Cyrnellus kesken* sp. nov. is a member of this species complex, and most close to *C. zapateriensis* Chamorro-Lacayo described from Nicaragua, but differs by anterior ventrum elongation on sternite IX short, not long reversed L-shaped; ventroapical process on the dorsal complex sclerotized, not membranous; produced laterad in dorsal view, not posterad; cerci exceeding complex, not shorter; ventral digitate process on cercus very slender compared to the ventral branch of the paraproct. Phallobase twice as broad as middle portion, not similar; phallotremal sclerite with adhered apical lobes in dorsal view, not diverted laterad.

Description. Male (in alcohol). Forewing length 4 mm. Brown coloured animal. Second segment on maxillary palp almost as long as the third segment resulted from its mesal elongation due to the subapical lateral articulation of the third



Figures 5−9. *Cyrnellus kesken* sp. nov. 5 = male genitalia in left lateral view, 6 = male genitalia in dorsal view, 7 = gonopods in ventral view, 8 = phallic organ in lateral view, 9 = phallotremal sclerite in dorsal view.

segment; maxillary palp formula is I-II-IV-III-V. Forewing with closed discoidal cell, open median cell and apical forks 2,3,4,5 present. Hindwing with open discoidal cell and apical forks 2, 5 present.

Male genitalia. Sternum IX with short anteriorly elongated ventrum. Tergite IX and segment X membranous forming a fused complex with the paraproct; components of the fused complex difficult to homologise. Cerci slender foliform exceeding the fused complex apicad. The pair of digitate ventral process on cercus more slender in lateral view than the ventral part of the paraproct (subgennital plate). Gonopods angulate in lateral view, apicomesal lobe long triangular and pointed; the sinus between the apicomesal and middle lobes low (narrow). Phallic organ with broad basal part, phallotremal sclerite complex bilobed apicad in dorsal view, lobes adhered.

Material examined. Holotype. Argentina, Corrientes Province, Carlos Pellegrini Posada, Aguape, 28°32’26”S, 57°10’20”W, 24. XI.2011, at UV light/watertrap, leg. A. G. Duff (1 male, OPC).

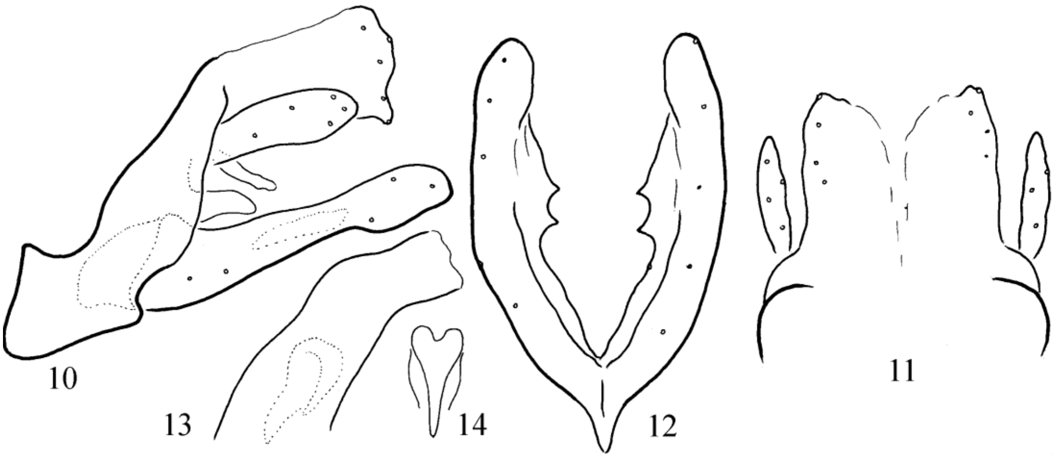
Etymology. *Kesken* from “keskeny” narrow, in Hungarian, refers to narrow and not wide bilobed apical divergence on the phallotremal sclerite in dorsal view compared to its close relatives.

Cyrnellus kozepes **sp. nov.**

(Figures 10–14)

Diagnosis. According to the bifid shape and position of the apicomesal lobe *C. kozepes* sp. nov. is related to *C. ulmeri* Flint and *C. arotron* Flint. *C. arotron* is immediately recognised by the large, dark sclerite complex in the aedeagus. The phallotremal sclerite complex is much less developed at *C. ulmeri* and *C. kozepes* sp. nov. However the lateral shape of this sclerite complex is different, the dorsal shape is not drawn at *C. ulmeri*. The new species differs from both relatives by having dorsal complex with apicoventral lobes present and well developed, lacking at relatives; the bifid apicomesal lobe on gonopods shifted to middle position, located middle, not subapicad; the points of bifid lobe is less developed, compared to *C. ulmeri*.

Description. Male (in alcohol). Forewing length 3.5 mm. Brown coloured animal. Second segment on maxillary palp almost as long as the third segment resulted from its mesal elongation



Figures 10−14. *Cyrnellus kozepes* sp. nov. 10 = male genitalia in left lateral view, 11 = male genitalia in dorsal view 12 = gonopods in ventral view, 13 = phallic organ in lateral view, 14 = phallotremal sclerite in dorsal view.

due to the subapical lateral articulation of the third segment; maxillary palp formula is I-II-IV-III-V. Forewing with closed discoidal cell, open median cell and apical forks 2,3,4,5 present. Hindwing with open discoidal cell and apical forks 2, 5 present.

Male genitalia. Sternum IX with short anteriorly elongated ventrum. Tergite IX and segment X membranous forming a fused complex with the paraproct; components of the fused complex difficult to homologise. Cerci broad foliform shorter than the fused complex. The pair of digitate ventral process on cercus more slender in lateral view than the ventral part of the paraproct (subgennital plate). Gonopods angulate subapicad in lateral view, bifid apicomesal lobe located in middle position. Phallic organ with broad basal part, phallotremal sclerite complex bilobed apicad in dorsal view; lobes not much diverted laterad.

Material examined. Holotype. Argentina, Corrientes Province, Carlos Pellegrini Posada, A-guape, 28°32’26”S, 57°10’20”W, 24. XI.2011, at UV light/watertrap, leg. A. G. Duff (1 male, OPC).

Etymology. *Kozepes* from “közepes” having middle position, in Hungarian, refers to location of the apicomesal lobe on the gonopods, shifted from subapicad ti middle.

Family Hydropsychidae

Centromacronema auripenne Rambour 1842

Material examined. Colombia, Yellow-eared Parrot Bird Reserve, village Ventanas, Jardin, Antioquia, 5°32’45.76”N, 75°47’19.96”W, 6. II. 2014, caught by hand, leg. A. G. Duff (1 male, OPC).

Smicridea discalis Flint, 1972

Material examined. Argentina, Corrientes Province, Ituzaingo, Howard Johnson Express Inn, 27°35’38”S, 56°48’12”W, 25. XI.2011, at lighted windows, leg. A. G. Duff (1male, OPC).

Cheumatopsyche nubila Kimmins, 1963

Material examined. Ethiopia, Awash National Park, Awash Falls Lodge, 8°50’33.60”N, 40°00’ 45.08”E, 946 m, 28. III.2014, at light leg. A. G. Duff (10 males, 28 females; OPC).

Family Hydrobiosidae

Apsilochorema annandalei Martynov, 1935

Material examined. India, Arunachal Pradesh, Eaglenest Wildlife Sanctuary, Bomphu Camp, 27°

03'57.40"N, 92°24'21.39"E, 15. IV.2013, at light leg. A. G. Duff (1 male, OPC).

Family Glossosomatidae

Glossosoma kissottoi Malicky, 1997

Material examined. Bhutan, Bumthang Dist. Jakar, hotel, 27°32'28.41"N 90°45'08.52"E, 22. IV.2013, light leg. A. G. Duff (2 males, OPC).

Glossosoma malayanum Banks, 1934

Material examined. Bhutan, Bumthang Dist. Jakar, hotel, 27°32'28.41"N, 90°45'08.52"E, 22. IV.2013, light leg. A. G. Duff (1 male, OPC).

Family Hydroptilidae

Orthotrichia palama sp. nov.

(Figures 15–16)

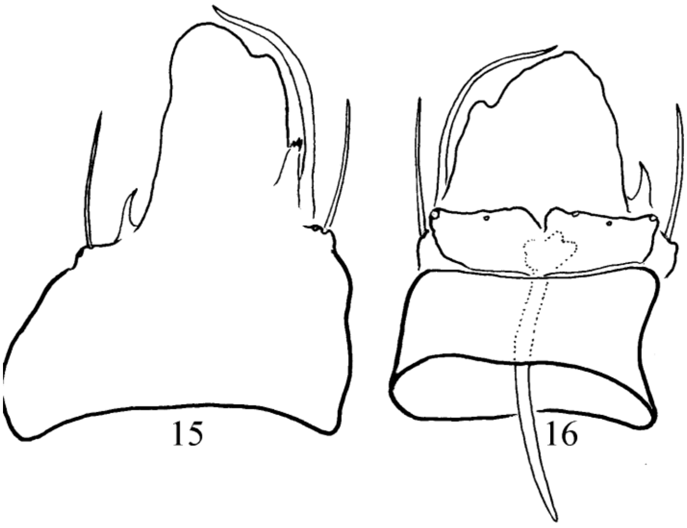
Diagnosis. This is a species with less asymmetric genitalia having some resemblance to *O. menjonkok* Wells & Malicky described from Indonesia (Sumatra), but differs by elongated segment X and lacking the spine-like free suspending discernible paraproct.

Description. Male (in alcohol). Forewing length 1 mm. Antennae 27 segmented, scapus double long, pedicel shorter than flagellar segments; flagellar segments quadratic; maxillary palp formula I-II-IV-III-V, first two segments extremely short, shorter than wide; post occipital setal warts prominent, ovoid, not modified as scent organ. Tentorium indiscernible, only anterior arm present. Ocelli lacking. Metascutellum short rectangular. Spur formula 034. Sternum VI with very small pointed apicomesal process and sternum VII without any process.

Male genitalia. Segment IX less asymmetric, dorsum little slonger than ventrum. Segment X (dorsal plate) present as a long less-pigmented lobe with slightly asymmetric apex. Paraproct not discernible. Gonopods fused quadratic with mesal constriction. The basal plate of the gonopods vestigial with long digitiform apodeme. Phallic organ forms a long tube with broader basal half and long titillator having complex multiple turning, apex dilated bifid.

Material examined. Holotype. India, Kerala State, Palamattom, Birds Lagoon Village Resort,, 10°06'N, 76°42'E, 30. XI- 1. XII.2010, light leg. A. G. Duff (1 male, OPC). *Paratype.* Same as of holotype (7 males, OPC).

Etymology. Coined from the name of locus typicus.



Figures 15−16. *Orthotrichia palama* sp. nov. 15 = male genitalia in left lateral view, 16 = male genitalia in dorsal view.

Family Odontoceridae

Marilia annae sp. nov.

(Figures 17–20)

Diagnosis. This new species is most close to *M. misionensis* Flint described from Argentina (Misiones), but differs by having suture pattern on segment IX differently developed, pleurotergal suture vestigial, not complete; cerci slender both in dorsal and lateral view, not broad; apex of segment X with more produced rounded triangular; phallotheca parallel-sided in lateral view, its curvature low.

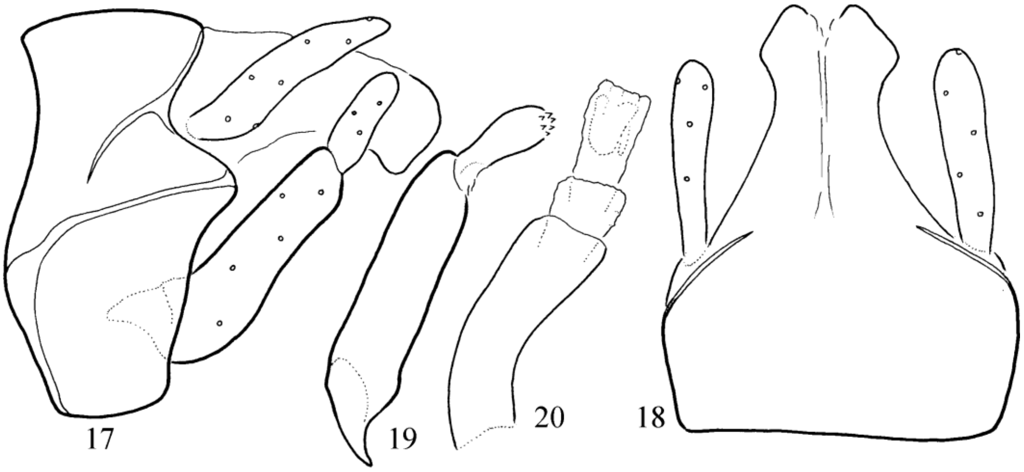
Description. Male (in alcohol). Slender, dark brownish animal. Wing membrane brown without any pattern, forewing length 11 mm. Eyes of male virtually touching middorsally. Spur formula 244, maxillary palp formula I-V-IV-II-II.

Male genitalia. Segment IX with S-shaped anteriorly, pleurotergal suture vestigial; pleurosternal suture straghtly directed to a midapical triangular lobe. Cerci slender tapering both basad and apicad in lateral view. Segment X with blunt apicolateral triangular lobe in dorsal view. Gonopods almost parallel-sided, harpago long, slightly mesad curving. Phallotheca or aedeagus less curved, phallotremal sclerite not distinct.

Material examined. Holotype. Argentina, Corrientes Province, Carlos Pellegrini Posada, Aguape, 28°32'26"S, 57°10'20"W, 24. XI.2011, at UV light/watertrap, leg. A. G. Duff (1 male, OPC). *Paratypes*. same as of holotype (2 male, 2 females, OPC)

Etymology. This beautiful dark brown and slender species with extremely enlarged male eyes is dedicated to the wife of the collector, who has accompanied her husband during his birdwatching trips.

Remarks. Marilia is a widespread genus, known from Oriental, Australasian, Nearctic and Neotropical regions. The male has variously enlarged eyes, and high degree of setal reduction on segments IX and X. Male genitalia rather similar, difficult to differentiate among species. Brace pattern of sutures on segment IX seems species specific in the Neotropical, but not so diverse in Oriental species. *Marilia* genus has significant enlargement of the compound eyes resulting specific modification of cephalic setal wart pattern. A long basal brush originates from the marginal surface of the small anal costal lobe near the very base of the hindwing. The setae in the brush are set close together, having the same length and form a pencil-like long brush. This pencil-like basal brush present in male absent in female and may serve some androconial function. *M annae* sp. n. has extremely enlarged eyes, well developed suture pattern on segment IX and complete spur pattern of 244.



Figures 17–20. *Marilia annae* sp. nov. 17 = male genitalia in left lateral view, 18 = male genitalia in dorsal view, 19 = left gonopod in ventral view, 20 = phallic organ in lateral view.

Family Calamoceratidae

Phylloicus kinovos sp. nov.

(Figures 21–24)

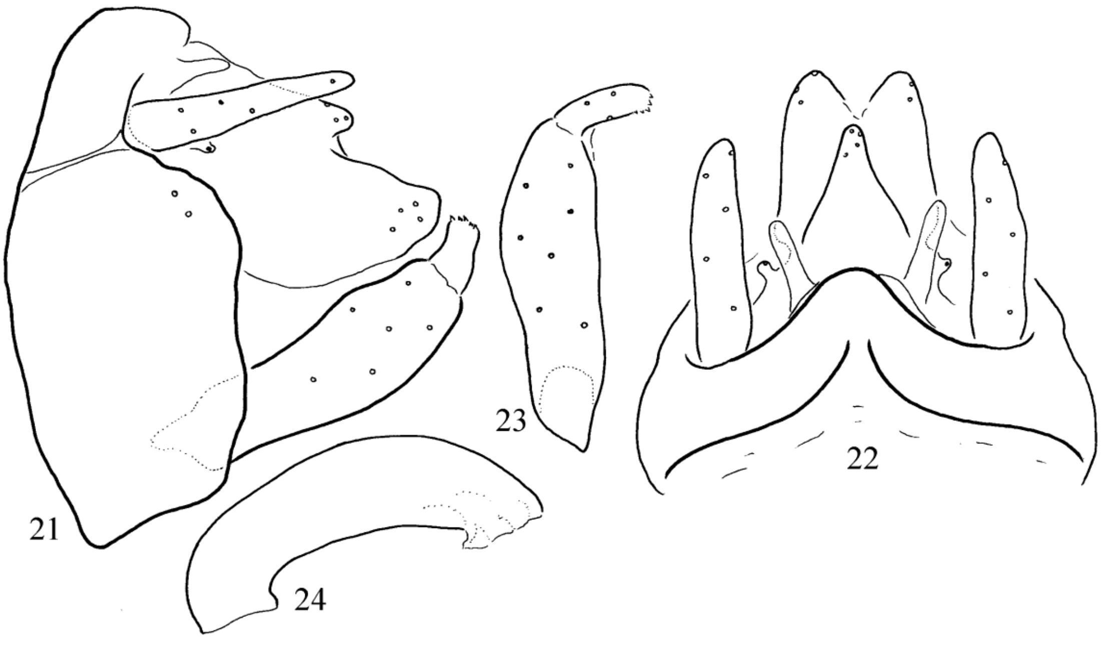
Diagnosis. In alcohol this unicoloured dark brown species is rather similar to *Phylloicus magnus* Banks from Colombia, but differs by having long triangular basodorsal process, long basolateral processes and an additional short lateral process on segment X; the phallobase has different curvature.

Description. Male (in alcohol). Dark brownish animal. Wing membrane dark brown without any pattern, densely packed with fine setae. Forewing length 18 mm. Maxillary palp formula I-IV-V-II-III. Tibial spur 244.

Male genitalia. Segment IX almost annular with horizontal suture at cerci. Segment X slightly sagitatte basally; basodorsal process long triangular, with produced apex in lateral view; basolateral processes of varying length and with some asymmetry; additional short lateral outgrowth near basolateral processes; apex truncate in lateral view, bilobed in dorsal view. Cerci digitate, shorter than segment X. Gonopods stout, coxopodite broadest midway, harpago parallel-sided. Phallic organ simple comprised of a tubular regularly arching phallobase and a membranous endotheca, phallotremal sclerite indistinct.

Material examined. Holotype. Colombia, Dusky Starfrontlet Bird Reserve, Cordillera Occidental, Urrao, Antioquia, 6°26’10.8” N, 76°5’ 25.15” W, 8. II. 2014, caught by hand, leg. A. G. Duff (1 male, OPC). *Paratypes*. Same as of holotype (2 males, OPC).

Etymology. *Kinovos* from “kinövős” with produced outgrowths”, in Hungarian, refers to the produced digitate processes on segment X, compared to its sibling *Phylloicus magnus*.



Figures 21−24. *Phylloicus kinovos* sp. nov. 21 = male genitalia in left lateral view, 22 = male genitalia in dorsal view, 23 = left gonopod in ventral view, 24 = phallic organ in lateral view.

Family Leptoceridae

Subfamily Triclectidinae

Atanatolica homora sp. nov.

(Figures 25–28)

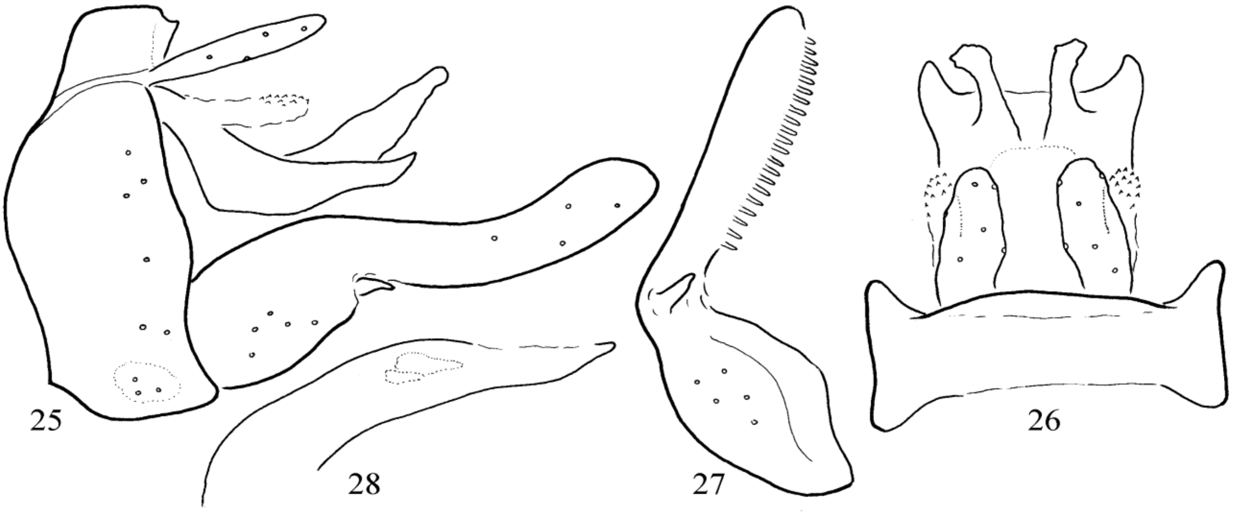
Diagnosis. This very slender animal is dark brown in alcohol. Distinguished from all the known species by its nominate character, the concave lateral profile of lower terminal region of the gonopods as well as by the presence of an additional less sclerotized pair of broad basolateral processes on segment X.

Description. Male (in alcohol). Dark brownish animal. Wing membrane dark brown without any pattern, densely packed with fine setae. Forewing length 11 mm. Maxillary palp formula I-IV-V-II-III.

Male genitalia. Segment IX almost annular with horizontal suture at cerci. Segment X rather complex, composed of apicomesal pair of most upward directed processes capitate in dorsal view, more tapering apicolateral pair of processes and an additional less sclerotized pair of broad basolateral lobes densely packed with short peg-like setae. Cerci digitate, shorter than segment X. Gonopods stout with shorter, higher (broader) basal region and longer, lower (narrower) apical region; small vestigial harpago present at the border between the basal and apical regions; apical region with highly concave lateral profile. Phallic organ simple, comprised of a tubular less arching phallobase and phallotheca and a membranous endotheca; phallotremal sclerite well sclerotized composed of dorsal and ventral parts, dorsal view of the dorsal sclerite bilobed.

Material examined. Holotype. Peru, Norther Peru, Abra Patricia Conservation Area, Amazonas, Moyobamba, 5°41’35.78”S, 77°47’49.41”W, 10. IX. 2014, at light, leg. A. G. Duff (1 male, OPC).

Etymology. *Homora* from “homorú” concave, in Hungarian, refers to the concave laterale profile of the low terminal segment of the gonopods..



Figures 25–28. *Atanatolica homora* sp. nov. 25 = male genitalia in left lateral view, 26 = male genitalia in dorsal view, 27 = left gonopod in ventral view, 28 = phallic organ in lateral view.

Subfamily Leptocerinae

Nectopsyche Müller, 1879

According to Holzenthal (1995) the species of the *Nectopsyche* genus are among the most beautifully coloured Trichoptera. Their forewing patterns are striking in appearance due to the presence of coloured hairs and scales with metallic or iridescent character. Specimens stored in alcohol usually very much denuded, forewing pattern and colour are usually lost. Identity of species is based largely on coloration pattern and less on male genital structure. However pinned, unrubbed specimens collected in dry, clean, cyanide killing jars, handled very carefully and mounted on pins, are seldom available for biodiversity studies. Moreover differences both in colour pattern and in genital structure are often subtle, but experienced apparently stable, even in sympatry with some intraspecific variation, but with very little interspecific overlap (Holzethal, 1995). A parallel careful examination and colourful illustration of forewing pattern on pinned material and very careful examination and detailed illustrations of the male genitalia are essential to a proper revision of this genus (Holzethal, 2016, personal communication).

Nectopsyche bruchi (Navas, 1920)

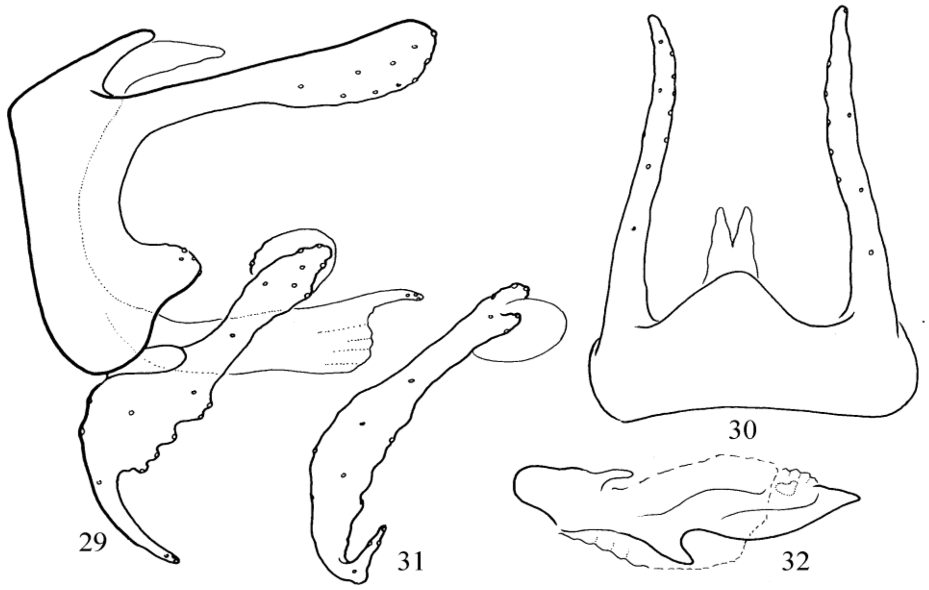
Material examined. Argentina, Corrientes Province, Carlos Pellegrini Posada, Aguape, 28°32'26"S, 57°10'20"W, 24. XI.2011, at UV light/ watertrap, leg. A. G. Duff (1 male, OPC).

Nectopsyche padrenavasi Holzenthal, 1999

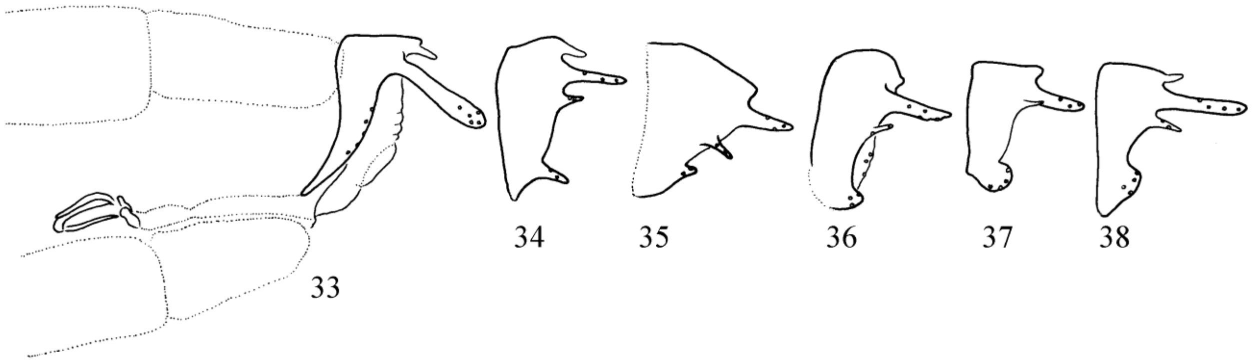
(Figures 29–38)

Material examined. Argentina, Corrientes Province, Ituzaingo, Howard Johnson Express Inn, 27°35'38"S 56°48'12"W, 25. XI.2011, at lighted windows, leg. A. G. Duff (2 males, 15 females; OPC).

Remarks. Specimens of *Nectopsyche padrenavasi* collected in alcohol by A. G. Duff were completely denuded. My genital drawings do not match to any published genital drawings. I have sent my diagrammatic genital drawings for determination to Professor Ralph Holzenthal who have drawn, but not published yet the genital structure of this poorly known species.



Figures 29–32. *Nectopsyche padrenavasi* Holzenthal, 1999. 29 = male genitalia in left lateral view, 30 = male genitalia in dorsal view, 31 = left gonopod in ventral view, 32 = phallic organ in lateral view.



Figures 33–38. Female genitalia of *Nectopsyche padrenavasi* Holzenthal, 1999 compared to other species. 33 = female genitalia in left lateral view, 34 = female segment IX of *N. cubana* in lateral view, 35 = female segment IX of *N. exquisita* in lateral view, 36 = female segment IX of *N. gemmoides* in lateral view, 37 = female segment IX of *N. lewisi* in lateral view, 38 = female segment IX of *N. paludicola* in lateral view,

Nectopsyche sp.

Material examined. Holotype. Colombia, Dusky Starfrontlet Bird Reserve, Cordillera Occidental, Urrao, Antioquia, 6°26’10.8”N, 76°5’ 25.15”W, 8. II. 2014, caught by hand, leg. A. G. Duff (1 male, OPC).

Remarks. Upon personal request this new species is set aside to describe until Ralph Holzenthal will complete his revision both on genital fine structure and forewing pattern of this very diverse genus with plenty of species complexes of closely related siblings.

Oecetis amazonica species complex

Material examined. Argentina, Corrientes Province, Ituzaingo, Howard Johnson Express Inn, 27°35’38”S, 56°48’12”W, 25. XI.2011, at lighted windows, leg. A. G. Duff (1 male, OPC). Argentina, Corrientes Province, Carlos Pellegrini Posada, Aguape, 28°32’26”S 57°10’20”W, 24. XI. 2011, at UV light/watertrap, leg. A. G. Duff (4 males, 2 females; OPC).

Remarks. Specimens from the two localities represent two undescribed species and a new species complex (see theoretical part). Based on the principles of fine structure analysis of the phallic organ we can delineate these young species also in this species complex. However, more comparative material is required to describe our species collected in Argentina.

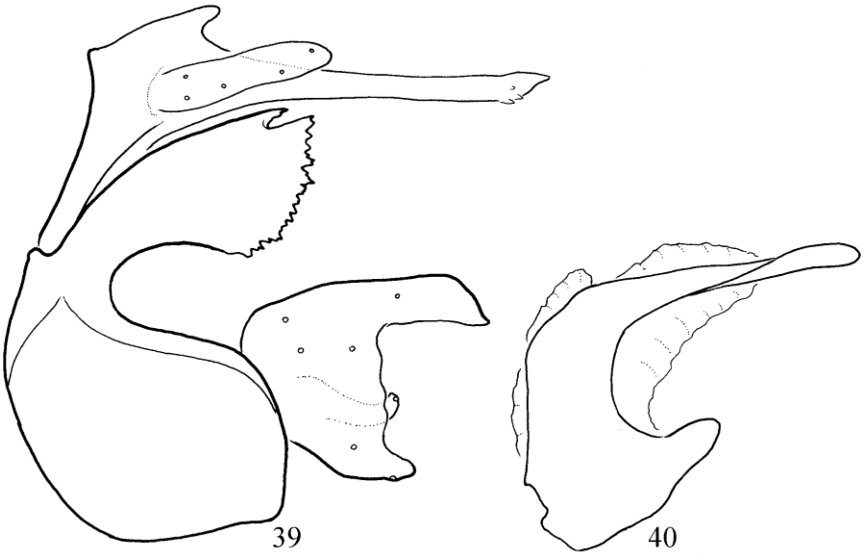
Oecetis fura sp. nov.

(Figures 39–40)

Diagnosis. The fused ventrum and pleuron form the basic body of segment IX; the dorsum of segment IX is reduced to a short band receiving the vestigial body of segment X, the fused long mesal lobe of segment X and the cerci. The fused ventrum and pleuron is uniquely subdivided into a pair of dorsal lobe and the rest ventrum. Such a structural development in the *Oecetis* genus is present only in a single known species, *O. dakchineswara* Schmid, 1995 described from Mysore of Karnataka State, India. The new species differs only in small divergences in the shape of the dorsal lobe of segment IX and of the gonopods as well as the apex of the mesal lobe of segment X has been modified.

Description. Male (in alcohol). Pale, yellowish animal. Wing membrane pale without any pattern, except crossveins have some brown pigmented small patches; forewing length 8 mm.

Male genitalia. Segment IX subdivided, dorsum reduced to a short band, fused ventrum and pleuron split into a pair of dorsal lobe and basal body of the segment. Segment X consisting of a slender median process, with pointed apex, accompanied by some subapical small out-



Figures 39–40. *Oecetis fura* sp. nov. 39 = male genitalia in left lateral view, 40 = phallic organ in lateral view.

growths. Cerci elongated foliate. Gonopods falcate in lateral view with a mesal additional lobe. Phallic organ asymmetrical with left-side sclerotized elongated and downward directed phallotheca, accompanied by a large membranous right side disposed membranous endotheca.

Material examined. Holotype. India, Kerala State, Palamattom, Birds Lagoon Village Resort, 10º06'N, 76º42'E, 30. XI–1. XII.2010, light leg. A. G. Duff (1 male, OPC).

Etymology. *Fura* from "fura" unusual, in Hungarian, refers to the unusually subdivided ventrum of segment IX.

Oecetis inconspicua complex

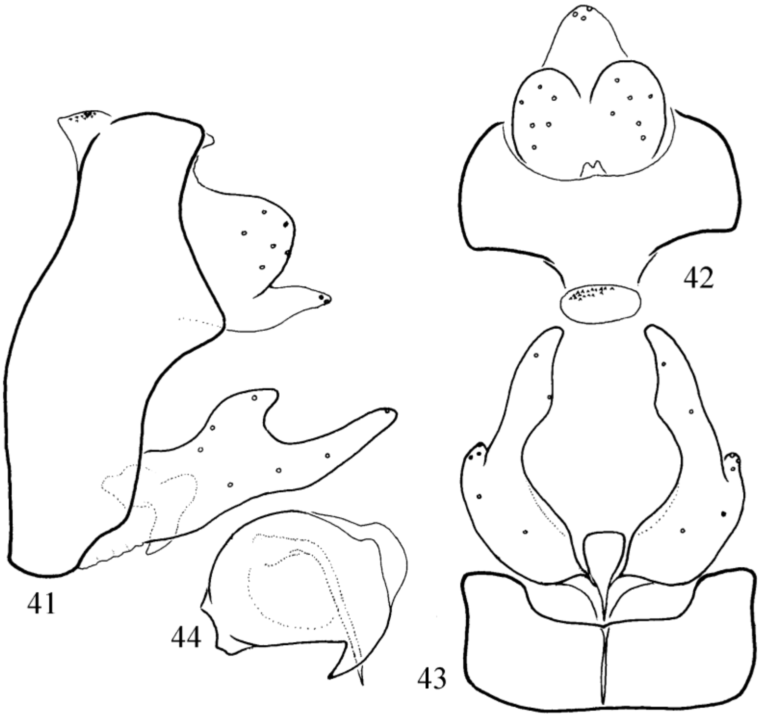
This known species complex, populating North and South America, may prove to contain significant species diversity still waiting to be described (Blahnik & Holzenthal, 2014). Larval morphology and cytochrome c oxidase subunit I (COI) sequences demonstrated that the examined populations of *Oecetis inconspicua* (Walker, 1852) represent a large species complex and need detailed revision. Studies on a limited number of populations revealed seven larval types (Floyd 1995) and 21 divergent COI clusters (Zhou *et al.* 1995). However, as usual, the real taxonomic revision is awaited to be realised with adult phenolmics of speciation traits. Those are the most diverged and stable genital structures or fine structures, the reproductive barrier products of sexual selection which are integrated under non-neutral, adaptive processes.

We have a few specimens from this complex collected in Argentina, outside of the presently known distribution range. We describe this population as a new species to give some impetus to a detailed revision. Our species delimitation is based primarily on the shape of the phallobase in lateral view. The intromittent organs have proved to be the most divergent and stable speciation traits in the caddisfly families of Hydropsychidae (Oláh & Johanson 2008a, b, 2012, Oláh & Kiss 2015), Hydroptilidae (Oláh & Ito 2013) and Limnephilidae (Oláh *et al.* 2015). The shape of the phallobase was found as the single most useful character also in the *Oecetis avara* group (Blahnik & Holzenthal 2014).

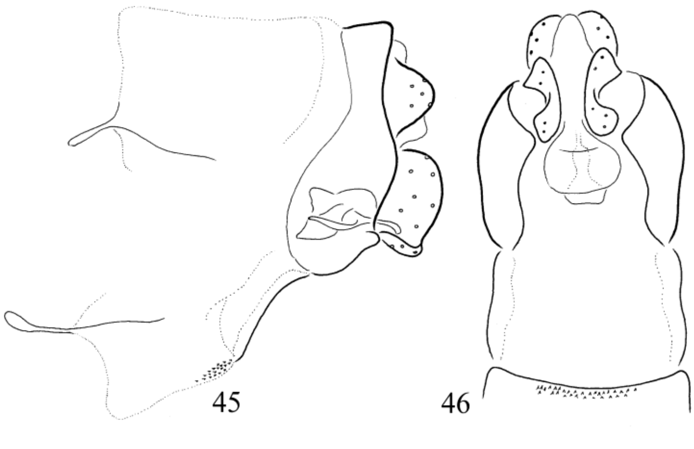
Oecetis siska sp. nov.

(Figures 41–46)

Diagnosis. If we compare the periphallic organs with all the published drawings, *O. siska* sp. nov. is most close to drawings of the popula-



Figures 41–44. *Oecetis siska* sp. nov. 41 = male genitalia in left lateral view, 42 = male genitalia in dorsal view 43 = male genitalia in ventral view, 44 = phallic organ in lateral view.



Figures 45–46. *Oecetis siska* sp. nov. 45 = female genitalia in left lateral view, 46 = female genitalia in ventral view.

tion from SE Brazil (Quinteiro & Calor, 2015), but the tip of segment X is triangular, not bilobed; the dorsal arm of the gonopod slender, not blunt; anteromesal region of dorsum IX produced, not concave; antecosta is discontinuous at acrotergite, not continuous; and moreover the membranous fulcrum excision on the apicomesal region of ventrum IX is very wide, not narrow. The lateral profile of the ventrum of the phallobase forms a uniquely long straight line, not short and not arched or bent. This trait is very stable at all the specimens, as examined at high resolution and at free disposition.

Description. Male (in alcohol). Pale brown animal. Male forewing length 8 mm, female forewing length 7 mm. Wing membrane pale without any pattern, except around crossveins there are some brown pigmented patches; spacing of the crossveins in the anastomosis (known also as chord, the diagonal line of crossveins more or less dislocated) seems stable at the examined 4 male and 1 female specimens: crossvein *s* placed more apicad and crossveins *r-m* and *m* arranged linearly placed basad.

Male genitalia. Segment IX fused, short annular, dorsum with produced anteromesal region, accompanied by a transversally ovoid acrotergite; apicomesal region of ventrum IX with a wide membranous excision giving fulcrum space for gonopod function during copulatory movement. Segment X short, triangular. Cerci rounded. Gonopods with longer ventroapical and shorter dorsal arms, basal plate of gonopods visible as a more sclerotized triangulum in ventral view. Phallic organ rounded, composed of somehow asymmetrical dorsal emarginations, long straight spine with basal bent, the lateral profile of the sclerotized phallobase is straight.

Female genitalia. Abdominal segment VIII complete, does not deviate much from the preceding segments; tergite and sternite VIII with short and thin anterolateral apophysis, the continuation of the longitudinal sutures; membranous pleural region large; ventrum VIII oblique with bare granulosed rugose surface. Segment IX short, broadening ventrad, dorsoapical pair of tiny papillae present. Cerci (preanal appendages, Yang & Morse 2000) semicircular. Sternite IX (lamellae) setose both on the lateral and mesal surfaces, double high than long, ventrum laterad directed. Segment X short, less pigmented, bare, flanked by cerci and forming the upper lip of vaginal opening. The complex gonopod of segment VIII and IX fused, glabrous, less sclerotized except the brown pigmented lateral bands. Vaginal sclerite complex well sclerotized and discernible.

Material examined. Holotype. Argentina, Corrientes Province, Carlos Pellegrini Posada, Aguape, 28°32'26"S, 57°10'20"W, 24. XI.2011, at UV light/watertrap, leg. A. G. Duff (1male, OPC). *Allotype*. Same as of holotype (1 female, OPC). *Paratypes*. Same as of holotype (3 males, OPC).

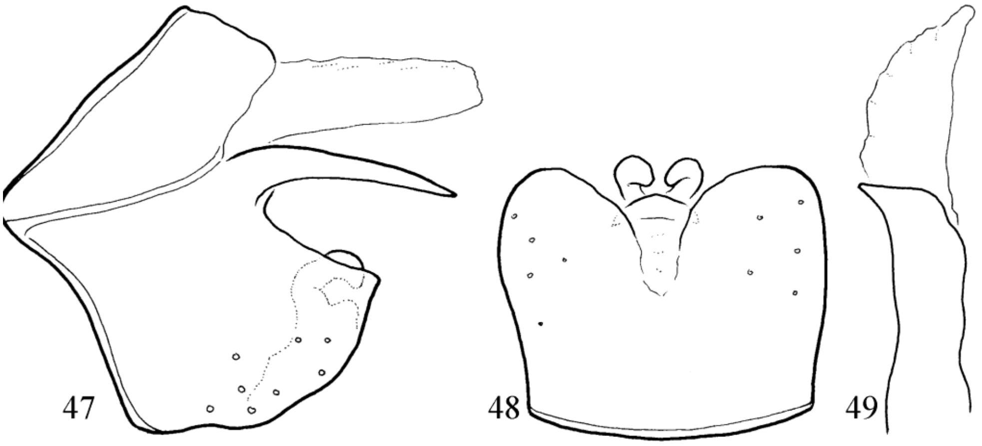
Etymology. *Siska* from "siska" a local variety of "egyenes" straight, in Hungarian, refers to the straight ventrum of the phallobase in lateral view.

Family Anomalopsychidae

Contulma duffi sp. nov.

(Figures 47–49)

Diagnosis. Having long membranous segment X and long dorsolateral process on sternite IX most similar to *Contulma bacula* Holzenthal & Flint, 1995 described from Ecuador, but differs by having tergite IX high, not low; dorsolateral process on sternite IX arching, not straight and longer than the sternite itself; both lateral and ventral shape of gonopods different.



Figures 47–49. *Contulma duffi* sp. nov. 47 = male genitalia in left lateral view, 48 = male genitalia in ventral view, 49 = phallic organ in lateral view.

Description. Male (in alcohol). Pale, brownish animal. Wing membrane pale without any pattern, densely packed with setae. Forewing length 5 mm. Ocelli 3. Maxillary palpi 5-segmented. Tibial spur 224, second spur of foreleg minute, no longer than wide. On forewing Rs shorter than either R2+3 or R4+5; MP fused, hence fork IV absent; discoidal and thyridial cells short, subequal; the crossvein from M3+4 joins the stem of CuA well basad of its fork.

Male genitalia. Posterior half of segments heavily setose, setae on tergum VIII longest. Segment IX synscleritous, triangular anterad; subdivided into tergite and sternite by a horizontal suture; sternite with a long arching and tapering dorsolateral processes. Segment X long quadratic membranous. Cerci indiscernible lost. Gonopods receded in sternite IX, falcate in lateral view; a pair of falcate process with a basal plate. Phallic organ simple, comprised of a tubular phallobase and a membranous endotheca.

Material examined. Holotype. Colombia, Dusky Starfrontlet Bird Reserve, Cordillera Occidental, Urrao, Antioquia, 6º25'N, 76º05'W, 9. II. 2014, caught by hand, leg. A. G. Duff (1 male, OPC).

Etymology. This new species is dedicated to the collector, Andrew G. Duff who was collecting caddisflies during his birdwatching trips.

Remarks. *Contulma* species are characterized by rarity. Adult specimens seldom fly to light; this specimen was also collected by hand.

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On the identity of some Oriental Acroneuriinae taxa (Plecoptera: Perlidae), with an annotated checklist of the subfamily in the realm

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Abstract. The monotypic Taiwanese genus *Mesoperla* Klapálek, 1913 is redescribed on the basis of a male syntype specimen, and its affinities are re-evaluated. The single female type specimen of further two Oriental monotypic genera, *Kalidasia* Klapálek, 1914 and *Nirvania* Klapálek, 1914, are confirmed to be lost or destroyed respectively; both genera are considered as nomina dubia. The Sichuan endemic *Acroneuria grahami* Wu & Claassen, 1934 is redescribed on the basis of male holotype. Distinctive characters of the genus *Brahmana* Klapálek, 1914 consisting of five, inadequately known Oriental species are discussed. *Flavoperla needhami* (Klapálek, 1916) and *Sinacroneuria sinica* (Yang & Yang, 1998) comb. novae are suggested for an Indian species originally described in *Gibosia* Okamoto, 1912 and a Chinese species originally described in *Acroneuria* Pictet, 1841. At present, 62 species of Acroneuriinae, classified in 10 valid genera are reported from the Oriental Realm but 29 species are inadequately known. A key is presented to distinguish males of the Asian Acroneuriinae genera. Asian distribution of each genera are detailed and depicted on a map.

Keywords. Stoneflies, Acroneuriinae, redescription, new combinations, nomen dubium, China, Taiwan, Indian subcontinent.

INTRODUCTION

The subfamily Acroneuriinae Klapálek, 1914 was established for Perlidae Latreille, 1802 taxa having hammer on male sternum 9. The concept of the subfamily became widely accepted and Perlidae was divided into two subfalimies; Perlinae and Acroneuriinae. Later, Illies (1966), recognized as distinctive features of Acroneuriinae the modified male paraprocts, lack of hemitergites 10, and occipital row of setae being irregular, incomplete or absent on larvae (Zwick 2000).

Contrary to Perlinae where the genera are well defined and their limits are clear and widely accepted (Sivec *et al.*, 1988), supraspecific classification of Acroneuriinae still raise some problems. The system of Nearctic taxa can be considered well defined both at generic and specific level (Stark & Gaufin 1976, Stark 2004). Also the Neotropical taxa received a generic synopsys (Stark 2001) and, though many new species are still expected to be found, there are relatively few nomina dubia or poorly known species left (Froehlich 2010). However, the Asian Acroneuriinae species are poorly defined and lack comprehensive review, despite of recent efforts done on regional faunas or certain genera (Inada 1998, Li & Wang 2014, Li *et al.,* 2014, Stark & Sivec 2008a, 2008c, 2008d, Uchida 1990, Uchida *et al.,* 2011).

The distribution of Acroneuriinae covers all of the Nearctis, Neotropics and Oriental realms, and the eastern part of the East Palaearctis (DeWalt *et al.* 2016). It is divided into three tribes, among which the Anacroneuriini Stark & Gaufin, 1976 is restricted to the Neotropics and southern portion of the Nearctis, while Acroneuriini Klapálek, 1914 spreads over most of the subfamily's range except the Neotropics. Kiotinini Uchida, 1990 is an Asian tribe having also an eastern Nearctic genus however; it is not throughout accepted as it was described in a thesis.

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During our visits to the Natural History Museum, Vienna (DM, April 2013), National Museum of Natural History, Washington D.C. (WHL, July 2014) and the National Museum Prague (DM, July 2014) we were searching for type specimens of certain Asian stoneflies. Several poorly-known taxa were already reported and described as an outcome of these projects (Li *et al.,* 2015, Murányi & Li 2013, 2015, Murányi *et al.,* 2015). In this paper the Oriental Acroneuriinae types of these collections are enumerated, redescribed or complementarily described. In addition, we present an annotated checklist of the subfamily from the Oriental realm, supplementing with their status, distribution and availability of type specimens.

MATERIAL AND METHODS

The specimens examined are stored dry in the Department of Entomology, Natural History Museum, National Museum Prague, Czech Republic, and in ethanol vials in the Department of Invertebrate Zoology, National Museum of Natural History, Washington D.C., USA.

Specimens' terminalia was cleared in KOH. Terminalia kept in the same ethanol vial, or for each dried specimen are stored in a microvial with glycerine pinned beneath the specimen. Drawings were made with the aid of a drawing tube applied to a Nikon SMZ800 microscope. Further illustrations were made with Nikon D70s and Leica C cameras. Terminology mainly follows Sivec & Stark (2008c).

Distributional data were compiled from literature information from various sources referenced in Plecoptera Species File (PSF) (DeWalt *et al.,* 2016).

TAXONOMY

Acroneuria grahamia Wu & Claassen, 1934

(Figures 1–6)

Acroneuria grahamia Wu & Claassen, 1934: 126. (original description of male); Wu 1935a: 309. (catalog).

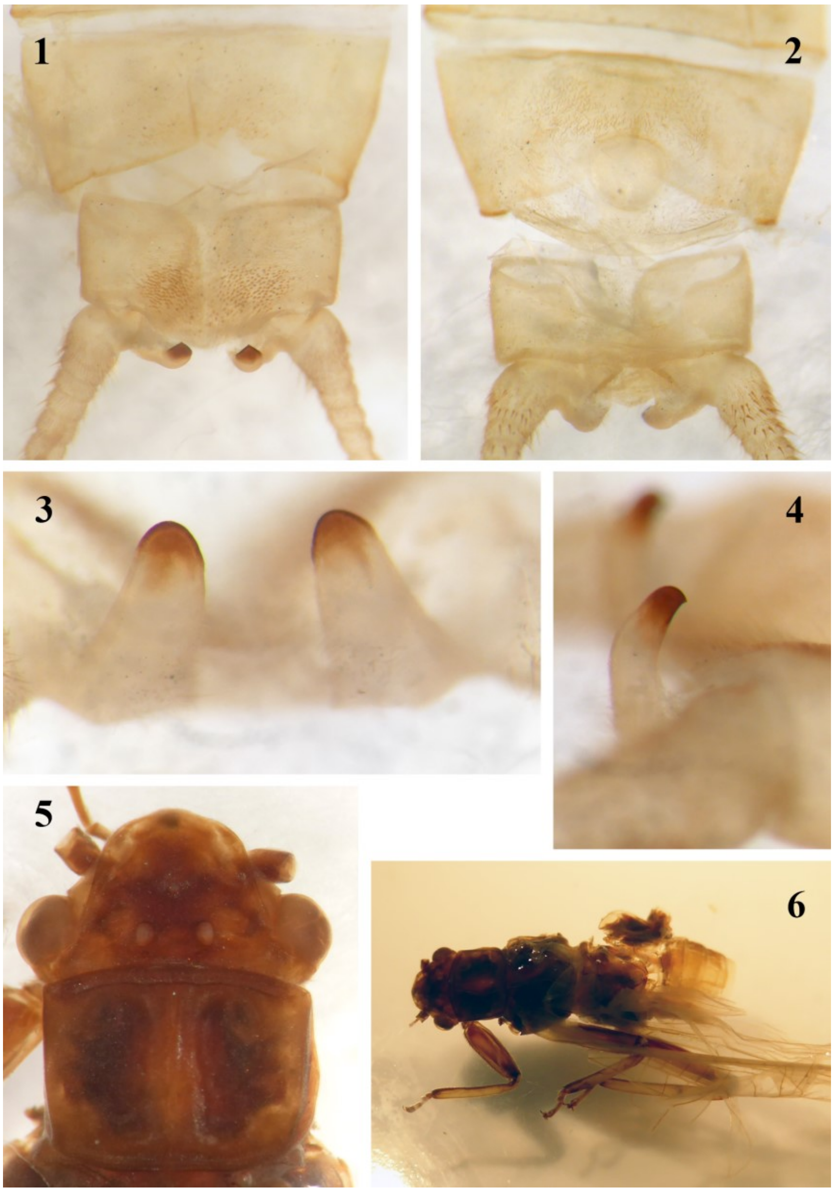
Acroneuria grahami Wu & Claassen, 1934: Wu 1938: 132. (monograph); Banks 1940: 175. (description of female, new records from Sichuan and Yunnan); Claassen 1940: 174. (catalog); Illies 1966: 308. (catalog); Du 1995: 154. (monograph); Du et al. 1999: 63. (checklist); Du 2000: 80. (note on neotype designation by Wu); DeWalt *et al.,* 2016 (catalog).

Type locality. Szechuan (Sichuan Province, without exact locality).

Material examined. Sichuan: no exact locality, viii.1928, leg. D.C. Graham: Holotype ♂ (USNM, in vial) (Labels: No. 113 / Acroneuria grahamia W-C / male holotype; Szechuan Aug. 1928 / Graham (handwritten); TYPE No. 55239 U.S.N.M. (red label)).

Description. Adult habitus (Figs. 5–6): Large sized species, general colour reddish brown. Triocellate. Head mostly dark brown with distinct, pale occipital and frontal patches. Occiptal ridge not defined, occipital suture indistinct, tentorial callosities and M-line distinct; paired wrinkle presents between M-line and the lateral margins. Eyes and ocelli large; distance between posterior ocelli more than two times diameter of one ocellus. Scape dark brown, rest of antennae lacking but said to be lighter in the original description. Pronotum square, narrower than head with eyes. Its ground colour brown, with prominent dark rugosities. Meso- and metanotum brown with dark brown pattern. Legs brown with darker distal portrions on femora, tibiae longitudinally striped; femora and tibiae slightly dilated. Wings hyaline, veins brown. Abdomen pale, only the apex of male paraprocts are brown.

Male terminalia (Figs. 1–4). Abdominal segments 1–8 unmodified, all antecosta weak but entire, interrupted only on sternum and tergum 10. No hair brushes nor laterocaudal spurs, but segments 8–9 strongly sclerotized laterocaudally. Sternum 9 moderately elongated and with short, rounded posterior lobe that covers only part of sternum 10 in natural position. Hammer large and round, positioned more caudad than in center, occupies one fourth of segment's width and more than one third of segment's length; posterior lobe lightly colored posteriolaterad to hammer but dark



Figures 1–6. *Acroneuria grahamia* Wu & Claassen, 1934, holotype male. 1 = terminalia relaxed with KOH, dorsal view; 2 = terminalia relaxed with KOH, ventral view; 3 = paraprocts, caudal view; 4 = paraprocts, lateral view; 5 = head and pronotum, dorsal view; 6 = specimen without terminalia, dorsal view. Not to scale.

medially, its posterior margin thickened. Sternum 10 sclerotized only laterally, antecosta interrupted in medial third of segment width. Tergum 9 with few and indistinct sensilla basiconica positioned in paired posterior field laterally to midline. Tergum 10 with distinct and dense sensilla basiconica, positioned in paired posterior field laterally to midline, occupy half of segment's length and two thirds of segment's width; median line pale and runs from the interrupted antecosta to the hardly distinguishable epiproct sclerite. Paraproct strong, base pale but apex darker than terminal segments. In lateral view, anterior edge broad V-shaped and with small apical tooth, posterior edge basally straight than strongly curved; in caudal view, broad rounded nearly straight. Cercus broken, covered with moderatelly long setae, each segment bears apical row of strong but short ventral and longer lateral setae. Aedeagus lacks distinct armature or sclerite; detailed study or artificial evertion was not possible, due to the specimen's condition.

Female, egg and larva. Unknown.

Affinities. Though the aedeagus of the holotype cannot be studied in details, structure of the terminalia, size and coloration of the holotype confirm its identity as an *Acroneuria*. On the basis of the distribution of sensilla basiconica patches, robust paraprocts with broad rounded apex in caudal view, size of hammer and the faded but still visible head pattern, it can be distinguished from the Asian congeners. However, some of those, e.g. *A. nobiliata* Enderlein, 1909a, are poorly known.

Distribution. The holotype lacks further locality details than 'Szechuan'. However, its collecting date is more specified, August 1928. According to the author's diaries available in the Smithsonian Institution Archives (https://transcription.si.edu/project/7026), David Crocket Graham spent that month on a collecting expedition to Ningyuenfu, the present day Xichang city of the Liangshan Yi Autonomous Prefecture in the south of Sichuan Province. Besides the holotype, the species is known only from three females reported by Banks (1940) from Sichuan and Yunnan, but their conspecifity is questionable. The two other *Acroneuria* known from Sichuan are *A. morsei* Du, 2000, described from Guanxian (presently Dujiangyan city), and *A. omeiana* Wu, 1948, described from Mt. Emei, both were found in central Sichuan.

Remarks. Du (2000) noted a neotype designed by Wu was found among the remnants of the Wu Collection. As the holotype still exists, the neotype designation is invalid. The species name was misspelled since Wu (1938).

Brahmana **Klapálek, 1914**

(Figures 16–17)

Brahmana Klapálek, 1914: 60. (original description in a key); Klapálek, 1916: 62. (detailed description, designation of type species, description of two new species and assignation of a further one, all from India and Nepal); Wu 1938: 129. (key); Claassen 1940: 180. (catalog); Wu 1962: 150. (description of a further species from China); Illies 1966: 326. (catalog); Zwick 1973a: 273. (catalog); Du 1995: 158. (monograph); Du & He 2001: 370. (generic checklist of China); DeWalt *et al.*, 2016 (catalog).

Type species. *Brahmana suffusa* (Walker, 1852).

Further species included. B. benigna (Needham, 1909); *B. chrysostoma* Klapálek, 1916; *B. flavomarginata* Wu, 1962; *B. microphthalma* Klapálek, 1916.

Material examined. India. West Bengal State, Darjeeling District, Kurseong subdivision, N26° 52', E88°16', 1400m, leg. P. Braet: *Brahmana chrysostoma* Klapálek, 1916 1♀ paralectotype (NMP, box VII.13: pinned) (Labels: Kurseong / leg. P. Braet; Typus; Brahmana chryso… (handwritten); Lectotypus / Brahmana / chrysostoma Klp. ♀ / det. P. Zwick 1980 (handwritten)).

Affinities. The genus was first proposed in a key for the newly introduced subfamily Acroneuriinae, without detailed description or any species attributed (Klapálek 1914). Soon after, detailed description together with type species designation, description of two new species and assignation of a further species to *Brahmana* was published (Klapálek 1916). Distinctive characters of the genus were listed as follows: head triocellate, short and inserted in the pronotum, eyes unusualy small, hind ocelli set close to each other, pronotum wide and not angled, anterior portion slightly enlarged, female subgenital plate large and covering most of sternum 9, male hammer large, paraprocts claw-like, no anal crossveins and hindwing A2 vein straight. Among the five species classified in the genus, three are known only from the female types (*B. chrysostoma, B. microphthalma* and *B. suffosa*), and no types of the other two are available (*B. benigna* and *B. flavomarginata*). Thus, the differences between the male terminalia of *Acroneuria* and *Brahmana* are hard to understand, especially as the *Brahmana* aedegaus remained unknown. The wing characters also do not seem distinctive enought, even individual variation between the lectotype and paralectotype of the type species was reported (Kimmins 1970). However, characters of the short head and its insertion into the pronotum like that of a Peltoperlidae seem to be decisive (Figs. 16–17), and this Oriental genus should be considered valid but poorly known, appearently closely related to *Acroneuria*.

Flavoperla needhami **(Klapálek, 1916) comb. nov.**

Perla duvaucelii Pictet, 1841: Needham 1909: 189. (redescription of the male);
Gibosia needhami Klapálek, 1916: 62. (nom. nov. on the basis of the specimens and description given as *Perla duvaucelii* by Needham 1909); Claassen 1940: 154 (catalog); Illies 1966: 335. (catalog); Zwick & Sivec 1980: 133. (lectotype designation, complementary description); DeWalt *et al.,* 2016 (catalog).

Type locality. Kulu, Ostindia (India, Himachal Pradesh State, Kullu District, Kullu, N31°35' E77°06').

Remarks. Klapálek (1916) named this species on the basis of the redescription given by Needham (1909) on Indian specimens he attributed to *Perla duvaicelii* Pictet, 1841. The species was assigned to *Gibosia* Okamoto, 1912. The genus *Flavoperla* Chu, 1929 was described later on the basis of a Chinese species, but soon placed in synonymy with *Gibosia* (Wu 1935). Recently, *Flavoperla* is reconsidered as valid (Uchida 1990, Harper 1994), though its distinction from *Gibosia* still remained problematic and based mostly on the habitus (Sivec & Strak 2008a). However, given from its small size and pale coloration, this Indian species should be considered as a *Flavoperla* instead of the dark colored and large *Gibosia.*

Kalidasia **Klapálek, 1914 nomen dubium**

Kalidasia Klapálek, 1914: 60. (original description in a key); Klapálek, 1916: 64. (detailed description, designation and description of type species); Wu 1938: 129. (key); Claassen 1940: 182. (catalog); Illies 1966: 338. (catalog); DeWalt *et al.,* 2016 (catalog).

Type species. *Kalidasia radiata* Klapálek, 1916. Monotypic.

Remarks. Similarly to *Brahmana,* this monotypic genus was first proposed in the key of Acroneuriinae (Klapálek 1914) and the type species was described later, together with the more detailed description of the genus (Klapálek 1916). The genus and species was known from the single female holotype, that is appearently lost. In the original description it was stated to be deposited in the Natural History Museum, Vienna, but we did not find there, nor in the Klapálek Collection in Prague.

The type locality was not specified, only East India ('Vých. Indie') indicated that perhaps refers the old geographical/geopolitical meaning covering all of the Indian Subcontinent, as 'West India' was used referring to Indochina.

The genus is considered to be very close to *Brahmana* but different in having small and trapezoid pronotum, one crossvein between veins A2 and A3, and lack of produced female subgenital plate. The brief description and diagnosis may refer to a large sized *Acroneuria* or even a *Claassenia* Wu, 1934 of reduced subgenital plate, as well as a distinct genus indeed. Given that the type is lost and by lack of concrete type locality there is no chance to collect topotypes, the genus and species must be considered nomen dubium.

Mesoperla **Klapálek, 1913**

Mesoperla Klapálek, 1913: 121. (original description); Klapálek, 1914: 56. (key, included in Perlinae); Klapálek, 1923: 110. (monograph); Claassen 1940: 126. (catalog); Illies 1966: 344. (catalog, transferred to Acroneuriinae); Du & He 2001: 370. (generic checklist of China); DeWalt *et al.,* 2016 (catalog).

Type species. *Mesoperla crucigera* Klapálek, 1913. Monotypic.

Mesoperla crucigera **Klapálek, 1913**

(Figures 7–15)

Mesoperla crucigera Klapálek, 1913: 121. (original description of male); Klapálek, 1923: 110. (monograph); Banks 1937: 272. (report of a probable female from Taiwan); Claassen 1940: 126. (catalog); Illies 1966: 345. (catalog); Du et al. 1999: 64. (species checklist of China); Sivec &

Yang 2001: 402. (species checklist of Taiwan); DeWalt *et al.,* 2016 (catalog).

Type locality. Formosa, Suisharyo (Taiwan, Chiayi County, Alishan Mts., Shui, N23°31' E120°48').

Material examined. Taiwan. Chiayi County, Alishan Mts., Shui, N23°31' E120°48', x.1911, leg. H. Sauter: 1♂ syntype (NMP, box VII.5: pinned, terminalia is in microvial) (Labels: Suisharyo F / H. Sauter; TYPUS; Cotype (red label); MESOPERLA / crucigera Klp. / Klapálek det.).

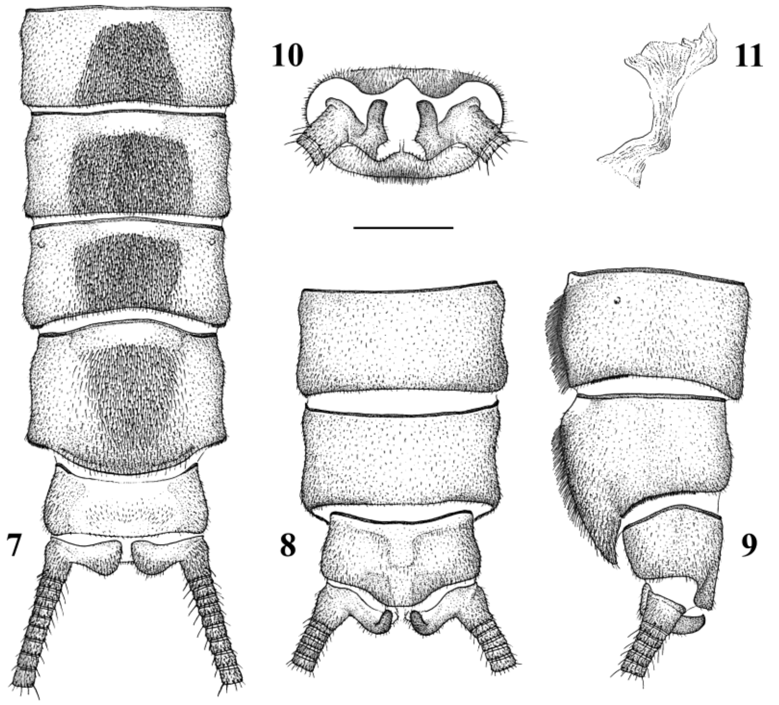
Description. Adult habitus (Figs. 12–13, 15): Medium sized species, general colour yellowish brown. Triocellate. Head yellowish brown with distinct dark medial stripe from occiput to labrum, occupies the whole area between ocelli and most of the frons anterior to M-line. Occipital ridge not defined, occipital suture indistinct, tentorial callosities and M-line distinct; a wrinkle presents between M-line and the lateral margins. Eyes and ocelli are small; distance between posterior ocelli about four times diameter of one ocellus. Antennae darker than head but scape, pedicell and basal antennomeres pale. Pronotum square, anterior edges slightly angled; narrower than head with eyes. Its ground colour pale brown, with prominent, darker rugosities and a darker medial stripe. Meso- and metanotum brown with dark brown pattern. Legs pale brown, femora and tibiae slightly dilated; wings hyaline, veins brown. Abdomen pale, only the male paraprocts brown.

Male terminalia (Figs. 7–11, 14): Abdominal segments covered with soft and pale hairs, sterna 5–9 bear distinct hair brushes and segments 7–9 with laterocaudal spurs but none with sensilla basiconica. All antecosta strong and entire, interrupted only on sternum 10. Ventral hair brushes occupy about half of segment length, start from a little behind antecosta and distributed to posterior edge, the strongest and denser setae occur on sternum 7. The hair brush possesses sharp edge on all but sternum 9, where the strong setae mixed with fine hairs on lateral and caudal edge of the brush. Laterocaudal spurs small on segments 7–8, but on segment 9 it occupies half of the posterior margin in lateral view. Sternum 9 elongated and with well developed rounded posterior lobe covering sternum 10 in natural position, but lacks any trace of hammer. Sternum 10 sclerotized only laterally, antecosta interrupted in medial three fourth of segment width. Terga all simple, tergum 10 with indistinct, bald median line in the anterior half and medially protruding posterior portion that dark colored on its lateral sides, but lacks distinguishable epiproct sclerite. Paraproct medium sized, darker than terminal segments. In lateral view, anterior edge straight and with small apical tooth, posterior edge regularly curved; in caudal view, inner basal lobe present and the rounded apex slightly bent inwards. Cercus long, covered with moderately long setae, each segment bears apical row of stronger ventral and inner lateral setae. Aedeagus lacks distinct armature or sclerite, covered by small scale-like setae; artificial eversion was not possible.

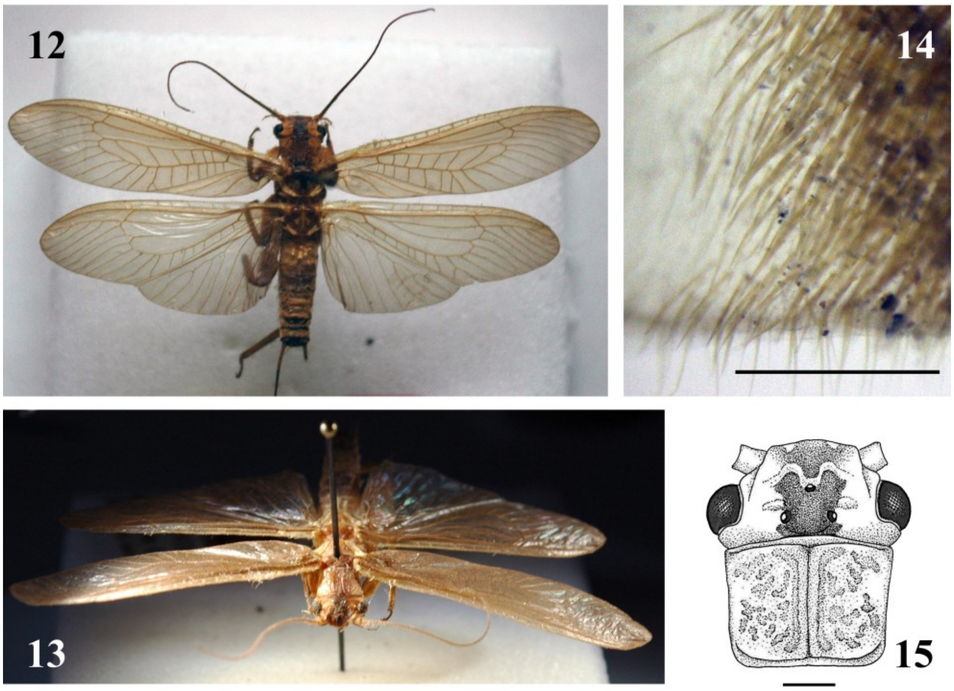
Female. Unknown; Banks (1937) reported but not described a female from Taiwan that may belongs to *Mesoperla.*

Egg and larva. Unknown.

Affinities. The male terminalia of *Mesoperla crucigera* is rather simplified lacks most modifications but of distinct ventral brushes, slightly developed sternum 9 lobe and paraprocts. Due to the lack of hammer on sternum 9, Klapálek (1914) classified it as a Perlinae that has no modified 10th hemitergites. However, modified parapocts clearly support its classification in Acroneuriinae, as later Illies (1966) proposed. Though uncommon, lack of hammer occurs in other Acroneuriinae, like *Perlesta* Banks, 1906 or the strongly modified *Caroperla* Kohno, 1946. The combination of presence of distinct ventral hair brush on terminal segments with lack of hammer, sensilla basiconica and distinct epiproct already distinguish *Mesoperla* from all other Acroneuriinae genera. However, affinities within the subfamily cannot be concluded, especially as the female, egg and larva are still unknown.



Figures 7–11. *Mesoperla crucigera* Klapálek, 1913, syntype male. 7 = terminalia relaxed with KOH, ventral view; 8 = terminalia relaxed with KOH, dorsal view; 9 = terminalia relaxed with KOH, lateral view; 10 = terminalia relaxed with KOH, caudal view; 11 = uneverted aedeagus. Scale 1 mm.



Figures 12–15. *Mesoperla crucigera* Klapálek, 1913, syntype male. 12 = habitus, dorsal view; 13 = habitus, anterodorsal view; 14 = scales of the ventral hair brush on sternum 7; 15 = head and pronotum, dorsal view. Scale 0.5 mm for Fig. 14, 1 mm for Fig. 15; Figs. 12–13 not to scale.

Distribution. The four male syntypes were collected in the Alishan Ranges of Central Taiwan, no additional specimens with detailed locality were reported since. Most probably endemic to Taiwan.

Nirvania Klapálek, 1914 nomen dubium

(Figure 18)

Nirvania Klapálek, 1914: 61. (original description in a key); Klapálek, 1916: 64. (detailed description, designation and description of type species); Claassen 1940: 183. (catalog); Illies 1966: 346. (catalog); DeWalt *et al.,* 2016 (catalog).
Nirvinia Klapálek, 1914: Wu 1938: 131. (key).

Type species. *Nirvania pertristis* Klapálek, 1916. Monotypic.

Material examined. Vietnam. Lào Cai Province, Sa Pa District, Thanh Phú, N22°15' E103° 59', 400–500m): labels and pin of the destroyed ♀ holotype (NMP, box VII.13) (Labels: Muong-Bo (handwritten); Tonkin; TYPE; Nirvania / pertristis Klp (Klapálek's handwrite)).

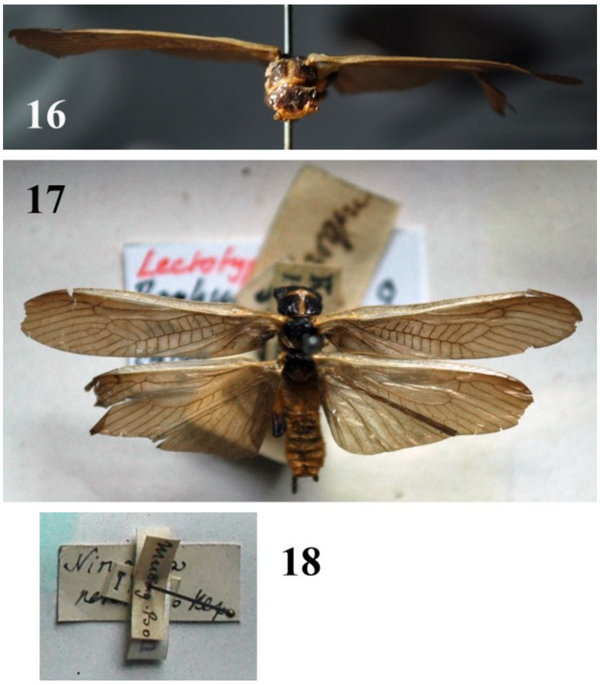
Remarks. Similarly to *Brahmana* and *Kalidasia,* this monotypic genus was first proposed in the key of Acroneuriinae (Klapálek 1914) and the type species was described later, together with the more detailed description of the genus (Klapálek 1916). The genus and species was known from the single female holotype that was totally destroyed by Dermestidae, and only its pin and labels remained in the National Museum Prague (Fig. 18). Distinctive characters of the genus were pointed as follows: head biocellate, occipital region not prolongated, pronotum with narrow median stripe, female lacks produced subgenital plate, and several wing venation characters that would separate it from Anacroneuriini and Kiotinini. There are several other Perlidae described or reported from the vicinity of the type locality of *N. pertristis*, including biocellate Acroneuriinae like *Hemacroneuria violacea* Enderlein, 1909b, *H. marginalis* Sivec & Stark, 2008d or *Sinacroneuria biocellata* Sivec & Strak, 2008b. As the single type was destroyed and the original description is rather brief, it is undoubtedly better to consider both the genus and species as nomen dubium than to transfer any of the properly described or redescribed species from Sa Pa.

Sinacroneuria sinica (Yang & Yang, 1998) comb. nov.

Acroneuria sinica Yang & Yang, 1998: 41. (original description of the male); DeWalt *et al.,* 2016 (catalog).

Type locality. China, Zhejiang Province, Longwangshan.

Remarks. The aedeagus of this species also has the Y-arm sclerites characteristic for *Sinacroneuria* Yang & Yang, 1995a (Yang & Yang 1998: Fig. 9-12). Thus, it should be considered as a further species of that genus.



Figures 16–18. *Brahmana* Klapálek, 1914 and *Nirvania* 1914 type specimens. 16 = *Brahmana chrysostoma* Klapálek, 1916, paralectotype female, habitus, frontal view; 17 = *Brahmana chrysostoma* Klapálek, 1916, paralectotype female, habitus, dorsal view; 18 = *Nirvania pertristis* Klapálek, 1916, labels and pin of the destroyed holotype female. Not to scale.

Key to the males of Asian Acroneuriinae genera

1. First cercal segment modified, longer than segment 10. .... ***Caroperla***
First cercal segment unmodified. ....**2.**

2. Sternum 9 lacks hammer. ....**3.**
Sternum 9 with distinct hammer. ....**4.**

3. Sterna 5–9 with distinct hair brush. ..... ***Mesoperla***
Sterna lack hair brush............................. ***Perlesta***

4. Paraprocts longer than segment 10, apex spatulated .... ***Niponiella***
Paraprocts much shorter than segment 10, apex not spatulated. ....**5.**

5. Tergum 10 with pair of lateral spines or knobs..**6.**
Tergum 10 lacks paired lateral modifications....**9.**

6. Hammer stalked, posterior ocelli set closer to eyes than to each other. ....**7.**
Hammer not elevated, posterior ocelli set closer to each other. ....**8.**

7. Pale, small sized species, epiproct weakly fused to tergum 10. .... ***Flavoperla***
Dark, large sized species, epiproct fully isolated.. .... ***Gibosia***

8. Tergum 10 with lateral spines, epiproct distinct... .... ***Kiotina***
Tergum 10 with lateral knobs, epipoct indistinguishable. .... ***Hemacroneuria***

9. Head short and inserted in the wide pronotum, eyes small... ***Brahmana***
Head not inserted in the usually rectangular pronotum. ....**10.**

10. Aedeagus with distinct, Y-shaped sclerite............ .... ***Sinacroneuria***
Aedeagus lacks sclerite. ....**11.**

11. Epiproct distinct and separated........................**12.**
Epiproct indistinct. .... ***Acroneuria***

12. Aedeagus with well developed spine patches, hammer rectangular. .... ***Calineuria***
Aedeagus lacks distinct spine patches, hammer oval. .... ***Xanthoneuria***

Checklist of the Oriental Acroneuriinae

Acroneuriini Klapálek, 1914

Genera included. **East Palaearctic**: *Xanthoneuria* Uchida, 2011 (in. Uchida *et al.* 2011). **East Palaearctic** and **Nearctic**: *Calineuria* Ricker, 1954. **Nearctic**: *Attaneuria* Ricker, 1954, *Beloneuria* Needham & Claassen, 1925, *Doroneuria* Needham & Claassen, 1922, *Eccoptura* Klapálek, 1921, *Hansonoperla* Nelson, 1979, *Hesperoperla* Banks, 1938, *Perlinella* Banks, 1900. **Nearctic** and **Oriental**: *Acroneuria* Pictet, 1841. **Oriental**: *Brahmana* Klapálek, 1914, *Mesoperla* Klapálek, 1913, *Sinacroneuria* Yang & Yang, 1995a.

Nomina dubia: *Kalidasia* Klapálek, 1914 (Oriental), *Nakaharia* Navás, 1916 (East Palaearctic), *Nirvania* Klapálek, 1914 (Oriental).

Acroneuria Pictet, 1841

(Figure 19)

Type species. *Perla (Acroneuria) arenosa* Pictet, 1841.

Further species included. 19 Nearctic species besides the type species, and the 16 Oriental species enumerated herein. Not known from the Palaeractic, neither from the Pacific region of the Nearctic.

Synonym. Nosatura Navás, 1918, type species *Perla carolinensis* Banks, 1905.

Acroneuria apicalis Stark & Sivec, 2008c
Sivec & Stark 2008c: description of male, female and egg; holotype and paratypes from Vinh Phu Province of Vietnam.

Known only from northern Vietnam. Holotype and paratypes are in the Royal Ontario Museum, Toronto, Canada, further paratypes in the Institute of Ecology and Biological Resources, Hanoi, Vietnam and Slovenian Museum of Natural History, Ljubljana, Slovenia. Larva is unknown.

Acroneuria azunensis Stark & Sivec, 2008c

Sivec & Stark 2008c: description of male, female and egg; holotype and paratypes from Gia Lai Province of Vietnam.

Known only from southern Vietnam. Holotype and paratypes are in the Royal Ontario Museum, Toronto, Canada, further paratypes in Institute of Ecology and Biological Resources, Hanoi, Vietnam, the Bill Stark Collection, Clinton, Mississippi, USA and Slovenian Museum of Natural History, Ljubljana, Slovenia. Larva is unknown.

Acroneuria bachma Cao & Bae, 2007

Cao & Bae 2007: description of male, female, and putative larva; holotype from Thua Thien-Hue Province of Vietnam.

Sivec & Stark 2008c: complementary description of male, confirmation of larval association; further records from Thua Thien-Hue Province.

Known only from central Vietnam. Holotype and paratypes are in Seoul Women's University Aquatic Insect Collection, Seoul, South Korea.

Acroneuria distinguenda Zwick, 1977

Zwick 1977: description of male; holotype from Bhutan.

Sivec 1981: description of female; first report from Nepal.

Known only from Bhutan and Nepal. Holotype is in Natural History Museum of Basel, Switzerland. Larva is unknown.

Acroneuria grahamia Wu & Claassen, 1934

Wu & Claassen 1934: description of male; holotype from Sichuan Province of China.

Banks 1940: description of female; new records from Sichuan and Yunnan.

Present paper: redescription of male, on the basis of the holotype.

Known from Sichuan and Yunnan. Holotype is in the National Museum of Natural History, Washington D.C., USA. Larva is unknown, association of female needs to be confirmed.

Acroneuria hainana Wu, 1938

Wu 1938: description of male and female; holotype and allotype from Hainan Province of China.

Du 2002: transfer to *Sinacroneuria* Yang & Yang, 1995a.

Li *et al.,* 2014: stat. rev. in *Acroneuria.*

Known only from the types, collected in Hainan. Holotype and allotype were deposited in Fan Memorial Institute of Biology, Beijing, China, but must be considered lost. Larva is unknown. Redescription on the basis of topotypes is needed.

Acroneuria magnifica Cao & Bae, 2007

Cao & Bae 2007: description of male, female, egg and larva; holotype from Lao Cai Province of Vietnam.

Sivec & Stark 2008c: complementary description of male; further records from Lao Cai Province.

Known only from northern Vietnam. Holotype and paratypes are in Seoul Women's University Aquatic Insect Collection, Seoul, South Korea.

Acroneuria morsei Du, 2000

Du 1995: manuscript description.

Du 2000: description of male and female; holotype and paratypes from Sichuan Province of China.

Known only from the types, collected in Sichuan. Holotype and paratypes are in Insect Collection of Yangzhou University, Yangzhou, Jiangsu, China. Larva is unknown.

Acroneuria multiconata Du, 2000

Du 1995: manuscript description.

Du 2000: description of male and female; holotype and paratypes from Shaanxi Province of China.

Du & Sivec 2005: first record from Gansu Province of China.

Known from Shaanxi and Gansu. Holotype and paratypes are in Insect Collection of Yangzhou University, Yangzhou, Jiangsu, China. Larva is unknown.

Acroneuria nobiliata Enderlein, 1909a

Enderlein 1909a: description of female as *Acroneuria (Niponiella) nobiliata*; holotype from Lang Son Province of Vietnam (Manson-Gebirge = Mt. Mau Son).

Klapálek 1909a: description of male and female of *Acroneuria ampla* Klapálek, 1909; syntypes are from the same serie like the type of *A. nobiliata*.

Klapálek 1909b: proposing the synonymy of the two species; classification as *Acroneuria s.s*.

Zwick 1973b: redescription of the holotype; notes on the priority between the two names.

Known only from the type locality in northern Vietnam. Holotype of *A. nobiliata* is in Institute of Zoology, Polish Academy of Sciences, Warsaw, Poland. Syntypes of *A. ampla* were stated to be deposited in the Natural History Museum Berlin, Germany; probably no specimen was left in the Klapálek Collection deposited in the National Museum Prague. Larva is unknown. If available, the male type should be redescribed.

Acroneuria omeiana Wu, 1948b

Wu 1948b: description of male and female; holotype, allotype and paratype from Sichuan Province of China.

Known only from the types, collected in Sichuan. Holotype, allotype and paratype were deposited in Yenching University Collection, Beijing, China, but must be considered lost. Larva is unknown. Redescription on the basis of topotypes needed.

Acroneuria personata Harper, 1976

Harper 1976: description of male and female; holotype and paratypes from Nepal.

Zwick 1977: complementary description of male; first record from Bhutan.

Sivec 1981: complementary description of female.

Known from Nepal and Bhutan. Holotype and paratypes are in the Collection of the Faculty of Agriculture of Hokkaido Uniersity, Sapporo, Japan. Larva is unknown.

Acroneuria zhejiangensis Yang & Yang, 1995b

Yang & Yang 1995b: description of male and female; holotype and paratypes from Zhejiang Province of China.

Known only from the types, collected in Zhejiang. Holotype and paratypes are in Entomological Museum of China Agricultural University, Beijing, China. Larva is unknown.

Acroneuria VN-A sensu Stark & Sivec (2008c)

Sivec & Stark 2008c: description of female and egg from Lao Cai Province of Vietnam.

Known only from the single female collected in northern Vietnam. The specimen is in the Royal Ontario Museum, Toronto, Canada. Association of male will be needed for formal description.

Acroneuria ? sp. 1 sensu Sivec (1981)

Sivec 1981: description of female and egg from Nepal.

Known only from a single female collected in Nepal. The specimen is in the Slovenian Museum of Natural History, Ljubljana, Slovenia. Association of male will be needed for formal description.

Acroneuria ? sp. 2 sensu Sivec (1981)

Sivec 1981: description of female and egg from Nepal.

Known only from the single female collected in Nepal. The specimen is in the Slovenian Museum of Natural History, Ljubljana, Slovenia. Association of male will be needed for formal description.

Brahmana **Klapálek, 1914**

(Figure 20)

Type species. Perla (Perla) suffusa Walker, 1852.

Further species included. Four Oriental species enumerated herein.

Brahmana benigna (Needham, 1909)

Needham 1909: description of male as *Perla benigna*; holotype from Sikkim State of India.

Klapálek 1916: key, and transfer to *Brahmana.*

Known only from the holotype, collected in Sikkim. The holotype was deposited in the Indian Museum, Kolkata, India. Though the specimens deposited in India are very probably lost, Zwick & Sivec (1980) found some of Needham's Indian types retained in his collection in the Cornell University, Ithaca, New York. Female and larva are unknown. If the type exists, male redescription is needed.

Brahmana chrysostoma Klapálek, 1916

Klapálek 1916: description of female; lectotype from Sikkim, paralectotype from West Bengal State of India.

Kimmins 1970: lectotype designation.

Known only from the types, collected in Sikkim and northern area of West Bengal. Lectotype is in the British Museum of Natural History, London, United Kingdom. The paralectotype was stated to be deposited in 'Mus. Brussel' (Klapálek

1916) but, as detailed above, it remained in the National Museum Prague. Male and larva are unknown.

Brahmana flavomarginata Wu, 1962

Wu 1962: description of male and female; holotype, allotype and paratype from Yunnan Province of China.

Du 1995: new distribution data from Oriental China, including Guangxi.

Du & Sivec 2005: first record from Shaanxi Province of China.

Known from Yunnan, Shaanxi and Guangxi. In his thesis, Du (1995) enumerated several additional localities from all over the Oriental regions of continental China, and also proposed a new species. However, these data were not formally published. Holotype, allotype and paratype were deposited in Institute of Zoology of Academia Sinica, Beijing, China, but must be considered lost. Larva is unknown. Redescription on the basis of topotypes is needed.

Brahmana microphthalma Klapálek, 1916

Klapálek 1916: description of female; holotype from Meghalaya State of India.

Known only from the holotype, collected in Meghalaya. Holotype was stated to be deposited in the Natural History Museum, Vienna, Austria. We were not able to locate it, neither in Vienna nor in the National Museum Prague, therefore it must be considered lost. Male and larva are unknown. Redescription on the basis of topotypes is needed.

Brahmana suffusa (Walker, 1852)

Walker 1852: description of female as *Perla (Perla) suffusa*; lectotype and paralectotype from Nepal.

Klapálek 1916: key, and transfer to *Brahmana* as its type species.

Kimmins 1970: lectotype designation and complementtary description.

Known only from Nepal on the basis of the two syntype specimens. Lectotype and paralectotype are in the British Museum of Natural History, London, United Kingdom. Male and larva are unknown. Redescription of the female is needed.

Mesoperla Klapálek, 1913

(Figure 21)

Type species. *Mesoperla crucigera* Klapálek, 1913. Monotypic.

Mesoperla crucigera Klapálek, 1913

Klapálek 1913: description of male: syntypes from Taiwan.

Banks 1937: report of a probable female from Taiwan.

Present paper: redescription of male, on the basis of a syntype.

Known only from Taiwan. In the original description, Klapálek (1913) did not state the depository of the four male syntypes. Three are held in the Deutschen Entomological Institutes, Berlin, Germany, like most of his specimens published from Taiwan (Petersen & Gaedike, 1968), while the fourth remained in his collection and now kept in the National Museum Prague, Czech Republic. Female and larva are unknown.

Sinacroneuria Yang & Yang, 1995a

(Figure 22)

Type species. *Sinacroneuria orientalis* Yang & Yang, 1995a.

Further species included. The nine Oriental species enumerated herein. *Nishineuria cornuta* Uchida, 1990, a not yet validated species from Palaearctic Japan may also belong here, and a further Oriental species is under description (Li *et al.,* in preparation).

Sinacroneuria bicornuata Stark & Sivec, 2008b

Sivec & Stark 2008c: description of male; holotype from Sichuan Province of China.

Li *et al.,* 2014: complementary description of male, on the basis of holotype.

Known only from the holotype, caught in Sichuan. Holotype is in the National Museum of Natural History, Washington D.C., USA. Female and larva are unknown.

Sinacroneuria biocellata Stark & Sivec, 2008b

Sivec & Stark 2008c: description of male; holotype from Lao Cai Province of Vietnam.

Known only from the holotype, caught in northern Vietnam. Holotype is in the Royal Ontario Museum, Toronto, Canada. Female and larva are unknown.

Sinacroneuria dabieshana Li & Murányi, 2014

Li *et al.,* 2014: description of male and female; holotype and paratypes from Henan Province, further paratypes from Hubei Province of China.

Known from Henan and Hubei. Holotype and paratypes are in the Insect Collection of Henan Institute of Science and Technology, Xinxiang, Henan, China, further paratypes are in the Department of Zoology, Hungarian Natural History Museum, Budapest, Hungary, and in the Entomological Museum of China Agricultural University, Beijing, China. Larva is unknown.

Sinacroneuria flavata (Navás, 1933)

Navás 1933: description of female as *Kamimuria flavata*; holotype from Zhejiang Province of China.

Illies 1966: nomen dubium.

Du *et al.,* 1999: transfer to *Sinacroneuria*.

Known only from the holotype, caught in Zhejiang. Holotype is in the National Museum of Natural History, Paris, France. Male and larva are unknown. Since the type exists, it is not a nomen dubium as stated by Illies (1966) but redescription of the female is needed.

Sinacroneuria longwangshana (Yang & Yang, 1998)

Yang & Yang 1998: description of male as *Acroneuria longwangshana*; holotype and paratype from Zhejiang Province of China.

Du *et al.,* 2001: transfer to *Sinacroneuria*.

Known only from the types, collected in Zhejiang. Holotype and paratype are in Entomological Museum of China Agricultural University, Beijing, China. Female and larva are unknown.

Sinacroneuria orientalis Yang & Yang, 1995a

Yang & Yang 1995a: description of male and female; holotype and paratype from Anhui Province of China.

Known only from the types, collected in Anhui. Holotype and paratype are in Entomological Museum of China Agricultural University, Beijing, China. Larva is unknown.

Sinacroneuria quadriplagiata (Wu, 1938)

Wu 1938: description of male as *Acroneuria quadricplagiata*; holotype from Zhejiang Province of China.

Du *et al.,* 2001: transfer to *Sinacroneuria*.

Known only from the holotype, caught in Zhejiang. Holotype was deposited in Heude Museum, Shanghai, China, but must be considered lost. Female and larva are unknown. Redescription on the basis of topotypes is needed.

Sinacroneuria sinica (Yang & Yang, 1998)

Yang & Yang 1998: description of male as *Acroneuria sinica*; holotype and paratypes from Zhejiang Province of China.

Present paper: transfer to *Sinacroneuria.*

Known only from the types, collected in Zhejiang. Holotype and paratypes are in Entomological Museum of China Agricultural University, Beijing, China. Female and larva are unknown.

Sinacroneuria wui (Yang & Yang, 1998)

Yang & Yang 1998: description of male as *Acroneuria wui*; holotype from Zhejiang Province of China.

Du *et al.,* 2001: transfer to *Sinacroneuria*.

Known only from the holotype, collected in Zhejiang. Holotype is in Entomological Museum of China Agricultural University, Beijing, China. Female and larva are unknown.

Sinacroneuria yiui (Wu, 1935a)

Wu 1935a: description of male as *Mesoperla yiui*; holotype from Jiangxi Province.

Wu 1938: transfer to *Acroneuria.*

Banks 1940: complementary description of male, on the basis of a specimen from Sichuan.

Yang & Yang 1998: redescription of male, on the basis of similar head and leg pattern, material from Zhejiang.

Du *et al.,* 2001: transfer to *Sinacroneuria*.

Known from Jiangxi and Zhejiang. Holotype was deposited in the Yenching University Collection, Beijing, China, but must be considered lost. The male reported from Sichuan by Banks (1940) clearly refers to another species. Female and larva are unknown.

Kiotinini Uchida, 1990

Genera included. **East Palaearctic**: *Niponiella* Klapálek, 1907. **East Palaearctic** and **Oriental**:

Caroperla Kohno, 1946, *Flavoperla* Chu, 1929, *Gibosia* Okamoto, 1912, *Kiotina* Klapálek, 1907. **Nearctic** and **Oriental**: *Perlesta* Banks, 1906. **Oriental**: *Hemacroneuria* Enderlein, 1909b.

Caroperla Kohno, 1946

(Figure 23)

Type species. *Caroperla pacifica* Kohno, 1946.

Further species included. The two Oriental species enumerated herein, besides the Honshu endemic type species. Further two, yet unnamed species were reported from Palaearctic Japan (Inada 1998).

Caroperla longiseta Sivec & Stark, 2010

Sivec & Stark 2010: description of male, female, larva and egg; holotype, paratypes and additional specimens from Chiang Mai Province of Thailand.

Known only from northern Thailand. Holotype and paratypes are in Slovenian Museum of Natural History, Ljubljana, Slovenia.

Caroperla siveci Li & Wang, 2014

Li & Wang 2014: description of male, female and egg; holotype and paratypes from Fujian Province of China.

Known only from the types, collected in Fujian. Holotype and paratypes are in Entomological Museum of China Agricultural University, Beijing, China. Larva is unknown.

Flavoperla Chu, 1929

(Figure 24)

Type species. *Flavoperla biocellata* Chu, 1929.

Further species included. The eight Oriental species enumerated herein, and further five species from the Pacific isles of the East Palaearctic, up to Sakhalin. Further three, yet unnamed species reported from Palaearctic Japan as *Gibosia sp. 2, 3, 4* (Inada 1998) probably also belong to *Flavoperla*.

Flavoperla biocellata Chu, 1929

Chu 1929: description of male and female; holotype and allotype from Zhejiang Province of China.

Wu 1935b: synonymy of *Gibosia* Okamoto, 1912 and *Flavoperla.*

Wu 1938: redescription on the basis of the original description.

Uchida 1990: revalidation of *Flavoperla.*

Known only from the types, collected in Zhejiang. Holotype and allotype were in Chu's collection in Hangzhou, Zheijang, China, but must be considered lost. Larva is unknown. Redescription on the basis of topotype is needed.

Flavoperla dao Stark & Sivec, 2010a

Stark & Sivec 2008a: description of male, female and egg; holotype and paratypes from Bac Kan Province of Vietnam.

Known only from northern Vietnam. Holotype and paratypes are in the Royal Ontario Museum, Toronto, Canada, further paratypes in Institute of Ecology and Biological Resources, Hanoi, Vietnam. Larva is unknown.

Flavoperla hmong Stark & Sivec, 2010a

Stark & Sivec 2008a: description of male, female and egg; holotype and paratypes from Lao Cai Province of Vietnam, further paratypes are from Thua Thien-Hue Province.

Known from northern and central Vietnam. Holotype and paratypes are in the Royal Ontario Museum, Toronto, Canada, further paratypes in Institute of Ecology and Biological Resources, Hanoi, Vietnam, and in the Museum of Zoology of the Humboldt University, Berlin, Germany. Larva is unknown.

Flavoperla lucida (Klapálek, 1913)

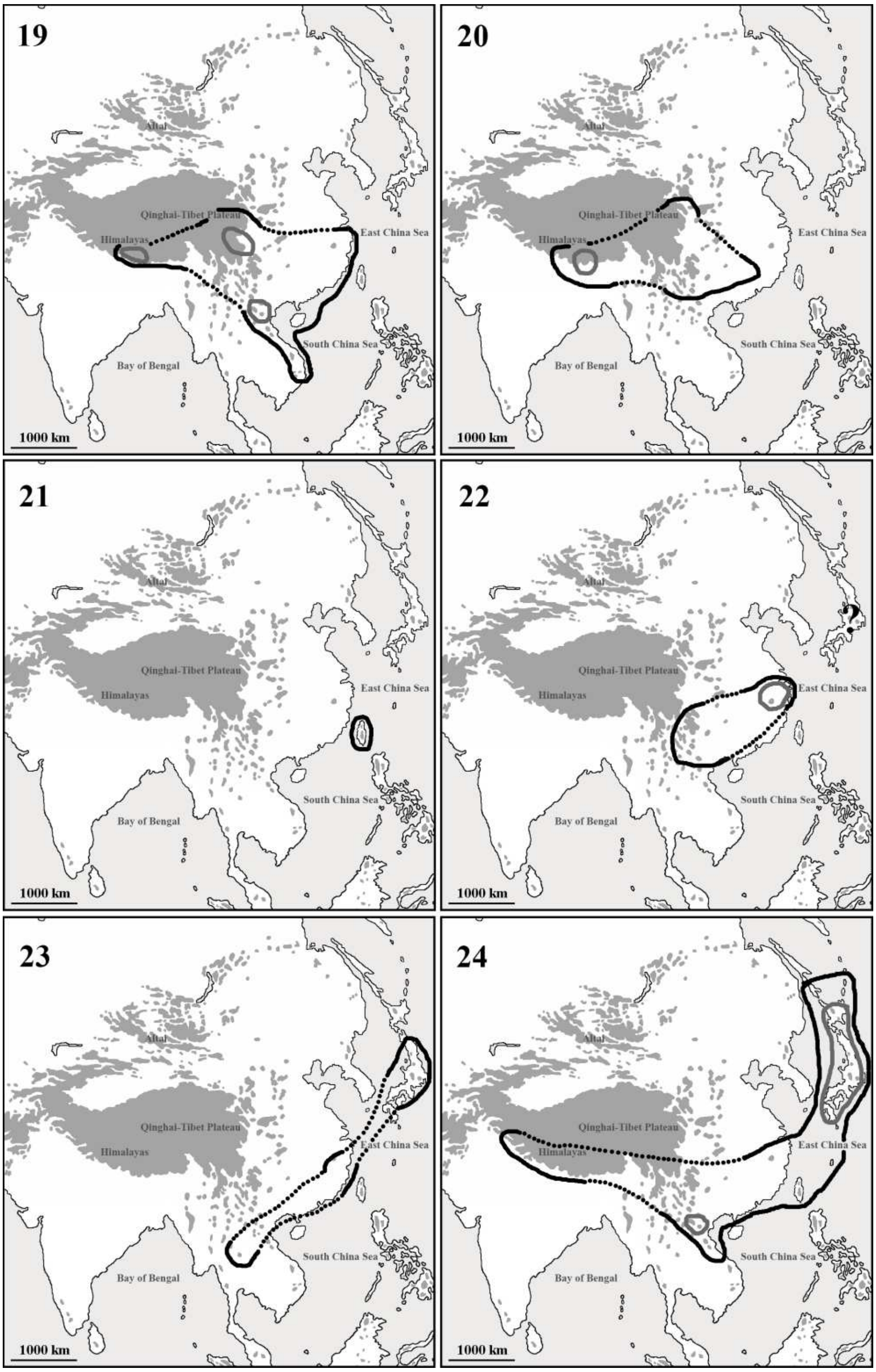
Klapálek 1913: description of male as *Kiotina lucida*; holotype from Taiwan.

Klapálek 1916: transfer to *Gibosia* Okamoto, 1912.

Banks 1937: further record from Taiwan.

Uchida 1990: transfer to *Flavoperla.*

Known only from Taiwan. Holotype exists in the Collection of the Deutschen Entomologischen Institutes, Berlin, Germany (Petersen & Gaedike 1968). Female and larva are unknown. Redescription of the male is needed.



Figures 19–24. Asian distribution of the Acroneuriinae genera. 19 = *Acroneuria* Pictet, 1841; 20 = *Brahmana* Klapálek, 1914; 21 = *Mesoperla* Klapálek, 1913; 22 = *Sinacroneuria* Yang & Yang, 1995; 23 = *Caroperla* Kohno, 1946; 24 = *Flavoperla* Chu, 1929. Black line deliminate areas where at least one species occur (dotted where only expected), while dark grey lines deliminate areas where more than one species occur; grey areas are above 2000 meters asl.

Flavoperla needhami (Klapálek, 1916)

Needham 1909: description of male as *Perla duvaucelii* Pictet, 1841; syntypes from Himachal Pradesh State of India.

Klapálek 1916: nom. n. *Gibosia needhami* Klapálek, 1916 on the basis of the specimens of Needham.

Zwick & Sivec 1980: lectotype designation, complementary description, first record from West Bengal State of India.

Present paper: transfer to *Flavoperla.*

Known from the Siwalik and Lesser Himalayan Ranges of the Himalayas, from Himachal Pradesh and West Bengal States of India. 'Kulu' is the type locality of further three species described by Needham in the same paper: *Kamimuria ione* (Needham, 1909), *Neoperla indica* Needham, 1909 and *Cryptoperla torva* Needham, 1909. In their case, it is specified as 'Kulu, W. Himalayas', thus it should refer to Kullu or Kulu, the capital of Kullu District in Himachal Pradesh. The two syntypes were stated to be deposited in the Indian Museum, Kolkata, India, but fragments of one specimen was found in Needham's collection in the Cornell University, Ithaca, New York, and it was designated as lectotype (Zwick & Sivec 1980). Female and larva are unknown. A detailed redescription of the male would be needed.

Flavoperla ovalolobata (Wu, 1948b)

Wu 1948b: description of male as *Gibosia ovalolobata*; holotype from Fujian Province of China.

Uchida 1990: transfer to *Flavoperla.*

Known only from the holotype, collected in Fujian. Holotype was deposited in Yenching University Collection, Beijing, China, but must be considered lost. Female and larva are unknown. Redescription on the basis of topotype needed.

Flavoperla pallida Stark & Sivec, 2010a

Stark & Sivec 2008a: description of male, female and egg; holotype and paratype from Lao Cai Province of Vietnam.

Known only from the types caught in northern Vietnam. Holotype and paratype are in the Royal Ontario Museum, Toronto, Canada. Larva is unknown.

Flavoperla thoracica (Okamoto, 1912)

Kawai 1968a: description of male of *Gibosia linguambita* Kawai, 1968a; holotype and paratypes from Okinawa Prefecture of Japan.

Uchida 1990: synonymy of *Gibosia linguambita* with *Kiotina (Gibosia) thoracica,* transfer to *Flavoperla.*

Inada 2013: first record from Amami Island of Kagoshima Prefecture.

Shimura *et al.* 2014: larval records of a *Flavoperla sp.* from Amami Island, probably also refer to *F. thoracica.*

Widespread species in Palaearctic Japan, enters the Oriental Realm down to Okinawa Island. Syntypes of *F. thoracica* were deposited in the Tohoku University, Sapporo, Japan, but presently kept in the Lake Biwa Museum, Kusatsu, Japan. Holotype and paratypes of *G. linguambita* were deposited in the Bishop Museum, Honolulu, Hawai.

***Gibosia* Okamoto, 1912**

(Figure 25)

Type species. *Kiotina angusta* Klapálek, 1907.

Further species included. As enumerated below. Generic identity of both further species are questionable, but a further, yet unnamed species was reported from Palaearctic Japan as *Gibosia sp. 1* (Inada 1998).

Gibosia bispinata Wu, 1962

Wu 1962: description of male; holotype from Yunnan Province of China.

Stark & Sivec 2008a: questioning generic identity, may belong to *Flavoperla* Chu, 1929.

Known only from the holotype, collected in Yunnan. Holotype was deposited in Institute of Zoology of Academia Sinica, Beijing, China, but possibly lost. Female and larva are unknown. Redescription on the basis of topotypes needed.

Gibosia perspicillata Klapálek, 1916

Klapálek 1916: description of female; five syntypes from Hong Kong, one syntype from North China without further details.

Wu 1938: redescription on the basis of the original description.

Kimmins 1970: designation of the North China syntype as lectotype.

Known only from the type specimens, originated from Hong Kong and an unspecified locality in Palaearctic North China. All syntypes were stated to be deposited in the British Museum of Natural History, London, United Kingdom. However, only three females exist there, and the one from North China was designed as lectotype while the further two from Hong Kong as paralectotypes (Kimmins 1970). We found no syntypes left in the Klapálek Collection in Prague. Despite that existence of male syntypes is evidently written in the German version of the original description (Klapálek 1916: page 80: '3♀, 2♂ aus Hong Kong, 1 aus Nordchina'; preceeding Czech section, page 60: 3♀, 2 z Hong-Kongu, 1 ze Sev. Číny'), the fact that the male terminalia was not described contradict their then presence.

Wu (1938) erroneously noted that the later lectotype from North China is a male, its gender was not specified in neither the Czech nor the German text. Since the male is unknown, generic identity is questionable. Given from the small size and pale coloration, it is very probably not a *Gibosia*. Moreover, due to the huge distance between the two localities, conspecificity of the lectotype and the paralectotypes is also in question.

Hemacroneuria **Enderlein, 1909b**

(Figure 26)

Type species. *Hemacroneuria violacea* Enderlein, 1909b.

Further species included. The two Oriental species enumerated herein.

Hemacroneuria malickyi Stark & Sivec, 2008d

Stark & Sivec 2008d: description of male, female and egg; holotype and paratypes from Vinh Phúc Province of Vietnam.

Known only from northern Vietnam. Holotype and paratypes are in the Slovenian Museum of Natural History, Ljubljana, Slovenia. Larva is unknown.

Hemacroneuria marginalis Stark & Sivec, 2008d

Stark & Sivec 2008d: description of male, female, and larva; holotype and paratypes from Lao Cai Province of Vietnam.

Known only from northern Vietnam. Holotype and paratypes are in the Royal Ontario Museum, Toronto, Canada, further paratypes in the Museum of Zoology of the Humboldt University, Berlin, Germany.

Hemacroneuria violacea Enderlein, 1909b

Enderlein 1909b: description of male and female; syntypes from Lang Son Province of Vietnam (Manson-Gebirge = Mt. Mau Son).

Klapálek 1916: transfer to *Kiotina* Klapálek, 1907.

Zwick 1973b: redescription of male and female; lectotype designation; transfer to *Acroneuria* Pictet, 1841; first record from Fujian Province of China.

Stark & Sivec 2008d: redescription of male; further record from Lao Cai Province of Vietnam.

Known from northern Vietnam and Fujian. Lectotype and paralectotype are in the Institute of Zoology of Polish Academy of Sciences, Warsaw, Poland. Larva is unknown.

Kiotina **Klapálek, 1907**

(Figure 27)

Type species. *Acroneuria (Kiotina) pictetii* Klapálek, 1907.

Further species included. Three East Palaearctic species besides the type species and the 13 Oriental species enumerated herein. Further one, yet unnamed species reported from Palaearctic Japan as *Kiotina sp. KM* (Nio & Inada 2005). Most of the Chinese species are inadequately known, and at least two of them very probably belong to another genus.

Synonym. Schistoperla Banks, 1937, type species *Schistoperla collaris* Banks, 1937.

Kiotina albopila (Wu, 1948b)

Wu 1948b: description of male as *Gibosia albopila*; holotype and paratype from Fujian Province of China.

Du 1995: transfer to *Kiotina* Klapálek, 1907.

Stark & Sivec 2008a: questioning generic identity, may belong to *Flavoperla* Chu, 1929.

Known only from the types, collected in Fujian. Holotype and paratype were deposited in Yenching University Collection, Beijing, China, but must be considered lost. Female and larva are unknown. Redescription on the basis of topotypes needed.

Kiotina bifurcata Stark & Sivec, 2008d

Stark & Sivec 2008d: description of male; holotype from Fujian Province of China.

Known only from the holotype, collected in Fujian. Holotype is in the Alexander Koenig Zoological Research Institute and Zoological Museum, Bonn, Germany. Female and larva are unknown.

Kiotina chekiangensis (Wu, 1938)

Wu 1938: description of male and female as *Atoperla chekiangensis*; holotype and allotype from Zhejiang Province of China.

Illies 1966: transfer to *Gibosia* Okamoto, 1912.

Du *et al.,* 1999: transfer to *Kiotina* Klapálek, 1907.

Known only from the types, collected in Zhejiang. Holotype and allotype were deposited in Heude Museum, Shanghai, China, but must be considered lost. Larva is unknown. Redescription on the basis of topotypes is needed.

Kiotina chiangi (Banks, 1939)

Banks 1939: description of male as *Atoperla chiangi*; syntypes from Guangdong Province of China.

Illies 1966: transfer to *Perlinella* Banks, 1900.

Du *et al.,* 1999: transfer to *Kiotina* Klapálek, 1907.

Known only from the two syntypes, collected in Guangdong. The type locality information was written as 'Yim Na San, Kwantung, China, 14 June (Gressitt coll.)' (Banks 1939). Kwantung would refers to the Kwantung Leased Territory that existed in Liaoning Province from 1898 to 1945, but most probably it is mistyped and refers to Kwangtung, the old name of Guangdong, because further insects were collected by L. E Gressitt in the neighbouring Hainan and Guangxi during the same month. Syntypes were deposited in the Museum of Comparative Zoology at Harvard University, Cambridge, Massachusetts. Female and larva are unknown. Redescription of the male is needed.

Kiotina collaris (Banks, 1937)

Banks 1937: description of male and female as *Schistoperla collaris*; types from Taiwan.

Kawai 1968b: redescription of male as *Schistoperla collaris.*

Uchida 1990: transfer to *Kiotina* Klapálek, 1907.

Stark & Sivec 2008d: redescription of male and female, description of egg and larva; further records from Taiwan.

Known only from Taiwan. Types were deposited in the Museum of Comparative Zoology at Harvard University, Cambridge, Massachusetts. Though gender and number of type specimens were not specified in the original description, Banks (1937) described both male and female. However, only a male, labelled as holotype, exists in the database of the MCZ (http://140.247.96.247/mcz/index.php).

Kiotina delicata Stark & Sivec, 2008d

Stark & Sivec 2008d: description of male; holotype and paratypes from Fujian Province of China.

Known only from the types, collected in Fujian. Holotype and paratypes are in the Alexander Koenig Zoological Research Institute and Zoological Museum, Bonn, Germany. Female and larva are unknown.

Kiotina kelloggi Wu & Claassen, 1934

Wu & Claassen 1934: description of female; holotype from Fujian Province of China.

Stark & Sivec 2008d: questioning generic identity, may be excluded from *Kiotina.*

Known only from the holotype, collected in Fujian. Holotype was deposited in Yenching University Collection, Beijing, China, but must be considered lost. Male and larva are unknown. Redescription on the basis of topotypes is needed. As already noted by Stark & Sivec (2008d), it is very probably not a *Kiotina*, because of its small sized subgenital plate.

Kiotina nigra (Wu, 1938)

Wu 1938: description of male and female as *Atoperla nigra*; holotype, allotype and paratypes from Zhejiang Province of China.

Illies 1966: transfer to *Gibosia* Okamoto, 1912.

Du *et al.,* 1999: transfer to *Kiotina* Klapálek, 1907.

Known only from the types, collected in Zhejiang. Holotype, allotype and one paratype were deposited in Heude Museum, Shanghai, China, further two paratypes in Yenching University Collection, Beijing, China, but all must be considered lost. Larva is unknown. Redescription on the basis of topotypes is needed.

Kiotina quadrituberculata Wu, 1948b

Wu 1948b: description of male; holotype and paratype from Fujian Province of China.

Stark & Sivec 2008d: redescription of male, on the basis of topotypes.

Known only from Fujian. Holotype and paratype were deposited in Yenching University Collection, Beijing, China, but must be considered lost. Female and larva are unknown.

Kiotina resplendens Banks, 1939

Banks 1939: description of male and female; male syntype from Jiangxi, female syntype from Guangdong Province of China.

Known only from the two syntypes, male collected in Jiangxi and female in Guangdong. The type locality of the female is the same like of *K. chiangi* and refers to Guangdong, while that of the male also must be mistyped and should refer to Kiangsi, the old name of Jiangxi Province (Banks 1939: 'Hong San, Kiansi, China, 26 June'). Syntypes were deposited in the Museum of Comparative Zoology at Harvard University, Cambridge, Massachusetts. Larva is unknown. Redescription of both male and female is needed.

Kiotina riukiuensis Uéno, 1938

Uéno 1938: description of female and larva; holotype and paratypefrom Okinawa Prefecture of Japan.

Kawai 1967: first report from Yakushima Island of Kagoshima Prefecture of Japan.

Kawai 1968a: description of male; further records from Okinawa.

Stark & Sivec 2008d: redescription of male and female, description of egg; further records from Okinawa.

Inada 2013: first record from Amami Island of Kagoshima Prefecture, as *Kiotina ryukyuensis*; larva reported as *Kiotina sp.* possibly also refers to this species.

Known only from the Ryukyu Isles. Holotype and paratype were deposited in the Ōtsu Hydrobiological Station of the Kyoto Imperial University, Ōtsu, Japan, but presently kept in the Lake Biwa Museum, Kusatsu, Japan.

Kiotina spatulata Wu, 1948b

Wu 1948b: description of male; holotype from Sichuan Province of China.

Known only from the holotype, collected in Sichuan. Holotype was deposited in Yenching University Collection, Beijing, China, but must be considered lost. Female and larva are unknown. Redescription on the basis of topotypes needed.

Kiotina sp. sensu Kawai (1968c)

Kawai 1968c: description of larva from Chiang Mai Province of Thailand.

Known only from larvae collected in northern Thailand. The specimens were in the Limnologische Flusstation of the Max-Planck-Institut für Limnologie, Schlitz, Germany. This collection is presently curated as the Collection of Prof. Peter Zwick, Schlitz, Germany. Association of adults will be needed for formal description.

Perlesta **Banks, 1906**

(Figure 28)

Type species. *Perla (Perla) placida* Hagen, 1861.

Further species included. 29 Nearctic species besides the type species and the two Oriental species enumerated herein. Similar to *Acroneuria,* not known from the Palaeractic, neither from the Pacific region of the Nearctic.

Perlesta chaoi Wu, 1948a

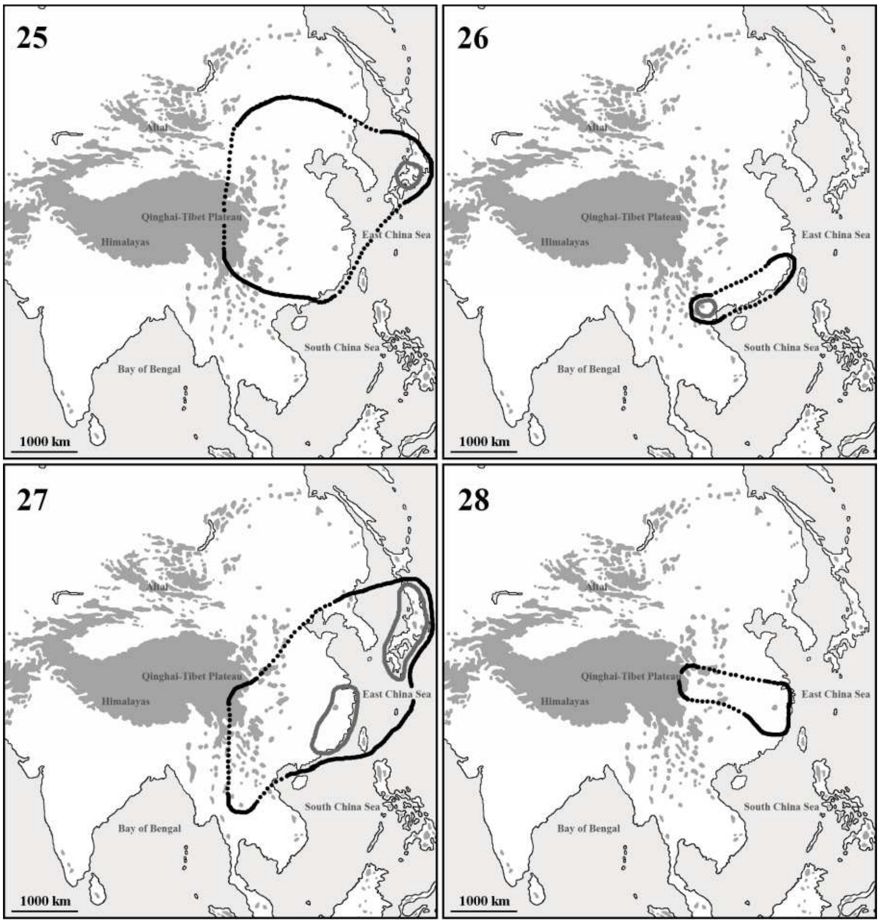
Wu 1948a: description of male; holotype and paratypes from Fujian Province of China.

Du & Sivec 2005: first records from Gansu and Shaanxi Provinces, mentioned one male neotype assigned by Wu from Gansu material.

Known from Fujian, Gansu and Shaanxi. Holotype was deposited in Yenching University Collection, Beijing, China, but must be considered lost. Female and larva are unknown. Redescription on the basis of topotypes is needed.

Perlesta spatulata Wu, 1938

Wu 1938: description of male and female; holotype, allotype and paratypes from Zhejiang Province of China.



Figures 25–28. Asian distribution of the Acroneuriinae genera. 25 = *Gibosia* Okamoto, 1912; 26 = *Hemacroneuria* Enderlein, 1909; 27 = *Kiotina* Klapálek, 1907; 28 = *Perlesta* Banks, 1906. Black line deliminate areas where at least one species occur (dotted where only expected), while dark grey lines deliminate areas where more than one species occur; grey areas are above 2000 meters.

Known only from the types, collected in Zhejiang. Holotype, allotype, and one paratype were deposited in Heude Museum, Shanghai, China, a further paratype in Yenching University Collection, Beijing, China, but all must be considered lost. Larva is unknown. Redescription on the basis of topotypes is needed.

DISCUSSION

The Acroneuriinae fauna of the Oriental Realm is presently contains 62 recognised species, classified in 10 genera of 2 tribes. Of the 62 species, 4 are not yet formally named as known only from females or larvae. Further 25 are inadequately known their specific status or generic assignment is unsure. Only 5 species are known from all life stages (male, female, larva and egg).

Of the 10 genera known from the Oriental Realm, 4 are endemic to the region, 4 share its distribution with the East Palaearctic while 2 with the East Nearctic; the latter two were not recorded from the Palaearctic so far. The distribution of Oriental Acroneuriinae is limited to the continent and Hainan, Taiwan and the Ryukyus. They enter the Indian Subcontinent only in the Himalayan Region and a single species spreads westwards to the Western Himalayan ranges. Their known distribution in Indochina is also limited, no Acroneuriinae was found south of northern Thailand.

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A new alien snail species from the Eger stream, Hungary (Mollusca, Ampullariidae)

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Abstract. Our macrozoobenthon samplings carried out in the Eger stream during 2015–2016 resulted in recording an alien species *Marisa cornuarietis* (Linneaus, 1758) the giant ramshorn snail which has not been reported so far from outdoor-waters in Hungary. Here we report on collecting several specimens from the urban section of the stream close to the outflow of the Eger thermal spa.

Keywords. Introduction, alien species, giant ramshorn snail, new record, temperate region, hypothermal water

INTRODUCTION

The register of the alien invasive species for Europe (DAISIE 2008) lists 10822 allochtonous (alien, non-indigenous or exotic) species. Not all of these listed species are regarded invasive, but *ca.* 10–15 % of the total represent potential threats to the European biodiversity (ALARM 2003).

A species is regarded invasive when it spreads effectively and has a considerable negative effect on the environment (Rosenzweig 2001, Pyšek & Richardson 2010). In Hungary, the official list of invasive species lists 69 plants and animals including 12 mollusc species (KvVm-TH 2005). It means that *ca.* 6% of the 200 Mollusca species recorded for Hungary (Pintér & Suara 2004) proved to be invasive in the country, and *ca*. 10 percent of the 90 species of molluscs reported from Hungarian waters represent alien invasive species. A smaller part of these aliens are aquarium species which are able to survive in outdoor waters or hypothermal water reservoirs. (Horváth 2010).

The molluscan species of the thermal and hypothermal waters in Eger has recently been reviewed by Gál (2016) who reported on four non-indigenous species. The occurrence of *Physella acuta* (Draparnaud, 1805) the acute bladder snail in the Eger stream has already been reported by Lukács (1950). Apart from this species, Gál (2016) recorded also the presence of *Potamopyrgus antipodarum* (Gray, 1883) the New Zealand mud snail, *Planorbella duryi* (Wetherby, 1879) the seminole ramshorn, and *Melanoides tuberculata* (Müller, 1774) the red-rimmed melania. However, the giant ramshorn snail has not been found during this survey and it is not reported so far from any outdoor-waters in Hungary (Gojdičová *et al.* 2014)

MATERIALS AND METHODS

The material was collected in the Eger stream near to the "Érsek-kert" outflow of the thermal spa. The spa is supplied by two thermal springs. One of the springs from the nearby produces 28 °C slightly radioactive water, the other is located a bit further from the spa and its 47 °C in sulphur calcium and hydrogen-carbonate rich water is conveyed by aqueduct in the spa (Schréter 1923, Kleb & Scheuer 1983, Deák & Scheuer 2009) (Fig. 1). The macrozoobenton samplings were carried out using the "kick-and- sweep" method combined with occasional sampling in different

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Figure 1A. Eger stream near to Érsek–kert, Eger.

Figure 1B. Outflow of the Eger thermal Spa.

Figure 2. Shells of the giant ramshorn snail collected.

Figure 3. Living specimen of *M. cornuarietis* collected and kept further in an aquarium at Department of Zoology, EKU, Eger.

habitat types in 18.11.2015, 17.05.2016 and 07. 07.2016. Both, living animals and empty shells were gathered. The living animals were transferred into the Department of Zoology, Eszterházy University for further breeding. Four empty shells as voucher specimens are deposited in the Mollusca Collection of the Hungarian Natural History Museum, Budapest.

RESULTS

During our first sampling 14 giant ramshorn snail specimens were collected including 5 living adult and juvenile specimen and 9 empty shells. In the second and third samplings six and five empty shells have been found respectively. Altogether five living specimen and 20 empty shells were gathered in this small, urban section of the Eger stream (Figs. 2–3).

The adult *Marisa cornuarietis* (Linneaus, 1758) is 3–5 cm in diameter possessing 3–4 spiral turns. Its colour varies between dark yellow and dark brown with 3–6 blackish spiral stripes. The snail is omnivorous but it more known as a generalist herbivore. In case of food shortage the adult animals can feed on eggs of other freshwater molluscs. As it reproduces rapidly it could threaten the population of the native snails (Hofkin *et al.* 1991, Pointier & David 2004, Howells *et al.* 2006).

The temperature demand of the giant ramshorn snail is quite wide it prefers 18–30 °C water temperature but the ideal range is 20–26 °C. At 18 °C the snail became almost inactive and does not tolerate 12 °C or below for a longer time (Ghesquiere 2016, Howels *et al.* 2006).

Marisa cornuarietis shows wide range of tolerance toward water oxygen content possessing duplicate respiratory system. It has gills as well as a lung to ensure an efficient respiration also in waters with lower dissolved oxygen level. It is able to close the shell with an operculum and in case of risk of desiccation and able to dig itself deep into the soil for surviving (Akerlund 1969, 1974).

Regarding the physicochemical requirements the giant ramshorn snail prefers the neural pH (7.2 – 8.0) and high calcium concentration which is essential for proper shell building; the ideal range is between 70–90 ppm In case of lower calcium content the shell bears smaller or larger holes (Meier-Brook 1978, Dillon 2000).

DISCUSSION

Here we report for the first time the outdoor water occurrence of this decorative and popular aquarium snail. Aquarium hobbyists sell it in Hungary under the name “cölöpszarvú csiga” which is the direct translation of the English ramshorn snail. Apart from this vernacular name *Marisa cornuarietis* is frequently called as Colombian ramshorn snail, marisa snail or South American giant ramshorn snail in the literature (Horváth 2010).

According to the recently accepted system, *Marisa cornuarietis* belongs to the family Ampullariidae and native in Central and South America and has moderately recently been introduced into Cuba (1940), Puerto Rico (1952), Florida (1970’s) and Texas (1990’s) (Cowie & Thiengo, 2003, *Hayes et al.* 2009, Ghesquiere 2016). In outdoor waters of Europe it was first reported not long ago from Spain (Arias, Torralba & Burrial 2014). The Hungarian outdoor population surely represents a recent introduction because the previous study in the Eger stream region carried out during 2013–2014 did not mention presence of this easily recognizable species (Gál 2016).

Apart from being a common aquarium snail the giant ramshorn snail is used also as ecotoxicological test organism (Oehlmann *et al.* 2006, Forbes *et al.* 2007) and in several regions (Puerto Rico, Brazil, Venezuela, Caribbean etc.) as biological control agent against *Biomphalaria* snails (*B. glabrata* (Say, 1818) and *B. straminea* (Dunker, 1848)) which are well known vectors of *Schisostoma mansoni* Sambon, 1907 one of the important schistosomes causing human schisostomiasis (Cedeño-León & Thomas 1983, Lockyer *et al.* 2008). It plays a similar role in the control of *Melanoides tuberculata* (Müller, 1774) a vector of the oriental lung fluke (*Paragonimus westermanni* Kerbert, 1878) (Ferrer *et. al.* 1991, Howells *et al.* 2006).

The spread of *Marisa cornuarietis* in outdoor waters in North America and Europe is possibly due to the aquarium trade of the snails and aquatic plants and also its use as biological control agent (Pointier 2001, Ghesquiere 2016). From 2013 the tread and release into natural waters of the giant ramshorn snail in the European Union is strictly prohibited. Due to its potential threat to the native flora and fauna in Hungary it is allowed to keep only in aquaria or garden ponds not connected to natural waters. The specimens reported here from the Eger stream might be escaped from the warm-water plant and animal exhibition pool of the Eger Thermal Spa or represents deliberate introduction by aquarists.

The outdoor population of *Marisa cornuarietis* is currently confined to a short section of the Eger stream where the outflow of the thermal spa maintains a year-round warmer water temperature. Their further spread at the present climatic condition is not anticipated however, a continuous monitoring of the population is needed as suggested earlier for the thermal and hypothermal waters which often serve as the first stepping stone for establishment of these tropical species in the temperate regions (Majoros *et al.* 2008).

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A brief overview of the long-term changes of fish fauna in the Slovak-Hungarian section of the Danube River

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Abstract. Description of the fish fauna was completed by way of literary review, field experience, and some rare species have been found in the catches of commercial fishermen. Suitable publications and reports are available from the 18th century. The upper part of the Slovak-Hungarian section of the Danube is aggrading and anabranching, while its lower part is a wandering sinuous channel. The native fish fauna includes 54 species, while the alien fish fauna contains 23 species, 11 of which are exotic in Europe. Two species, *Huso huso* and *Acipenser stellatus* are practically extinct from the Middle Danube region. This river stretch is heavily modified, and the historical changes of the fish fauna were evaluated in conjunction with human impacts.

Keywords. historical fish fauna, invasive species, endangered fish, large river, Žitný Ostrov, Szigetköz, Middle Danube.

INTRODUCTION

The fish fauna of the Slovak-Hungarian Danube and its changes from the 19th century is evaluated, based on literature data and results of recent observations from the 1990s. Regarding Danubian river fisheries located on the Rye Island (Žitný Ostrov) and Szigetköz floodplain – the left and right side of the Danube's alluvial cone between Bratislva and Komarom – numerous archival documents can be found from the 13th century (Takáts 1902, Alapy 1933). The fishery colony of 'Wöniki' (Vének) was already mentioned in a document dating from 1093 (Méry 1874), however, information on the region's fish populations is scarce in these early records. In terms of the fish fauna, initial publications can be evaluated from the 18th century (Marsigli 1726, Kramer 1756, Bél 1767, Grossinger 1794, Reinsinger 1830, Heckel 1847, Heckel & Kner 1858, Méry 1874, Herman 1887, Ortvay 1902, Vutskits 1904, 1918). More detailed data were taken from ichthyological studies published from the 1960s in Slovakia (Balon 1967, Holčík *et al.* 1981, 1989, Holčík 2003, Černý 2006, Kováč 2015) and in Hungary (Berinkey 1960, 1966, Tóth 1970, Jancsó & Tóth 1987, Guti 1993, 1997, Sallai 2001, 2003, Györe & Józsa 2005, Sallai & Vida 2010).

The description of the fish fauna was completed by updating the scientific names of the species, according to the current nomenclature.

The Slovak-Hungarian section of the Danube

The natural system

The 172 km long Slovak-Hungarian section of the Danube is located in the upper part of the Middle Danube (r.km 1880–1708), stretching from the mouth of the Morava River to the confluence with the Ipeľ (Ipoly) River. Its mean annual discharge is 2024 m^3s^{-1} at Bratislava (Holčík *et al.* 1981), and its natural bed formation has foothill and lowland features and is characterised by a progressively decreasing slope and a finer load in downstream direction. Discharge and water regime are mainly determined by precipitation and snow and glacier melt water from the 131,000 km^2 water catchment area of the northern Alps and the Alps' foothills.

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The water regime is basically stochastic; however, from spring to the middle of summer, generally several flood pulses arrive consecutively. The melting of the Alps' snow cover and glaciers, and the simultaneous significant quantity of precipitation characteristic from the end of May and throughout June generally result in large flood pulses. The low water period usually sets in by October, followed by a weak increase in discharge. In December, a low water period begins, as the high mountains in the catchment area no longer provide water, due to the freezing conditions. The fluctuation of discharge and associated sediment transport are the governing forces of the evolution of the riverbed. The main flow used to change its course frequently during major flood events, producing a channel network at various elevations, with arbitrary distributions of flows at different stages, in the pristine conditions.

The Slovak-Hungarian section of the Danube can be divided into two main stretches, according to geomorphic patterns, succeeding downstream (Tőry 1952, Pécsi 1959):

- The upper stretch (r.km 1880-1790) is located in the lower Alpine foothills zone. It is an aggrading and anabranching section, formed on a large alluvial cone with extensive floodplains. It was supplied with coarse load mainly by the Upper-Danube. The main arm of the river has a relatively high slope (0.12–0.35%.), and the lateral wandering of anabranches used to be intensive, thus floodplains are parcelled by abandoned channels.
- The lower stretch of the Slovak-Hungarian section (r.km 1790–1708) has a slightly wandering, sinuous channel with irregular islands and narrow floodplains. Its slope is 0.05–0.10%, and the river bed is composed of gravel.

The river and its associated floodplains support a considerable proportion of the fluvial biodiversity in the Hungarian Lowland ecoregion, but they suffer the impacts of a multitude of human activities.

Human impacts

In the 19th century, the acceleration of social, demographic, and economic development generated driving forces for extensive river utilisation and land use. The driving forces (river engineering, navigation, hydropower utilisation, fishery, agriculture, forestry, etc.) provide several benefits for the society and provoke changes in economic production however, these needs put pressure on the riverine environment. The progress of regular boat services, particularly between Budapest and Vienna, necessitated the dredging, tightening and straightening of the river bed, including cutting off meanders. Comprehensive flood protection works were carried out at the end of the 19th century, and the passage of the flood pulses accelerated, therefore the duration of flooding dropped.

In the second half of the 20th century, installations of the high water regulation were maintained or reconstructed, navigability was improved, and hydropower utilisation started to develop. Since the beginning of the 1990s, when the Gabčikovo hydropower dam was put into operation, the Danube has been diverted into a 29 km long bypass canal and only 20% of its discharge (even less during the winter period: 200 m^3s^{-1}, about 10%) has remained in the former river bed. In subsequent years, minor mitigation measures were implemented for water replenishment in the floodplain branches, and several scenarios were proposed for the extensive rehabilitation of the river-floodplain ecosystem, but the bilateral negotiations between Hungary and Slovakia did not resulted in any significant outcomes (Kern & Zinke 2000).

Since the completion of the Rhine-Main-Danube Canal, further improvement of navigability of the Slovak-Hungarian section of the Danube has been encouraged, but the development of the navigation route may have numerous negative impacts on the ecological status of the river. The EU water policy includes strict provisions regarding the options of river engineering, which could lead to confrontations between the inland shipping sector and environmental protection.

The native fish fauna

The fish fauna of the Slovak-Hungarian section of the Danube is characterised by a relatively high number of species (Jancsó & Tóth 1987, Holčik *et al.* 1989, Guti 1997, Holčik 2003, Sallai & Vida 2010). This can be explained by the following reasons:

- the zoogeographical significance of the Danube basin (Bănărescu 1991)
- the transitional zone between the foothill and the lowland zones, i.e. hyporhitron–epipotamon–metapotamon
- the continuously changing river-floodplain ecosystem (Welcomme 1985), characterised by a great variability in geomorphological and hydrological conditions, and a high diversity of aquatic habitats with different degrees of spatio-temporal connectivity

The hydrological variety of the upper braided-anastomising section of the Slovak-Hungarian stretch of the Danube was favourable for fish reproduction. In the spawning period, several fluvial species migrate instinctively against the current, sometimes covering a distance of more than 100 km (Waidbacher & Haidvogl 1998), before they find a suitable habitat for spawning. The high gradient upstream is hard to overcome for most of the migratory species, but fish can spread into floodplain waters during the spring and early summer inundations. The large, slow flowing sidearm systems serve as ideal nursery habitats and provide rich feeding areas for several fish species.

The native fish fauna includes 54 species (Table 1). It contains elements from the montane stretch of the Upper Danube (*Hucho hucho, Salmo trutta*, etc.); and Black Sea migratory species, such as anadromous sturgeons (*Huso huso, Acipenser gueldenstaedti, A. stellatus*). The fish fauna of the eupotamon type riverbed is dominated by rheophilic fish species (*Acipenser ruthenus, Barbus barbus, Chondrostoma nasus, Cottus gobio, Gymnocephalus schraetser, Zingel zingel*, etc.). The connected backwaters represent the parapotamon type habitats, and their fauna includes several rheophilic and eurytopic species (*Rutilus rutilus, Alburnus alburnus, Blicca bjoerkna, Perca fluviatilis*, etc.). The disconnected plesiopotamic or paleopotamic backwaters are populated with eurytopic and limnophilic fish species (*Scardinius erythrophthalmus, Carassius carassius, Tinca tinca, Misgurnus fossilis, Umbra krameri*, etc.) that are bound to the still waters of the floodplain. In general, the diversity of fish species is the greatest in the eupotamon and parapotamon, and it tends to decrease in the plesio- and paleopotamon.

Alien species

The Danube basin is being rapidly colonised by alien species, due to the introduction of exotic species, as well as the overall deterioration of the fluvial ecosystem from the end of the 19th century.

The list of the alien fish fauna of the Slovak-Hungarian river section contains 23 species, 11 of which are exotic in Europe (Table 1). Most of the alien species had been introduced unintentionally into the Danube, therefore a description of potential routes and mechanisms of their introduction, including an assessment of the environmental conditions necessary for their reproduction, is an important issue concerning the long-term changes of the fish fauna.

The development of navigation ways, vessel traffic, and the increasing interconnection of various water bodies promoted by canals significantly contribute to the dispersion of non-native species, such as the spreading of Ponto-Caspian gobies, which began in the final decades of the 20th century. The most abundant species is the round goby (*Neogobius melanostomus*), occurring in rip-rap embankments of the main channel, side arms and irrigation canals. Bighead goby (*Ponticola kessleri*) inhabits the same habitats, while monkey goby (*Neogobius fluviatilis*) prefers the sandy-bottom habitats. Racer goby (*Babka gymnotrachelus*) is more limnophilic, and occurs in more or less disconnected side arms with muddy bottoms.

The severe impacts on native species and the structure and functioning of the ecosystem caused by alien species can be demonstrated on the case of the invasive gobies. European bullhead (*Cottus gobio*) used to be a relatively abundant species along the upper part of the Slovak-Hungarian section of the Danube at the beginning of the 1990s. When the discharge of the Danube was diverted to the bypass canal of the Gabčikovo hydropower station in 1992, the water level in the main arm of the river dropped by 4 m compared to the previous mean water levels, in the section between Rajka and Dunaremete. In this situation, the fish surveys along the rip-rap embankments indicated the massive occurrence of *Cottus gobio*, more the 100 ind./100 m abundance at some sampling sites in the Hungarian side of the main arm. The frequency of the species started to decline in the next years, and it nearly disappeared, parallel to the widespread appearance of *Ponticola kessleri* (Figure 1). Only a few specimens were recorded in Bratislava in 2013. On the other hand, the populations of predators such as burbot (*Lota lota*) seem to be increasing since the gobies started spreading.

The investigation of stickleback specimens collected in the Danube and in Western Hungary demonstrated that specimens of both *Gasterosteus aculeatus* and *Gasterosteus gymnurus* can be found in Hungary. The former presumably spread from the direction of the Black Sea, while the latter, on the contrary, arrived from the Upper-Danube and its tributaries (Harka & Szepesi 2010).

Asian herbivore fish species (*Ctenopharyngodon idella, Hypophthalmichthys molitrix, Hypophthalmichthys nobilis*) were commercially harvested, and their natural reproduction is increasingly successful due to climate change. Their juveniles have been observed along the Hungarian section of the Tisza river (Pintér 1989), and commercial fishermen reported some spawning events in the main arm of the Danube at Dunakiliti in the 1990s.

Siberian sturgeon (*Acipenser baeri*) and other non-native sturgeons that are occasionally recorded in the Danube can mean a threat to native sterlet populations, via competition for resources and possible hybridisation.

It is currently believed that alien species very likely become even more significant in the future, as the importance of the Danube as an international waterway increases. Climate change may be another important factor in the spreading of non-native biological invaders. A rapidly changing climate might favour species which are able to extend their ranges quickly.

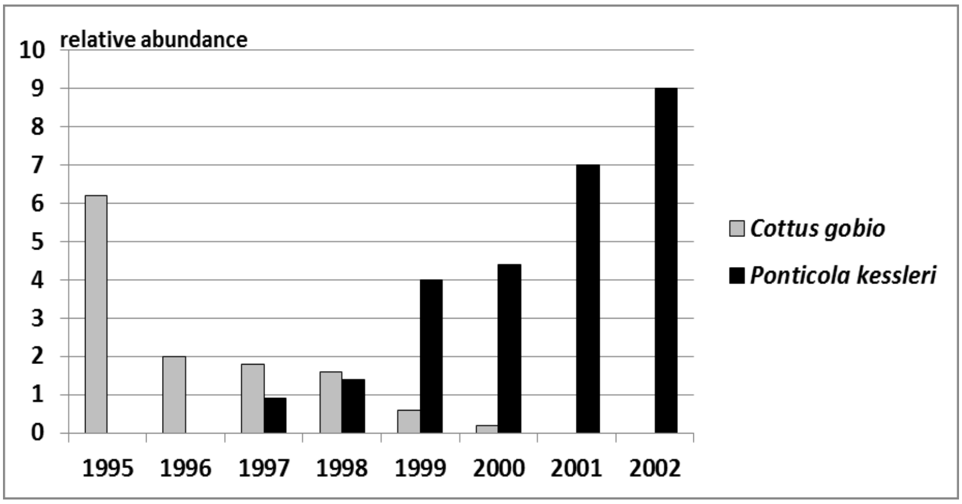

Figure 1. Changes of the relative abundance of *Cottus gobio* and *Ponticola kessleri* at Medve (Medveďov) from 1995 to 2002 (according to Sallai &Vida 2010).

Table 1.: Fish fauna of the Slovak-Hungarian section of the Danube. In the second (native) column, grey cells indicate periodic occurrences. In the third (alien) column, European species are indicated by grey cells and species from other continents are indicated by black cells.

species	native	alien	regionally extinct
Eudontomyzon mariae	■		
Huso huso	▒		■
Acipenser gueldenstaedtii	■		
Acipenser nudiventris	■		
Acipenser stellatus	▒		■
Acipenser ruthenus	■		
Acipenser baeri		■	
Anguilla anguilla	▒		
Rutilus rutilus	■		
Rutilus virgo	■		
Rutilus meidingeri		▒	
Ctenopharyngodon idella		■	
Scardinius erythrophthalmus	■		
Leuciscus leuciscus	■		
Leuciscus idus	■		
Squallius cephalus	■		
Phoxinus phoxinus	▒		
Aspius aspius	■		
Leucaspius delineatus	■		
Alburnus alburnus	■		
Alburnoides bipunctatus	▒		
Blicca bjoerkna	■		
Abramis brama	■		
Ballerus ballerus	■		
Ballerus sapa	■		
Vimba vimba	■		
Pelecus cultratus	■		
Chondrostoma nasus	■		
Tinca tinca	■		
Barbus barbus	■		
Gobio obtusirostris	■		
Romanogobio vladykovi	■		
Romanogobio kessleri	■		
Romanogobio uranoscopus	▒		
Pseudorasbora parva		■	
Rhodeus amarus	■		
Carassius carassius	■		

Carassius gibelio		▒	
Cyprinus carpio	■		
Hypophthalmichthys molitrix		■	
Hypophthalmichthys nobilis		■	
Misgurnus fossilis	■		
Cobitis elongatoides	■		
Sabanejewia balcanica	■		
Sabanejawia bulgarica	■		
Barbatula barbatula	■		
Ameiurus nebulosus		■	
Ameiurus melas		■	
Silurus glanis	■		
Esox lucius	■		
Umbra krameri	■		
Coregonus lavaretus		▒	
Coregonus albula		▒	
Thymallus thymallus		▒	
Hucho hucho	■		
Salvelinus fontinalis		■	
Salmo trutta	▒		
Oncorhynchus mykiss		■	
Lota lota	■		
Gasterosteus aculeatus		▒	
Gasterosteus gymnurus		▒	
Cottus gobio	■		
Lepomis gibbosus		■	
Micropterus salmoides		■	
Perca fluviatilis	■		
Gymnocephalus cernua	■		
Gymnocephalus baloni	■		
Gymnocephalus schraetser	■		
Sander lucioperca	■		
Sander volgensis	■		
Zingel zingel	■		
Zingel streber	■		
Babka gymnotrachelus		▒	
Neogobius fluviatilis		▒	
Neogobius melanostomus		▒	
Ponticola kessleri		▒	
Proterorhinus semilunaris		▒	
Sum.	54	23	2

Endangered species

Under the pressure of river utilisation and land use, the long-term changes of the pristine fish fauna manifested itself in species extinction, and the increase in the number of endangered and non-native fish species. Habitat loss and modification, due to river engineering, as well as fishery exploitation were the most important factors threatening the fish in the Slovak-Hungarian section of the Danube.

Over-fishing played a primary role in the decay of sturgeon species. Historical archives prove the prevalence and economic importance of sturgeon fishery in the region. For instance, in 1553, 77 specimens of great sturgeon (*Huso huso*) were caught within a day at one fishing site (Unger 1931). Catches began to decline from the 16th century, and in the 19th century, sturgeon were only rarely caught in the region (Kriesch 1876, Károli 1877, Herman 1887, Khin 1957, Hensel & Holčik 1997, Guti 2008, 2014). From the Middle Danube region, anadromous species (*Huso huso, Acipenser stellatus, A. gueldenstaedti*) can now be regarded extinct, and ship sturgeon (*A. nudiventris*) and the non-migratory population of Danube sturgeon (*A. gueldenstaedti*) are also at the verge of extinction.

Long-standing river engineering has resulted in the loss of several important fish habitats, alterations in hydraulics, flow regime and sediment transport, as well as the interruption of longitudinal and lateral connectivity of the river-floodplain system. For potamodromous fish species (*Barbus barbus, Chondostoma nasus, Leciscus idus*, etc.), migration (between 30–300 km) means a feeding and reproduction strategy which, by reducing competition, enables the development of abundant fish populations. Interrupting the connectivity between the main arm of the Danube and the floodplain side-arms resulted in a blockage of fish migration into the floodplain spawning habitats, feeding grounds and winter refuges. This poses a serious threat to the reproductive success and recruitment of the medium distance migratory species and can lead to a decline in their populations.

From the end of the 19th century, abandoned oxbows in flood-free areas of the Szigetköz floodplain have lost their direct connections with the Danube, therefore rheophilic species generally disappeared from their fish fauna, and limnophilic elements became characteristic, such as *Carassius carassius*, *Tinca tinca, Misgurnus fossilis, Umbra krameri*. Since the middle of the 1990s, water supply of the branches in the flood-free area of the Szigetköz has been directly provided from the floodplain water replenishment system. This intervention resulted in the shifting of habitat character and the dominance of eurytopic species in their fish fauna.

Closing remarks

High number of endangered as well as alien species along the Slovak-Hungarian section of the Danube indicates the deterioration of ecological integrity of the fluvial hydrosystem. Conservation strategies and management of fish populations (Schiemer & Waidbacher 1992) should be orientated to the improvement of protection of the natural inshore bed structure and the remaining active floodplains with backwaters for the future, as well as to the recreation of the lateral connectivity at selected sites in the flood-free area to allow fish migrations between the main channel and the floodplain waters.

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